

Imnaha Subbasin Assessment

May 2004



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Table of Contents

1	SUBBASIN ASSESSMENT	1
1.1	Subbasin Overview	1
1.1.1	<i>General Description</i>	<i>1</i>
1.1.2	<i>Subbasin Water Resources</i>	<i>63</i>
1.1.3	<i>Trends in Aquatic and Terrestrial Ecology</i>	<i>79</i>
1.1.4	<i>Regional Context</i>	<i>100</i>
1.2	Species Characterization and Status	114
1.2.1	<i>Species of Ecological Importance</i>	<i>114</i>
1.2.2	<i>Focal Species Selection</i>	<i>128</i>
1.2.3	<i>Spring/Summer Chinook Population Delineation and Characterization.....</i>	<i>131</i>
1.2.4	<i>Fall Chinook Population Delineation and Characterization</i>	<i>163</i>
1.2.5	<i>Summer Steelhead Population Delineation and Characterization.....</i>	<i>170</i>
1.2.6	<i>Bull Trout Population Delineation and Characterization.....</i>	<i>189</i>
1.2.7	<i>Lamprey Population Delineation and Characterization</i>	<i>198</i>
1.2.8	<i>Aquatic Environmental Conditions.....</i>	<i>202</i>
1.2.9	<i>Terrestrial Focal Species Habitat Use and Population Characterization</i>	<i>226</i>
1.2.10	<i>Environmental Conditions for Focal Species</i>	<i>247</i>
1.3	Out-of-Subbasin factors	259
1.3.1	<i>Aquatic</i>	<i>259</i>
1.3.2	<i>Terrestrial</i>	<i>268</i>
1.4	Environment–Population Relationships	269
1.4.1	<i>Aquatic</i>	<i>269</i>
1.4.2	<i>Terrestrial</i>	<i>270</i>
1.4.3	<i>Key Relationships between fish and wildlife</i>	<i>271</i>
1.5	Identification and Analysis of Limiting Factors and Conditions	272
1.5.1	<i>Local Factors Limiting Aquatic Focal Species</i>	<i>273</i>
1.5.2	<i>Local Factors Limiting Terrestrial Species</i>	<i>303</i>
1.6	References	317
2	APPENDICES	339

List of Tables

Table 1.	Subecoregion area and percentage of total area in the Imnaha subbasin.	4
Table 2.	Climate station metadata. Stations shown do not occur in the Imnaha River drainage but are considered relevant for use due to their proximity and relative position and/or elevation.....	11
Table 3.	Monthly climate summary for stations representing conditions in the Imnaha subbasin during the period of record.	13
Table 4.	General soil characteristics of subecoregions in the Imnaha subbasin (Watershed Professionals Network 1999).....	17
Table 5.	Soil properties of the STATSGO Map Units (MUIDs) in the Imnaha subbasin. 20	
Table 6.	Assumptions made about relationship between vegetative series and wildlife habitat types (WHTs).....	32
Table 7.	Summary of rights to divert McCully Creek waters into the Wallowa subbasin (Bliss 2001).....	55
Table 8.	Land management entities in the Imnaha subbasin.	61
Table 9.	USGS gaging summary, Imnaha River basin, Oregon.	63
Table 10.	Annual flood flow frequency summary for the Imnaha gage at Imnaha.	65
Table 11.	Imnaha River watershed §303(d) listings (downloaded May 22, 2003, from ODEQ website, http://www.deq.state.or.us/wq/WQLData/SubBasinList02.asp). 65	
Table 12.	ODEQ criterion used to define where and when the water quality standard for temperature in the Imnaha subbasin is in exceedance. ODEQ uses the 50° F(10° C) for year round bull trout spawning, rearing, and adult presence (http://www.deq.state.or.us/wq/standards/WQStdsImnahaSpawn.pdf).	66
Table 13.	USFWS criterion to rate habitat function for bull trout subpopulations at the watershed scale	68
Table 14.	Potential streamside vegetation associated with the Canyons and Dissected Uplands subecoregion 11g (reproduced from Watershed Professionals Network 1999).	71
Table 15.	Potential streamside vegetation associated with the Canyon and Dissected Highlands subecoregion 11f (reproduced from Watershed Professionals Network 1999).	72
Table 16.	Potential streamside vegetation associated with the Blue Mountain Basins subecoregion 11k (reproduced from Watershed Professionals Network 1999)..	73
Table 17.	Potential streamside vegetation associated with the Mesic Forest Zone subecoregion 11l (reproduced from Watershed Professionals Network 1999)....	74
Table 18.	Potential streamside vegetation associated with the Subalpine Zone subecoregion 11m (reproduced from Watershed Professionals Network 1999).	75
Table 19.	Characterization of hydrologic processes in the Imnaha subbasin at the subecoregion level (Watershed Professionals Network 1999).	81
Table 20.	Area in square miles for hydrologic soil groups of rangeland and/or agricultural ground at the subecoregion-scale in the Imnaha subbasin.....	91
Table 21.	Minimum instream water rights (cfs) at the confluence of Big Sheep Creek and the Imnaha River (reproduced from Wallowa County and NPT 1993).....	93

Table 22.	Wildfires over 100 acres with high- or moderate-intensity burns (USFS 2003d). 96
Table 23.	Areas infested with noxious weeds documented in recent surveys of portions of the Imnaha subbasin. 100
Table 24.	Comparison of reaches used by fish species of concern in the Imnaha subbasin (IS) vs. the Blue Mountain Province (BMP) and the U.S. portion of the Columbia Basin (CB) (based on StreamNet 2003 ¹). 101
Table 25.	Comparison of the historical and current distribution of wildlife habitat types (WHTs) in the Imnaha subbasin (IS), the Blue Mountain Province (BMP), and the Columbia Basin (CB) (based on data from NHI 2003). 103
Table 26.	Changes in percentage of wildlife habitat types (WHTs) distribution in the Columbia Basin (CB) and Blue Mountain Province (BMP) contributed by the Imnaha subbasin (IS) (bold figures indicate an increase in contribution from historical to current) (based on data from NHI 2003). 104
Table 27.	Areas selected as centers of biodiversity or centers of endemism and rarity in the Imnaha subbasin. 105
Table 28.	Type, distribution sources, and representation goals for the 978 coarse and fine scale conservation targets selected for the Middle Rockies-Blue Mountain Ecoregion SITES run. 109
Table 29.	Proposed bull trout Critical Habitat Subunits (CHSUs) in the Imnaha subbasin (USFWS 2002b) 113
Table 30.	ESA-listed or candidate species known to or that potentially occur in the Imnaha subbasin. 114
Table 31.	Species that occur or potentially occur in the Imnaha subbasin that are listed as threatened or endangered by the State of Oregon. 115
Table 32.	Disposition of lynx habitat within the Imnaha subbasin (USFWS 2003a). 118
Table 33.	ODFW sensitive species with potential habitat in the Imnaha subbasin (species with potential habitat from IBIS 2003; sensitive species ODFW 2003b). 121
Table 34.	USFS Region 6 sensitive species (USFS 1995). 123
Table 35.	Priority habitat features and associated landbird species for conservation in habitats of the Northern Rocky Mountains Landbird Conservation region of Oregon and Washington. 124
Table 36.	Oregon game species with potential habitat in the Imnaha subbasin (IBIS 2003). 125
Table 37.	Species extirpated from the Imnaha subbasin (from Johnson and O'Neil 2001, with exceptions noted). 127
Table 38.	Introduced wildlife species of the Imnaha subbasin (Johnson and O'Neil 2001). 128
Table 39.	Terrestrial focal species to be assessed in the Imnaha subbasin. 128
Table 40.	Total escapement, number of broodstock collected, and number and origin of natural spawners in the Imnaha River (1979–2003). 132
Table 41.	Summary of $\Pr(\hat{\mu} < 0)$ estimated with available data series of spring/summer chinook salmon ESU and Imnaha populations (Code: mainstem Imnaha (7) and Big Sheep Creek (6); n: the length of annual time series data; y1 and y2: the range of annual time series data; and DA risk: $\Pr(\hat{\mu} < 0)$). 140

Table 42.	Summary of integrated risk metric for spring/summer chinook salmon ESU and Imnaha subbasin populations (Code: mainstem Imnaha (7) and Big Sheep Creek (6). The first row under the table header has results for the ESU, and the other rows have results for the populations; n: the length of data used for calculation of $\Pr(\hat{\mu} < 0)$; y1 and y2: the range of annual time series data used for calculation of $\Pr(\hat{\mu} < 0)$; DA risk: $\Pr(\hat{\mu} < 0)$; m: the length of data used for calculation of $\Pr(RVC < 1)$; α and β : shape and scale parameters in a Gamma density; p: p-value of K-S goodness of fit test for the Gamma density; RVC risk: $\Pr(RVC < 1)$; and Integ. risk: Integrated risk metric.....	140
Table 43.	Mean \pm coefficient of variation (and range) for spawners, recruits, and recruit per spawner numbers in aggregate and index populations of wild spring and summer chinook in the Imnaha subbasin (1949–1990). Values for recruits per spawner represent geometric means and standard deviations (coefficient of variation is standard deviation divided by the mean and expressed as a percentage) (reproduced from Beamesderfer et al. 1996).....	142
Table 44.	Detections of PIT tagged Imnaha River adult chinook salmon and estimated smolt to adult return rate indices (SAR) of in-river migrating fish from the lower Imnaha River trap to Lower Granite Dam (LGR) and from LGR to LGR for brood years 1996 to 1998. All pre-smolts were tagged in the fall and all smolts were tagged in the spring (Cleary et al. 2003).....	144
Table 45.	Estimated number of chinook smolts at Lower Granite Dam and returning adults (age 4 and only) to Lower Granite Dam for Imnaha hatchery fish during migration years 1997-2000 (reproduced from DeHart et al. 2003).....	144
Table 46.	Season-wide estimates of survival from the lower Imnaha River trap to Lower Granite Dam from 1993 to 2003. Ninety-five percent confidence intervals are shown in parentheses (Modified from Cleary et al. 2003; updated with NPT data files from P. Cleary).....	146
Table 47.	Life stage specific abundance and survival for Imnaha River spring/summer chinook salmon hatchery production program 1982 – 2003 (ODFW LaGrande data files)	149
Table 48.	Life history timing for anadromous focal species in the Imnaha subbasin, from the confluence with the Snake River to the confluence with Big Sheep Creek (ODFW, unpublished data, created May 30, 2003, by Brad Smith and Bill Knox). 151	
Table 49.	Life history timing for anadromous focal species in the Imnaha subbasin, upriver from the confluence with Big Sheep Creek (ODFW, unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).....	152
Table 50.	Mean lengths, weights, and condition factors of natural and hatchery chinook salmon captured from the Imnaha River trap (RM 4) from February 26 to June 15, 2000 (Cleary et al. 2000).....	155
Table 51.	Mean first, median, 90%, and last arrival timing for natural chinook salmon presmolts and smolts, and hatchery chinook salmon smolts, at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN). All fish were captured in the Imnaha River Trap. Mean arrival timing is presented with the 95% C.I. (\pm days) (Cleary et al. in prep)... 157	

Table 52.	Historical sport and tribal harvest of Imnaha River chinook salmon between 1953 and 2003 (Beamesderfer et al. 1996; B. Knox, ODFW, personal communication, April 2003; J. Oatman , NPT, personal communication, April 2004).....	159
Table 53.	Hatchery releases of spring/summer chinook in the Imnaha subbasin (reproduced from TRT 2003).....	161
Table 54.	Maximum and minimum fork lengths for in-season race identification of fall chinook salmon seined on the Snake River (Connor et al. 1993, as cited in Mundy and Witty 1998).....	165
Table 55.	Hatchery releases of Snake River fall chinook (reproduced from TRT 2003)..	169
Table 56.	Summer steelhead redd counts (#/mile) for various years and tributaries in the Imnaha subbasin (ODFW data, recd. 02/04)	172
Table 57.	Vital statistics for adult steelhead collected at the Little Sheep Creek trapping facility (ODFW unpublished data). M = males, F = females, W = wild fish, H = hatchery fish.....	172
Table 58.	Snorkeling observations of steelhead density (fish/100m ²) by habitat conducted in Big Sheep Creek, Lick Creek, and the Imnaha River (1992–1999) (Blenden and Kucera 2002).....	175
Table 59.	Juvenile <i>O. mykiss</i> rearing density (number/m ²) estimates for Lightning, Big Sheep, Little Sheep, and Gumboot creeks in the Imnaha River subbasin, 1999 and 2000 (ODFW and NPT unpublished data collected under LSRCP evaluation studies).....	176
Table 60.	Mean first, median, 90%, and last arrival timing for natural and hatchery steelhead smolts, at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN). All fish were captured in the Imnaha River Trap. Mean arrival timing is presented with the 95% C.I. (\pm days) (Cleary et al 2003 and Cleary et al in prep).	179
Table 61.	Creel survey results for summer steelhead caught in the Imnaha River for the run years 1987–1998 (ODFW data presented in Carmichael et al. 1989a,b; Carmichael et al. 1991; Flesher et al. 1993; Flesher et al. 1994a,b; Flesher et al. 1995, 1996, 1997, 1999).....	187
Table 62.	Hatchery releases of Imnaha summer steelhead (reproduced from TRT 2003)	188
Table 63.	Estimated density of bull trout in selected streams in the Imnaha subbasin that were sampled in 1992 (ODFW data presented in Buchanan et al. 1997).....	190
Table 64.	Spawning survey results for bull trout in the Imnaha subbasin (reproduced from USFWS 2002b, USFS 2003d).....	190
Table 65.	Life history timing for nonanadromous species in the Imnaha subbasin, from the confluence with the Snake River to the confluence with Big Sheep Creek (ODFW unpublished data, created May 30, 2003, by Brad Smith and Bill Knox). 192	
Table 66.	Life history timing for nonanadromous species in the Imnaha subbasin, from the Big Sheep Creek confluence to the headwaters (ODFW unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).....	193
Table 67.	Trends in counts of Pacific lamprey in fish ladders at mainstem dams between the Pacific Ocean and the Salmon subbasin, Idaho (Source: Fish Passage Center, http://www.fpc.org/adult.html).....	199
Table 68.	QHA-generated comments about riparian condition.....	205

Table 69.	QHA-generated comments about channel stability	208
Table 70.	QHA-generated comments about habitat diversity.....	210
Table 71.	QHA-generated comments about fine sediment.....	212
Table 72.	QHA-generated comments about high flows.	213
Table 73.	Seven-day moving maximum stream temperatures (°F) recorded at USFS monitoring sites (USFS 2003d).	221
Table 74.	QHA-generated comments about high stream temperatures.	222
Table 75.	QHA-generated comments about instream obstructions.	225
Table 76.	Rocky Mountain goat introductions in the area surrounding the Imnaha subbasin.	235
Table 77.	Key habitat relationships required for breeding grasshopper sparrows (Altman and Holmes 2000).....	238
Table 78.	Mule deer herd composition in 2001 for the game units partially contained in the Imnaha subbasin (ODFW 2001b).	244
Table 79.	Changes in wildlife habitat types (WHTs) distribution in the Imnaha subbasin from historical to current (changes viewed to be most significant to the wildlife of the subbasin based on local knowledge, regional knowledge, and subbasin habitat data in bold).	248
Table 80.	Attributes used to differentiate forest structure classes (Johnson and O'Neil 2001).	250
Table 81.	Historic Range of Variability for Forested Structural Stages by Biophysical Environment, reference point used for analysis by WWNF denoted in parenthesis	
Table 82.	Acreages and percent of area with data covered by current structural condition classes in the Imnaha subbasin	253
Table 83.	Comparison of historic structural stages to current structural conditions	254
Table 84.	Distribution of forest structural condition classes by 6 th field HUC, Imnaha subbasin (see Figure 3 for HUC locations).....	256
Table 85.	Attributes used to differentiate grassland structure classes Johnson and O'Neil 2001.	258
Table 86.	Chronology of the eight U.S. Army Corps of Engineers dams that currently impede migration of Imnaha anadromous salmonids.	263
Table 87	Trophic relationship KEF preformed by the American avocet (<i>Recurvirostra americana</i>)	270
Table 88.	Concern or focal species of the Imnaha subbasin that consume salmon during one or more salmonid lifestages (IBIS 2003).	272
Table 89.	Average stream miles per sixth field HUC occupied by spring chinook, fall chinook, steelhead, and bull trout in the Imnaha subbasin. Averages were used to standardize restoration scores derived from QHA modeling efforts.	283
Table 90.	Conservation protection status of 100-foot buffer zones in each of the 43 sixth field HUCs in the Imnaha subbasin. A score of 1 or 2 ('High') indicates the dominance of conservation-based management, whereas a score of 3 or 4 ('Low') indicates that the buffer zone receives no special protection.	285
Table 91.	Comparative restoration versus protection value for spring chinook sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.	286

Table 92.	Restoration ranks ¹ for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows ...	288
Table 93.	Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows ...	289
Table 94.	Comparative restoration versus protection values for fall chinook sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.	290
Table 95.	Restoration ranks ¹ for sixth code HUCs and habitat variables within each, for HUCs occupied by fall chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows ...	290
Table 96.	Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows ...	291
Table 97.	Comparative restoration versus protection value for summer steelhead sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.	293
Table 98.	Restoration ranks ¹ for sixth code HUCs and habitat variables within each, for HUCs occupied by summer steelhead within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.	295
Table 99.	Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by summer steelhead within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows	297
Table 100.	Comparative restoration versus protection value for bull trout sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity	299
Table 101.	Restoration ranks ¹ for sixth code HUCs and habitat variables within each, for HUCs occupied by bull trout within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows ...	301
Table 102.	Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by bull trout within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows ...	302
Table 103.	Concern and focal species of the Imnaha subbasin closely associated with ponderosa pine habitats (Johnson and O'Neil 2001).	304
Table 104.	Distribution of the ponderosa pine WHT in the Imnaha subbasin by subwatershed.....	304
Table 105.	Subwatersheds with a high concentration of fuel models 9 and 10.....	309
Table 106.	Road-associated factors with deleterious impacts on wildlife (Wisdom et al. 2000).	310
Table 107.	Road density by subwatershed and multi-species matrix ratings (USFS 2003d).	311
Table 108.	Wallowa County "A" List Noxious Weed Species.....	313
Table 109.	Wallowa County "B" List Noxious Weed Species.....	314
Table 110.	Wallowa County Watch List Noxious Weed Species	315

Table 111.	Descriptions of structural conditions in forest habitats	390
Table 112.	Descriptions of structural conditions in grassland habitats	393

List of Figures

Figure 1.	Location of the Imnaha subbasin in the Blue Mountain Province, Oregon, and the Columbia Basin.	2
Figure 2.	Counties and major features of the Imnaha subbasin.	3
Figure 3.	Sixth field HUC analysis units in the Imnaha subbasin.	5
Figure 4.	USEPA Level III and IV subcoregion classification in the Imnaha subbasin.	6
Figure 5.	Geology of the Imnaha subbasin.	9
Figure 6.	General elevation intervals in the Imnaha subbasin for climate.	12
Figure 7.	Precipitation patterns in the Imnaha subbasin.	14
Figure 8.	Mean monthly precipitation recorded at Enterprise Ranger Station (1932–1994). 15	
Figure 9.	Annual precipitation recorded at Mt. Howard SNOTEL (1981–2000).	16
Figure 10.	Mean monthly precipitation recorded at Mt. Howard SNOTEL (1980–2000). ...	17
Figure 11.	Soil mapping units of the Imnaha subbasin.	19
Figure 12.	Topography and elevation in the Imnaha subbasin.	24
Figure 13.	Current land cover types of the Imnaha subbasin.	25
Figure 14.	Current wildlife habitat types (WHTs) of the Imnaha subbasin.	31
Figure 15.	Historical livestock numbers on the Wallowa National Forest (WWNF 1995). ..	39
Figure 16.	Active grazing allotments in the Imnaha subbasin.	41
Figure 17.	Road densities in the Imnaha subbasin.	45
Figure 18.	Volumes of timber harvested from significant sales in the Big Sheep Creek watershed (1943–1950) (data presented in USFS 1995).	48
Figure 19.	Wallowa County timber harvest (<i>Wallowa County Land Use Plan and State of Oregon Timber Harvest Report</i> , as cited in Wallowa County and NPT 1993)...	49
Figure 20.	Land management patterns in the Imnaha subbasin.	59
Figure 21.	Management area strategies for USFS lands in the Imnaha subbasin.	60
Figure 22.	Protection status of the Imnaha subbasin.	62
Figure 23.	Average annual flows in the Imnaha subbasin (Imnaha gage 13292000) (USGS unpublished data).	64
Figure 24.	Mean monthly discharge at Imnaha gage 13292000 (1929–2003) (USGS unpublished data).	64
Figure 25.	Streams in the Imnaha subbasin listed on Oregon's 2002 §303(d) list.	67
Figure 26.	Classes of wetlands surveyed by the National Wetlands Inventory in the Big Sheep watershed (USFWS 2003b).	78
Figure 27.	Water regimes of wetlands surveyed by the National Wetlands Inventory in the Big Sheep watershed (USFWS 2003b).	79
Figure 28.	Palmer drought severity index for Oregon Climate Zone 8 (NCDC unpublished data 2001).	83
Figure 29.	Pacific Northwest Index (PNI) and spring chinook returns for Oregon Climate Zone 1 (coastal) (reproduced from Taylor and Southards [1997]).	84
Figure 30.	PDSI and spring/summer chinook recruits per spawner relationship for the Imnaha subbasin. (Recruit per spawner data and methods used in its derivation are from Beamesderfer et al. [1996]).	85
Figure 31.	Current fuel models of the Imnaha subbasin.	97

Figure 32.	Location and year of occurrence of recent large fires (> 10 ac) in the Imnaha subbasin.....	98
Figure 33.	Centers of biodiversity in the ICBEMP analysis area and the Imnaha subbasin.....	106
Figure 34.	Centers of endemism and rarity in the ICBEMP analysis area and the Imnaha subbasin.....	107
Figure 35.	Areas selected for the Middle Rockies-Blue Mountain conservation portfolio.....	112
Figure 36.	Estimated abundance of natural and hatchery-origin adult chinook salmon to the Imnaha River subbasin 1982 – 2003 (ODFW unpublished data provided by P. Kinery).....	132
Figure 37.	Big Sheep Creek spring/summer chinook redd counts (StreamNet data, downloaded August 2003).....	134
Figure 38.	Lick Creek spring/summer chinook redd counts (StreamNet data, downloaded August 2003).....	135
Figure 39.	Spring/summer chinook redd counts on the mainstem Imnaha River (StreamNet data, downloaded August 2003).....	136
Figure 40.	Average density (fish/100m ²) of age 0+ chinook salmon in pool and run habitat in lower Big Sheep Creek from 1992 to 1995 (Blenden and Kucera 2002).....	137
Figure 41.	Average density of age 0+ chinook salmon in pool and run habitat in the Imnaha River from 1991 to 1996 (Blenden and Kucera 2002).....	138
Figure 42.	Abundance index (expanded redd counts adjusted for estimated Columbia River harvest) over time of Imnaha River mainstem spring/summer chinook salmon population.....	140
Figure 43.	Annual progeny-parent ratio for natural and hatchery-origin chinook salmon in the Imnaha River Subbasin for brood years 1982 – 1998 (ODFW LaGrande data files P. Kinery).....	142
Figure 44.	Imnaha River hatchery-origin spring/summer chinook salmon smolt-to-adult survival rate (release to tributary) by brood year. Estimates based on total number of smolts released and estimated number of returning adults at ages 3 to 5 (ODFW data files from P. Kinery).....	145
Figure 45.	Annual prespawning mortality frequency for natural and hatchery-origin chinook salmon. Insufficient data for years 1990 and 1991 (ODFW LaGrande data files)	146
Figure 46.	Estimated survival from the trap to Lower Granite Dam of natural chinook salmon pre-smolts, tagged in the fall, from for migration years 1994 to 2003 (Cleary et al 2003 and Cleary et al in press).....	147
Figure 47.	Seasonwide survival estimates for natural chinook salmon smolts (tagged in spring) released from the Imnaha River trap to Lower Granite Dam, from 1993 to 2000. Error bars indicate 95% confidence limits. Asterisks indicate upper confidence levels greater than 100% (Cleary et al 2003 and Cleary et al in press)	147
Figure 48.	Seasonwide survival estimates for hatchery chinook salmon smolts (tagged in spring) released from the Imnaha River trap to Lower Granite Dam, from 1993 to 1999. Error bars indicate 95% confidence limits (Cleary et al. 2003 and Cleary et al in prep).....	148

Figure 49.	Annual survival of hatchery chinook salmon from the Imnaha River acclimation facility to the Imnaha River trap from 1994 to 2003. The size of annual PIT tag release groups are shown above for each year and error bars indicate the 95% C.I. (Cleary et al 2003 and Cleary et al in press).....	148
Figure 50.	Spawning and rearing locations of Imnaha spring/summer chinook.....	154
Figure 51.	Number of fall chinook salmon redds counted in the Imnaha River between the years 1964 and 2002 (from Mundy and Witty 1998, Garcia 2000, H. Burge, USFWS, personal communication, 2003).	163
Figure 52.	Fall chinook distribution and use type, Imnaha subbasin.....	168
Figure 53.	Summer steelhead redd counts in the lower 6 miles of Camp Creek for the run years 1965–2001 (USFS 2003d; ODFW unpublished data, 2004).	171
Figure 54.	Seasonwide survival estimates for natural steelhead released from the Imnaha River trap to Lower Granite Dam, from 1995 to 2003. Error bars indicate the 95% confidence limit (modified from Cleary et al. 2000, Cleary et al. 2003, and Cleary et al. in prep.).	177
Figure 55.	Seasonwide survival estimates for hatchery steelhead released from the Imnaha River trap to Lower Granite Dam, from 1995 to 2003. Error bars indicate the 95% confidence limit (modified from Cleary et al. 2000, Cleary et al 2003, and Cleary et al. in prep).	178
Figure 56.	Steelhead distribution and use type, Imnaha subbasin.	185
Figure 57.	Estimated annual steelhead harvest in the Imnaha subbasin for the run years 1956–1993 (StreamNet database 2001).	186
Figure 58.	Bull trout distribution and use type, Imnaha subbasin	197
Figure 59.	Summary of lamprey catch in the lower mainstem Imnaha River (Gaumer 1968). 200	
Figure 60.	Streamflow restoration priorities in the Imnaha subbasin (ODFW 2001a).....	217
Figure 61.	Breeding bird survey counts for the yellow warbler for two routes in or just outside the Imnaha subbasin 1971–2002.....	241
Figure 62.	Distribution of close habitat associations among current WHTs in the Imnaha subbasin and species groups.	249
Figure 63.	Number of concern species closely associated with forest structural conditions 251	
Figure 64.	Distribution of current forest structural condition classes in the Imnaha subbasin 252	
Figure 65.	Number of concern species closely associated with grassland structural conditions.....	258
Figure 66.	Smolt-to-adult survival rates (SAR; bars) and smolts/spawner (solid line) for wild Snake River spring/summer chinook. The SAR describes survival during mainstem downstream migration to adult returns, whereas the number of smolts per spawner describes freshwater productivity in upstream freshwater spawning and rearing areas (from Petrosky et al. 2001).....	266
Figure 67.	Imnaha subbasin sixth-field HUCs used in the QHA modeling process.....	284
Figure 68.	QHA-based restoration and protection areas for spring chinook in the Imnaha subbasin	287
Figure 69.	QHA-based restoration and protection areas for fall chinook in the Imnaha subbasin	292

Figure 70.	QHA-based restoration and protection areas for summer steelhead in the Imnaha subbasin	294
Figure 71.	QHA-based restoration and protection areas for bull trout in the Imnaha subbasin	
	300	

List of Appendices

Appendix A	Wildlife Species and Habitat Use, Imnaha Subbasin	340
Appendix B	Information on the grazing allotments of the Imnaha subbasin.	354
Appendix C	Continuous water temperature monitoring data (1999-2003) for select tributaries and mainstem reaches in the Lower Imnaha, Big Sheep Creek, and Upper Imnaha watersheds.....	358
Appendix D.	Comparison of the historical and current distributions for the major wildlife habitat types (WHTs) of the Imnaha subbasin and Blue Mountain Ecoprovince.	
	379	
Appendix E.	Species that contributed to the selection of portions of the Imnaha subbasin in the conservation Portfolio for the Middle Rockies-Blue Mountain Ecoregion.....	385
Appendix F.	Federal Species of Concern-Wallowa County.....	387
Appendix G.	PACFISH/INFISH PFC Matrix	388
Appendix H.	Descriptions of Forest and Grassland Structural Conditions (Johnson and O'Neil 2001).	390
Appendix I.	GIS layers used in determining forest structural condition	395
Appendix J.	Definitions of Key Environmental Correlates (Johnson and O'Neil 2001).	398
Appendix K.	Key Environmental Correlates identified to impact habitat selection by the Imnaha subbasin focal species (Johnson and O'Neil 2001).	411
Appendix L.	QHA methods used.....	426
Appendix M.	Critical Functional Link Species of the Blue-Mountain Province and their Functions (IBIS 2003).	431
Appendix N.	Regional impacts of out-of-subbasin limiting factors impacting anadromous focal species.....	440
Appendix O.	Raw data and results of the qualitative habitat assessment	444

1 Subbasin Assessment

1.1 Subbasin Overview

1.1.1 General Description

1.1.1.1 Location

The Imnaha subbasin is located in the farthest northeastern corner of Oregon (45° Latitude, 117° Longitude) near the center of the Columbia Basin. The Columbia Basin has been divided into 11 provinces by the Northwest Power and Conservation Council (NPCC, formerly the Northwest Power Planning Council or NPPC) to aid in the subbasin planning process. The grouping of subbasins into provinces was based on physical similarities among subbasins. The Imnaha subbasin is one of four subbasins in the Blue Mountain Province; it is bordered to the west by the Grande Ronde subbasin, to the east by the Snake Hells Canyon subbasin, and to the north by the Asotin subbasin (Figure 1).

Like the Grande Ronde, the Imnaha River flows in a northerly direction and is a direct tributary to the Snake River. The entire drainage is contained in U.S. Geological Survey (USGS) 4th field hydrologic unit code (HUC) 17060102 and joins the Snake River at river mile (RM) 191.7, approximately 48 river miles upstream of Lewiston, Idaho, and 3.4 miles upstream of the Salmon River confluence. The headwaters of the Imnaha River drain the eastern escarpment of the Wallowa Mountains and originate within the Eagle Cap Wilderness. At lower elevations, the Imnaha obtains flow from streams draining an adjacent plateau, which is located between the Wallowa River drainage to the west and Hells Canyon of the Snake River to the east (Kucera 1989). Ninety-eight percent of the subbasin lies within Wallowa County, with the remaining 2% split between Baker and Union counties. The subbasin is sparsely populated and contains only the small town of Imnaha (population 25) within its boundaries (Figure 2).

1.1.1.2 Size

The Imnaha subbasin drains an area of 850 square miles (2,202 square kilometers or 549,600 acres). It is one of the smallest subbasins; of the 62 subbasins delineated by the NPCC for use in subbasin planning, 16 are smaller and 45 are larger. When compared with the other three subbasins within the Blue Mountain Province, the Imnaha subbasin ranks third in size since it is significantly smaller than the Grande Ronde subbasin (roughly 4,000 square miles), slightly smaller than the Snake Hells Canyon subbasin (924 square miles) and more than twice the size of the Asotin subbasin (325 square miles). The subbasin is commonly divided in half at the town of Imnaha, which marks the confluence of the mainstem Imnaha and its largest tributary, Big Sheep Creek. The total area of the mainstem Imnaha, including all tributaries but Big Sheep Creek, is 508 square miles, while the total area of the Big Sheep Creek watershed is approximately 350 square miles.

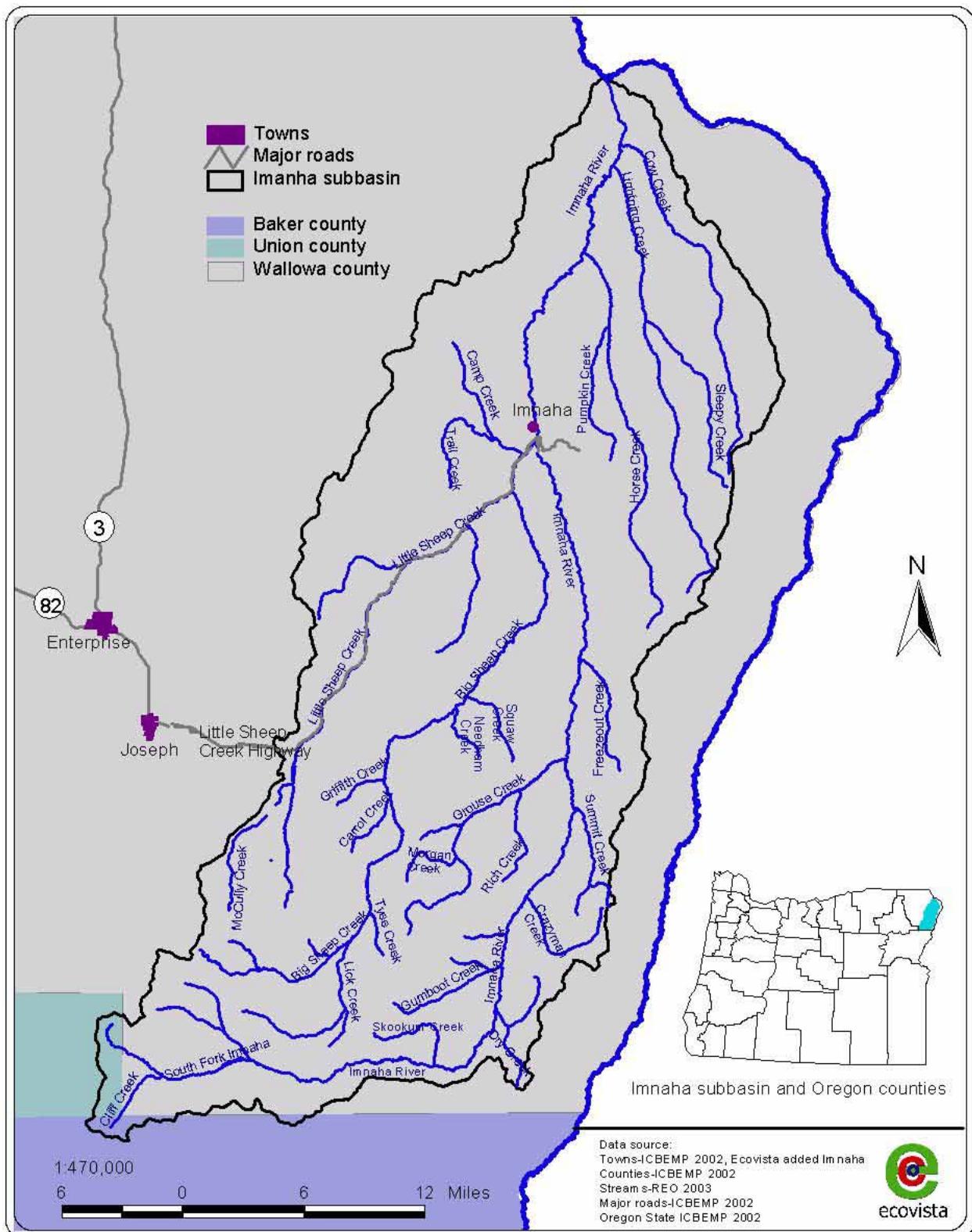


Figure 1. Location of the Imnaha subbasin in the Blue Mountain Province, Oregon, and the Columbia Basin.

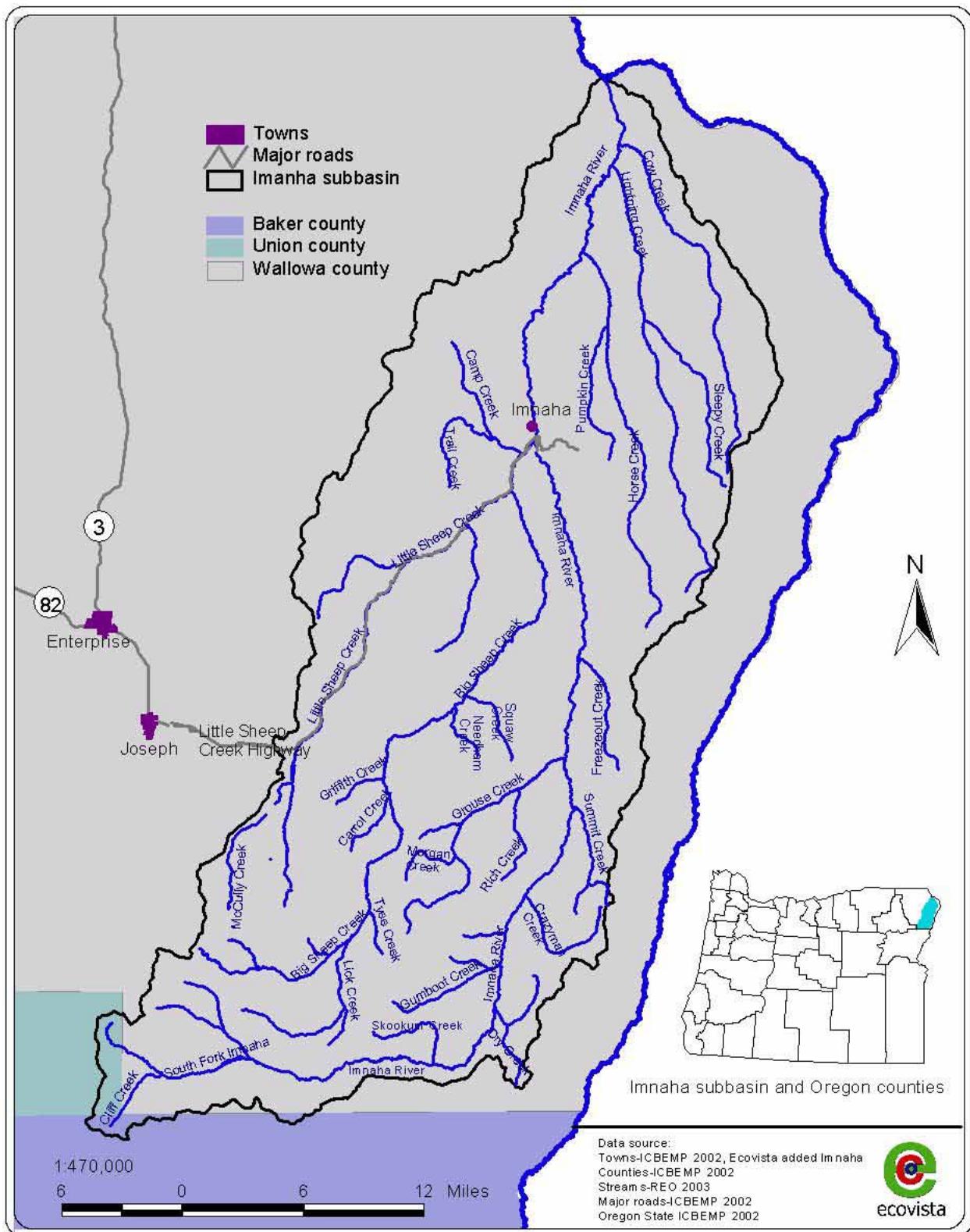


Figure 2. Counties and major features of the Imnaha subbasin.

1.1.1.3 Analysis Units

A combination of analysis units is used to characterize fish and wildlife resources throughout the assessment. In the overview section, the authors largely rely on U.S. Environmental Protection Agency (USEPA)-defined Level III ecoregions to stratify discussions pertinent to specific areas throughout the subbasin. In subsequent sections, analyses are based on 6th field HUCs. The two approaches were used since they provide varying levels of resolution. Assessment of broad-scale topics, such as climate, geology, and topography, were considered to be most suited toward the use of the ecoregion analysis unit, whereas assessment of finer-scale topics, such as fish habitat, required the resolution provided by the 6th field HUC. There are a total of 47 6th field HUCs (Figure 3) in the Imnaha subbasin, compared with only five subecoregions (discussed below; see also Table 1).

1.1.1.4 Ecoregions

The Blue Mountain Province, as defined by the NPCC, is contained within the Blue Mountain Level III Ecoregion defined by the USEPA. The larger Blue Mountain Ecoregion contains portions of the NPCC's Columbia Plateau and Middle Snake provinces, in addition to the Blue Mountain Province.

Ecoregions are defined as areas of general similarity in type, quality, and quantity of environmental resources (i.e., climate, geology, physiography, vegetation, soils, land use, wildlife, and hydrology) (Watershed Professionals Network 2001). Ecoregions also share a similar response pattern to physical activities (e.g., rainfall, fire, human land use activities, etc.), thereby providing a logical framework on which ecosystem research, assessment, management, and monitoring may be conducted (Watershed Professionals Network 1999).

Kagan (2001) and Pater et al. (1997) delineated a hierarchical set of ecoregions for Oregon, as have the USEPA and Oregon Natural Heritage Program (ONHP). The USEPA definitions, which are used in this document, have recently been summarized in Appendix A of the *Oregon Watershed Assessment Manual* (Watershed Professionals Network 1999). The USEPA delineations incorporate Level III and Level IV descriptions to characterize patterns within a watershed.

In the Imnaha subbasin, five subecoregions are nested within the Blue Mountain Ecoregion. The percentage of area by subecoregion type and location is shown in Table 1 and Figure 4. A textual characterization of the Blue Mountain Ecoregion and each subecoregion has been summarized in Bryce and Woods (2000) and is provided below.

Table 1. Subecoregion area and percentage of total area in the Imnaha subbasin.

Subecoregion Name	Code	Area (Square Miles)	% Total Area
Canyons and Dissected Highlands	11f	229.7	27
Canyons and Dissected Uplands	11g	450.5	52
Blue Mountain Basins	11k	44.0	5
Mesic Forest Zone	11l	67.9	8
Subalpine Zone	11m	66.5	8

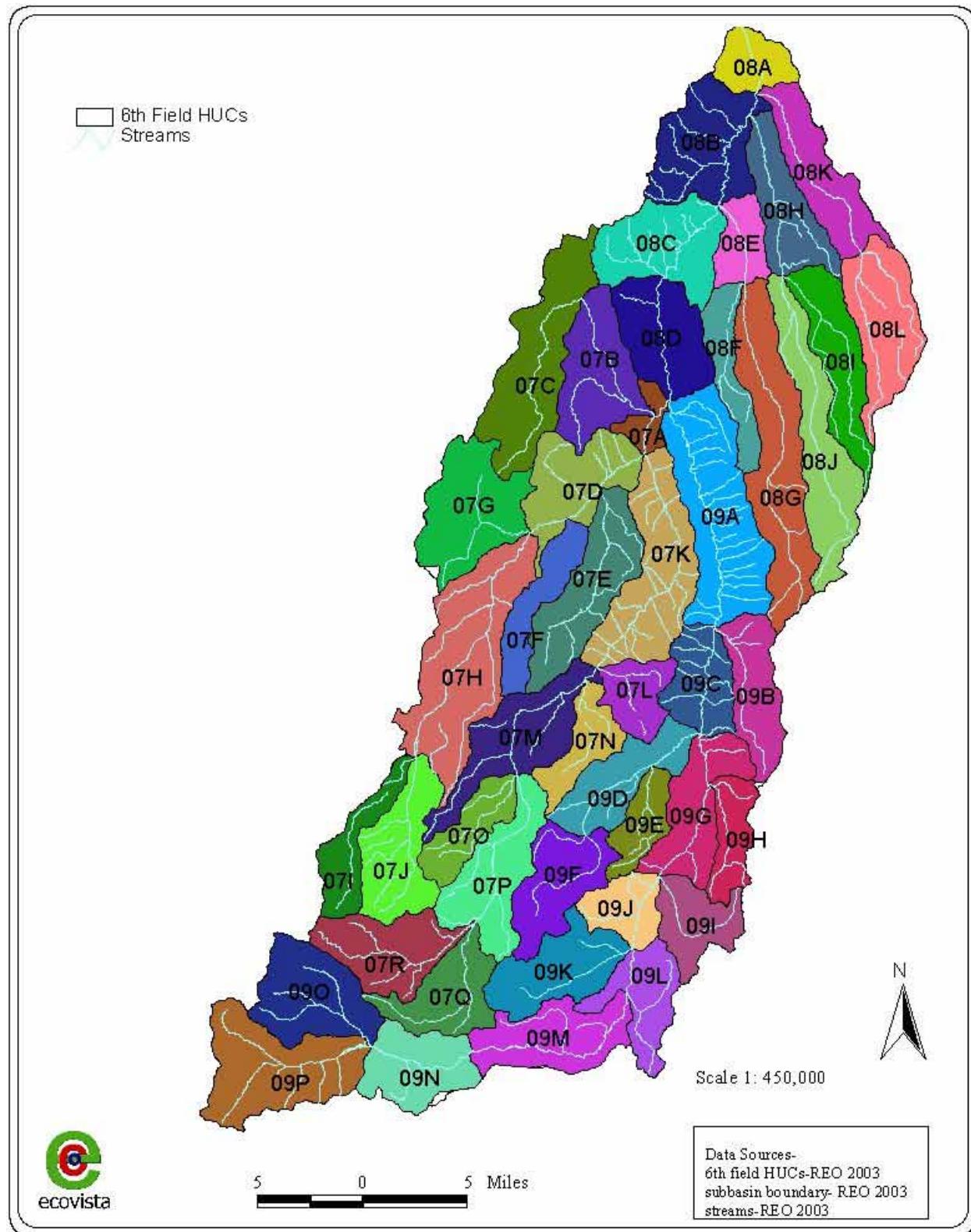


Figure 3. Sixth field HUC analysis units in the Imnaha subbasin.

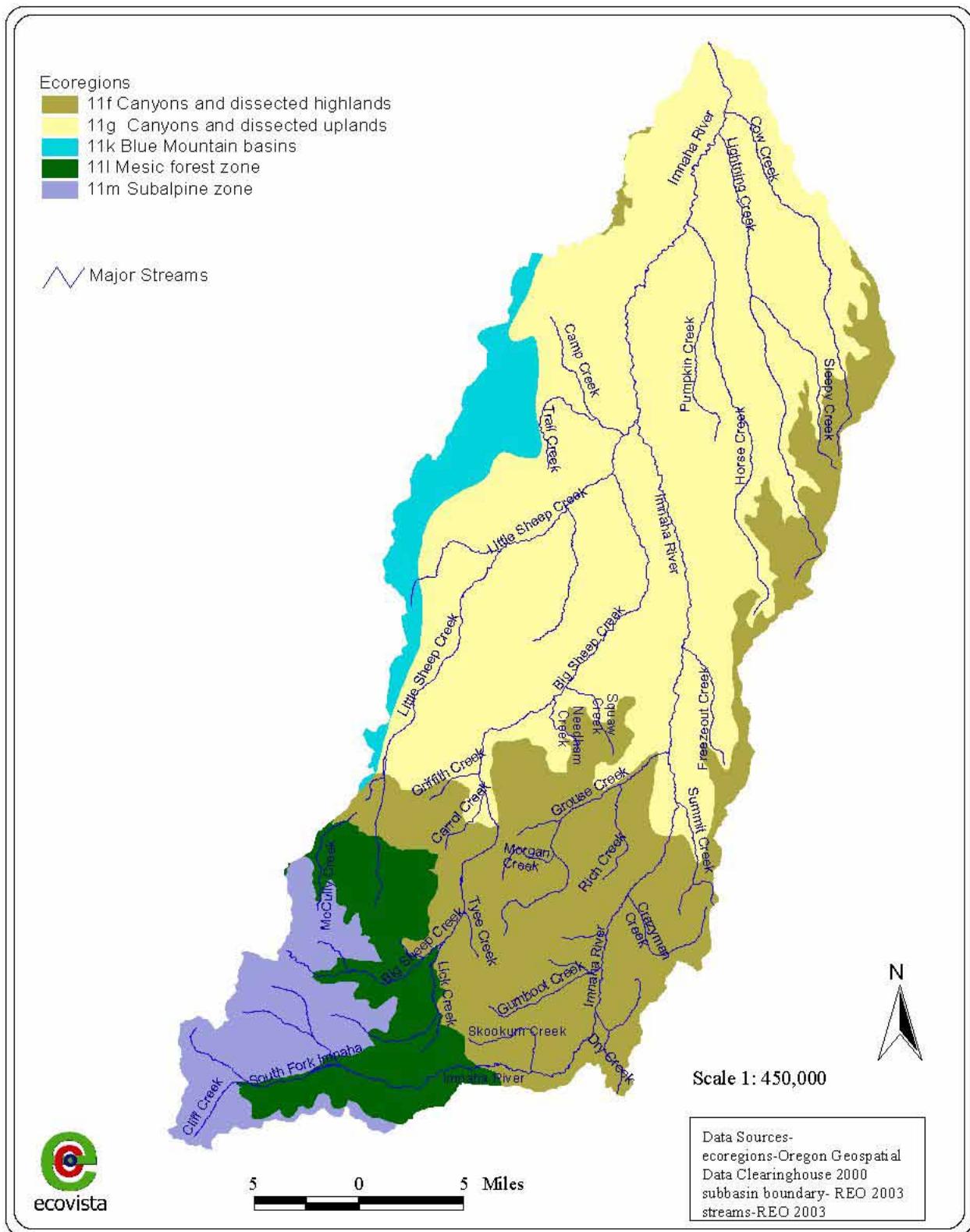


Figure 4. USEPA Level III and IV subecoregion classification in the Imnaha subbasin.

Blue Mountain Ecoregion (Ecoregion 11)

The Blue Mountain Ecoregion includes three mountain ranges: the Blue, Ochoco, and Wallowa mountain ranges. The Blue Mountains Ecoregion (11) is mostly volcanic in origin. Only its highest ranges, particularly the Wallowa and Elkhorn mountains, consist of intrusive rocks that rise above the dissected lava surface of the region. The area has deep canyons, high plateaus, broad river valleys, mountain lakes, forests, and meadows. Short, dry summers and long, cold winters characterize this region. Much of Ecoregion 11 is grazed by cattle.

Canyons and Dissected Highlands (Subecoregion 11f)

The Canyons and Dissected Highlands subecoregion includes the eastern Blue Mountains, the eastern Wallowa Mountains, and isolated islands of uplifted Columbia Plateau that have been cut by the Snake River in Hells Canyon. Subecoregion 11f is on the lee side of the mountains and is drier than the marine-influenced Mesic Forest Zone subecoregion (11l) found at similar elevations to the west. Vegetation is primarily coniferous, with subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta*), and Engelmann spruce (*Picea engelmannii*) occurring at the highest elevations. Grand fir (*Abies grandis*) and stringers of ponderosa pine (*Pinus ponderosa*) are the most abundant conifer species associated with the middle to lower elevations of subecoregion. Human activities are limited by the steep terrain of Subecoregion 11f.

Canyons and Dissected Uplands (Subecoregion 11g)

In the Canyons and Dissected Uplands subecoregion, deep river canyons divide the Blue Mountains from the Rocky Mountains. The Snake, Grande Ronde, Imnaha, and Salmon rivers and their tributaries have cut the Columbia Plateau to depths of 2,000 to 5,000 feet. These canyons are cut through the same metasedimentary and metavolcanic rock that forms the Wallowa and Seven Devil mountains; they differ from their lower stretches in Ecoregion 11, which are cut into basalt. The depth of the canyons and the exposed metamorphic rocks result in stony soils on canyon slopes that retain little moisture. Vegetative species of this subecoregion, which are primarily grasses, are adapted to grow in highly drained soil under hot, dry conditions. Land use includes grazing and recreation on National Forest land and in the Hells Canyon National Recreation Area (HCNRA).

Blue Mountain Basins (Subecoregion 11k)

The Blue Mountain Basins subecoregion includes the Wallowa, Grande Ronde, and Baker valleys. All three valleys are fault-bounded grabens or depressions; all are well-watered from surrounding mountains. Because the climate of the Wallowa and Grande Ronde valleys is moderated by a marine influence, these valleys receive an average annual precipitation of 13 to 24 inches. The fine-textured soils provide favorable agricultural conditions. Wetlands were once abundant in this subecoregion, but many have been drained for agricultural purposes, although remnants exist.

Mesic Forest Zone (Subecoregion 11l)

The Mesic Forest Zone subecoregion is found between 4,000 and 7,000 feet in the western Wallowa, the western Seven Devils, and the higher-elevation Blue Mountains. These areas are influenced by marine air coming through the Columbia River Gorge to the west. Much of the subecoregion's precipitation falls as snow that persists late into the spring. The soil has a

significant ash layer, which is relatively rock free, that helps to retain moisture during the dry season. These soils make growing conditions favorable for a highly productive and diverse forest community that includes true firs, Engelmann spruce, Douglas-fir, larch (*Larix occidentalis*), and lodgepole pine (Bryce and Woods 2000).

Subalpine Zone (Subecoregion 11m)

The Subalpine Zone subecoregion includes the highest areas of the Elkhorn, Wallowa, Seven Devils, and Strawberry mountains, beginning near tree line at an elevation of 6,500 feet where the forest cover becomes broken by alpine meadows and continuing through alpine meadowland to include the exposed rock, snowfields, and glacial ice of the highest mountain peaks. These areas characteristically have cold soil, deep snowpack, and a very short growing season. Forest species adapted to these conditions include subalpine fir, Engelmann spruce, and whitebark pine (Bryce and Woods 2000).

1.1.1.5 Geology

The geology of the Imnaha subbasin is comparatively more diverse than other subbasins of similar size located throughout the Pacific Northwest. This diversity is due in large part to the combination of Paleozoic and Mesozoic rocks that occur in the area and the associated mountain building and canyon downcutting processes by which the rocks were formed.

The geologic foundation for the Blue Mountain Ecoregion consists of several unique oceanic terranes that were once part of the Blue Mountains volcanic island chain that occurred west of the North American landmass (Orr and Orr 1996). The terrane underlying the Imnaha subbasin is the Wallowa Terrane, the largest remnant of the ancestral Blue Mountains volcanic arc (Orr and Orr 1996). The Wallowa Terrane was formed from lava flows and ash deposition produced by offshore eruptions during two separate episodes in the Permian and Triassic periods and comprises the older basement rock found throughout the subbasin (Vallier 1973). The Clover Creek Greenstone, a massive, indurated strata of rocks, resulted from metamorphosed volcanic and sedimentary rock and is evident in the upper section of the subbasin (Vallier 1973).

A period of subsidence occurred during the late Triassic and early Jurassic periods (between 150 and 200 million years ago), during which oceans became shallower and ancient reefs of limestones and shales formed and accumulated atop the volcanic material. These fossiliferous and siltstone rocks belong to the Martin Bridge and Hurwal formations (respectively), which currently underlie headwater portions of the mainstem Imnaha River, Big Sheep Creek, and Little Sheep Creek (Figure 5). Cobbles of lime rock line the river and creek beds through this section of the subbasin (USFS 1998a).

The Wallowa batholith, Oregon's largest pluton, intruded the Wallowa Terrane during the Mesozoic era (Cretaceous/Jurassic period, 160–120 million years ago), forming the Wallowa granite and trapping many of the precious metals that would later be sought in the Imnaha subbasin by miners (Vallier and Brooks 1987). The weather-resistant granite forms the high peaks of the Wallowa Mountains with nine peaks over 9,000 feet in elevation (Weis et al. 1976).

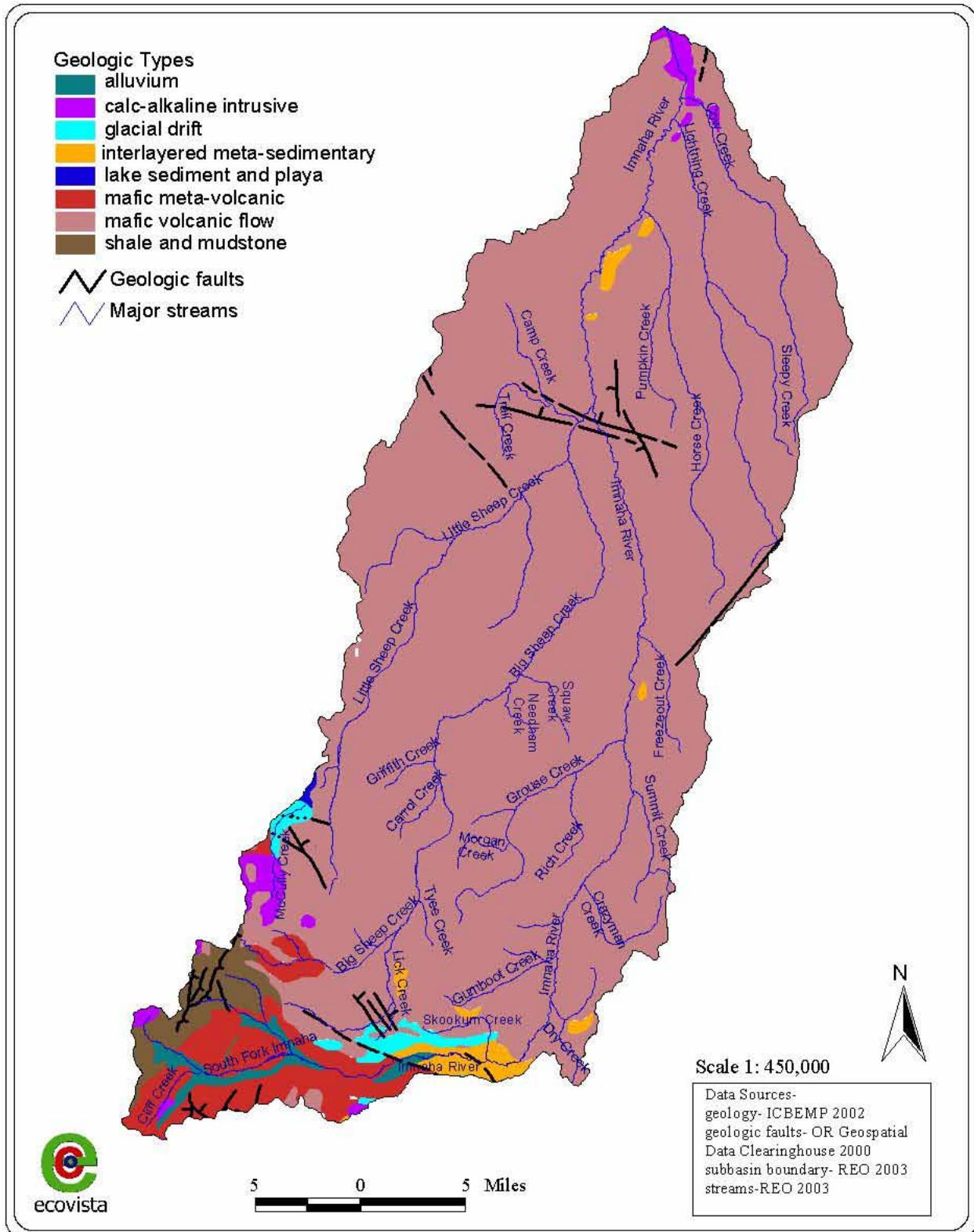


Figure 5. Geology of the Imnaha subbasin.

Layer upon layer of Columbia River basalts eventually covered the area during the Miocene epoch (17.5–15.6 million years ago), until only the tallest peaks projected above a seemingly level black landscape (Orr and Orr 1996). The Grande Ronde and Imnaha basalts, which represent two of six separate lava formations of the Columbia River basalts, brought about the most dramatic changes to the physiography of the province (Orr and Orr 1996). The Grande Ronde basalt, which is the most common of the Columbia River basalts, is more durable than the other Miocene flows (Orr and Orr 1996). The characteristic cliff-faced columnar exposures of the Grande Ronde basalt overlay previous flows and are common along the deep V-shaped valleys bordering tributaries such as Dry, Crazyman, Summit, and Freezeout creeks.

The underlying Imnaha basalt group is softer and more easily weathered than the Grande Ronde basalt. The Imnaha basalt is most evident in the lower canyon (below Summit Creek) and occur in areas of reduced relief that are mantled with deeper soils and fewer columnar basalt outcrops (Art Kreger, USFS soils scientist, personal communication, February 8, 2001). Big and Little Sheep creek valleys have a similar geology and morphology through the Columbia River basalt lava layers and join together in the Imnaha basalt in the central part of the subbasin. The successive basalt layers through which the rivers have cut can be seen from various vantage points, including the Hat Point overlook, an area bordering the Imnaha and Snake Hells Canyon subbasins.

Processes of glaciation dominated the Pleistocene era (\leq 2 million years ago) and sculpted the Wallowa Mountains, also known as “Oregon’s Alps” (Orr and Orr 1996). Long trough-like, U-shaped valleys; clear glacial lakes; and winding moraines of crushed rock, gravel, sand, and fine sediment characterize the area and serve as the headwaters for many of the streams and rivers in the subbasin (USFS 1998b). The points at which the myriad intermittent channels join often occur at terminal moraines. These junctions represent the uppermost reaches of perennial channels and may serve as source areas for the till that is common to Imnaha streams and rivers during runoff periods.

Quaternary alluvial deposits form narrow river terraces along the banks of the Imnaha River and its major tributaries. The alluvium contains river rock from upstream, colluvial basalt from the canyon side slopes, and Mazama ash and windblown silt mixed in with the soils that formed on the river terraces. These terraces are found in the central part of the Imnaha River and lower Big and Little Sheep creeks where the main channels have some ability to meander through the unconsolidated sediment. A study found that 84% of the riverbanks in the subbasin, including these terraces, are stable due mainly to vegetation and coarse sediment (USFS 1994a).

1.1.1.6 Climate and Weather

The climate in the Imnaha subbasin is temperate continental and dry. It is regionally influenced by the Cascade Mountains and locally influenced by the Wallowa Mountain Range. Variations in elevation, topography, and physiography contribute significantly to a number of unique microclimates found in the subbasin. For instance, north slopes tend to be wetter and cooler than south slopes; stream bottoms provide a cooler, damper climate than hillsides or ridge tops; and areas with good air drainage remain warmer in the winter than pockets with little or no air drainage. Long-term climate data specific to the Imnaha subbasin do not exist. Climate patterns

in nearby drainages, reports, professional judgment, modeled data, and anecdotal accounts are the best available source of Imnaha-specific climate information.

Climate data from nearby drainages (Table 2) provide an indication of climatic conditions in the Imnaha and will be referenced in the following discussion. Because of topographic and elevational differences, the climate in the Imnaha subbasin is assessed using three general elevation zones (Figure 6). Data from the Riggins, Idaho station are used to characterize climate in the lower-elevation portions of the subbasin, while climate data from the Enterprise Ranger Station (RS in figures and tables) and Mt. Howard Snowpack Telemetry (SNOTEL) stations in Oregon are used to describe conditions in the middle and upper portions of the Imnaha, respectively.

Table 2. Climate station metadata. Stations shown do not occur in the Imnaha River drainage but are considered relevant for use due to their proximity and relative position and/or elevation.

Station Number	Station Name	Start Date	End Date	Latitude (ddmm)	Longitude (dddmm)	Elevation (feet)
107706	Riggins	01/01/1940	12/31/2000	4525	11619	1800
352672	Enterprise RS	12/01/1931	10/31/1981	4526	11716	3820
17D18S	Mt. Howard SNOTEL	10/01/1980	Present	4527	11717	7910

Lower-Elevation Climate (Based on Data from Riggins, Idaho)

In winter, average temperatures throughout the lower ($\leq 1,800$ feet) elevation portions of the subbasin fluctuate around 37 °F. The average daily minimum temperature in the winter is around 29 °F. Summer temperatures range from 52 to 92.3 °F (Table 3) and average 72.4 °F. The average daily maximum temperature during the summer is 88 °F.

Precipitation in the lower-elevation portions of the Imnaha subbasin occurs almost exclusively as rain and is most abundant during spring and early summer months. The lower and middle elevations in the Imnaha subbasin are most susceptible to rain-on-snow events ($\leq 3,500$ feet). On average, a total of 16.8 inches of precipitation accumulate each year in the lower Imnaha (Figure 7). An estimated 7.3 inches of total snowfall may be expected annually, although snow depth is considered negligible during all months except January (see Table 3). Thunderstorms occur on average about 15 to 20 days each year, primarily between May and August (based on data collected from First Order station, Lewiston, Idaho).

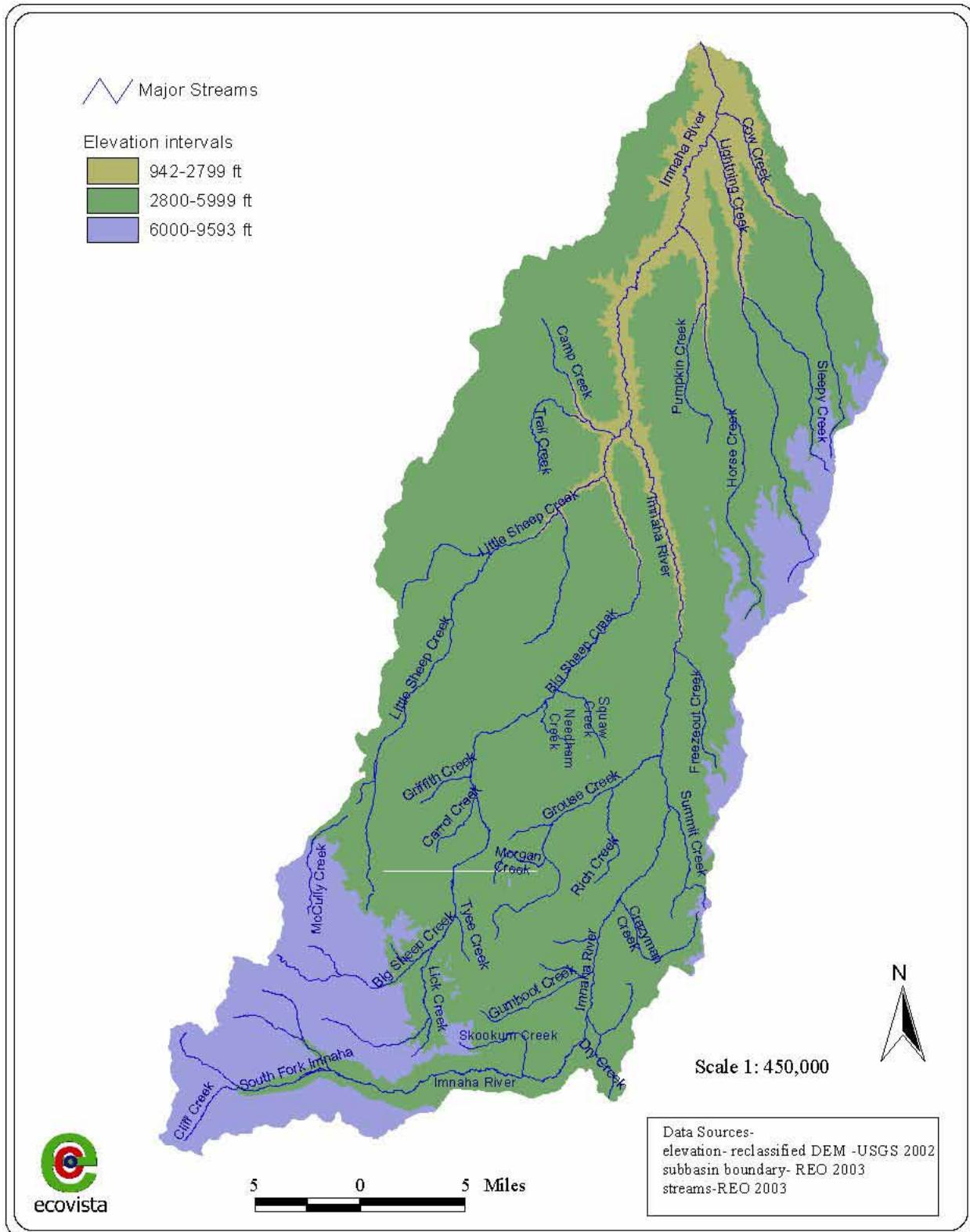


Figure 6. General elevation intervals in the Imnaha subbasin for climate.

Table 3. Monthly climate summary for stations representing conditions in the Imnaha subbasin during the period of record.

Station	Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Ridgeims	Avg. maximum temp. (°F)	41.5	49.4	57.1	65.9	74.0	81.4	92.2	92.3	81.4	67.4	50.8	42.4	66.3
	Avg. minimum temp. (°F)	27.5	30.9	34.5	39.5	45.9	52.4	58.1	57.9	50.5	41.9	34.5	29.2	41.9
	Avg. total precip. (inches)	1.2	1.1	1.6	1.7	2.2	1.9	0.8	0.8	1.1	1.3	1.5	1.4	16.6
	Avg. total snowfall (inches)	3.0	1.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.1	7.4
	Avg. snow depth (inches)	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Avg. maximum temp. (°F)	33.9	40.0	47.3	56.7	65.5	72.3	82.9	82.1	73.3	61.2	45.3	36.5	58.1
Enterprise Ranger Station	Avg. minimum temp. (°F)	13.9	18.6	23.0	28.9	34.7	39.9	42.8	40.4	35.1	29.1	22.3	17.5	28.9
	Avg. total precip. (inches)	0.9	0.7	1.0	1.2	1.7	2.1	0.7	0.8	1.0	1.1	1.0	1.0	13.2
	Avg. total snowfall (inches)	10.9	7.5	7.0	2.2	0.4	0.1	0.0	0.0	0.0	0.8	4.7	7.9	41.5
	Avg. snow depth (inches)	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
	Avg. maximum temp. (°F)	31.1	33.7	38.0	42.1	49.4	53.4	63.8	66.5	59.3	44.6	33.5	30.8	45.5
	Avg. minimum temp. (°F)	14.9	15.1	16.3	20.3	27.5	33.1	40.7	43.0	36.7	26.2	18.5	14.5	25.6
Mt. Howard SNOTEL	Avg. total precip. (inches)	5.0	4.4	4.9	4.6	4.9	4.9	2.3	1.3	1.5	1.1	4.0	5.8	44.7
	Avg. snow water equiv. (inches) for 1st and 15th of each month	7.2	8.4	12.3	16.6	13.7	8.1	0.0	0.0	0.0	0.3	1.2	4.3	
		8.5	9.8	15.8	17.0	13.6	3.7	0.0	0.0	0.0	0.6	2.4	6.1	

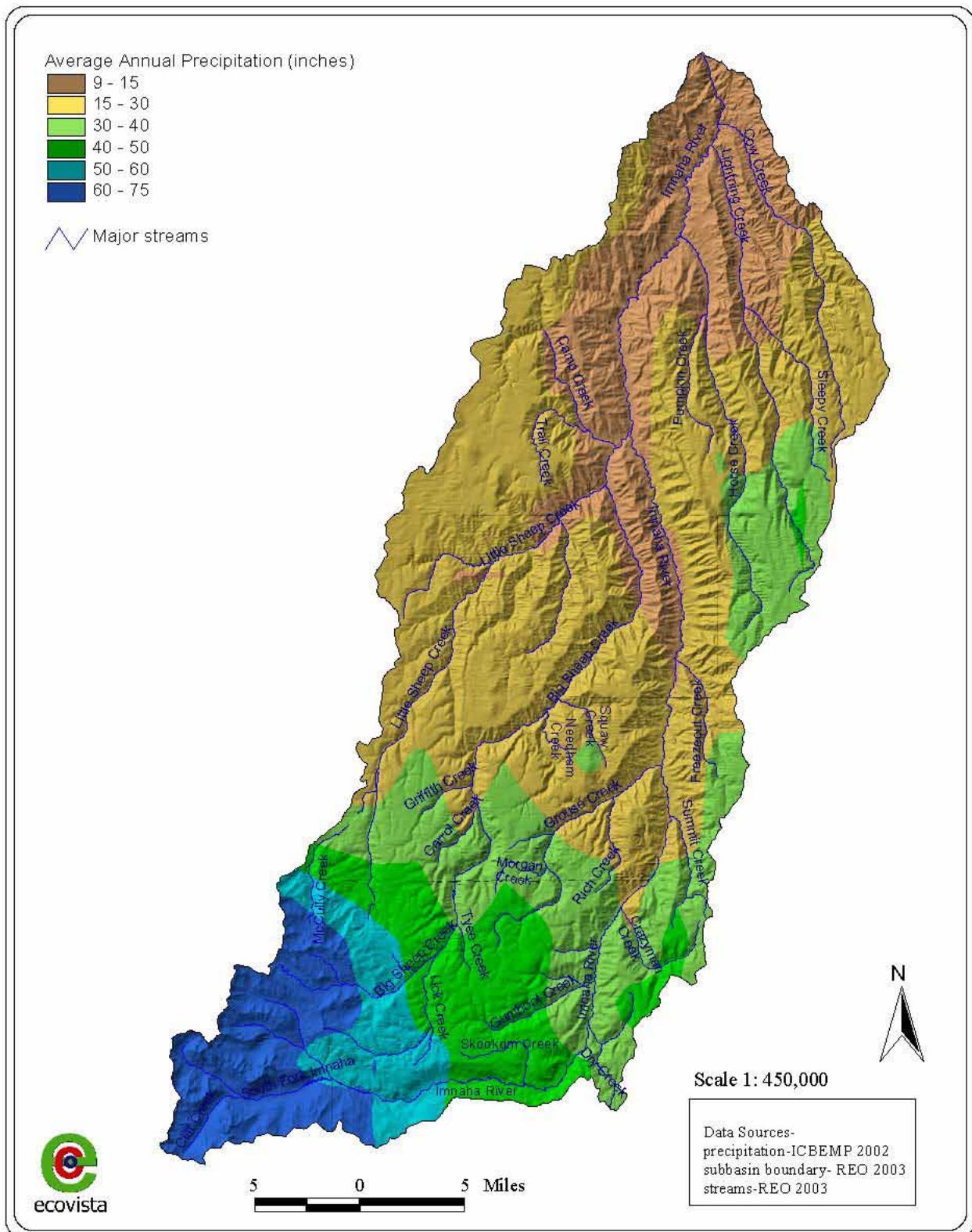


Figure 7. Precipitation patterns in the Imnaha subbasin.

Mid-Elevation Climate (Based on Data from Enterprise Ranger Station)

Based on climate data from the Enterprise Ranger Station, mid-elevation winter temperatures average around 27.3 °F. The average daily minimum temperature during winter months is 17.5 °F. During summer months, the average temperature is 60.5 °F. The average daily maximum temperature is 78.8 °F. Based on 30 years of data, two years in ten have an annual maximum temperature higher than 99 °F and an annual minimum temperature lower than –22 °F.

Average annual precipitation at the Enterprise Ranger Station is 12.8 inches. Precipitation generally increases monthly starting in February and peaking in June, during which an average 7 inches may accumulate (Figure 8). Average total annual precipitation measured at the Enterprise Ranger Station is less than that measured at the Riggins station (16.6 inches), a difference due in part to the rain shadow effect produced by the Wallowa Mountains. Average total snowfall is slightly less than 42 inches a year. On average, 31 days a year have at least 1 inch of snow on the ground.

The average relative humidity in midafternoon is about 70% in midwinter and about 25% in July and August. Humidity is higher at night, and the average at dawn is about 80% in midsummer. The sun shines 75 to 80% of the time in summer and about 40% in winter. Prevailing winds are very dependent on location due to the influence of the complex topography of the region, although they are generally from the southwest in winter and from the northwest in summer. Average wind speeds are highest in the spring, at around 10 miles an hour in open terrain in March and April.

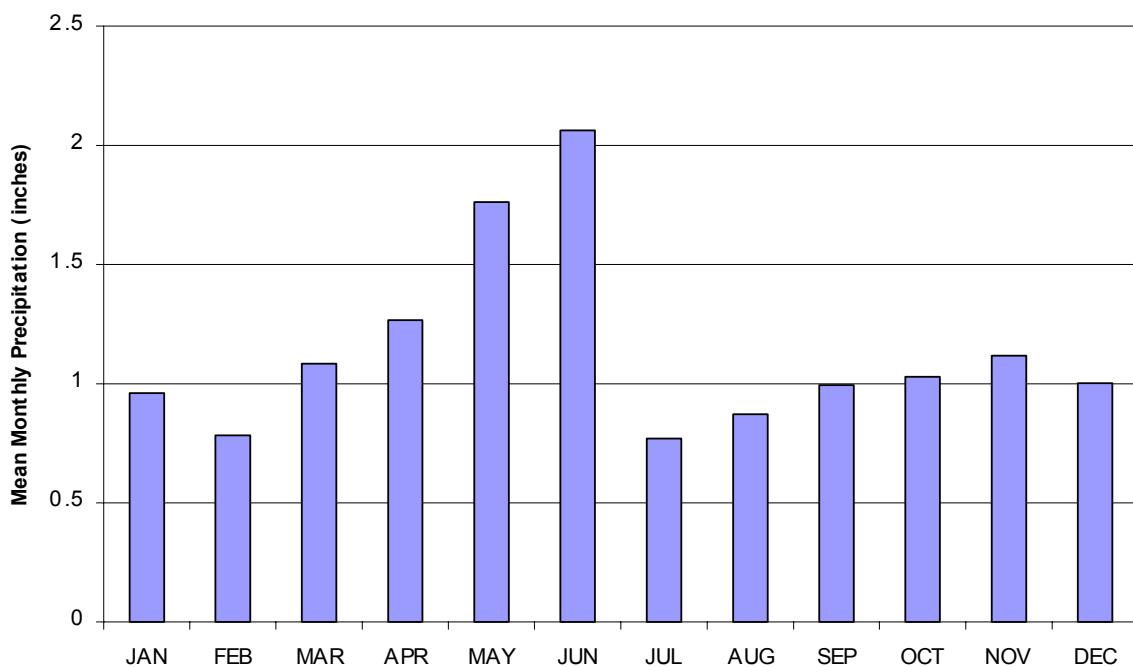


Figure 8. Mean monthly precipitation recorded at Enterprise Ranger Station (1932–1994).

Higher-Elevation Climate (Based on Data from Mt. Howard SNOTEL)

Not surprisingly the coolest climate occurs throughout the higher-elevation portions of the subbasin, where maximum temperatures recorded at the Mt. Howard SNOTEL climate station average only 46.5 °F over the course of the year, and minimum temperatures average less than 26 °F annually. The average maximum temperature during winter months at the SNOTEL site is just under 34 °F, although this statistic is based on only 10 years of data (1990–2000). In comparison, the average minimum temperature between December and March is 14.8 °F. Maximum temperatures during summer months range from 64.4 to 82.4 °F.

Average annual precipitation at Mt. Howard is 44.7 inches. Total precipitation over the period of record has varied considerably (Figure 9). Wet years recently occurred in 1982 and 1997; dry years, in 1987, 1992, 1994, and 2000. Precipitation at the Mt. Howard station is greatest during winter months and generally falls as snow (Figure 10). Although snowfall and snow depth data specific to the Mt. Howard station have not been collected, the higher-elevation areas of Wallowa County generally receives up to 80 inches or more each year (NRCS unpublished data). Based on snow water equivalent data and snow pillow data, the Mt. Howard station has at least one inch of snow on the ground over the course of four months. Snow water equivalent is highest between February and May and is negligible June through September. Snow water equivalent is variable and highly susceptible to moisture-laden warm fronts raising the freezing level in a short time period.

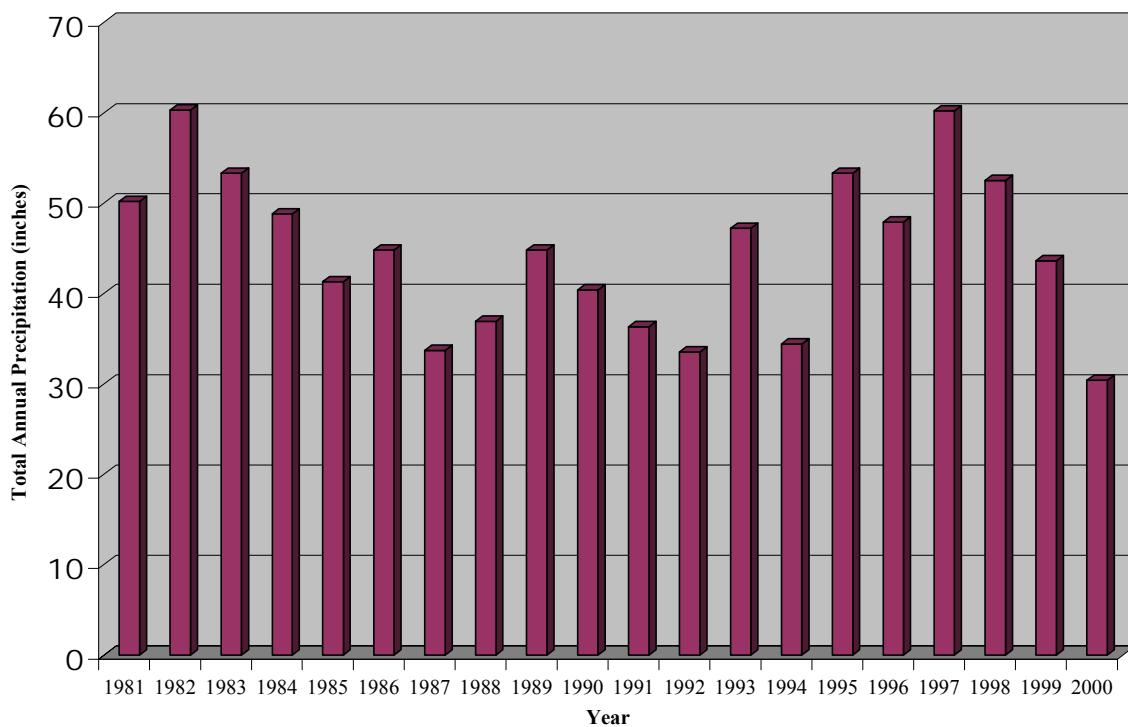


Figure 9. Annual precipitation recorded at Mt. Howard SNOTEL (1981–2000).

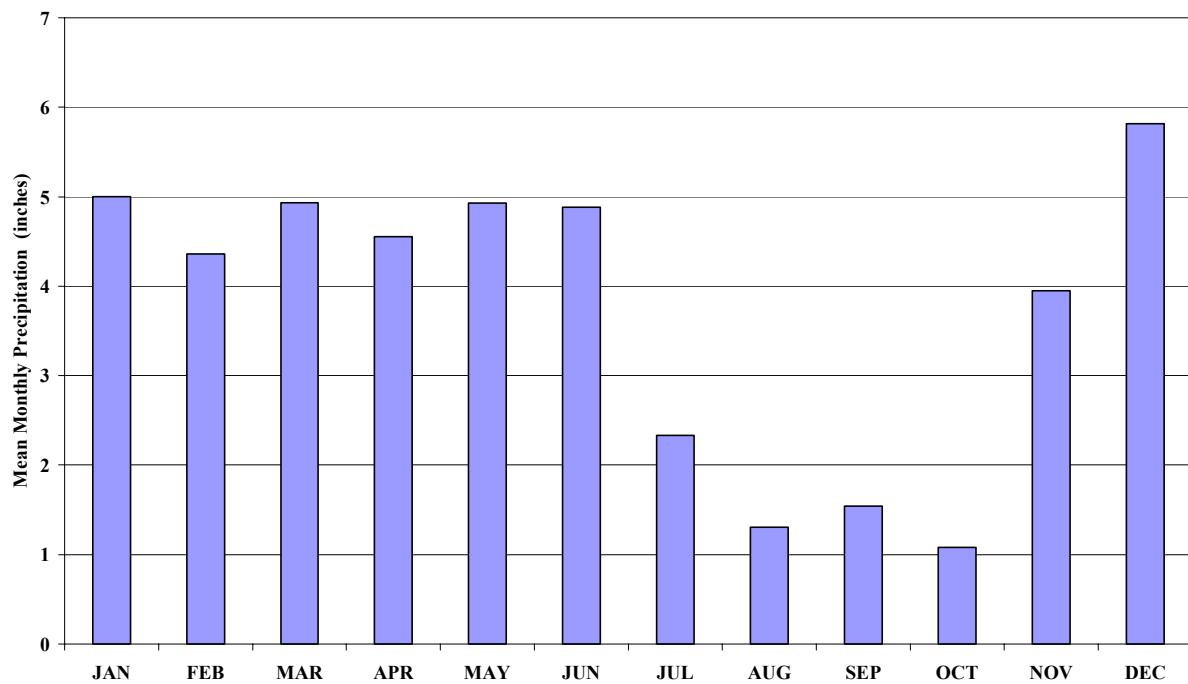


Figure 10. Mean monthly precipitation recorded at Mt. Howard SNOTEL (1980–2000).

1.1.1.7 Soils

The Imnaha River drainage provides a unique and diverse area for soil development due to its geologic setting. Varying rock type, topography, and climatic conditions have a large impact on soil-forming processes throughout the subbasin. General characteristics of soils in the Imnaha subbasin, as they relate to subcoregions, are presented in Table 4.

Table 4. General soil characteristics of subcoregions in the Imnaha subbasin (Watershed Professionals Network 1999).

Subcoregion	Soil Characteristics	Erosion Rate
Canyons and Dissected Highlands	Clay loam to gravelly loam derived from basalt with an ash and loess (western portion) mantle	Moderate due to moderate precipitation and stable geology
Canyons and Dissected Uplands	Clay loam to gravelly clay loam	Low due to low precipitation and gentle slopes
Blue Mountain Basins	Deep and fine-textured	Low due to gentle terrain
Mesic Forest Zone	Usually highly productive, with abundant soil moisture	Moderate; most erosion occurs during high-intensity runoff events during snow melt or during thunderstorms
Subalpine Zone	Fine-textured in meadows and rocky in canyon areas	Low; most erosion occurs during high-intensity runoff events during snow melt or during thunderstorms

Soils are generally derived from the weathering of local bedrock or colluvial rock materials (called residual soils). Thus, granitic soils predominate above Indian Crossing Campground (from weathering of the Wallowa batholith), while basaltic soils predominate below Indian Crossing. Residual soils tend to be deeper on north- and east-facing slopes (capable of supporting conifer stands) and shallower on south- and west-facing slopes (capable of supporting mainly grasslands). Forces other than weathering of bedrock, however, have also been active in the subbasin.

Wind-derived soils (loess) and ash deposits from the eruptions of Glacier Peak (12,000 years ago) and Mount Mazama (6,600 years ago) have added greatly to the productivity of the local soils. Ash deposits are very productive, with low compactibility and high permeability and water holding capacity, but because of their low density, they are easily erodible. They are generally found on the plateaus where the densest conifer stands are located.

Sedimentation rates are accelerated in the upper portion of the subbasin due to the instability of the barren granite mountain peaks. Primary mechanisms of sediment delivery to aquatic habitats in these areas include debris flows and other processes of mass wasting, which are commonly triggered by thunderstorms or rain-on-snow events (BLM 1993). Low-gradient areas and deep pools in the upper and middle portions of the subbasin act to filter out much of the suspended sediment load delivered to headwater tributaries and mainstem reaches (Art Kreger, USFS soils scientist, personal communication, February 8, 2001).

The soils that formed from Imnaha basalt along the central part of the valley have much higher clay and coarse sand content than typically found in similar soils in the region (Art Kreger, USFS soils scientist, personal communication, February 8, 2001). The well-drained and fertile soils of this area are suited to agriculture, but are also a potential source of sedimentation into the river during flood stages or following storm events (Tom Smith, NRCS soils scientist, personal communication, February 8, 2001).

Soil surveys at varying resolutions have been conducted or are in development in the Imnaha subbasin. State Soil Geographic (STATSGO) data at 1:250,000-scale are available across the entire subbasin. The finer-scale Soil Survey Geographic (SSURGO) data have recently been completed for the privately owned lands in the subbasin but does not include public land ownerships (NRCS 2002). The Wallowa-Whitman National Forest is currently developing a detailed soil survey for the lands they manage, but such a survey has not yet been developed for the Imnaha subbasin (USFS 2002).

The Imnaha subbasin contains seven STATSGO Map Units (MUIDs) (Figure 11). Each MUID may contain multiple soil components and layers. To determine the average soil properties across the MUID, weighted averages were calculated based on the thickness of soil layers and the percent contributed by each soil component (Table 5).

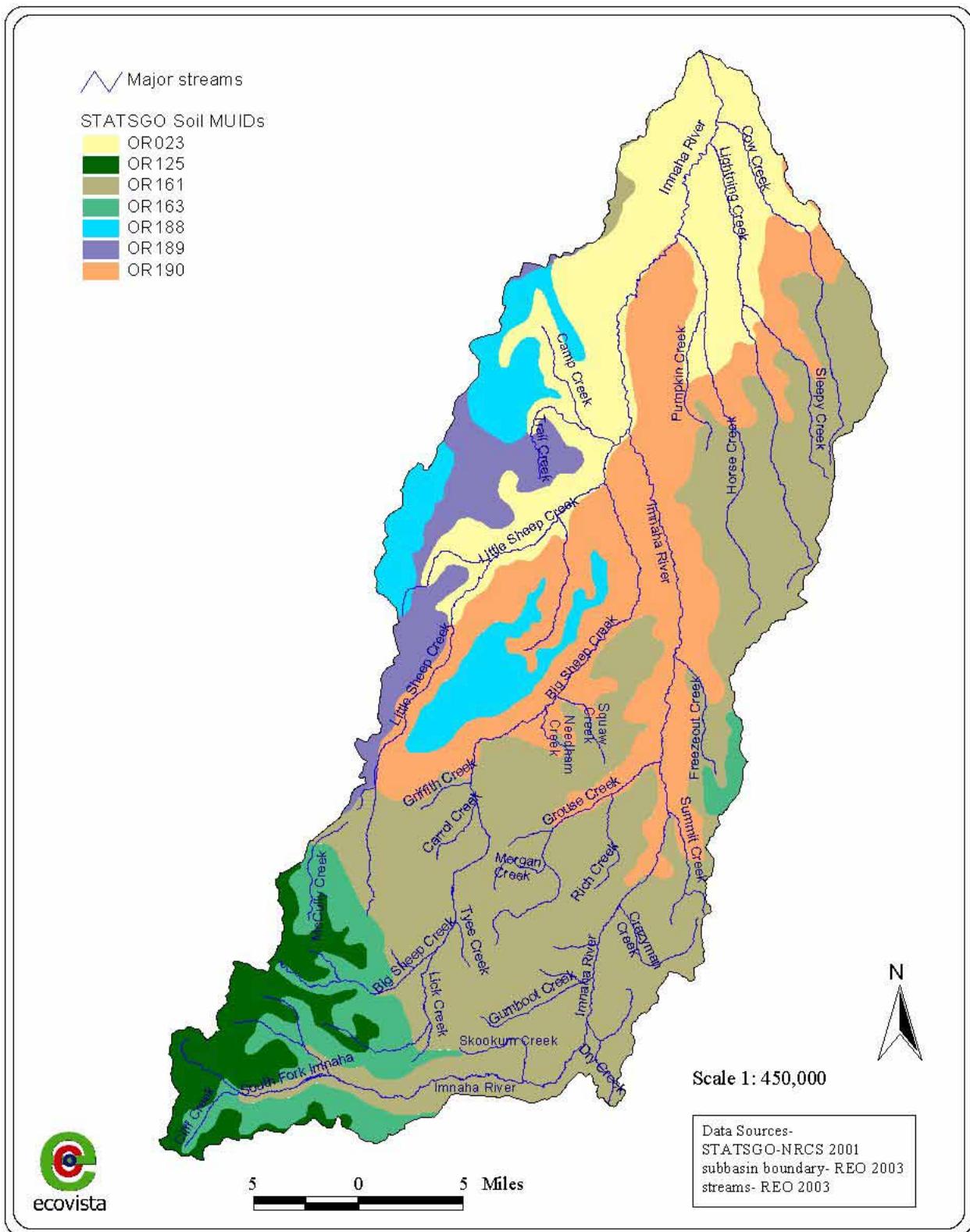


Figure 11. Soil mapping units of the Imnaha subbasin.

Table 5. Soil properties of the STATSGO Map Units (MUIDs) in the Imnaha subbasin.

MUID	Map Unit Name	Depth to Seasonally High Water Table (Inches)	Depth to Bedrock (inches/hour)	Available Water Capacity (inches/inch)	Bulk Density (grams/cubic centimeter)	Organic Matter Content (percent by weight)	Soil Loss Tolerance Factor	Wind Erosion Factor	Soil Erodibility Factor
OR23	Lickskillet-Schuelke-Bolicker	6.000	26–37	0.75–2.43	0.089–0.140	1.261–1.402	0.794–1.583	1.968	6.779
OR125	Rock Outcrop								0.225
OR161	Tolo-Klicker-Anatone	6.000	37–48	0.32–1.96	0.151–0.215	1.095–1.276	0.777–0.202	3.220	5.900
OR163	Helter-Brickel-Ateron	6.000	34–49	0.73–2.60	0.119–0.184	1.087–1.279	0.724–1.805	2.814	6.093
OR180	Lostine-Ladd-Langrell	5.140–5.435	60	3.16–4.75	0.113–0.154	1.257–1.427	0.810–1.811	4.170	5.450
OR188	Powwatka-Zumwalt-Wallowa	6.000	19–38	0.49–1.61	0.181–0.202	1.122–1.258	1.898–4.566	1.900	5.950
OR189	Hurwal-Snell-Ateron	6.000	24–41	0.32–1.02	0.101–0.148	1.228–1.374	1.050–2.175	2.050	7.300
OR190	Snell-Harlow-Getaway	6.000	22–39	0.32–1.04	0.086–0.125	1.238–1.410	1.174–2.444	1.950	7.450
									0.124

1.1.1.8 Topography

The Imnaha subbasin is made up of a broad range of elevation and topographic relief (975–10,000 feet and 0 to > 90% slopes) (Figure 12). The granite peaks of the Wallowa Mountains are barren rock slopes and cliffs ranging from 90% to vertical slopes. The Martin Bridge and Hurwal formations have soils forming on 30 to 90% slopes in the higher elevations in the Imnaha drainage where the South, Middle, and North forks converge in U-shaped valleys on the eastern side of the Wallowa Mountains (Weis et al. 1976).

As the river turns north near Coverdale Campground, it begins cutting through the Grande Ronde basalt, forming a deep V-shaped valley with the typical columnar basalt cliff faces on the steeper slopes (30 to 90%). This is often referred to as “bench type” topography (Tom Smith, NRCS soils scientist, personal communication February 8, 2001). The Imnaha river channel erodes through the Grande Ronde basalt and into the more erodible Imnaha basalt near the intersection of North Pine Road and the Imnaha River Road. The river valley begins to widen, forming the shallow valley slopes that typify the central part of the Imnaha River valley corridor. The shallow slopes range from 5 to 15% near the river and 15 to 30% near the canyon walls (Art Kreger, USFS soils scientist, personal communication, February 8, 2001).

Near-vertical canyon walls contain the Imnaha River as it courses its way through the more durable metamorphic rocks of the Wallowa Terrane (USFS 1998b). The canyon bottoms in these areas provide only enough room for the riverbed itself and the well known Ni-Mi-Puu foot trail.

1.1.1.9 Land Cover

Cover Types

As explained in section 1.1.1.4 the distribution of vegetative communities in the subbasin is a reflection of its climate, soils, elevation and topography. The uppermost part of the subbasin occurs above tree line and contains alpine communities (Rose et al. 1992). Below the tree line, the watershed contains subalpine communities that grade into mixed conifer forests and

eventually grassland as elevations decrease (USFS 1995).

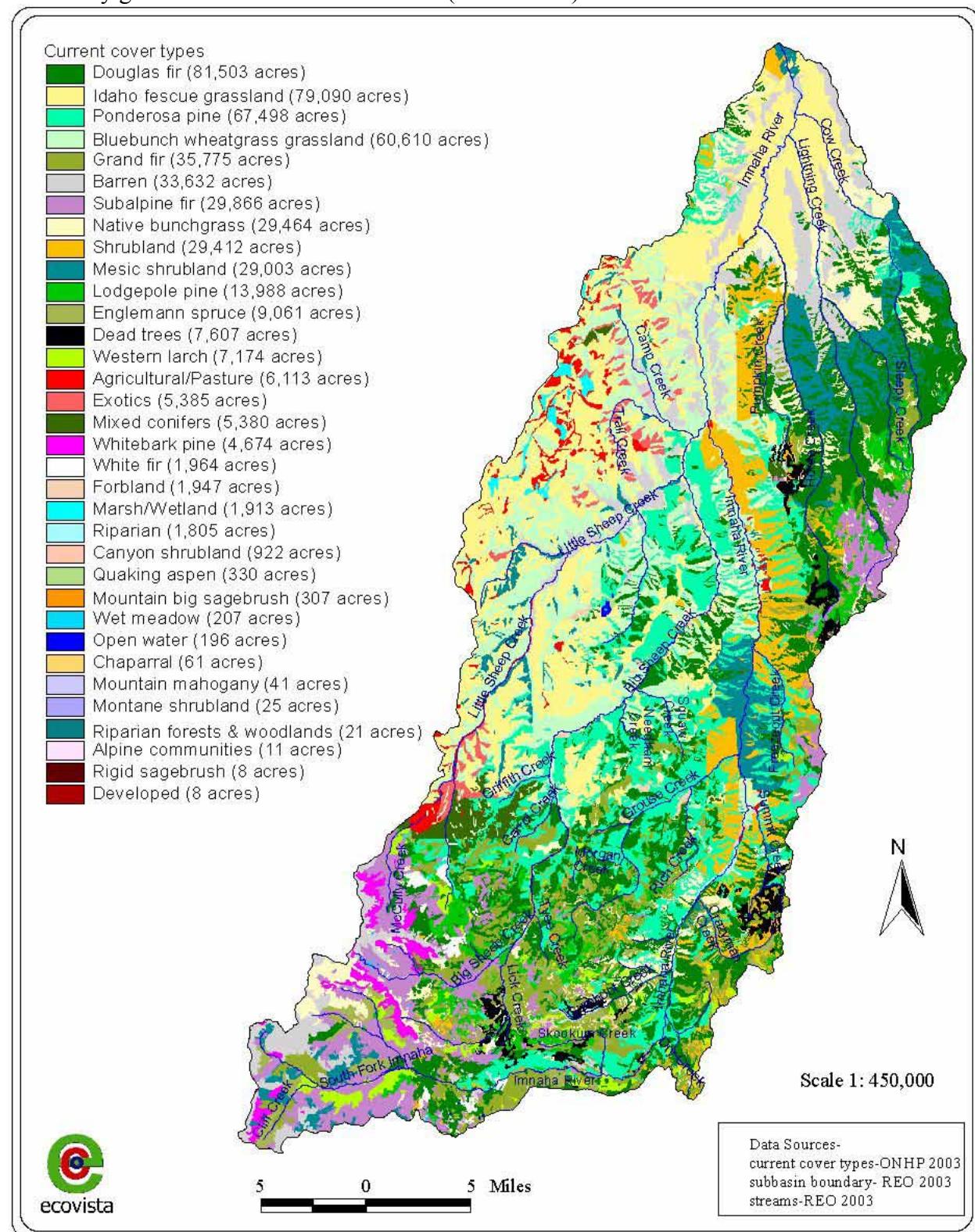


Figure 13 shows the locations and relative abundance of cover types in the subbasin. These data were compiled by the Oregon Natural Heritage Program (ONHP) using Wallowa-Whitman

National Forest data on the USFS lands and SSURGO and Gap Analysis Program (GAP) data on the non-USFS lands.

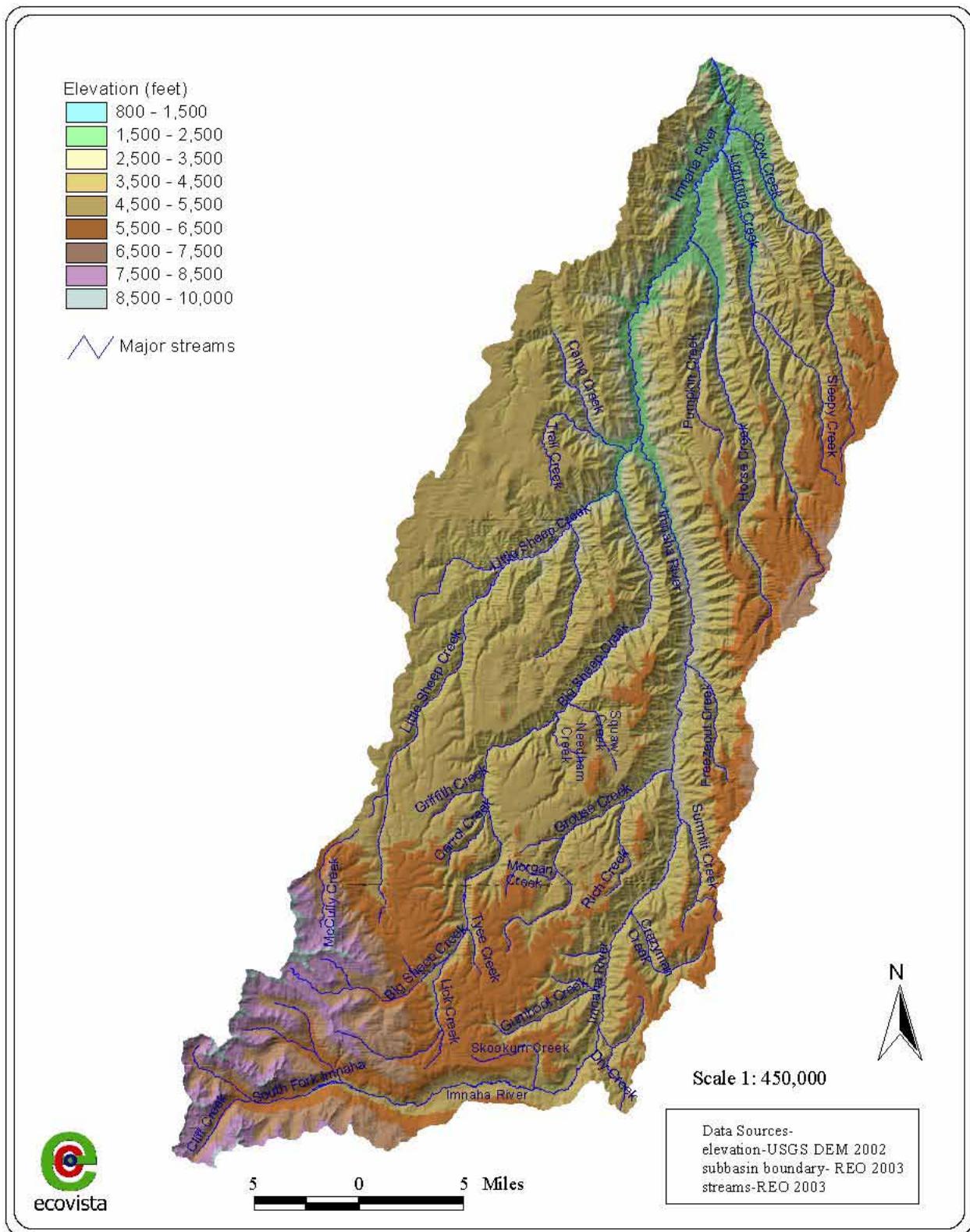


Figure 12. Topography and elevation in the Imnaha subbasin.

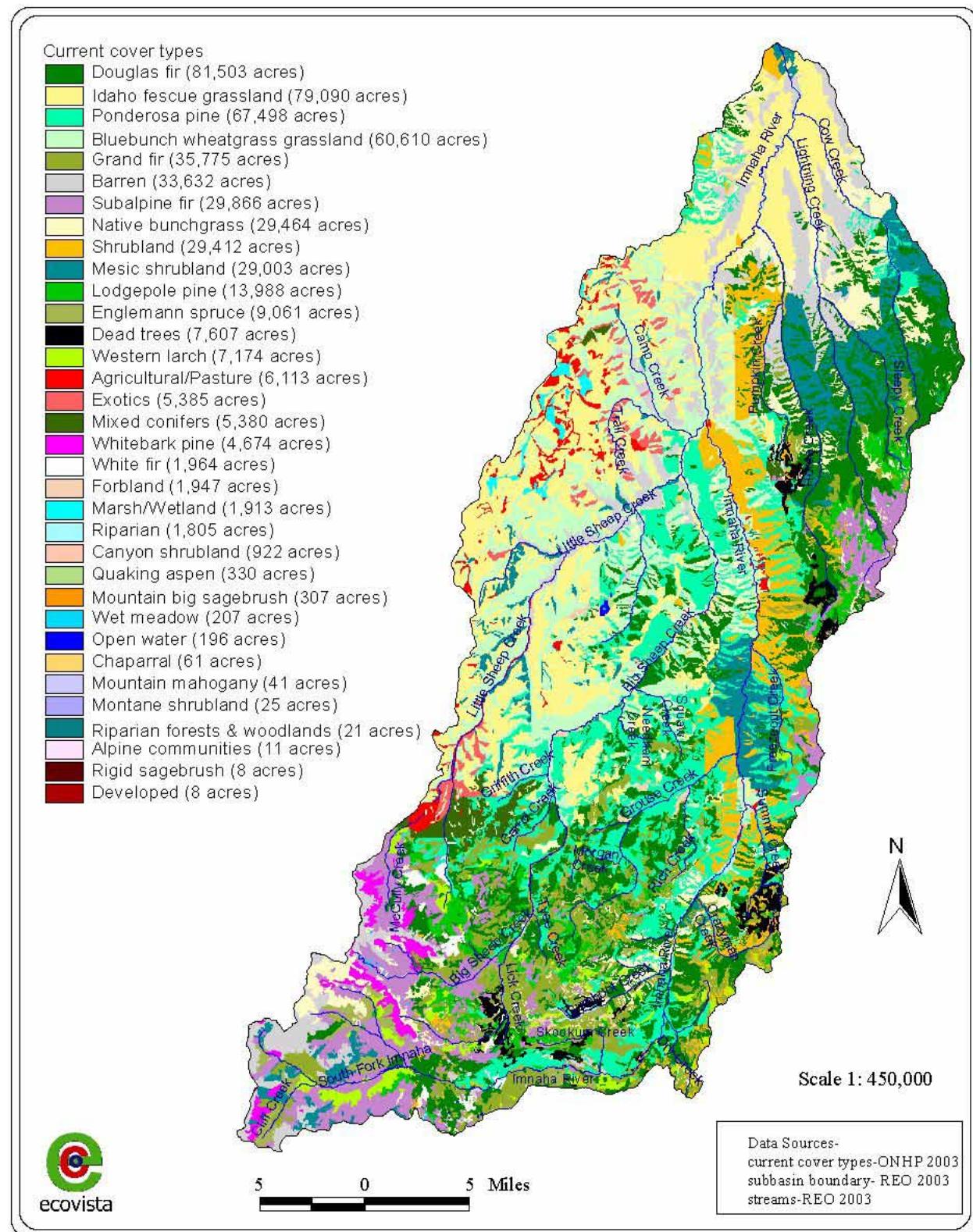


Figure 13. Current land cover types of the Imnaha subbasin.

Based on the ONHP data, Douglas-fir is currently the most abundant cover type in the subbasin covering 81,500 acres. Grassland areas dominated by Idaho fescue are a close second covering slightly more than 79,000 acres. Idaho fescue and bluebunch wheatgrass vegetation types cover most of the lower-elevation areas of the subbasin. Cover types reflecting the highest degree of human influence occur primarily on the lower western side of the subbasin, the agricultural and pasture areas are here as well as many of the areas dominated by undesirable exotic species. Ponderosa pine occurs intermixed with shrub communities, as stringers along draws in the grassland dominated areas. The mid-elevation areas are dominated by a mix of conifer species, particularly Douglas-fir but also grand fir, western larch, lodgepole pine, and ponderosa pine. At higher elevations, white-fir, Engelmann spruce, subalpine fir and whitebark pine are also

important forest components (Figure 12 and

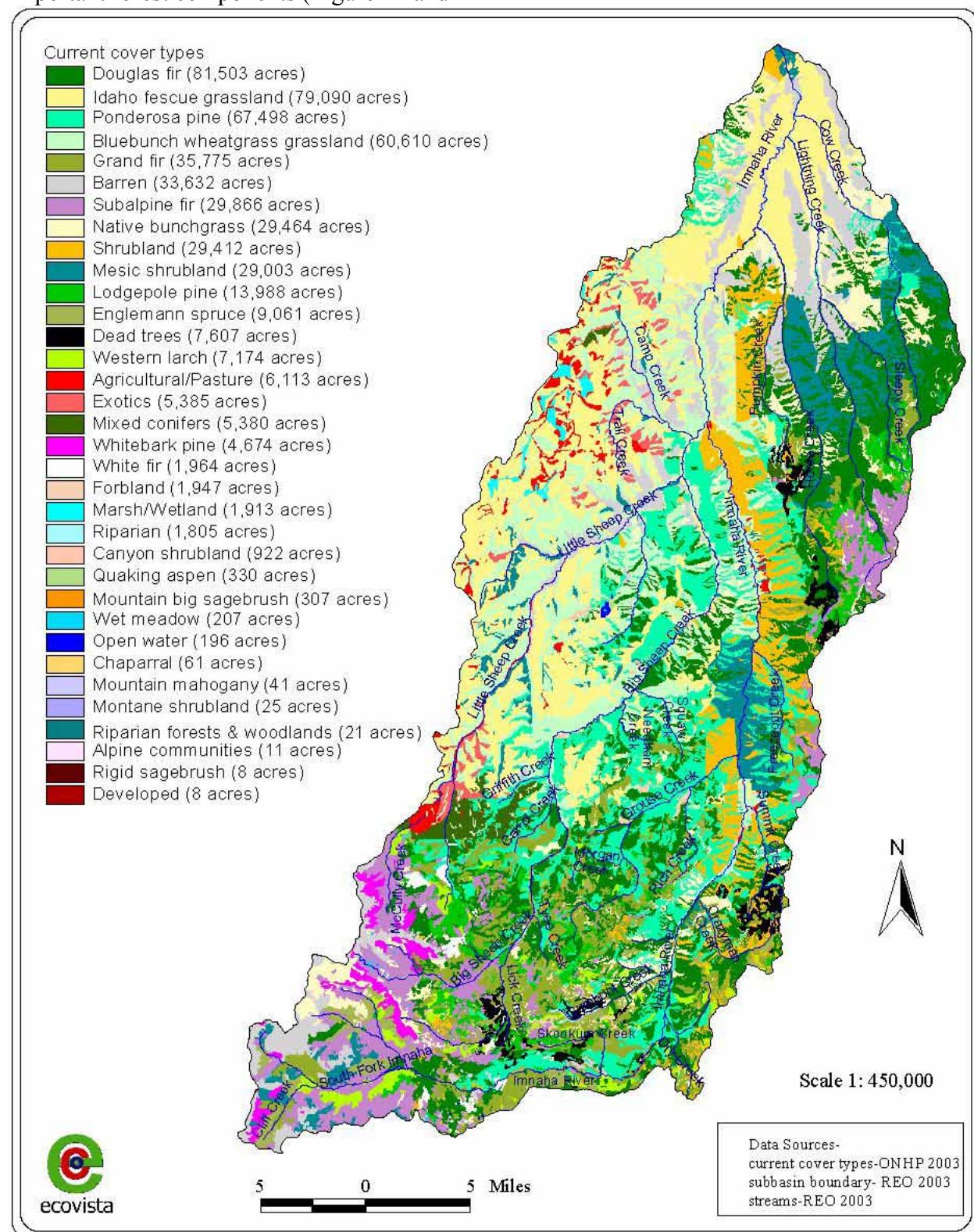


Figure 13). Characteristics of these vegetative communities and their understory components are discussed in greater depth in the following section.

Wildlife Habitat Types

Johnson and O’Neil define a wildlife habitat as “an area with the combination of the necessary resources (e.g., food, cover, water) and environmental conditions (temperature, precipitation, presence or absence of predators and competitors) that promotes occupancy by individuals of a given species (or population) and allows those individuals to survive and reproduce” (2001). Wildlife habitats are viewed as hierarchical in nature with vegetative type being the coarsest element selected for by a species, vegetative structure the next, and unique habitat elements (e.g., snags) the finest (Johnson and O’Neil 2001).

Wildlife habitat types (WHTs) represent the first level in this hierarchy. They are groupings of vegetative cover types based on similarity of wildlife use that have been delineated across the Columbia Basin by the Northwest Habitat Institute. The use of WHTs in this assessment facilitates the assessment of wildlife conditions at the scale of the subbasin and allows for interpretation of this subbasin scale assessment in the context of the Blue Mountain Province and the Columbia Basin as a whole. The 395 species of wildlife with potential habitat in the Imnaha subbasin and the WHTs with which they are closely associated are displayed in Appendix A. The current distributions and abundance of WHTs in the subbasin are shown in Figure 14. When compared with the current cover type distributions

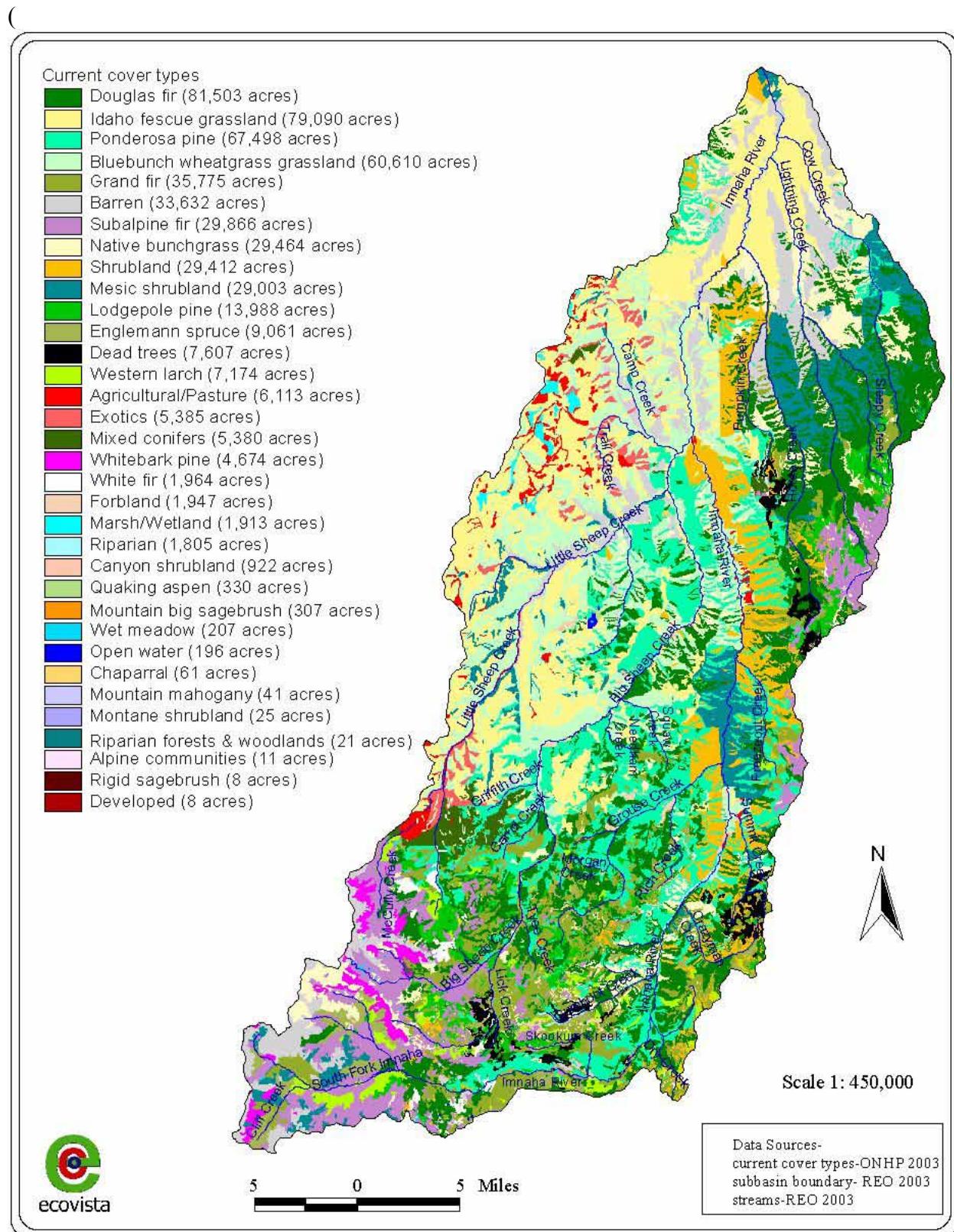


Figure 13) some apparent discrepancies emerge. This is partially due to differences in the sources and resolution of the base data but also to differences in the definitions of a cover type

and a WHT. For example an area of the subbasin currently covered by ponderosa pine trees would be classified as ponderosa pine cover type but could be classified as eastside mixed conifer forest WHT if ponderosa pine is seral to grand fir on that site.

Columbia Basin scale descriptions of the vegetation and climatic conditions characteristic of each WHT have been developed by the Northwest Habitat Institute. Imnaha subbasin specific descriptions of vegetative characteristics, organized by vegetative series, were written by the Walla-Walla National Forest for inclusion in the *Big Sheep Creek Watershed Analysis Report* released in August 1995. The vegetative series align closely with the WHTs, and so their descriptions were used to interpret the coarse-scale WHT descriptions and make them more specific to the Imnaha subbasin. Table 6 documents the assumptions made when “crosswalking” between vegetative series and WHT.

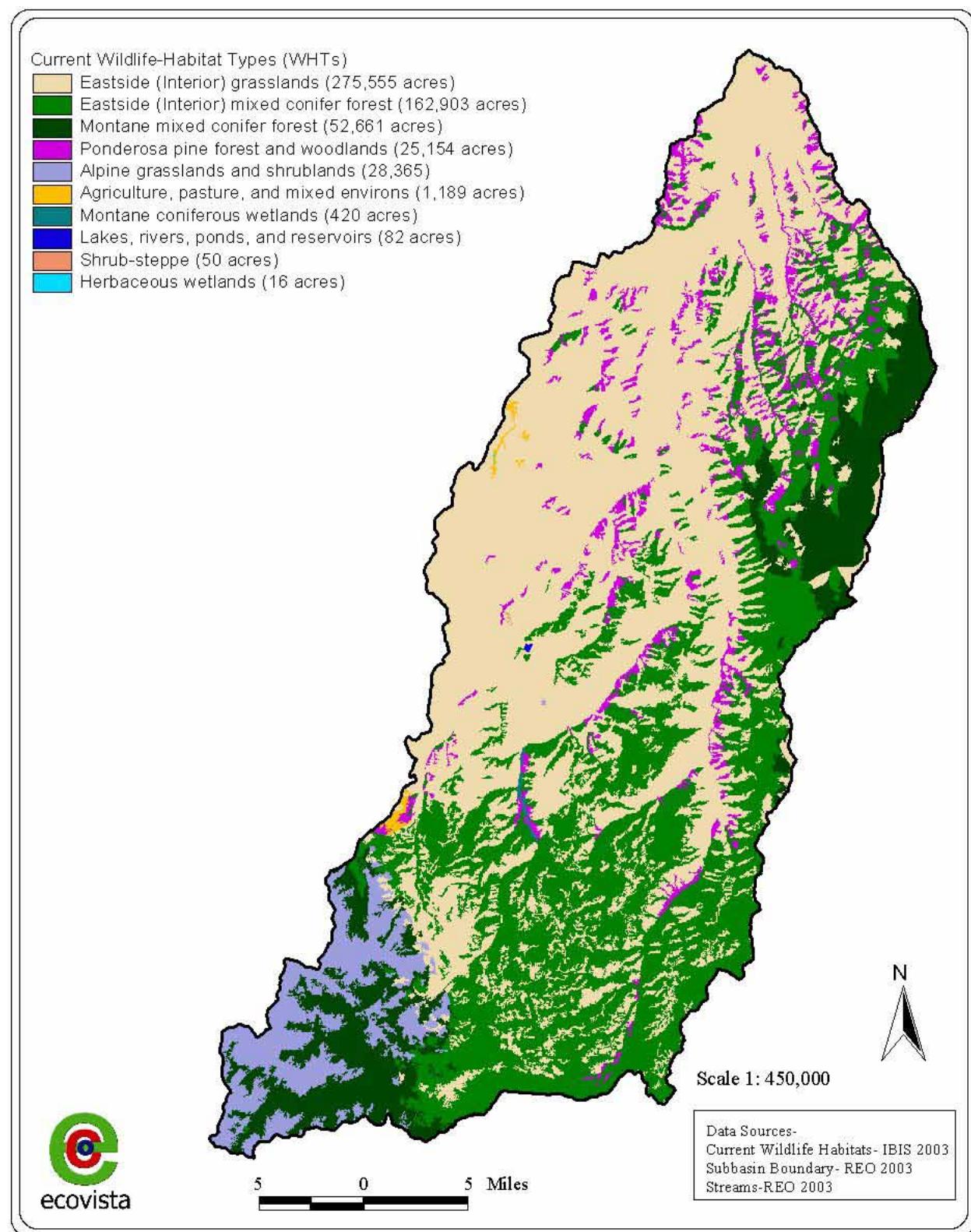


Figure 14. Current wildlife habitat types (WHTs) of the Imnaha subbasin.

Table 6. Assumptions made about relationship between vegetative series and wildlife habitat types (WHTs).

Vegetative Series or Type (USFS 1995)	WHT (IBIS 2003)
Alpine Green fescue	Subalpine parkland Alpine grasslands and shrublands
Subalpine fir	Montane mixed conifer forest
Mixed conifer	Eastside mixed conifer forest Lodgepole pine forest and woodlands
Douglas-fir Ponderosa pine	Ponderosa pine forests and woodlands
Idaho fescue Shrublands	Eastside grasslands
Moist and wet meadows	Herbaceous wetlands Montane coniferous wetlands
Quaking aspen	Upland aspen forest
Riparian vegetation	Eastside riparian-wetlands

Descriptions of the current WHTs in the Imnaha subbasin follow. Lodgepole pine forest and woodlands, subalpine parklands, wetlands and upland aspen habitat are important components of the historical WHT map but are absent from the current WHT map. Most local literature indicates that, although these WHTs may have declined in the Imnaha subbasin, they are not absent. Therefore, these WHTs are also described below to aid the reader in understanding the factors that may have led to their decline, which will be discussed later in this document. A very small amount of the shrub-steppe WHT occurs in the subbasin; this habitat is viewed by the terrestrial subcommittee to be almost nonexistent in the subbasin and will not be discussed in this document. Conversely, the eastside riparian and wetland habitat is absent for the current WHTs, this is likely due to the difficulties associated with mapping riparian habitats at all but the finest of data resolutions; this habitat type is considered a priority habitat by the terrestrial subcommittee and is discussed in detail in section 1.1.2.4. The Open Water (lakes, streams and rivers) and wetlands habitats are also described in sections 1.1.2.1, and 1.1.2.5, respectively. See section 1.1.1.10 for a description of agricultural areas in the subbasin.

Montane Mixed Conifer

This WHT occurs in the upper elevation forests (4,800–9,100 feet) of the Imnaha subbasin and is usually dominated by subalpine fir or Engelmann spruce. Other tree species that occur within this WHT include Douglas-fir, lodgepole pine, western larch, grand fir, white bark pine, or white fir. Understory species include grouse huckleberry, big huckleberry, Utah honey suckle, prince's pine, round-leaved violet, and skunk leave polemonium. Succession lodgepole pine and western larch are early seral pioneers of this WHT following disturbance (USFS 1995). This WHT receives an average of 48.0 inches of precipitation a year (Figure 7 and Figure 12).

Eastside Mixed Conifer

This WHT makes up most of the continuous montane forests of the inland Pacific Northwest. It is located between the subalpine portions of the montane mixed conifer forest and the lower tree line ponderosa pine and Forest (IBIS 2003). In the Imnaha subbasin, this WHT is found between approximately 1,000 and 7,200 feet in elevation. These areas receive an average of 33.6 inches a year (Figure 7 and Figure 12).

The Eastside Mixed Conifer WHT of the subbasin is characterized by a wide variety of tree species, which includes seral ponderosa pine, lodgepole pine, western larch, Douglas-fir, and during middle to late seral stages, grand fir and Engelmann spruce. Understory species include big huckleberry, Utah honeysuckle, prince's pine, ninebark, round leaved pyrola, heartleaf arnica, and rattlesnake plantain. Due to past activities, introduced grasses such as timothy orchard grass and mountain brome are also a component of the understory (USFS 1995). Stand structure is diverse, including both single-layered forest canopies and multilayered forests. Stands can be open or closed (IBIS 2003).

Generally, on this WHT early seral forests develop on previously forb and/or shrub dominated communities around 50 years after disturbance. Early seral forest develops into mid-seral habitat of large trees during the next 50 to 100 years. Under natural conditions stand replacing fires would recycle most of the landscape back to an early seral condition but areas that escaped these fires typically, cooler wetter areas would develop into large diameter mature forests (IBIS 2003).

Lodgepole Pine Forests and Woodlands

In most parts of the Columbia Basin, this WHT is located mostly at middle to higher elevations (3,000–9,000 feet). These environments are usually cold and relatively dry, with persistent winter snowpack. Historically, this WHT was a relatively minor component (1%) of the subbasins forests, and it does not exist on the current WHT map (Figure 14). The loss may be in part due to differences in mapping techniques between the historical and current data, but is probably also attributable to the affects of fire suppression (IBIS 2003).

Lodgepole pine WHTs originated with fires. Typically, lodgepole pine establishes within 10 to 20 years after fire. With time, lodgepole pine stands increase in fuel loads. Woody fuels accumulate on the forest floor from insect (typically mountain pine beetle) and disease outbreaks and residual wood from past fires. Under natural conditions a fire eventually, burns the stand and succession is reinitiated. Inland Pacific Northwest lodgepole pine has a mean fire interval of 112 years (IBIS 2003).

Lodgepole pine is dependent on fire to reinitiate growth, since it cannot reproduce under its own canopy. In the absence of fire, lodgepole pine stands are eventually replaced by shade-tolerant conifers. These species, which are common in the undergrowth of most stands, grow up through the understory and eventually shade out the lodgepole pine. This would result in the conversion of the lodgepole pine WHT to Eastside Mixed Conifer Forest. On well-drained, deep Mazama pumice soils in this WHT lodgepole pine is the climax tree species. Lack of natural regeneration on these sites can lead to the creation of “pumice deserts” within otherwise forested habitats (IBIS 2003).

Ponderosa Pine Forests and Woodlands

This woodland habitat typifies the lower treeline zone forming transitions with Eastside Mixed Conifer Forest and Eastside Grassland WHTs. In the Imnaha subbasin, it occurs between approximately 1,000 and 5,900 feet in elevation. These areas receive an average of 19 inches of precipitation a year (Figure 7 and Figure 12).

The Ponderosa pine WHT contains areas where Ponderosa pine is the mature community dominant as well as areas where Ponderosa pine is seral and replaced by Douglas-fir at climax (IBIS 2003). In the hottest driest forested sites of the subbasin, ponderosa pine is the only tree species that can exist. These sites occur on southern aspects at middle elevations or on northern aspects in lower elevations. On low-elevation sites ponderosa pine occurs in narrow stringers along draws. Common understory species include common snowberry, Idaho fescue, bluebunch wheatgrass, pinegrass, and introduced cheatgrass (USFS 1995).

On cooler sites with more precipitation within this WHT ponderosa pine is seral to Douglas-fir. These areas sometimes also support a western larch or grand fir contingent (IBIS). Here common understory species include common snowberry, spirea, ninebark, Oregon-grape, pinegrass, elk sedge and western fescue (USFS 1995).

Natural fire regimes maintained open park-like stands of mature ponderosa pine on this WHT. Fire suppression has resulted in an increase in the prominence of Douglas-fir and higher stand densities (USFS 1995).

Upland Aspen Forest

This WHT type was mapped as occurring historically in the subbasin but is absent from the current WHT maps. Local knowledge indicates that while rare and typically small, quaking aspen stands continue to be an important component of the subbasin's forests. Aspen clones are generally limited to fringes around meadows or as islands in a ridgetop grassland where subsurface moisture is available throughout most of the growing season. Because most aspen stands have been highly modified by cattle and big game use, describing the native community is difficult. Grasses and sedges occurring in better condition stands include pinegrass, elk sedge, Hood's sedge, Kentucky bluegrass, and mountain brome. Major associated species include leafy aster, showy fleabane, sticky cinquefoil, paintbrush, lupines, penstemons, blue stickseed, and meadowrue (USFS 1995).

Subalpine Parkland

The Subalpine Parkland habitat represents the highest elevation habitat in the subbasin able to support trees. It is very cold, with a very short growing season and high snow levels. Tree species found on these sites are whitebark pine and subalpine fir. Tree canopy cover on these sites is sparse, usually between 10 and 30%. Trees are distributed either as isolated trees or in small groups. Understory species can include grouse huckleberry, Parry's rush, and green fescue. Large rock and talus slopes can be prominent landscape components (USFS 1995).

Alpine Grasslands and Shrublands

The climate of this WHT is the coldest of any in the subbasin. Conditions are extreme with a short growing seasons, high snow levels and intense winds (USFS 1995). Blowing snow and ice

crystals on top of the snow pack at and above treeline prevent vegetation such as trees from growing above the depth of the snow pack (IBIS 2003). In the Imnaha, this WHT is found between 5,100 and 9,600 feet in elevation. It receives an average of 64 inches of precipitation per year (Figure 7 and Figure 12). Historically, it occurred adjacent to, or in a mosaic with, Subalpine Parkland but now abuts Montane Mixed Conifer Forest (IBIS 2003).

Green fescue plant communities dominate much of the Alpine Grassland and Shrubland WHT in the subbasin. Under natural conditions, late seral stands of green fescue will form dense mats of almost continuous sod virtually free of forbs (USFS 1995). The green fescue communities of the Imnaha subbasin were severely overgrazed by sheep in the late 1800s and early 1900s (Reid, Johnson and Hall 1991). This resulted in severe erosion of topsoil and the replacement of much of the green fescue by Letterman's needlegrass (*Stipa lettermanii*) and Western needle grass (*Stipa occidentalis*). Dramatic reductions in sheep grazing in the subbasin between 1900 and 1960 resulted in improved conditions. By 1988, concentrations of needlegrass and forbs had decreased and green fescue had increased. Slender wheatgrass, prairie junegrass (*Koeleria cristata*), and timber oatgrass (*Danthonia intermedia*) began to occupy what had been bare patches between the Idaho fescue clumps. Forbs that continue to be associated with these sites include Wyeth's buckwheat (*Eriogonum heracleoides*), fleeceflower (*Polygonum phytolaccacefolium*), Nuttall's lianthastrum (*Linanthes nuttalli*) (Reid, Johnson, and Hall 1991), and spurred lupine (*Lupinus laxiflorus*) (USFS 1995). Conditions continue to improve on the green fescue grasslands of the subbasin, although evidence still remains of past overuse with areas of erosion persisting (USFS 1995).

Eastside Grasslands

Eastside Grassland WHT occurs in the lowest elevations of the subbasin. These sites receive an average of 20 inches of precipitation a year (Figure 7 and Figure 12). The majority of grasslands in the subbasin are dominated by Idaho fescue or bluebunch wheatgrass association (USFS 1995). Characteristics of the major grassland associations found in this watershed follow.

Idaho Fescue–Prairie Junegrass (*Festuca idahoensis*–*Koeleria cristata*)

Idaho fescue–prairie junegrass associations are among the most productive in the watershed producing between 990 and 1,200 pounds per acre. They occur at a wide range of elevations and on all aspects. Associated plant species include bluebunch wheatgrass, Sandberg bluegrass, and rattlesnake brome, as well as forbs such as arnica, geum, red besseya, wild hyacinth, frasera, hawkweed, lupine, Wyeth's buckwheat, gumweed, yarrow, and paintbrush. Degraded areas can be invaded by annuals such as bromes, red threeawn, chickweed, arnica, annual fescues, and goat weed. Disturbance may also result in replacement of Idaho fescue by Kentucky bluegrass on deeper soils (USFS 1995).

Idaho Fescue–Bluebunch Wheatgrass (*Festuca idahoensis*–*Agropyron spicatum*)

These plant associations occur up to 6,000 feet in elevation on all aspects depending on the particular association. Associated plant species included prairie junegrass, Sandberg bluegrass, rattlesnake brome, one spike oat grass and forbs such as silky lupine, deerhorn, willowweed, balsamroot, hawksbeard, fleabane, and phlox. Production in the deeper soil types averages between 600 and 805 pounds per acre; on ridgetops, production is lower, at 360 pounds per acre (USFS 1995).

Bluebunch Wheatgrass–Sandberg Bluegrass (*Agropyron spicatum*–*Poa sandbergii*)

The bluebunch wheatgrass–Sandberg bluegrass association produces an average of 685 pounds per acre. Associated species include lupine, yarrow, balsam root, and annual bromes. On highly disturbed sites cheatgrass will invade aggressively and may form continuous pure stands.

Bluebunch Wheatgrass–Wyeth’s Buckwheat

Bluebunch wheat grass–Wyeth’s buckwheat plant associations are found at moderate elevations in the watershed and produces an average of 420 pounds of forage per acre. Associated plant species include sulfur buckwheat, pine bluegrass, oniongrass, and forbs such as yarrow, penstemon, lupine, lomatium, balsamroot, frasera, and paintbrush (USFS 1995).

1.1.1.10 Human Influences on Natural Resources

The use of natural resources and associated population of lands within the Imnaha subbasin has been relatively minimal, when compared with that which has taken place in similar sized subbasins throughout the Columbia Basin. Peak periods of land use in the Imnaha coincide with the introduction of domestic livestock, establishment of a transportation infrastructure, and advancements in industrial technology. The relative remoteness and ruggedness of the subbasin has precluded it from much of the development and/or population common to similar subbasins. Land use activities most commonly cited as producing a measurable impact on fish and wildlife communities in the Imnaha subbasin include grazing, roads and road building, timber harvest, agriculture, and to a lesser extent, water development and mining.

Population of the Subbasin—Historical and Current

In the late 1700s, events in eastern North America set the stage for the changes about to commence in the Imnaha subbasin, and in the Pacific Northwest. After signing the Declaration of Independence in 1776, a newly formed nation of states along the eastern seaboard looked westward for expansion possibilities. Exploration of the recently acquired Louisiana Purchase in the early 1800s led Meriwether Lewis and William Clark into the largely unknown Oregon Country and ultimately to the mouth of the Columbia River. Early reports of vast and valuable natural resources prompted a westward migration of immigrants, some who eventually settled in the Imnaha subbasin.

In 1878 the first permanent white settlers in the Imnaha established residence just south of the present town of Imnaha (Mays 1992). Homesteaders and associated livestock production were soon to follow, especially along the gentler slopes and benchland areas. These regions, which coincided with many of the areas previously occupied by the Nez Perce, were primarily public domain lands (USFS 1998d). Passage of the Timber and Stone Act, coupled with railroad construction in the late 1880s, initiated the first nonagricultural resource use in the Imnaha subbasin and stimulated further development of ranches and farms in the valleys (Duncan and Cawthorn 1994).

As more settlers entered the Wallowa Valley, their grazing operations were expanded throughout the region. This expansion included some of the more remote areas along the Imnaha and Big and Little Sheep creeks (USFS 1995). By 1881, the Pallette Ranch area (formerly Fruita, OR),

represented one of the more upstream regions of the mainstem Imnaha where settlers established residency and livestock operations.

Early accounts of locations of schools and/or school districts provide insight into settlement patterns and population densities in the Imnaha. Government Land Office records describe the establishment of the Bridge School District No. 11 at the present site of the town of Imnaha in 1884 (USFS 1998d). The Bridge is the only remaining school district presently in operation in the subbasin. Other districts historically in the subbasin included District No. 9, located on the divide between Twobuck and Coyote creeks (out of the subbasin), District No. 15, located near the present site of the old Midway stage stop on the Zumwalt Road, District No. 53, located in the head of Camp Creek between Harsin and Findley Buttes, District No. 73, located on Clear Lake Ridge, and District No. 89, located on Marr Flat (Government Land Office records presented in USFS 1995). Government Land Office data indicate a period of rapid population growth in the subbasin between 1881 and 1889. However, by 1949, the only remaining school district in the subbasin was the Bridge School District. This was due to several factors including improved transportation networks, changes in population distribution, and shifts in agricultural production.

Based on Government Land Office data analysis, early homesteaders preferred lands in or near stream valleys to uplands or ridge tops (USFS 1995). This preference was also shared by the Nez Perce and is evident today. The selection of lands is clearly based on resource abundance and quality, as the upland areas tend to have less water and thinner soils than in the valleys. The early settlers rapidly exploited riparian areas, meadows, and any other lands near the homestead that could potentially be used in the production of livestock or agricultural commodities (Wallowa County and NPT 1993). The Wallowa National Forest Atlas reveals that, by 1917, the bottoms of Big and Little Sheep creeks had all been claimed (USFS 1995).

Regardless of location, the early settlers in the Imnaha were mainly subsistence oriented (USFS 1995). They generally maintained a few head of livestock, farmed tillable lands within the boundaries of their homestead, and built cabins from locally available materials, which were often large diameter logs from adjacent timber stands. Crops of hay or grain were raised for livestock feed, and were often grown on the bars adjacent to the stream channel (USFS 1995). Dryland farming occurred to a limited extent on upland and bench areas, as did irrigated agriculture near streams (USFS 1995). Because of the limited transportation network, the incentive to grow surplus crops was limited. Orchards were established in the immediate vicinity of the homesteads, many of which still exist.

The homesteaders soon found the Imnaha country to be less hospitable than originally perceived. The remoteness and difficulty in obtaining supplies and getting animals to market, coupled with a depression of livestock prices and harsh winters in 1918 and 1919, were too much for many of the small operators to bear (USFS 1998d). By 1919, only 5% of the original homesteaders remained on their claims on the Wallowa National Forest (Straton and Lindeman, as cited in USFS 1995). Some of the 160-acre homesteads reverted back to federal ownership, while the more established, larger livestock operators purchased the remainder.

Current commercial development in the Imnaha subbasin is restricted to the small town of Imnaha (population 25), which consists of a cafe, store and tavern, gas station, motel, and GTE

field office (USFS 1998d). Community buildings include an elementary school (the historical “bridge” school), library, post office, and church. There are also home-based businesses and a privately owned lodge and outfitter and guide services.

Private residences are scattered along the river corridor, including the Imnaha River Woods subdivision, a housing development located near the upper third of the drainage. Hydrologists have expressed concern over the amount of bank armoring adjacent to dwellings and structures, fearing that the riprap will alter downstream flow regimes and channel morphology (T. Carlson, Wallowa-Whitman National Forest, personal communication, April 12, 2001). Current land use regulations passed by the Wallowa County Planning Commission restrict the sale of land for subdivision. In general, the pattern of settlement and use of private land within the watershed has not changed much since the 1940s, and many descendants of the original settlers still reside in the Imnaha Valley.

Grazing

The first domestic livestock to be grazed in the Imnaha were owned by the Joseph band of the Nez Perce. The tribe first grazed horses in the canyon lowlands circa 1730–1750. The Nez Perce acquired cattle sometime after 1840 (Wallowa County and NPT 1993) and began grazing them with their bands of Appaloosa (Mays 1992). It is estimated that the Nez Perce were grazing as many as 500–650 head of cattle in the Imnaha by the late 1840s (Chalfant 1974; Womack 1996, as cited in WWNF 1998). By 1877, the tribe was running between four and five thousand head of livestock in the lowlands (Skovlin and Thomas 1995).

The Imnaha subbasin (and most of Wallowa County) was one of the last areas in Oregon to be settled by Euroamerican livestock producers (Wallowa County and NPT 1993). Its remoteness and rugged topography caused most westward-bound stockmen to bypass or ignore the area. Upon their eventual discovery of the Imnaha, the early settlers contributed considerable numbers of domestic livestock to Indian herds and effectively diluted the once dominant Nez Perce stock. Although some of the settlers attempted to raise livestock for profit, the majority relied on cattle, sheep and horses for subsistence purposes. Cattle and sheep were raised for food and clothing, while horses were generally raised for power and transportation.

Shortly following the Nez Perce Tribe’s exile from the Imnaha, the settlers brought large numbers of sheep to the subbasin, augmenting the already growing number of domestic ungulates. The number of sheep and cattle continued to grow through the 1890s and into the 1900s. Cattle were emphasized initially, but by 1911 were far outnumbered by sheep (Figure 15) (WWNF 1995). While it is unknown whether the data in Figure 15 represent actual or permitted livestock, it is known that the data are for animals on National Forest lands only and do not include livestock operations within the private sector. Numbers of livestock during the late 1890s and early 1900s therefore likely exceeded those shown in 1911 (WWNF 1995).

Sheep were grazed heavily in the Imnaha subbasin from the early 1890s until around 1920 (Mays 1992, Skovlin and Thomas 1995, WWNF 1995). Concern for the condition and loss of range arose during the early 1900s, and resulted in the institution of grazing restrictions by the USFS in 1910 (Mays 1992).

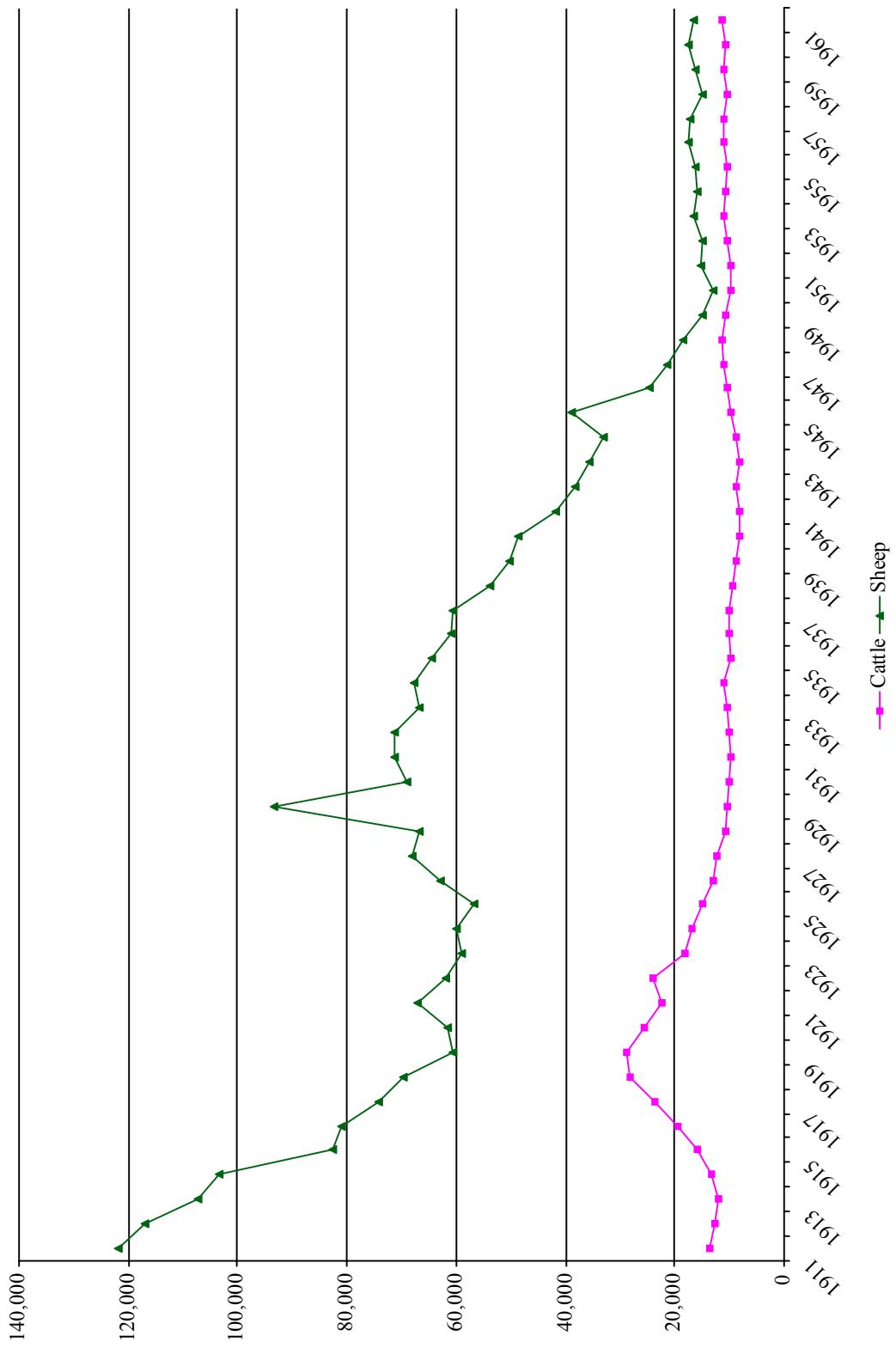


Figure 15. Historical livestock numbers on the Wallowa National Forest (WWNF 1995).

The legacy effects from grazing practices of the late 1800s and early 1900s caused intense competition for grass between the livestock operators. Soon all the best or most accessible ranges and pastures were overgrazed (Wallowa County and NPT 1993). By 1930, most riparian areas had lost their native grasses and woody vegetation (Wallowa County and NPT 1993). Defoliation of ridges, upland meadows, and side hills contributed to excessive sedimentation in stream channels during spring runoff and following summer storm events and caused many of the streams to “run brown with mud” (Wallowa County and NPT 1993).

Concern for the land by livestock producers who had seen the Imnaha in its prime soon mounted. Associations were formed, and with the assistance of the USFS, grazing in the subbasin was reduced. As stated by Wallowa County and the Nez Perce Tribe (1993), “only the people present during the years of fierce competition for rangeland can appreciate the improvements that have occurred since the early thirties.” The improvements were driven in large part by passage of private and federal land regulations in 1994 and again in 1997 that set forth certain rules governing land use activities and development. Within the regulations was a record of decision signed in 1995, which formally terminated sheep grazing in the subbasin. The primary goal of the removal of sheep from the area was to reduce potential interaction between domestic and bighorn sheep. The HCNRA was grazed through the 1996 season, at the end of which all allotments occurring in the area became vacant. The Eagle Cap Wilderness Area was grazed through the end of the 1998 season and became vacant in 1999 (D. Bryson, Nez Perce Tribe, personal communication, May 2001).

Livestock, specifically sheep, grazing public ranges have been reduced to 15% of the highest number grazed historically (Wallowa County and NPT 1993). Currently there are 27 active allotments (Figure 16) and 5 administrative horse pastures within the Imnaha watershed. Term grazing permits issued to individual permittees specifies the authorized number of livestock and period of use to be grazed within the allotment. The allotments may be divided into various pastures through which the livestock are rotated. See Appendix B for more details on the number of livestock and season of utilization of the allotments in the Imnaha subbasin. The allotments support grazing at a level of approximately 37,900 animal unit months (Mays 1992).

Management approaches designed at improving vegetative cover, retaining soil and protecting streams are employed by both the USFS and permittees (WWNF 1999). A downward trend in AUMs has occurred in recent years and an upward trend in the number of cross fences, exclosures and off-stream water developments constructed in or near riparian areas. The Wallowa-Whitman National Forest has recently excluded 3 miles of stream (a total of six miles of fence) from livestock, and has completed 38 upland exclosures, ensuring protection of springs, seeps, wetlands, intermittent draws, perennial nonfish-bearing streams, ephemerals, and ponds (J. Platz, Wallowa-Whitman National Forest, personal communication, May 2001). The USFS has also planted coniferous and deciduous trees along 19 miles of stream channel.

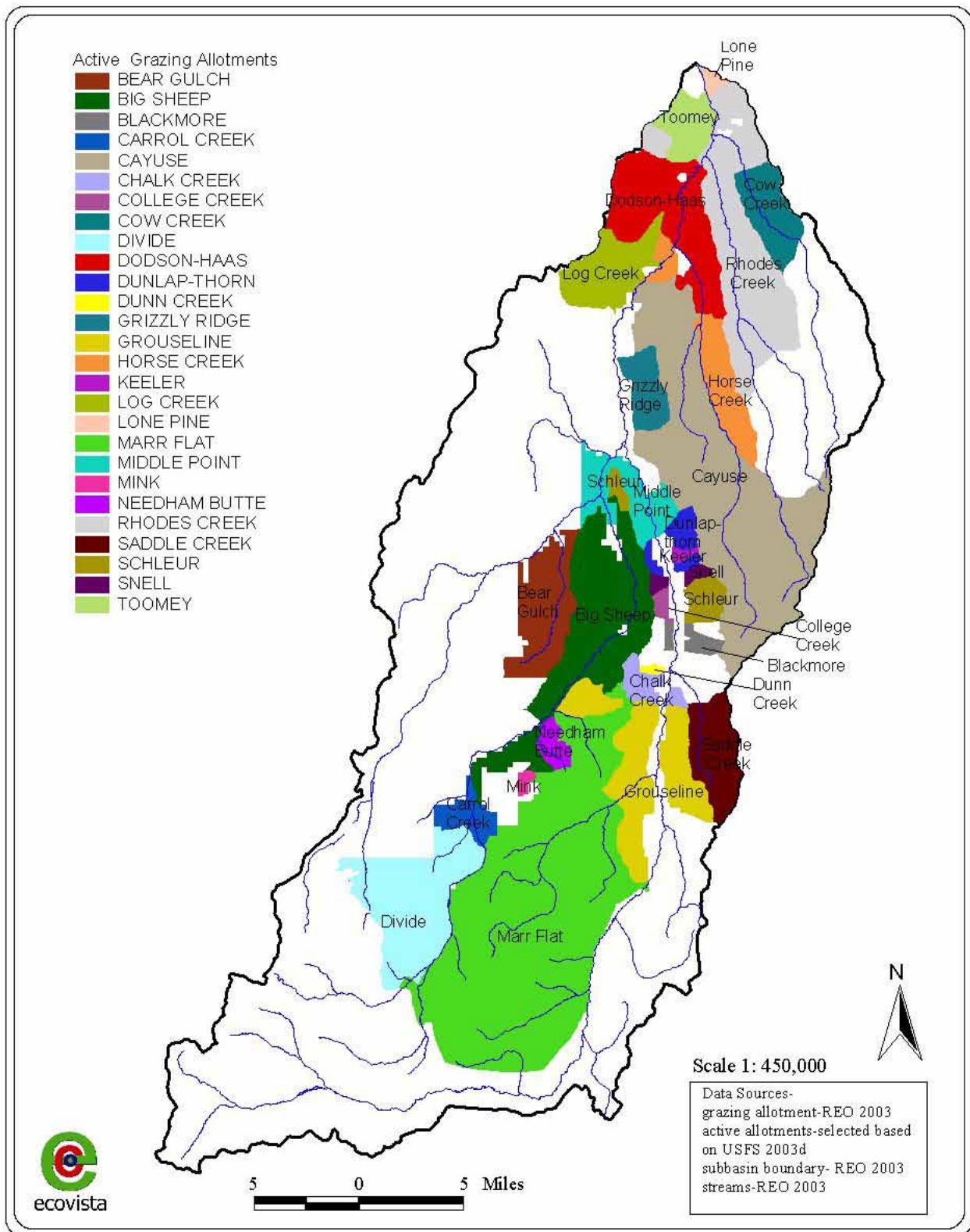


Figure 16. Active grazing allotments in the Imnaha subbasin.

Despite restoration efforts, legacy effects from the extensive historical grazing pressure in the Imnaha persist and can still be seen around seeps, springs and some stream segments where the native fescue plant communities were removed, streambanks disturbed, and soil compacted (WWNF 1998, Ashe et al. 2000). Grazing and cattle allotments in the Grouse, Big Sheep and Little Sheep watersheds have contributed to reduced water quality (increased nutrients) and fish habitat degradation (reductions in shade-providing vegetation). Feedlots, located on private lands along Little Sheep Creek and the upper and lower mainstem Imnaha, contribute varying amounts of nutrients to surface water (NPT et al. 1990), most notably following localized, high-intensity thunderstorms (B. Smith, ODFW, personal communication, April 12, 2001). The impacts of this pollution on the aquatic environment are, however, considered to be short in duration and scope due to the volume and velocity of flows in the affected areas (B. Smith, ODFW, personal comm

Transportation

Transportation systems in the Imnaha have developed in response to population growth and associated supply and demand for goods and services. The extent of the transportation network has, however, been limited by the remoteness and ruggedness of the drainage. Roads established along the mainstem Imnaha River, Big Sheep and Little Sheep creeks during early settlement remain in use today, although they have been improved.

The Joseph band of the Nez Perce Tribe was the first to construct transportation networks in the Imnaha. Their trail systems, which were built along stream channels, ridges, and hillslopes, provided access to hunting, fishing, and root gathering areas (Haines 1955). The Nez Perce trails were often dirt paths clear of vegetation. They also used fire to aid in travel corridor maintenance and construction (e.g., Haines 1955, USFS 1995).

Homesteaders who had settled in the subbasin in the late 1800s constructed roads in areas that required the least development, such as along ridgetops or stream bottoms (USFS 1998b). The early settlers also relied on the preexisting Nez Perce trail system to access hunting and grazing (sheep) areas in the higher-elevation portions of the subbasin (USFS 1998d). There were two primary dirt roads/trails in and out of the town of Imnaha at this time; one connected Imnaha with Joseph and Enterprise via Findley Buttes, Trail, Camp, and Big Sheep creeks, while the other road followed the main channel upstream to the Pallette Ranch area and then on up to Joseph. Because of limited use and narrow size neither road likely represented significant risk to Imnaha fisheries or fish habitat (Mays 1992).

Early roading in the Big Sheep Creek subwatershed began in 1902 with the construction of a stage route from what is now the Zumwalt road to the Midway stage stop, and eventually to the town of Imnaha (USFS 1995). A road from the Divide area to Salt Creek Summit, and eventually to Tenderfoot Mine in the Eagle Cap Wilderness was also constructed circa 1902–1905, connecting the upper portions of the Big Sheep Creek subwatershed to the Wallowa Valley (USFS 1995).

Early transportation systems were not limited to roads. A considerable demand existed for a Snake River travel corridor to be established between Lewiston and the Eureka Mine, a claim staked in 1898 downriver from the mouth of the Imnaha (for information about mining, see p. 57). The copper ore smelted at the site represented a potentially lucrative commodity to downriver interests, and justified the construction of steamships capable of navigating the

“writhing” Snake River from Lewiston to the Imnaha (Carrey et al. 1979). The steamer *Imnaha* was built to service the Eureka Mine with supplies for construction and mining operations, and made fourteen successful trips from Lewiston to the mine before sinking in 1903. The loss of the *Imnaha* was significant since the ship was carrying machinery essential for the mills operation. The Eureka Mine subsequently shut down circa 1906 (Carrey et al. 1979).

The Enterprise/Joseph area was connected to Wallowa and La Grande, Oregon, in 1909, following completion of the Enterprise Line of the Union Pacific Railroad (Wallowa County and NPT 1993). This provided a market for large tracts of virgin timber present in Wallowa County. Railways were also used to access Wallowa County forests and transport the logs to nearby mills (Wallowa County and NPT 1993). Completion of the railroad also greatly influenced the development of the agricultural economy by providing farmers and ranchers a railhead from which to quickly and efficiently move livestock, grain and other produce to Northwest markets (USFS 1995).

Improvements to the Midway/Imnaha stage line occurred circa 1905–1910 (USFS 1995). The new road followed the Little Sheep Creek channel, roughly paralleling the course of the present Imnaha Highway. Construction of this road is significant since it laid the foundation and general location for State Highway 350, which is considered to have significant effects on channel function, hydrology, and fish habitat quality and quantity of Little Sheep Creek (e.g., USFS 1994a; 1995; 1998a). The 1905–1910 road also opened up more portions of the subbasin for development, as it deviated considerably from the location of the original road, as shown in the following quote (USFS 1995):

Turning up Rail Canyon, the track crossed the head of Threebuck Creek, down Coyote Creek to Big Sheep Creek, thence up Big Sheep for approximately 4.5 miles. The road then switchbacks up the steep slope to Marr Flatt, across Marr Flatt to Road Canyon, down the bottom of this draw to Grouse Creek, and then down the bottom of Grouse Creek to the Imnaha River. It is hard to imagine this road being less tortuous than the Midway stage road.

In 1935, the Little Sheep Creek road to Imnaha was opened to the public. In the late 1950s and early 1960s, Oregon State Highway 350 was paved.

Development and improvement of existing road networks elsewhere in the Imnaha occurred between the 1940s and 1960s (Mays 1992, Wallowa County and NPT 1993). The era is described as one of “massive road building” for timber harvest in Wallowa County (Wallowa County and NPT 1993). Roads were paved, widened, and networks expanded to provide access to timber sales, pastures for grazing, and areas for ranch development. Although the relative density of road networks was low, some of this construction came at a cost to the environment. A common road construction practice by the USFS and other entities was to sidecast the excess or “overburden” material as the road was being built (Mason et al. 1993). Invariably, much of this material would enter stream channels due to the inherently steep gradient common to the drainage. For example, during the winter of 1952–1953, road construction activities along the Imnaha River (Road 3955) triggered a rockslide approximately 15 miles above the town of Imnaha. The deposition of material posed a serious barrier to fish migration, albeit partial, for at

least two years (Beamesderfer et al. 1996). The USFS now endhauls this material to designated dumpsites (Wallowa County and NPT 1993).

From the late 1970s to 1985, the miles of road constructed on the Wallowa-Whitman National Forest doubled from 4,350 miles to over 8,700 miles (McIntosh et al. 1994). Currently, 1,292 miles of open and closed roads exist in the Imnaha watershed (USFS 2000). Of these, 834 miles occur on lands administered by the Wallowa-Whitman National Forest, and 438 miles occur on private, state, and Bureau of Land Management (BLM) lands (USFS 2000) (Figure 17).

The overall road density for open and closed roads (all management jurisdictions) is 1.52 miles of road per square mile of land (USFS 2000). On that portion of the watershed not administered by USFS, the road density (open and closed) is 1.53 miles of road per square mile, compared with USFS-administered land where it is 1.57 miles per square mile (land area includes unroaded wilderness). Road densities in USFS-managed *nonwilderness* areas may be higher than in other areas of the watershed. Generally, road densities on federally administered lands fall within the Forest Plan Standards and Guidelines of fewer than 2.5 miles of open roads per square mile of land.

In two subwatersheds of the Imnaha, road densities are considerably higher than the road density for the watershed as a whole (USFS 1998b). The Gumboot subwatershed has 3.2 miles of open road per square mile of land, while the upper Imnaha (near RM 55) subwatershed has 3.66 miles of open road per square mile of land (see section 1.5.2 for details).

Sections of the upper and lower Imnaha River road that were built in the floodplain or along unstable areas directly above the channel have contributed to problems throughout the drainage. Road failures, landslides, sedimentation, channelization, and reduction/elimination of riparian habitat are among the effects the upper and lower Imnaha road have had on aquatic resources (e.g., Thompson and Haas 1960; Mays 1992; USFS 1998a,b). The Imnaha road infrastructure was considerably disrupted following the 1997 flood event, necessitating reconstruction efforts throughout much of the subbasin (USFS 1998b). As a result of the 1997 flood, sections of the USFS Road 39, upper and lower Imnaha River Road (county jurisdiction), associated bridges, and adjacent residential property were damaged. The county roads and bridges have since been reconstructed. This often involved riprap, rechannelization of the Imnaha River, and rock barb placement (USFS 1998).

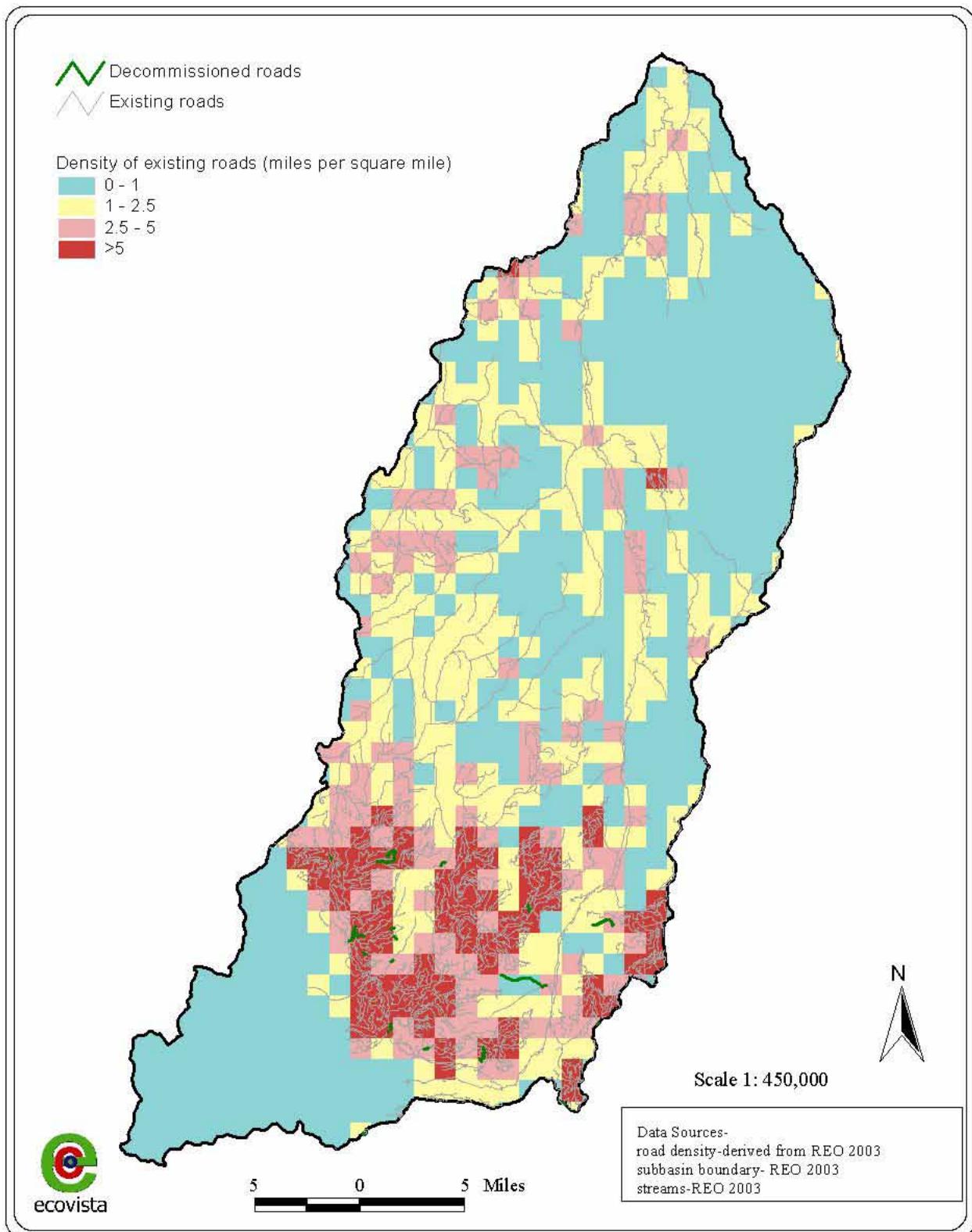


Figure 17. Road densities in the Imnaha subbasin.

Because of the scale of the 1997 flood, much of the repair work was designed to fortify the infrastructure in anticipation for the occurrence of an event of similar magnitude. This work, combined with the permitted and nonpermitted reconstruction/protection efforts by local landowners has detrimentally influenced channel morphology and hydraulics in some areas of the subbasin (e.g., USFS 1998b). Because of its Wild and Scenic Status, the Imnaha should be managed to flow unregulated (USFS 2001). Flood damage reparation and preventative maintenance by landowners has necessitated enforcement action by the Environmental Protection Agency on at least one occasion (USFS 2001).

In response to sedimentation, wildlife harassment, and access concerns, the USFS has closed, decommissioned, relocated, and restricted access on several roads and/or road segments on federally administered lands. In 1990 and 1991, the Wallowa-Whitman National Forest closed 6.4 miles of road, obliterated 3.0 miles, and seeded 26 acres of roadbed (USFS 1998a). Road-obliteration projects have occurred in the Ferguson, Big Sheep, and West Fork Carroll creek subwatersheds. Many of the decommissioned roads were located in draw bottoms where timber was skidded to landing areas. Road relocation and reconstruction projects, designed to ameliorate sedimentation to streams, have occurred throughout the subbasin, including a five-mile section of USFS Road 3900 between the Imnaha River and Lonesome Saddle (USFS 2000). Road 3900 was completely rebuilt following the 1997 flood. Seasonal road use restrictions between October and December are implemented to protect soils and wildlife habitat, minimize harassment of wildlife, maintain adequate bull [elk] escapement, and promote quality hunting. These seasonal restrictions, otherwise known as Cooperative Travel Management Areas or Green Dot Closure Areas, are those roads *not* marked by a carbonite stake with a green dot at the road intersection.

Since 1989, USFS road maintenance has been performed every one to seven years, depending on circumstances and road use (USFS 1998b). In 1990, a full-time position was established at the Wallowa Mountains Engineering Zone to coordinate the Access and Travel Management Program, including annual maintenance (USFS 2000).

Timber Harvest

Euroamericans have harvested timber across most of the forested parts of the Imnaha since their arrival to the subbasin in the middle to late 1800s. The timber in Wallowa County has been logged over at least once—and much of it as many as three times (Wallowa County and NPT 1993).

The amount of timber cut by the early Imnaha settlers was minimal, primarily because of the lack of an established transportation system. Timber to be used in cabin, barn, and corral construction had to be felled relatively local to the homestead or during winter since the early pioneers lacked sufficient transportation networks and power to log remotely. As described in *The History of Wallowa County* (as cited in Wallowa County and NPT 1993),

The usual procedure...was to fell the trees and buck them into lengths usually of 16 feet six inches, skid or drag them with a team of horses to a sled road, then load them on to a sled pulled with one or more teams of horses.

The early logging practices removed essentially all mature and high-grade ponderosa pine, Douglas-fir, and western larch (Wallowa County and NPT 1993) growing in or near homestead

locations. Similarly, much of the mature, high-quality riparian timber floatable to downstream locations was harvested during this era (National Research Council 1995). To meet community needs, small-scale milling operations were located in the more populated areas of the subbasin; however, due to the limited transportation network, it was not realistic or profitable to mill more than was locally demanded (Wallowa County and NPT 1993, USFS 1995).

Development of the Eureka Mine and townsite in the early 1900s required timber harvest. A sawmill, purchased in Portland, Oregon, was set up and cut a reported 350,000 board feet of lumber for construction of the smelter and other camp buildings (Carrey et al. 1979). This included a two-story hotel, grocery store, post office, and the smelter. Local ranchers salvaged timbers from the Eureka site following its closure in 1906 (Carrey et al. 1979). The USFS bought the remaining lumber and used it for trail bridge construction.

With the arrival of the railroad to Enterprise in 1909, the market for locally harvested timber suddenly expanded. This expansion was also driven by the construction of timber mills in Minam, Wallowa, and Enterprise during the following two decades (Wallowa County and NPT 1993). The East Oregon Lumber Company, located in Enterprise, became operational in 1916 but was totally destroyed by fire in 1919. A new mill was constructed and became operational in the mid-1920s. Forests in the Imnaha subbasin, and specifically those in the Sheep Creek subwatershed, contributed timber to the estimated 300 million board feet cut in Wallowa County between 1910 and 1930 (Wallowa County and NPT 1993). It was also during this era that many of the mature and high-grade tree species were harvested, leaving behind species of little economic value at the time, such as grand fir, lodgepole pine, subalpine fir, and Engelmann spruce (Dunn et al., as cited in Wallowa County and NPT 1993).

Advances in timber harvest technology (specifically tractor skidders) were determinant factors during the 1930s and 1940s. Tractor skidders came into use in the late 1930s and early 1940s, replacing the slower and less powerful horse logging systems of the 1910s and 1920s (USFS 1995). Although the tractor skidders were capable of moving greater volumes of timber, they were underpowered and, like horse logging, required draws or gentle downhill slopes for skidding. The heavy tractor, combined with the compactable soils of the moist draws, often caused water quality problems, which were given little consideration until the late 1960s (USFS 1995). A partial list of significant timber harvest activities during the 1940s within the Big Sheep Creek subwatershed is shown in Figure 18.

Even-aged timber management practices gained momentum in the late 1950s in response to the increased demand for timber products (USFS 1998b). Clearcutting, shelterwood cuts, seed tree cuts, and regeneration cutting were common harvest methods applied on National Forest lands, including the Gumboot, Nesbit Butte, Blackhorse Ridge, and Harl Butte areas (USFS 1998b). The first prescribed clearcut in the subbasin was implemented in the Gumboot Butte area in the late 1950s (USFS 2000). Extensive commercial harvest operations in the Big Sheep Creek subwatershed were also initiated in the 1950s, and they included selective harvest and partial removal of overstory trees (USFS 1998a).

The momentum initiated during the 1950s continued into the next decade (Figure 19), as an estimated 20% of the basin contained saw lumber in 1960 (OWRB 1960, as cited in Beamesderfer et al. 1996). Timber harvest was designed in part to “manage” the condition of

stands on Wallowa County National Forest lands. Three decades of previous management had produced overstocked, nondiverse, and even-aged forests. Imnaha timber was described by Boise Cascade foresters as “a mixture of second-growth ponderosa pine, somewhat mixed age classes of Douglas-fir and Western Larch (tough heavy to second growth), even-aged stands of Lodgepole pine and Grand Fir, and Engelmann Spruce ranging from old growth to very young stands to multi-aged stands” (Dunn et al., as cited in Wallowa County and NPT 1993).

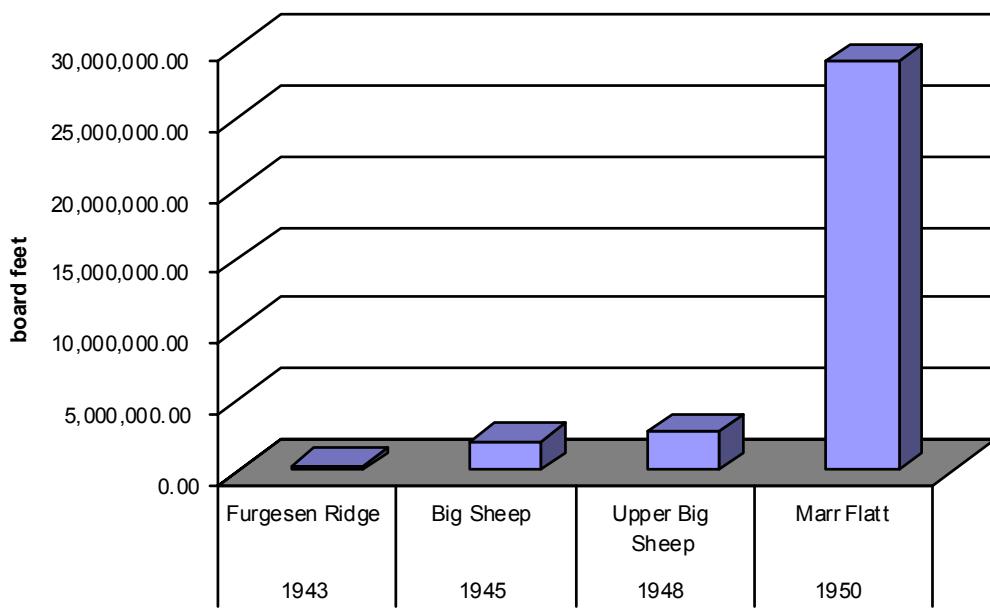


Figure 18. Volumes of timber harvested from significant sales in the Big Sheep Creek watershed (1943–1950) (data presented in USFS 1995).

Regeneration cutting continued in the Big Sheep Creek drainage in the 1970s (USFS 1998a). The scale of cutting was considerably greater than it was for the previous decade and entailed primarily shelterwood and seed tree type cutting. Regeneration cutting also occurred between the Gumboot Creek watershed and Harl Butte (USFS 1998b). Establishment of the HCNRA in 1975 (PL 94-199) significantly modified harvest practices in 68% of the subbasin. Uneven-aged harvest techniques were imposed on the areas where harvest was permitted (USFS 1998b). These restrictions were, and continue to be, designed to protect and enhance wildlife habitat, recreation, or scenic values.

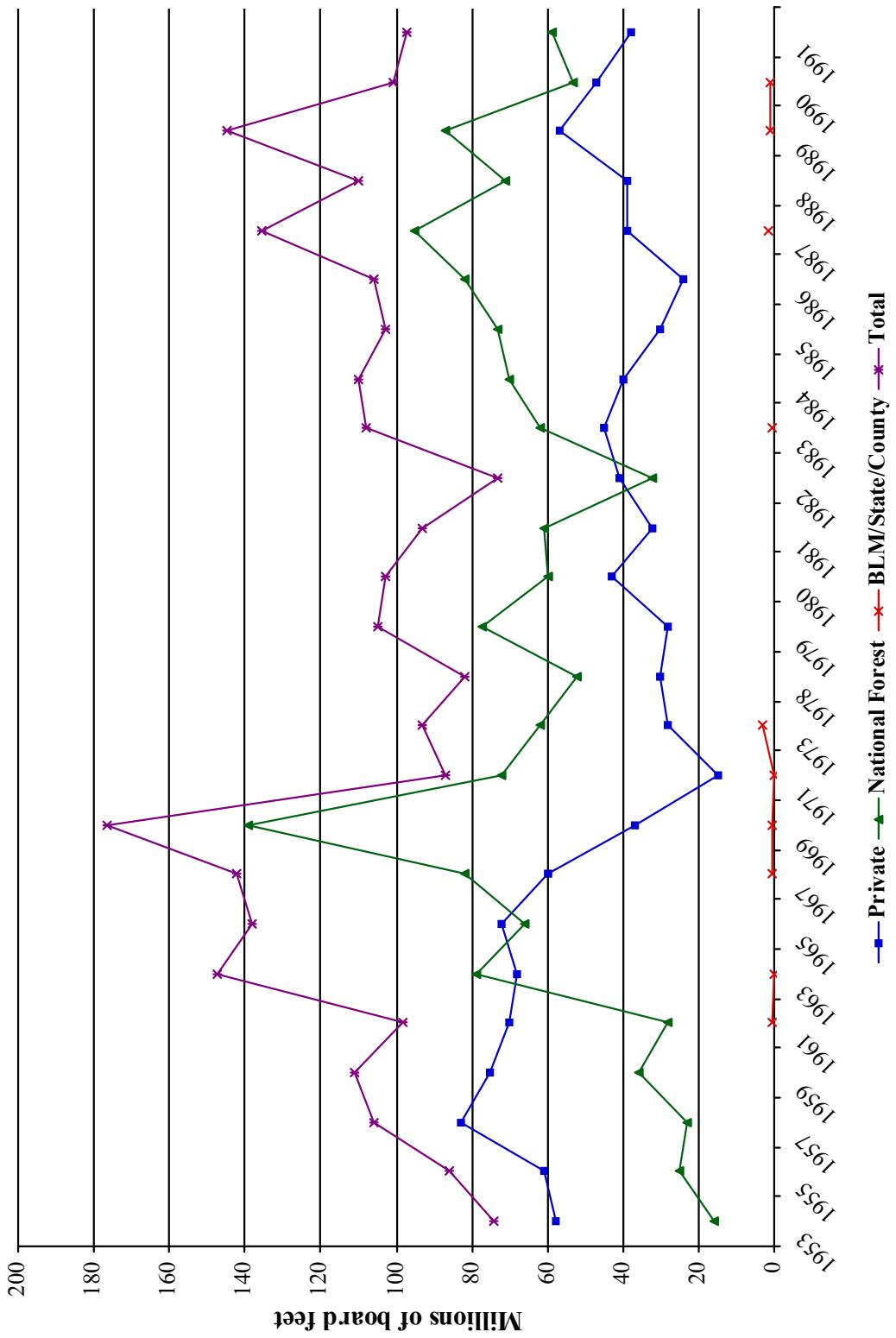


Figure 19. Wallowa County timber harvest (*Wallowa County Land Use Plan* and *State of Oregon Timber Harvest Report*, as cited in Wallowa County and NPT 1993).

Insect infestation, wildfire, and salvage logging were common themes of the 1980s. Timber throughout the entire subbasin was affected by a widespread infestation of the Engelmann spruce bark beetle in the early 1980s (USFS 1998a; 1998b). Salvage logging of the timber killed or damaged by the beetle and by subsequent windthrow occurred at an extensive scale from 1982 to 1987 (USFS 1998b). Timber continues to be salvage logged in response to bark beetle infestations, although techniques differ from those two decades prior. In 1989, a large wildfire (the Canal Fire) prompted salvage logging of burned timber on several thousand acres in the Sheep Creek drainage. Total area harvested within the Big Sheep Creek watershed between 1989 and 1992 was approximately 10,791 acres, 2,003 of which were clearcut and 8,788 of which were partial cut (USFS 1998a).

A switch from commodity production to natural resource management and conservation defined the 1990s. Timber harvest on the Wallowa Whitman National Forest had declined from nearly 80,000 million board feet in the late 1960s, to 1,200 million board feet in the 1990s (USFS 1998d). The change was largely driven by federal legislation designed to protect and enhance ecosystem health, in response to precipitous declines in fish and wildlife populations. Prior actions, such as the establishment of the Eagle Cap Wilderness in 1964, the designation of the HCNRA in 1975, and designation of the Imnaha as a Wild and Scenic River in 1988, had already limited timber harvest in the subbasin. Endangered Species Act (ESA) listings for chinook salmon in 1992, 1994 federal land use regulations, ESA listings for bull trout in 1998, and various high priority watershed designations combined to drastically reduce timber harvest on USFS lands within the Imnaha River watershed. Between 1989 and 1997, the total acreage harvested from the subbasin (excluding the Sheep Creek subwatershed) was approximately 1,127 acres, of which only 14 acres were clearcut and 822 partial cut (USFS 1998b). In 1992, all clearcutting in the Imnaha was eliminated on National Forest lands, and the practice of salvage logging insect-infested trees was modified. In 1994, federal land use regulations were established, establishing standards for the management, utilization, and disposal of natural resources by timber harvesting (36 CFR Ch. 11, 292.46). The 1994 regulations stipulate that timber may only be harvested to protect and enhance ecosystem health, wildlife habitat, or recreational and scenic uses and that trees may only be selectively harvested. In 1994–1995, the *Regional Forester's Eastside Forest Plan Amendment* formally prohibited timber harvest in riparian habitat conservation areas. In 1998, the Forest Supervisor issued a two-year moratorium on timber harvest, other than hazard tree removal, within the HCNRA (USFS 1998d).

Today, harvest only occurs in USFS Management Area 1 on the Wallowa Valley Ranger District and USFS Management Area 11 in the HCNRA (Figure 20 and Figure 21). These two management units comprise 21% of the watershed, or 57,913 acres. The units are located in the southern portion of the subbasin and are characterized by flat ridge tops and timbered draws (USFS 2000). Many of the timbered stands (27,152 acres) in the Imnaha subbasin are less than 30 years old, a result of insect infestations, windstorms, harvest, and fire. For example, the 1989 Canal Fire in the Big Sheep Creek subwatershed consumed considerable portions of the upper drainage, which contributed to the current 9,139 timbered acres that are at or less than 30 years old (USFS 2000).

Special forest product harvesting (e.g., poles, Christmas trees, firewood) is only permitted in Management Units 1, 3, 6, 10, and 11, and only to the extent that it does not adversely impact wildlife or aquatic biota (USFS 1998d). PacFish buffer stipulations prohibit harvesting near

streams and other water bodies. Buffers range in size from 300 feet for perennial fish-bearing streams to 100 feet for intermittent streams and other water bodies.

Recent and current timber harvest on private lands has predominately occurred along the lower portions of Imnaha tributaries (USFS 1998d). As much as 800,000 board feet of select cut (specific tree species) timber was harvested from these areas during the late 1980s (USFS 1998d). This volume decreased considerably during the 1990s, primarily due to a depressed market.

Agriculture

The first farmers in the Imnaha subbasin were the subsistence-based Joseph band of the Nez Perce Tribe who tended crops of khouse in the benchland areas, camas in the meadows and wetlands, and huckleberries in the mountains. Their methods of cultivation included the weeding of undesirable species and burning of meadow areas to discourage development of trees or other unwanted vegetation. Fire was also used to encourage the growth of huckleberries.

The early homesteaders also practiced subsistence-based agriculture, although their activities were generally located in the lower portions of the subbasin where the mild climate, fertile valley bottom, and available irrigation water allowed for year-round production of fruits and vegetables (USFS 1998d). The growing conditions in the lower Imnaha produced some of the best and most dependable fruit and vegetables in the region (USFS 1998d). The demand for Imnaha produce spread throughout the surrounding high mountain plateaus and valleys, prompting out-of-basin families to visit the Imnaha and harvest the otherwise unavailable or prohibitively expensive fruits and vegetables (USFS 1998d). It was during this homesteading period that the small family farms and ranches expanded throughout the subbasin.

With the increase in settlement came an increase in livestock production. And, with an increase in livestock production came an increase in the demand for grass and hay. The homesteads soon lined the streams and all other areas near water that seemed capable of supporting agriculture (Wallowa County and NPT 1993). Meadows were cultivated, benchlands cleared and plowed, and bars adjacent to streams planted in hopes of producing grain, hay or vegetables. Flood irrigation was utilized in some areas, and consisted of hand dug ditch systems originating from upstream head boxes on the creeks (USFS 1995). With the exception of the fruits and vegetables, most crops were grown to feed the livestock (USFS 1995).

Today, the primary crops grown in the Imnaha are barley, wheat, and hay (Wallowa County Chamber of Commerce 2001). Channelization efforts to protect cropland and infrastructure (homes, outbuildings, barns, etc.), sediment inputs, and irrigation withdrawals are currently considered to be the main effects of agricultural practices on aquatic resources in the Imnaha (Ashe et al. 2000). Agricultural spraying is minimal (NPT et al. 1990). Although the majority of irrigation withdrawals have negligible effects on the streams and rivers, the Wallowa Valley Improvement Canal significantly affects flows in the Big and Little Sheep Creek watersheds, as it maintains a 120 cubic feet per second (cfs) water right on Big Sheep Creek, Little Sheep Creek, and all associated streams, seeps, or springs (Ashe et al. 2000) (for more information about water development, see the following section).

Water Development

The following discussion is based on information provided in Bliss (2001) and through other sources. Many of the statements regarding the amount of water purportedly used for stock are assumptions, but are included in this document to estimate overall water allocations within the subbasin. The amount of stock and domestic use is not specified in the 1930 decree (*see below*), and therefore should be considered as amount of water that can be beneficially used for these purposes.

Irrigated agriculture occurred in the Imnaha subbasin with the arrival of the first settlers. In 1930, a decree was recorded completing the adjudication of water rights established prior to the 1906 water code. The decree filed was for 23.16 cfs of water to be diverted from McCully Creek from April 1 through July 31 for irrigation, plus an undefined amount for stock and domestic use, which was estimated to be about 0.09 cfs (Bliss 2001). As shown in Table 7, additional rights were filed over the years for the annual diversion of McCully Creek waters into the Wallowa subbasin for use during different times of the year. The decree of 1905 is considered to be the first water right filed associated with the Wallowa Valley Improvement Canal, which at the time was called Sheep Creek Ditch, granting an undefined contribution of as much as 162.74 cfs from McCully Creek, Little Sheep Creek, and all tributaries crossed by the ditch up to but not including Big Sheep Creek during the months April through July (NPT et al. 1990, Bliss 2001).

A subsequent filing for 33.65 cfs from Big Sheep Creek and again all springs or tributaries along the canal (not including Little Sheep Creek or McCully Creek) was added to the system in 1919 (NPT et al. 1990). Permits were granted in following years that provided for a total right of 114.57 cfs (based on 1877, 1941, and 1976 rights) of water to be diverted from McCully Creek each year between April 1 and July 31 for irrigation. Similarly, annual irrigation rights for 57.79 cfs (based on 1877, 1941, and 1976 rights) of McCully Creek water were granted for use from August 1 through October 15. Between 0.85 and 2.55 cfs of water are used for stock and domestic use from October 16 through March 31, with about 0.18 to 0.27 cfs assigned to McCully Creek diversion 1 (Table 7) (Bliss 2001). The net result of water rights appropriated on McCully Creek is that all water above the canal is diverted year-round, however, due to seepage from the canal and groundwater recharge, there is measurable discharge in Little Sheep Creek, especially in the spring.

Tim Bliss of the Wallowa-Whitman National Forest has conducted an exhaustive evaluation of water rights, water use, and associated allocation of McCully Creek water in an attempt to define watershed boundaries occurring within the National Forest. Findings from the assessment are listed below.

1. The Forest has some stream survey data for McCully Creek above Point A. Terry Carlson, Wallowa Mountains Zone Hydrologist, has estimated Q bankfull to be between 110 and 120 cfs, with a range of 91 to 170 cfs, depending on the variables and equations used. This estimate of bankfull flow closely matches water rights of about 114 cfs for the April 1 to July 31 period that are diverted at Point A (see Table 7).
2. Oregon Water Resources Department has not developed Water Availability Tables for McCully Creek. Oregon Department of Fish and Wildlife (ODFW) has not filed for an instream water right on McCully Creek.

3. Domestic use is mentioned on the (4) 1877 water rights and the 1905 right, but the number of households is not. The watermaster indicates that OWRD assumes one household per property. There are four properties on the 1877 rights. If one assumes one property per 160 acres on the 1905 right, there would be 32 properties. Total estimates households would be 36. If one uses the current state allowance of 0.01 cfs per household for domestic use expanded, which includes an acre of lawn and garden irrigation, this right would be only 0.36 cfs¹.
4. Stock use is mentioned on 5 water rights, but the number of livestock is not. If one assumes each of the 32 properties (identified for the estimate for the domestic rights) has 139 cows, there would be 5,000 cows requiring a flow of 0.50 cfs, plus enough water to prevent freezing of the streams and ditches in the winter¹.
5. Information in Table 7 suggests the stream is fully to overappropriated during the irrigation season. This means landowners have the right to divert all flow for irrigation use from April 1 through October 15².
6. It is unclear if the stream is fully appropriated during the nonirrigation season. Answers to some questions are needed.
 - Should the upper diversion be treated as a diversion, or as the natural flow of McCully Creek into Prairie Creek? (Locals treat the upper diversion as a natural stream).
 - What is the mean monthly flow of McCully Creek at the upper and lower diversions? Is there any data? (There may be some data for Sheep Creek Ditch).
 - How much water is diverted by the upper and lower McCully Creek diversions in comparison with the estimate of 2.0 cfs needed for domestic/stock use?
 - Should any unappropriated flow during any month continue to flow into Prairie Creek, or be diverted back into the old McCully Creek channel below Sheep Creek Ditch?
7. Bill Knox, ODFW fish biologist comments that the changing of the McCully Creek boundary might complicate efforts to return flow below the two out-of-basin diversions.
8. Rick Lusk, Baker County Watermaster (former Union/Wallowa County Watermaster), comments that the OWRD still treats McCully Creek as part of the Imnaha subbasin; it is part of the Imnaha Decree. Changing the boundary might confuse water rights issues.

¹ According to OWRD (Debbie Colbert, OWRD, personal communication, January, 2004), the decree does not mention “domestic use expanded,” only domestic use. OWRD therefore does not interpret domestic use to include one acre for lawn and garden. This has implications for the assumptions made here regarding total domestic use in the subbasin. (Also, note that domestic use expanded is for $\frac{1}{2}$ acre, not 1 acre.)

² According to OWRD (Debbie Colbert, OWRD, personal communication, January, 2004), it is important to note that while the degree of water right appropriation may be determined by adding up water right rates (as was done in statement 5), water rights are also limited to duty (acre-foot of water per acre). Many rights would exceed their duty limitation prior well before exceeding their rate limitation so Table 7 describes the greatest possible amount of withdrawal from rights on this system, assuming no duty limitation.

9. Coby Menton, NRCS, comments that Prairie Creek is on the §303(d) list. The NRCS is studying water delivery from Sheep Creek Ditch (Wallowa Valley Improvement District Canal). A gage was installed on the canal in June 2000 just above the blocked McCully Creek turnout (McCully Creek diversion 2). The low flow was 1.4 cfs on October 17. There is no gage on the upper diversion (McCully Creek diversion 1), which is entitled to divert up to X cfs. The Wallowa Valley Improvement Canal is providing only about 10% of augmented flow of Prairie Creek; the rest of the water is coming from Wallowa Lake/Wallowa River.
10. Ralph Browning, Fish Program Manager, Wallowa-Whitman National Forest, comments that the U.S. Fish and Wildlife Service (USFWS) would like to reconnect the bull trout population in upper McCully Creek with other populations in the Imnaha River subbasin. The National Marine Fisheries Service (NMFS, also known as the National Oceanic and Atmospheric Administration's Fisheries Service or NOAA Fisheries) would like to reconnect the steelhead population in lower McCully Creek with former habitat in upper McCully Creek. The consultation watershed boundary between the Wallowa and Imnaha subbasins includes McCully Creek as part of the Imnaha subbasin. It would appear best to leave McCully Creek in the Imnaha subbasin, even though the watershed delineation protocol suggests otherwise.

Table 7. Summary of rights to divert McCully Creek waters into the Wallowa subbasin (Bliss 2001).

Diversion Rights April 1–July 31	Diversion Rights August 1–October 15	Diversion Rights October 16–March 31
Decree (1877 rights) 23.16 cfs primary rights from McCully Creek for irrigation, plus an undefined amount for stock and domestic use estimated to be about 0.09 cfs	Decree (1877 rights): 11.58 cfs from McCully Creek for irrigation, plus an undefined amount for stock and domestic use estimated to be about 0.09 cfs	Decree (1877 rights): An undefined amount for stock and domestic use estimated to be about 0.09 cfs plus an undefined flow needed to keep ditches from freezing during the winter. Out of stream domestic use is estimate to be negligible during nonirrigation season. Total use is estimated to be less than 0.18 to 0.27 cfs, 2 to 3 times the estimated minimum.
Decree (1905 ² and 1919 ² rights): Undefined McCully Creek contribution to 162.74 cfs primary rights diverted into Sheep Creek Ditch, including undefined part of 129.09 cfs for stock and domestic use estimated to be about 0.76 cfs. Supplemental 1919 right does not include McCully Creek.	Decree (1905 and 1919 rights): Undefined McCully Creek contribution to 81.35 cfs diverted into Sheep Creek Ditch, including undefined part of 64.54 cfs for stock and domestic use estimated to be about 0.76 cfs. Supplemental 1919 right does not include McCully Creek.	Decree (1905 and 1919 rights): An undefined amount for stock and domestic use estimated to be about 0.76 cfs plus an undefined flow needed to keep ditches from freezing during the winter. Out of stream domestic use is estimate to be negligible during nonirrigation season. Total use is estimate to be less than 1.52 to 2.28 cfs, 2 to 3 times the estimated minimum. Current ditch management limits this to water intercepted north of Ferguson Creek in the winter.
Permits (1941 and 1976 ¹ rights): 91.41 cfs from McCully Creek, including 2.28 cfs primary rights and 89.13 cfs supplemental rights.	Permits (1941 and 1976 rights): 46.21 cfs from McCully Creek, including 1.14 cfs primary rights and 45.05 cfs supplemental rights.	Permits: No diversion allowed.
Permits (1912 ² , 1913 ² , 1917 ² , and 1921 ¹ rights): Undefined McCully Creek contribution to 22.21 cfs diverted into Sheep Creek Ditch, including 2.29 cfs primary rights and 19.92 supplemental rights.	Permits (1912, 1913, 1917, and 1921 rights): Undefined McCully Creek contribution to 22.21 cfs diverted into Sheep Creek Ditch, including 2.29 cfs primary rights and 19.92 supplemental rights.	Permits: No diversion allowed.
Total Right: 114.57 cfs from 1877, 1941, and 1976 rights, plus an estimate of 0.85 cfs for stock and domestic use from 1877 and 1905 rights, plus undefined 1905 and 1919 diversion rights for irrigation.	Total Right: 57.79 cfs from 1877, 1941, and 1976 rights, plus an estimate of 0.85 cfs for stock and domestic use from 1877 and 1905 rights, plus undefined 1905 and 1919 diversion rights for irrigation.	Total Right: Estimated to be between 0.85 cfs and 2.55 cfs for stock and domestic use, with about 0.18 to 0.27 cfs assigned to McCully Creek diversion 1 and 1.52 to 2.28 cfs assigned to McCully Creek diversion 2.

¹ 1877, 1921, and 1976 rights are believed to be diverted from the stream diverted at McCully Creek diversion 1, somewhere along the stream as it flows through the Prairie Creek drainage.

² 1905, 1912, 1913, 1917, 1919, and 1941 rights are diverted from McCully Creek diversion 2 on Sheep Creek Ditch (Wallowa Valley Improvement District Canal).

Mining

Mining represents one of the earliest resource uses in the subbasin. Gold, silver, copper, and cinnabar mining have all occurred in the Imnaha watershed (USFS 1998, Ashe et al. 2000); however, there has been only a limited amount of precious metals extracted. Accessibility, quality of ores, and the establishment of the HCNRA in 1975 have contributed to minimize mining activity. That which has taken place is generally small-scale prospecting for gold, silver, copper, and molybdenum (Mays 1992). No flow of toxic mine leachates into waters of the Imnaha drainage has ever been reported (Mays 1992).

Mining in the Imnaha was borne from a regional fever sweeping the Northwest during the second half of the 1800s. Many mines in Montana, Nevada, Idaho, and, to a lesser extent, in Oregon, had been paying their way, both for those directly working in them and for those who were bankrolling their operation (Bartlett 1992).

Copper was discovered near the mouth of the Imnaha (although not in the subbasin proper) in the late 1800s and a claim was staked in the summer of 1898 (Bartlett 1992). Development of the claim came from the Eureka Mining, Smelting and Power Company, a copper company composed of “capitalists and well-known smelter men” who planned to build an electric smelter capable of producing 200 tons of copper per day (Carrey et al. 1979). As reported in the Wallowa County Chieftain March 12, 1903 (as cited in Carrey et al. 1979)

At their Imnaha camp a force of 30 men are now driving extensive tunnels to the bowels of the mountains making mother earth give up her precious metals.

Development of the site included the construction of a townsite, a wagon road, a sawmill, and a transportation corridor between Lewiston and the mine. Access issues eventually proved to be the demise of the Eureka claim, as the developers were unable to construct a boat capable of surmounting the rough water of the Snake River and could not economically justify the construction of roads or rail networks into the remote location.

The Eureka claim spurred other mining activity in the Imnaha. From the 1890s through the 1920s, three gold placer mines were developed in the upper portion of the subbasin, from Skookum Creek to the present site of Ollokot Campground (Mays 1992, USFS 1998d). Hydraulic dredging techniques were employed in the early 1900s as a more efficient technique to work placer gravels. The mine sites produced very little gold over their lifetime, however, and were soon abandoned. The primary effects of the placer and hydraulic mining include redeposition of mine tailings along the streambank and subsequent channelization. Other damage has not been assessed or reported, although Beamesderfer (et al. 1996) contends that mining activities have not severely degraded riverine habitat in the Imnaha.

Metals in the Imnaha were also mined as lode deposits. Unlike placer mining, this approach entails the construction of tunnels to mine the ore as a part of the bedrock. Several horizontal exploratory shafts for copper were dug into the east wall of the Imnaha canyon just above the confluence with the Snake between 1900 and 1905 (Tucker, as cited in Mays 1992). Among the shafts drilled was the Mountain Chief Mine, which tunneled through a fault zone in the ridge separating the Imnaha from the Snake River. It was later determined that the character of the ore was noncommercial, and the relative inaccessibility of the area limited potential profitability.

The shaft, which is visible today, “showed no evidence of mine leakage or other detrimental effects to the fisheries of the Imnaha River” following a 1991 survey by the USFS (Mays 1992).

Mining in the Big Sheep Creek drainage has been limited. Gold, silver and copper prospecting efforts in the late 1800s produced only one silver mine, the Zollman-Wells Mine, located along Quartz Creek, a tributary to Lick Creek (Smith et al., as cited in USFS 1995). The mine has produced limited amounts of precious metals over its lifetime, but continues to operate through annual assessment work that is required to keep the claim active (USFS 1995).

Currently, several small gold prospecting mines are located on the headwaters of the North Fork Imnaha, and on Boner Flat on the North Fork Imnaha. These prospect holes and shafts represent little disturbance to aquatic environments, as they are located away from perennial streams (Mays 1992). The ongoing active metal ore mining in Wallowa County is limited to small “hobby” mines (Ashe et al. 2000), including a certain degree of placer mining in the Imnaha River (Wallowa County and NPT 1993). The current degree of impact from “hobby mining” has not been estimated.

Regulations associated with the establishment of the HCNRA, Eagle Cap Wilderness, and Imnaha Wild and Scenic River Management Plan have limited the establishment of new claims from mineral entry. The remainder of the watershed, although open for mineral entry, is unlikely to be mined as it is composed entirely of basalt, which does not contain a marketable source of minerals.

1.1.1.11 Land Ownership

Approximately 71% of the Imnaha subbasin is under public ownership (Figure 20). The majority of the subbasin lies within the Wallowa-Whitman National Forest, under the management of four Ranger Districts (Eagle Cap, HCNRA, Wallowa Valley, and Pine) (Table 8). The ODFW manages two small parcels of land in the subbasin, the largest of these is along Little Sheep Creek and is where they operate the Little Sheep fish hatchery. BLM lands are primarily grasslands and are utilized for domestic livestock grazing under the provisions of the Taylor Grazing Act (USFS 2003a).

In 2000, the Nature Conservancy purchased a large portion of the Zumwalt prairie at the lower western edge of the subbasin. The land was purchased to preserve its high value to fish, wildlife and botanical resources and its acquisition made the Nature Conservancy the second largest land manager in the subbasin (TNC 2001) (Table 8). Twenty-four percent of the subbasin is privately owned. Most of the lands in private ownership are used for ranching.

The goals and focus of land management in the subbasin varies across and within ownerships. The Wallowa-Whitman National Forest has divided the lands they manage into Management Areas. Each Management area is managed following a strategy developed in the Forest Plan. Strategies for management in the subbasin range from protection as a Wilderness Area to a timber production emphasis (Figure 21). Differences in the focus and goals in land management across the subbasin result in differing ecosystem conditions and levels of protection for the fish and wildlife populations of the subbasin.

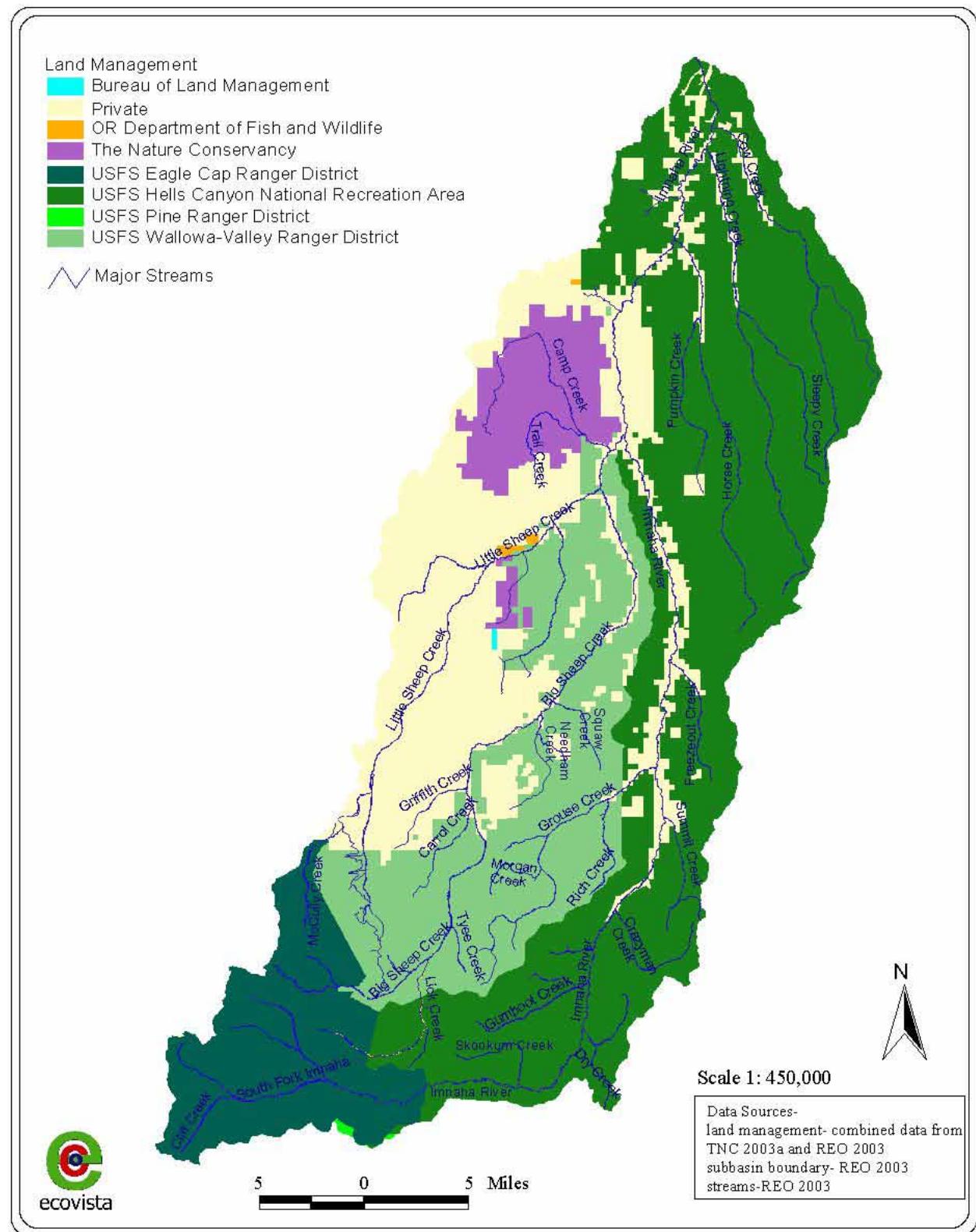


Figure 20. Land management patterns in the Imnaha subbasin.

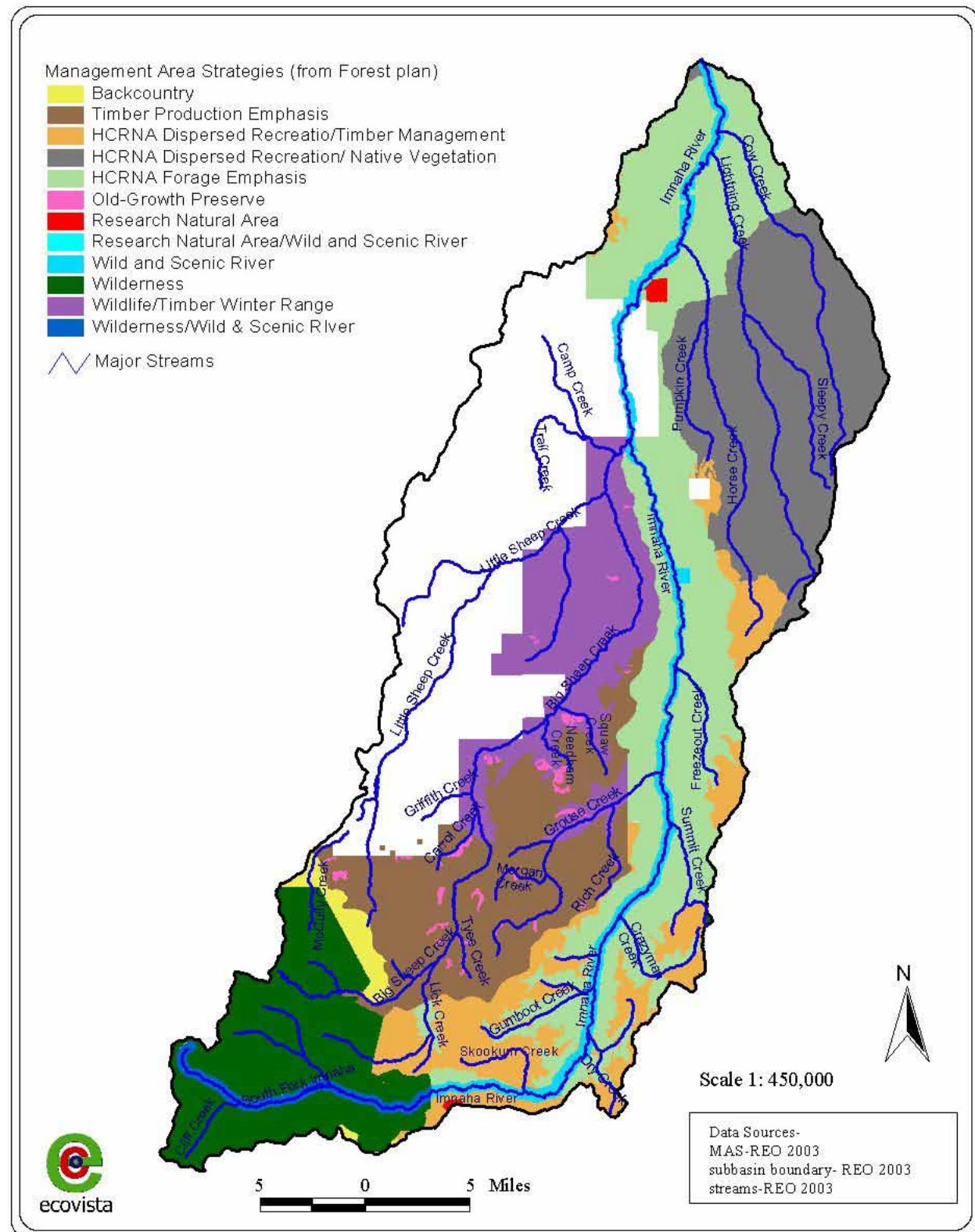


Figure 21. Management area strategies for USFS lands in the Imnaha subbasin.

Table 8. Land management entities in the Imnaha subbasin.

Description	Acres of Land Managed	Percent of subbasin
BLM	158	0.03
ODFW	612	0.11
The Nature Conservancy	28,919	5.32
Private	129,668	23.87
USFS		
Eagle Cap Ranger District	58,145	10.71
HCNRA	223,766	41.20
Pine Ranger District	319	0.06
Wallowa Valley Ranger District	101,554	18.70
Total USFS	383,784	70.66

To assess and account for these differences, a GIS layer containing land protection status was developed for the subbasin (Figure 22). GIS layers depicting land protection status have been developed by the Northwest Habitat Institute, but because of recent changes in the subbasins ownership and management focus, these are no longer accurate. To create the layer, the subbasin was stratified into different ownership/management types and assigned a protection status classification. Protection status classifications were based on those used by both the Natural Heritage Program and GAP (Idaho GAP 2003). Examples of a similar process used in the *Middle Rockies-Blue Mountain Ecoregional Plan* (TNC 2003) were used to help guide the selection of protection levels.

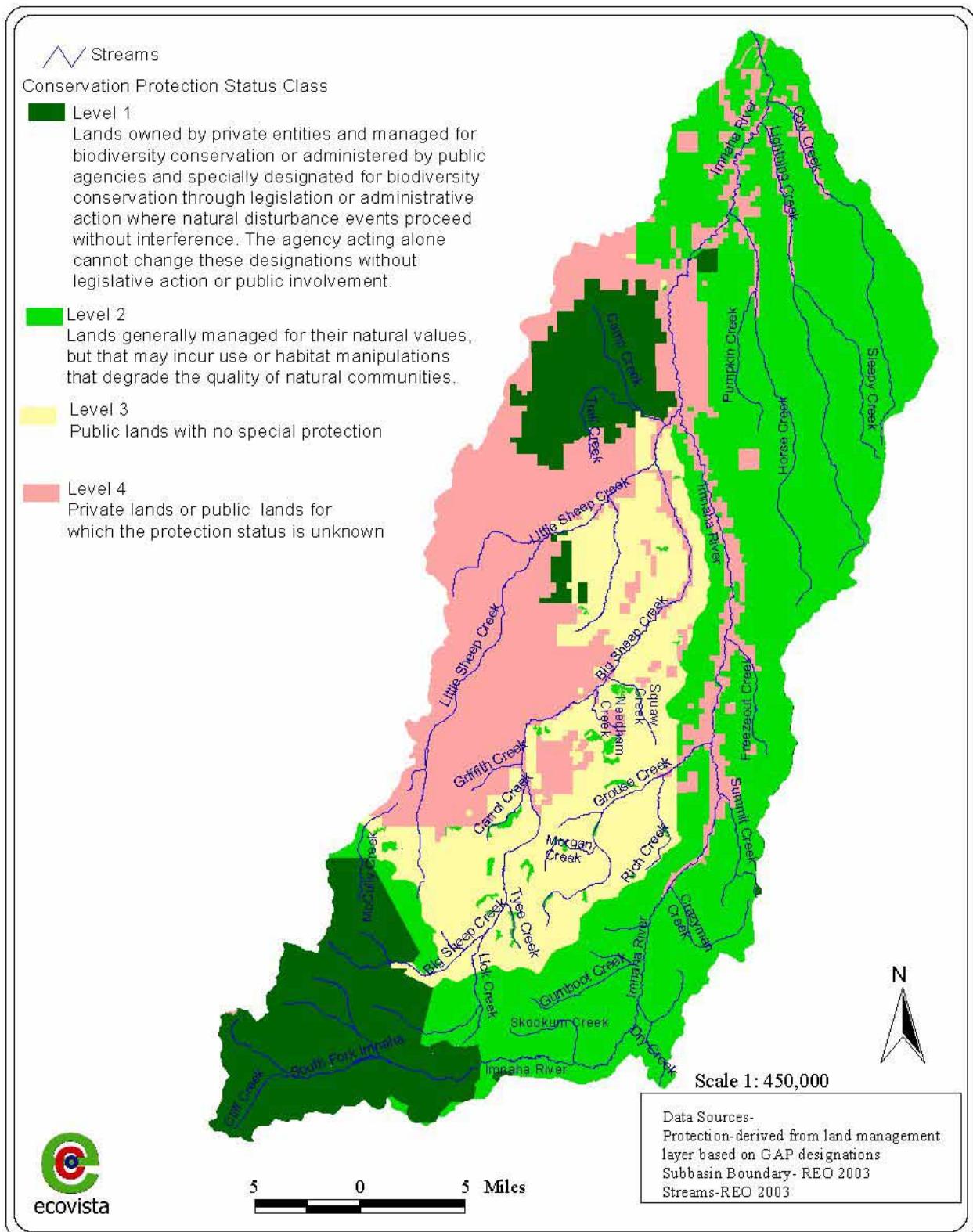


Figure 22. Protection status of the Imnaha subbasin.

1.1.2 Subbasin Water Resources

1.1.2.1 Watershed Hydrography

The Imnaha River subbasin consists of three U.S. Geological Survey (USGS) hydrologic segments of the Snake River in Oregon: the lower Imnaha River (USGS cataloging unit 17060102-08), upper Imnaha River (107060102-09), and Big Sheep Creek (17060102-07). Primary tributaries, starting at the confluence with the Snake River, include Cow, Lightning, Horse, Big Sheep, Freezeout, Grouse, Summit, Crazyman, Gumboot, Dry, and Skookum creeks and the South Fork, Middle Fork, and North Fork Imnaha River (Figure 3).

1.1.2.2 Hydrologic Regime

Current flow data in the Imnaha have been collected from the USGS-maintained gage located near the town of Imnaha (gage 13292000) since 1928 (Table 9). The discharge measured at the gaging station represents 622 square miles, or 72% of the entire subbasin (USFS 1998d). Four other gages, three of which collected only peak flow data, were historically used in the subbasin, yet are no longer in service. These include the Deer Creek station (13291400), the Mahogany Creek station (13291200), and the Gumboot station (13291000) (Table 9). The Imnaha's mean annual discharge at the town of Imnaha is 517 cfs. The highest mean annual discharge (\approx 830 cfs) occurred during 1996; the lowest mean annual discharge (200 cfs) occurred during the 1977 drought year. Mean monthly flows are shown in Figure 24.

Table 9. USGS gaging summary, Imnaha River basin, Oregon.

Gage Number	Gage Name	Latitude	Longitude	Area (mi ²)	Elevation (ft)	Period of Record
¹ 13291400	Deer Creek near Imnaha	45:33:00	116:47:30	2	3,760	1965, 1971–1972, 1974–1976, 1978–1979
¹ 13291200 ¹ 13291200	Mahogany Creek	45:12:15	116:52:05	4	3,740	1965–1972, 1975
13291000	Imnaha above Gumboot Creek	45:11:00	116:52:00	100	3,813	1945–1953
13292000	Imnaha at Imnaha	45:33:45	116:50:00	622	1,941	1929–1998

¹ Peak flows only

Water availability within the Imnaha subbasin is influenced by a major diversion on Big Sheep Creek and various smaller irrigation projects (for information about diversions, see p. 91). There are no known water storage structures large enough to require inspection by the county watermaster because of their potential threat to people or property (S. Hattan, OWRD, personal communication, February 2, 2001).

Peak streamflows in the subbasin usually occur from March through May, while low flows occur August through September, and December through February (USFS 2000). The Imnaha River reached a record high discharge of 20,200 cfs during a rain-on-snow flood event on January 1,

1997 (USGS 2002). The event triggered landslides, destroyed a house (T. Smith, NRCS, personal communication, February 8, 2001), and significantly modified stream channel morphology through mass movements of bedload material (USFS 1998d). The 1997 flood and a similar event that occurred in 1996 were of such magnitude that seral development of the riparian areas and channel development in tributaries has been retarded (USFS 2000). The record low was 16 cfs on November 22–23, 1931 (USFS 1998d). Flood frequency analysis is shown in Table 10.

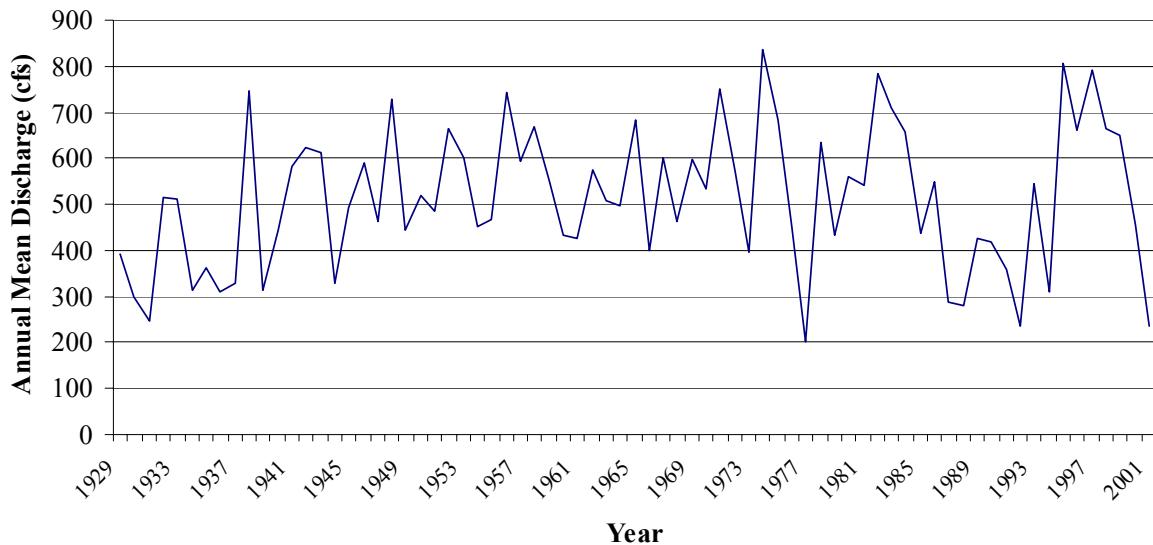


Figure 23. Average annual flows in the Imnaha subbasin (Imnaha gage 13292000) (USGS unpublished data).

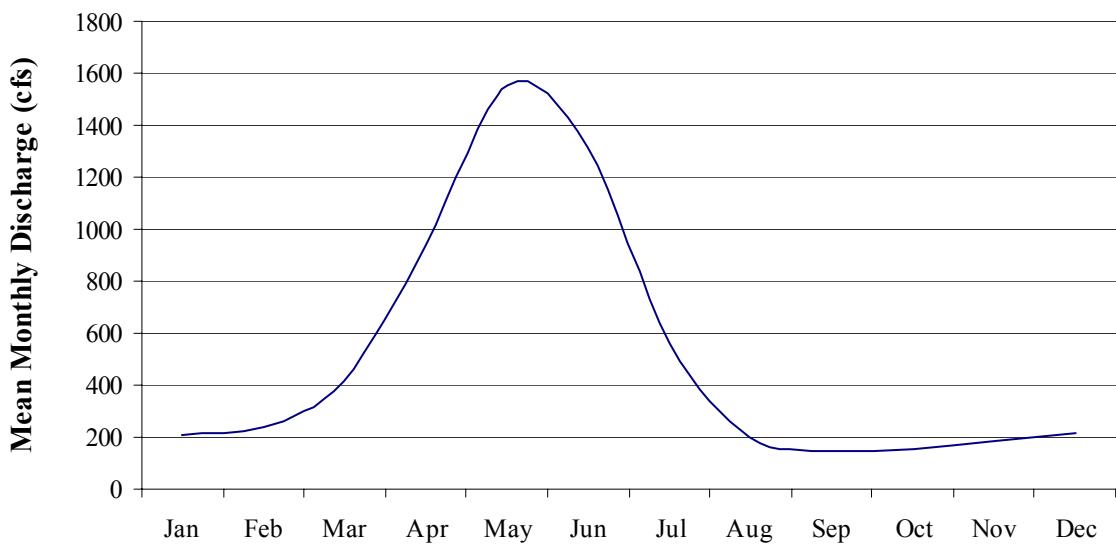


Figure 24. Mean monthly discharge at Imnaha gage 13292000 (1929–2003) (USGS unpublished data).

Table 10. Annual flood flow frequency summary for the Imnaha gage at Imnaha.

Exceedance Probability (%)	Return Period (years)	Expected Flood Flows (cfs) Based on Data from Gage 13292000
99	1	974
50	2	2,607
20	5	4,284
10	10	5,739
5	20	7,435
2	50	10,145
1	100	12,625

1.1.2.3 Water Quality

Water quality standards are benchmarks established to assess whether river and lake quality is adequate to protect fish and other aquatic life, recreation, drinking, agriculture, industry and other uses. Water quality standards are also regulatory tools used by the Oregon Department of Environmental Quality (ODEQ) and the USEPA to prevent water pollution. States are required to adopt water quality standards by the federal Clean Water Act. Standards are subject to approval by the USEPA.

The Clean Water Act also requires states to maintain a list of stream segments that do not meet water quality standards. This list is called the §303(d) list because of the section of the Clean Water Act that makes the requirement. The Clean Water Act requires states to develop water quality goals (called Total Maximum Daily Loads, or TMDLs) along with an implementation plan and schedule to achieve water quality goals for §303(d)-listed water bodies.

The U.S. Environmental Protection Agency approved Oregon's 2002 §303(d) list on March 24, 2003 (<http://www.deq.state.or.us/wq/303dlist/303dpage.htm>). The §303(d)-listed streams within the Imnaha subbasin, which includes the entire Imnaha River mainstem and some stream reaches in key tributaries (Table 11 and Figure 25), exceed the numeric criteria of the water quality standard for temperature (Table 12). Accordingly, a TMDL is being developed for the Imnaha.

Table 11. Imnaha River watershed §303(d) listings (downloaded May 22, 2003, from ODEQ website, <http://www.deq.state.or.us/wq/WQLData/SubBasinList02.asp>).

Record ID	Water Body Name	RM	Parameter	Season	List Date
828	Big Sheep Creek	0–28.8	Temperature	Summer	1998
829	Big Sheep Creek	28.8–36.6	Temperature	Summer	1998
9177	Big Sheep Creek	0–28.8	Temperature	August 1–July 15	2002
9183	Crazyman Creek	0–6.7	Temperature	Summer	2002
9186	Dry Creek	0–4.2	Temperature	August 1–July 15	2002
9180	Freezeout Creek	0–8.5	Temperature	Summer	2002
9181	Freezeout Creek	0–8.5	Temperature	August 1–July 15	2002

Record ID	Water Body Name	RM	Parameter	Season	List Date
1185	Grouse Creek	0–17.3	Temperature	Summer	1998
9182	Grouse Creek	0–17.3	Temperature	August 1–July 15	2002
9184	Gumboot Creek	0–7.4	Temperature	August 1–July 15	2002
9176	Imnaha River	0–49.5	Temperature	August 1–July 15	2002
824	Imnaha River	0–49.5	Temperature	Summer	1998
825	Imnaha River	44–72	Temperature	Summer	1998
827	Lightning Creek	0–24.8	Temperature	Summer	1998
9178	Little Sheep Creek	0–29	Temperature	Summer	2002
9179	Little Sheep Creek	0–29	Temperature	August 1–July 15	2002

Table 12. ODEQ criterion used to define where and when the water quality standard for temperature in the Imnaha subbasin is in exceedance. ODEQ uses the 50° F(10° C) for year round bull trout spawning, rearing, and adult presence (<http://www.deq.state.or.us/wq/standards/WQStdsImnahaSpawn.pdf>).

Imnaha Basin Segments	Application	Dates
Imnaha River upstream to Big Sheep confluence	Overall Application	10/15–7/15
(Check individual species ¹ distribution maps for specific locations.)	Fall chinook	10/15–6/30
	Spring/summer chinook	N/A
	Summer steelhead	3/15–7/15
	<i>O. mykiss</i> —resident	3/15–7/15
Imnaha River above and including Big Sheep Creek	Overall Application	8/1–7/15
(Check individual species distribution maps for specific locations.)	Fall chinook	N/A
	Spring/summer chinook	8/1–5/15
	Summer steelhead	3/15–7/15
	<i>O. mykiss</i> —resident	3/15–7/15

¹ The bull trout temperature criterion (50.0 °F/10.0 °C) applies year-round to bull trout spawning, rearing, and adult presence in areas identified in *Status of Oregon's Bull Trout* (Buchanan 1997). These areas include portions of the mainstem Imnaha River, Big Sheep Creek, and Little Sheep Creek subbasins. The bull trout criterion supercedes the 55 °F spawning criterion.

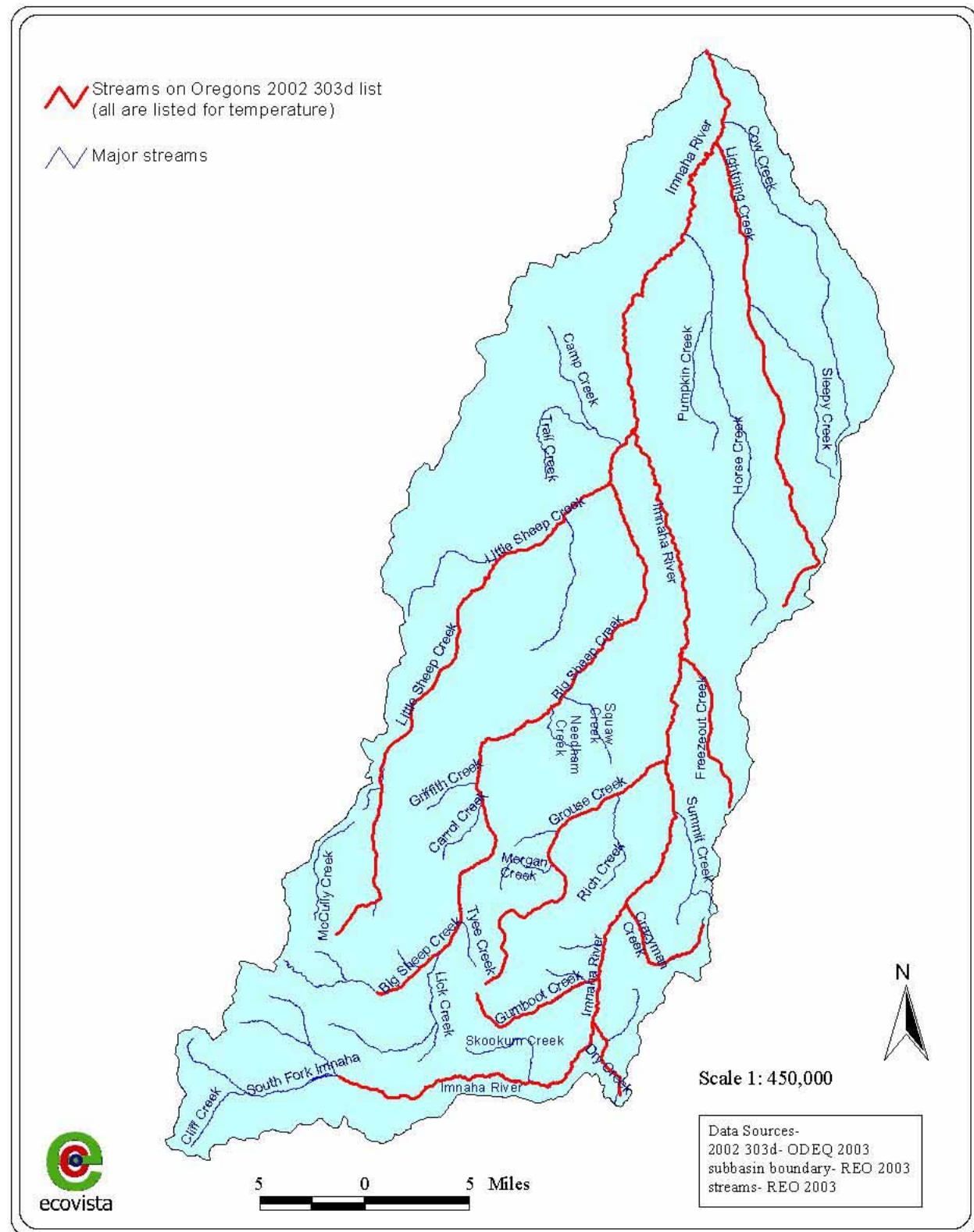


Figure 25. Streams in the Imnaha subbasin listed on Oregon's 2002 §303(d) list.

Criterion used by the USFWS in their assessment of bull trout subpopulations at the watershed scale are presented in Table 13.

Table 13. USFWS criterion to rate habitat function for bull trout subpopulations at the watershed scale

Diagnostic or Pathway	Indicators	Functioning Adequately	Functioning at Risk	Functioning at an Unacceptable Risk
Water Quality	Temperature	7 day average maximum temperature in a reach during the following life history stages: ^{1,3} incubation 2 - 5EC (35.6-41°F) rearing 4 - 12 EC (39.2-53.6°F) spawning 4 - 9EC (39.2-48.2°F) also temperatures do not exceed 15EC (59°F) in areas used by adults during the local spawning migration	7 day average maximum temperature in a reach during the following life history stages: ^{1,3} incubation <2EC or 6EC (<35.6°F or 42.8°F) rearing <4EC or 13-15EC (<39.2°F or 55.4-59°F) spawning <4 EC or 10EC (<39.2°F or 50°F) also temperatures in areas used by adults during the local spawning migration sometimes exceeds 15EC (59°F)	7 day average maximum temperature in a reach during the following life history stages: ^{1,3} incubation <1EC or >6EC (<33.8°F or >42.8°F) rearing >15 EC (>59°F) spawning <4 EC or > 10EC (<39.2°F or >50°F) also temperatures in areas used by adults during the local spawning migration regularly exceed 15EC (59°F)

¹ Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S.D.A. Forest Service, Intermountain Research Station, Boise, ID.

³ Buchanan, D.V. and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. In W.C. Mackay, M.K.

Lower Imnaha Subbasin

The lower mainstem Imnaha River (mouth to Summit Creek) is listed on the ODEQ §303(d) list for summer temperatures. The seven-day moving average of daily maximum temperatures recorded in 1995 below the town of Imnaha was 69.1 °F, with 21 days exceeding temperature standards of 64 °F (ODEQ Data). The only §303(d)-listed tributary occurring in the lower Imnaha subbasin is Lightning Creek. Temperatures recorded in 1993 (65.5 °F) at a USFS monitoring site on Lightning Creek exceeded state standards; however, zone fisheries biologists and hydrologists contend that the current temperature regime to be within the natural potential, given the low-elevation grassland ecosystem, the size of the drainage basin, and limited amounts of riparian modification (USFS 1998d, USFS 2000). Continuous water temperature monitoring data for the years 1999-2003 have been collected in Cow, Lightning, and Horse Creek, as well as the mainstem Imnaha River (at RKM 7) and are provided in Appendix C.

Big Sheep Creek

Water temperatures in the Big Sheep Creek drainage have exceeded State standards on numerous occasions. In the Little Sheep Creek drainage, stream temperatures are considered to be below environmental potential for bull trout, and “functioning at risk” (USFS 2000). Elevated summer stream temperatures are naturally common in the lower-elevation portions of Little Sheep Creek due to its biophysical attributes. The inherently high July/August stream temperatures have been elevated, however, by riparian modification and removal of streamflow. Riparian species, such as cottonwood and ponderosa pine, have been eliminated in portions of the lower subwatershed by grazing, cultivation, homesteading/clearing, and road construction (USFS 2000), and have been reduced in upper portions of the watershed by fire, windthrow, and insect infestation. For

example, the Little Sheep Creek Highway (including the Loop Road) borders the naturally confined channel for approximately 75% of its length and in many areas is bounded by either pastures or cultivated land. These land uses have effectively limited floodplain function and ultimately riparian vegetation establishment. Compounding this problem are the effects from insect infestations and the Canal Creek Fire of 1989, which have reduced effective stream shade-providing riparian vegetation in the upper portions of the subwatershed.

A sparse riparian canopy along portions of Little Sheep Creek, both before and following fire and insect infestation, has contributed to excessively high stream temperatures. The seven-day moving average of daily maximum temperatures for Little Sheep Creek measured near the confluence in 1999 exceeded 65 °F for the majority of July and the entire month of August (*refer to Appendix C for continuous water temperature data in Little Sheep Creek, 1999-2001*). In 2000, the seven-day moving average was in excess of 65 °F as early as June 18, and exceeded 70 °F between July 21 and August 12. Stream temperatures in 2001 warmed to at least 65 °F during the latter part of June and remained in excess of 65 °F through the first week in September.

Similar to Little Sheep Creek, the lower portion of Big Sheep Creek has inherently high summertime stream temperatures due to its basalt parent material and shrub/grassland vegetation (USFS 2000). Also similar are the land use activities that have exacerbated summer and winter temperature maximums through the reduction of riparian vegetation and cool water inflows. Water withdrawals from Big Sheep Creek into the Wallowa Valley Improvement Canal occur during summer months and may completely divert Big Sheep Creek at certain times. It is unlikely, however, that the cumulative volume from these withdrawals are of a sufficient amount to cool the inherently warm, low-elevation reaches of Big Sheep Creek during summer months (below Coyote Creek). The relationship between water withdrawals and base flow temperatures in Big Sheep Creek currently represents a data gap.

Water temperatures for Big Sheep Creek, approximately 1 mile upstream from the Little Sheep Creek confluence, have been periodically monitored from 1991 through 1993, and again from 1999 through 2001 (*refer to Appendix C for continuous water temperature data in Big Sheep Creek, 1999-2001 and for monitoring data in Camp Creek, 1999-2003*). In 1999, the seven-day moving average for maximum daily stream temperatures near the confluence exceeded 70 °F twice in August, while in 2000 seven-day moving averages were in excess of 70 °F for half of the month of July and the majority of August. Seven-day moving average maximum stream temperatures generally exceeded 70 °F from June 30, 2001, to September 3, 2001. Maximum stream temperatures recorded between July 1 and July 9 were in excess of 77 °F, and were in excess of 75 °F between June 30 and July 12.

Upper Imnaha Subbasin

The mainstem Imnaha, from Summit Creek to the North/South Fork confluence, violates state temperature standards for bull trout and is on the ODEQ §303(d) list. However, despite the high stream temperatures, this area maintains one of the healthiest bull trout populations in the Columbia River system (B. Knox, ODFW, personal communication, January, 2004).

The seven-day moving average of daily maximum temperatures measured in 1993 at Indian Crossing (approximately 4,500 feet elevation) and Nine Point Creek (approximately 3,642 feet

elevation) were 56.2 °F and 61.5 °F, respectively, exceeding the bull trout temperature standard of 50 °F (USFS 1998d; *refer to Appendix C for continuous water temperature monitoring data*). In 1999, seven-day moving average maximum stream temperatures at the Indian Crossing monitoring station exceeded 50 °F from July 7 to September 24. The maximum weekly average temperature at the Indian Crossing station was 57°F on August 27, 1999. The seven-day moving average maximum stream temperatures at the Nine Point Creek station were similar to those measured at the Indian Creek Station in that they exceeded the 50 °F bull trout criteria twice in June and from July 2 to September 26 (*refer to Appendix C for continuous water temperature monitoring data*). The maximum weekly average stream temperature at the Nine Point Creek station was 62.4 °F on August 27, 1999. The seven-day moving average of daily maximum temperatures measured by the ODEQ in 1995 at Coverdale Campground was 57.2 °F (ODEQ data). Zone fisheries biologists and hydrologists contend that the inclusion of the upper mainstem Imnaha (from Ollokot Campground to the North/South Fork confluence) on the §303(d) list should be reevaluated given the size of the river and limited riparian modification (USFS 1998b).

Riparian modification is known to have influenced stream temperatures throughout private land parcels bordering the mainstem (roughly from the town of Imnaha upriver to Gumboot Creek) (USFS 2000). Cultivation, farming, and settlement have reduced the occurrence of riparian species in certain areas, and are believed to be primary contributors to stream temperature increases. For instance, stream temperatures below the Imnaha River Woods Development (RM 50–RM 54) have increased following the removal of forest canopy for the establishment of a powerline right-of-way (RM 57–RM 60) (USFS 2000). The modification has shifted a historical cold water to cool water transition zone upriver several miles. In 1992, the seven-day moving average of daily maximum temperatures recorded on Grouse Creek was 65.3 °F (ODEQ data). The moving seven-day maximum stream temperature in Gumboot Creek was 66 °F, measured in 1992 (*refer to Appendix C for continuous water temperature monitoring data for Gumboot and Grouse Creeks, 1999-2003*).

1.1.2.4 Riparian Resources

Riparian communities in the Imnaha subbasin vary by location within the riparian corridor and within the subbasin. Shrubs and grass/forb species generally occur in the primary riparian zone (where water, wet soil types, or hydrophilic plants occur), while shade-providing overstory species such as cottonwood (*Populus* spp.), ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) dominate the secondary riparian zone. Grass forb species generally grade from those that are more tolerant to warm, drier conditions to those adapted to cooler, wetter climates, with an upriver progression.

Subcoregion-specific descriptions of riparian vegetation are provided below. The descriptions are drawn from the Oregon Watershed Assessment Manual (OWAM; 1999), Appendix A, which provides an indication of potential or expected streamside vegetation. The Assessment Manual assumes the species composition to reflect conditions following 120 years of growth with no major natural disturbances and no human-caused disturbances (tree removal, animal grazing, and encroachment of buildings or roads). The information presented below does not include a description of streamside vegetation following infrequent (average intervals of one to many centuries) and major disturbances such as floods, windstorms, wildfire, or earthquakes.

Descriptions are according to valley type (constrained, semi-constrained, and unconstrained). Where available, the OWAM discussions are supplemented with known species composition information provided through either literature review or personal communications.

Average widths of the stream adjacent riparian area (RA1), and (if applicable) upland-adjacent riparian area (RA2) are provided. Dominant species or types (e.g., conifers, hardwoods) of vegetation are described for each zone. Focus is on general pattern with some exceptions noted, such as unstable slopes, wet soils, low terraces, and beaver disturbance.

Streamside vegetation is highly variable and dynamic. Potential streamside vegetation descriptions (below) provide a minimum set of guidelines against which current conditions can be evaluated. Species lists do not comprise a plant community. All of the species listed may not be present together on a site.

Canyons and Dissected Uplands (11g)

Riparian vegetation common to the canyons and dissected uplands of the lower Imnaha consists primarily of low shrubs and grasses with patches of hardwoods and conifers. The shrubs are mainly willows (*Salix* spp.), alder (*Alnus* spp.), currant (*Ribes* spp.), dogwood (*Cornus* spp.), hackberry (*Celtis occidentalis*), and box elder (*Acer negundo*) (USFS 2001; B. Knox, ODFW, personal communication, January, 2004). The grass communities are comprised of brome, carex, and fescue. Where a canopy is present, cottonwood and ponderosa pine are the most common species. The relative occurrence of streamside vegetation, as it relates to channel habitat type (CHT) and primary/secondary riparian areas (RA), is provided in Table 14.

Table 14. Potential streamside vegetation associated with the Canyons and Dissected Uplands subcoregion 11g (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	Type: hardwoods (willow, cottonwood, and shrubs) Size: medium Density: dense	25–100	Type: conifers (Douglas-fir, white pine, lodgepole pine, ponderosa pine) Size: large Density: sparse	Few streamside trees in driest portions of the ecoregion.
Semi-constrained	0–50	Type: hardwoods (willow, cottonwood, and shrubs) Size: medium Density: dense	50–100	Type: conifers (Douglas-fir, white pine, lodgepole pine, ponderosa pine) Size: large Density: sparse	Few streamside trees in driest portions of the ecoregion.

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Un-constrained	0–75	Type: hardwoods (willow, cottonwood, dogwood, and shrubs). Also aquatic sedge or wolly sedge, shrubby cinquefoil, silver sage, or big sage Size: medium Density: dense	75–100	Type: conifers (Douglas-fir, white pine, lodgepole pine, ponderosa pine) Size: large Density: sparse	Few streamside trees in driest portions of the ecoregion. In some RA1 areas, woody veg. is absent altogether—herb. veg. exclusive.

Canyons and Dissected Highlands (11f)

Riparian communities common in the Canyons and Dissected Highlands portion of the subbasin include shrub and grass/sedge plant communities in the primary riparian area, and cottonwood, alder, ponderosa pine, and hawthorn in the secondary riparian area. Where the Canyons and Dissected Highlands subecoregion occurs in the Big Sheep Creek subwatershed, the primary riparian zones are dominated by a mixed-age, early seral stage grand fir overstory, with a few ponderosa pine, lodgepole pine, and western larch (USFS 2001). Engelmann spruce is sparse in the Big Sheep Creek riparian zones, as they have suffered 50 to 100% mortality due to insect infestations (USFS 2001). The absence of spruce and other overstory species in Big Sheep Creek has resulted in a dominance of 6-to 10-foot-high trees/shrubs along with grasses/forbs (USFS 2001). The relative occurrence of streamside vegetation, as it relates to channel habitat type (CHT) and primary/secondary riparian areas (RA) is provided in Table 15.

Table 15. Potential streamside vegetation associated with the Canyon and Dissected Highlands subecoregion 11f (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	Type: mixed (Engelmann spruce, willows, dogwood) and shrubs (mountain alder) Size: small Density: dense	25–100	Type: (Engelmann spruce, Douglas-fir, true fir, lodgepole pine, ponderosa pine) Size: medium Density: sparse	Disease, insects, and fire often suppress one or more tree species.
Semi-constrained	0–50	Type: mixed (Engelmann spruce, red alder) and shrubs (pacific ninebark, mountain alder, common snowberry) Size: small Density: dense	50–100	Type: Engelmann spruce, Douglas-fir, true fir, lodgepole pine, ponderosa pine) Size: medium Density: sparse	Disease, insects, and fire often suppress one or more tree species. In some cases, there is no woody veg.—herb.

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Un-constrained	0–75	Type: hardwoods (willow, dogwood, aspen), shrubs (Geyer, Booth, and Lemmon willow; mountain alder, common snowberry; shrubby cinquefoil; silver sage, or big sage), and sedges Size: small Density: dense	75–100	Type: Engelmann spruce, Douglas-fir, true fir, lodgepole pine, ponderosa pine Size: medium Density: dense	Disease, insects, and fire often suppress one or more tree species. In some cases, there is no woody veg.—herb. (tufted hairgrass, bluejoint reedgrass, or aquatic sedge).

Blue Mountain Basins (11k)

Because only a small portion of the subbasin is defined by the Blue Mountain Basins subecoregion (see Figure 4), there are only limited portions of tributary headwaters bordered by riparian vegetation. For the most part, the riparian vegetation common to these areas is similar to that found in the Canyons and Dissected upland subecoregion (11g). The relative occurrence of streamside vegetation is provided in Table 16.

Table 16. Potential streamside vegetation associated with the Blue Mountain Basins subecoregion 11k (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	Type: hardwoods (cottonwood) and shrubs (willows) Size: small Density: dense	N/A	Type: N/A Size: N/A Density: N/A	
Semi-constrained	0–50	Type: hardwoods (cottonwood) and shrubs (willows) Size: small Density: dense	N/A	Type: N/A Size: N/A Density: N/A	
Un-constrained	0–75	Type: hardwoods (cottonwood and aspen) and shrubs (willows) Size: small Density: dense	N/A	Type: N/A Size: N/A Density: N/A	Under certain conditions, there are a few potential plant communities with no woody veg. in RA1; they are characterized by herbaceous plants.

Mesic Forest Zone (11I)

Riparian vegetation in the Mesic Forest Zone is similar to that found in the Canyons Dissected Highlands subecoregion in that the primary riparian zone communities are largely comprised of hardwoods and grasses/forbs, while the secondary vegetation consists mostly of conifer species. It is not uncommon to find some higher-elevation riparian plant communities in the Mesic Forest Zone, such as bog-blueberry, or various aquatic sedges. Similarly, the Mesic Forest Zone marks a transition area where various plant communities grade from one biome to the next, such as the change from ponderosa pine and western larch to subalpine fir and lodgepole pine. The Mesic Forest Zone represents the area in the subbasin where riparian community health (measured by stream shading, large woody material in the channel, diversity of vegetation types, and percent ground cover) is the highest (USFS 2001). The relative occurrence of streamside vegetation, as it relates to channel habitat type (CHT) and primary/secondary riparian areas (RA) is provided in Table 17.

Table 17. Potential streamside vegetation associated with the Mesic Forest Zone subecoregion 11I (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	Type: hardwoods and shrubs (willows, bog blue-berry, dogwood, mountain alder) Size: small Density: dense	25–100	Type: conifers (Engelmann spruce, Douglas-fir, true fir, larch, lodgepole pine) Size: large Density: dense	Disease, insects, and fire often suppress one or more tree species. Under certain conditions, there are a few plant communities that have no woody veg. in RA1 and characterized by herb. plants such as aquatic sedge (at higher elevations), queencup beadlily, and widefruit sedge.
Semi-constrained	0–50	Type: hardwoods and shrubs (willows, bog blueberry, dogwood, mountain alder, Pacific ninebark, common snowberry) Size: small Density: dense	N/A	Type: Conifers (Engelmann spruce, Douglas-fir, true fir, larch, lodgepole pine) Size: large Density: dense	(See the cell above but include smallfruit bulrush and beaked sedge to the list of potential herbaceous plants.)

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Un-constrained	0–75	Type: hardwoods and shrubs (willows, bog blueberry, dogwood, mountain alder, Pacific ninebark, common snowberry) Size: small Density: dense	N/A	Type: conifers (Engelmann spruce, Douglas-fir, true fir, larch, lodgepole pine) Size: large Density: dense	(See the two cells above but include blue-joint reedgrass to list of potential herbaceous plants.)

Subalpine Zone (11m)

Riparian plant communities in the subalpine zone are largely limited to subalpine fir, lodgepole pine, and whitebark pine (USFS 2001). The trees here are small and unevenly distributed due to the abbreviated growing period and avalanche disturbance (respectively). The relative occurrence of streamside vegetation, as it relates to channel habitat type (CHT) and primary/secondary riparian areas (RA), is provided in Table 18.

Table 18. Potential streamside vegetation associated with the Subalpine Zone subecoregion 11m (reproduced from Watershed Professionals Network 1999).

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Constrained	0–25	Type: conifers (subalpine fir) and shrubs (willows, mountain alder, Sitka alder, bog blueberry) with ladyfern, arrowleaf, groundsel, and queencup beadlily Size: small Density: sparse	25–100	Type: conifers (grand fir, Engelmann spruce, subalpine fir) Size: medium Density: sparse	Under certain conditions, there are a few potential plant communities lacking woody veg. in RA1 and characterized by herbaceous plants such as black alpine sedge, showy sedge, and aquatic sedge at higher elevations and queencup beadlily and widefruit sedge in lower areas.

CHT Group	RA1 Width (feet)	RA1 Description	RA2 Width (feet)	RA2 Description	Other Considerations
Semi-constrained	0–50	Type: conifers (subalpine fir) and shrubs (willows, mountain alder, Sitka alder, bog blueberry) with ladyfern, arrowleaf, groundsel, Holm's sedge, and queencup beadlily Size: small Density: sparse	50–100	Type: conifers (grand fir, Engelmann spruce, and subalpine fir) Size: medium Density: sparse	(See the cell above but include Holm's sedge and smallfruit bulrush to the list of high-elevation herbaceous plants.)
Un-constrained	0–75	Type: conifers (subalpine fir) and shrubs (willows, mountain alder, common snowberry, bog blueberry) meadow vegetation and queencup beadlily Size: small Density: sparse	75–100	Type: N/A Size: N/A Density: N/A	(See the two cells above but include bluejoint reed-grass and woodrush sedge to the list of high-elevation herbaceous plants.)

1.1.2.5 Wetland Resources

Wetland habitats are relatively rare in the Imnaha subbasin but are most prevalent in the Big Sheep watershed. Approximately 1% or 330 acres of the National Forest land in the Big Sheep watershed is covered by wet meadows. These meadows were likely historically dominated by tufted hairgrass and sedges, although vestiges of tufted hairgrass remain in some of the subbasin's wet meadows. These areas are now more typically dominated by Kentucky bluegrass, timothy, showy aster, cinquefoils, and sedges. Sedge types include pond sedge, meadow sedge, woodrush sedge, Liddon's sedge, and Holm's Rocky Mountain sedge. Hydric areas often contain bistort and California oatgrass. Some of the subbasins wet meadows are extremely degraded and contain mules ears, wollyhead clover, slender rush, groundsel, and twin arnica (USFS 1995).

Wet meadows likely were more extensive in size and distribution, although the change is difficult to quantify. Portions of the Big Sheep Creek watershed on private land have been channelized. These areas are now flood irrigated and farmed and the wet meadow vegetation has been replaced with agricultural crops. Beaver dams may be providing some wet meadow habitat in the lower reaches of Big Sheep Creek (USFS 2003). Condition trends for the subbasins wetlands are estimated as upward (USFS 1995).

National Wetlands Inventory surveys have been completed across most of the subbasin but the surveys have only been digitized 9% of the subbasin. Hard copy quad maps of the wetland inventories were provided to the project team but unfortunately due to time constraints it was

only possible to do a cursory review of these maps. The digitized data is for portions of the Big Sheep watershed where wetlands are the most prevalent in the subbasin and may be indicative of the larger trend. The following discussion summarizes the Big sheep data, completing the digitizing of the wetland quad maps was identified as a important step in improving the management of wetland habitats in the subbasin, and was identified as a strategy under Objective 16A in the *Innaha Subbasin Management Plan*.

These surveys located 147 wetlands in the mid-elevation, western portion of the Big Sheep watershed. The largest of these wetlands was 9.9 acres in size while the smallest was 0.16 acres in size (USFWS 2003b). All of the wetlands were palustrine, a term used for wetlands that have been traditionally referred to as marshes; swamp; bogs; fens; ponds; prairie wetlands; and wetlands associated with streams, rivers, or lakes. Surveyed wetlands fall into the following six classes (based on Cowardin et al. 1979, as cited in USFWS 2003b). Each classification refers to the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. The greatest number of the surveyed wetlands fell into the unconsolidated bottom class, while emergent wetlands covered the largest area (Figure 26) (USFWS 2003b).

Aquatic Bed—Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years.

Emergent—Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens.

Forested—Characterized by woody vegetation that is 6 meters tall or taller.

Scrub-Shrub—Includes areas dominated by woody vegetation less than 6 meters (20 feet) tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions.

Unconsolidated Bottom—Includes wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6–7 cm), and a vegetative cover less than 30%.

Unconsolidated Shore—Includes all wetland habitats having three characteristics:(1) unconsolidated substrates with less than 75% aerial cover of stones, boulders, or bedrock;(2) less than 30% aerial cover of vegetation other than pioneering plants; and (3) any of the following water regimes (see below): irregularly exposed, regularly flooded irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, seasonal-tidal, temporary-tidal, or artificially flooded.

The wetlands surveyed by the National Wetlands Inventory in the subbasin exhibit the following five different types of water regimes. These water regimes refer to how much water is present in these systems and at what times. Most of the surveyed wetlands exhibited either a seasonally or permanently flooded water regime, while the largest wetlands were temporarily flooded (Figure 27).

Temporarily Flooded—Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

Seasonally Flooded—Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years.

Semipermanently Flooded—Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

Permanently Flooded—Water covers the land surface throughout the year in all years.

Saturated—The substrate is saturated to surface for extended periods during the growing season, but surface water is seldom present.

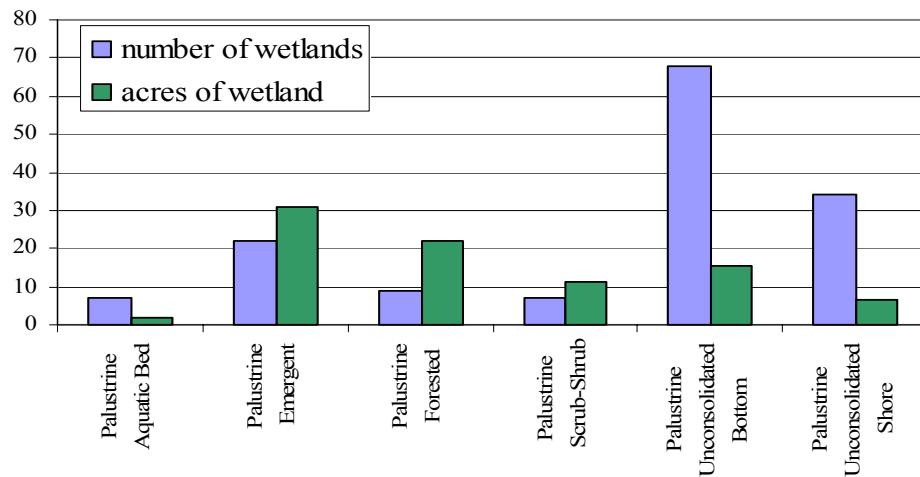


Figure 26. Classes of wetlands surveyed by the National Wetlands Inventory in the Big Sheep watershed (USFWS 2003b).

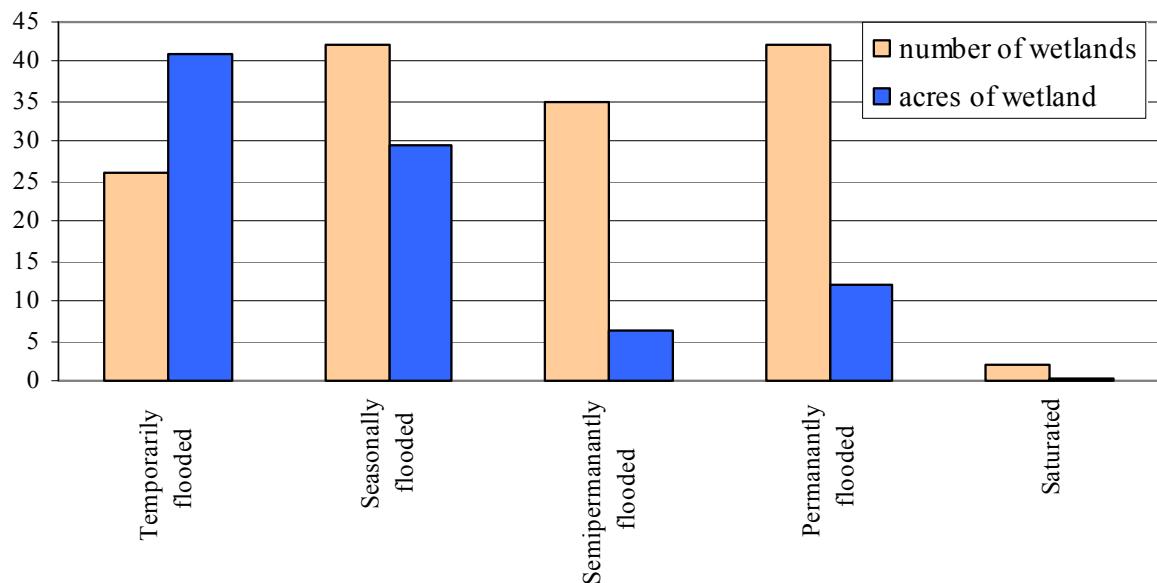


Figure 27. Water regimes of wetlands surveyed by the National Wetlands Inventory in the Big Sheep watershed (USFWS 2003b).

1.1.3 Trends in Aquatic and Terrestrial Ecology

The relationships between fish and wildlife species—to each other and to their physical surroundings—are a function of the various environmental processes acting in the watershed and the degree to which the species' environment has been modified. Climate, hydrology, erosion, and fire, are among the most important habitat-shaping process in the Imnaha subbasin. The affect a given process may have on aquatic and terrestrial habitats may be heightened given the degree to which the habitat is in disequilibrium. For instance, the magnitude of effect from a particular storm may be increased if a stream reach has been channelized or its competence to mobilize substrate changed. Similarly, the frequency and magnitude of effect from wildfires may be increased given a change in the condition and/or composition of the timber stand.

The following sections focus on how natural and anthropogenically modified processes affect fish and wildlife communities in the Imnaha. Examination of population trends (if available) at differing scales and/or over different time intervals enables the discussion.

1.1.3.1 Influence of Natural Ecologic Processes on Aquatic Systems

The primary natural ecologic processes influencing the quantity and quality of aquatic habitat in the Imnaha subbasin are climate, hydrology, and erosion, with climate being the only process that is mutually exclusive of the others. Climate dictates the hydrologic regime of the streams and rivers, which in turn affect the amount and form of erosion. We examine the effects of climate on peak and base flows, and discuss how certain areas may be responding differently based on their biophysical characteristics. Also discussed are erosion processes and their influence on aquatic systems.

Macroclimate and Peak Flows

The types of peak flow generating processes that occur naturally in eastern Oregon watersheds include rainstorms, winter and spring rain-on-snow events, spring snowmelt, and cloudburst storms or thunderstorms (Kjelstrom and Moffatt 1981, Kjelstrom 1998, Watershed Professionals Network 2001). The Watershed Professionals Network (2001) evaluated peak flows in the Blue Mountain Ecoregion using the Level III classification scheme developed by Pater et al. (1997) and Kagan (2001). The Watershed Professionals Network (2001) found that the majority (63% of all flows recorded from 55 streamflow stations) of annual peaks in the Blue Mountain Ecoregion occur in the springtime. In the Imnaha, however, the size of the drainage on which flows were gaged incorporated considerable spatial and temporal variability in meteorologic conditions, thereby making it difficult to ascribe a specific peak flow to a particular cause (MacDonald and Hoffman, as cited in WPN 2001). Because of this problem, peak flows relative to the Imnaha were assessed by the Watershed Professionals Network (2001) using data from the Doe Creek gage, located approximately 15-20 air miles from the Imnaha in the neighboring Joseph Creek drainage (see Table 9). Thirty-three percent of peak flows occurred in the winter, while the remaining 67% occurred during the spring.

Based on the results from the Watershed Professionals Network (2001) study, an estimated 15% of the Imnaha subbasin is subject to rain-on-snow events during the winter and spring, while the remaining 85% of the subbasin is dominated by spring snowmelt runoff patterns. Differences in spring snowmelt runoff patterns and rain-on-snow runoff patterns are coincident with an elevational gradient of around 3,600 feet (see Figure 6 and Figure 7) (WPN 2001); however, warm fronts from the west can quickly raise the freezing level to 7,000 feet or above. If these fronts are associated with moisture, rain falling below the freezing level can result in rapid melting of the snowpack and flash flooding (USFS 1998d). If the snowmelt and rain falls on frozen ground, the effects of the storms may be compounded. These storms commonly affect small intermittent and perennial tributaries more than they do the mainstem because of differences in buffering capacities (USFS 1998d).

Natural factors influencing peak runoff include the size and topography of the watershed, amount, form, and distribution of precipitation, soil type, climate, elevation, groundwater characteristics, and vegetation removal through fire, wind, and/or pathogens. In the Imnaha, these differences can be substantial due to the physiographic diversity of the subbasin.

Stratification of watersheds by ecoregions/subecoregions is therefore useful when attempting to gage how a specific area would hydrologically respond to various physical activities (i.e., rainfall, fire, human land use activities, etc.). Relevant hydrologic characteristics of subecoregions are shown in Table 19 (see Figure 4 for location of subecoregions). When considering the area influenced by the various flow patterns, the portion of the Imnaha mainstem between Freezeout and Dry creeks contributes significant flow volume during annual peak flow events based on its two-year, 24-hour precipitation and peak flow magnitude. Peak flows generated from rainfall and/or rain-on-snow events are more likely to occur in the lower portions of the subbasin defined by the Canyons and Dissected Uplands subecoregion.

Table 19. Characterization of hydrologic processes in the Imnaha subbasin at the subecoregion level (Watershed Professionals Network 1999).

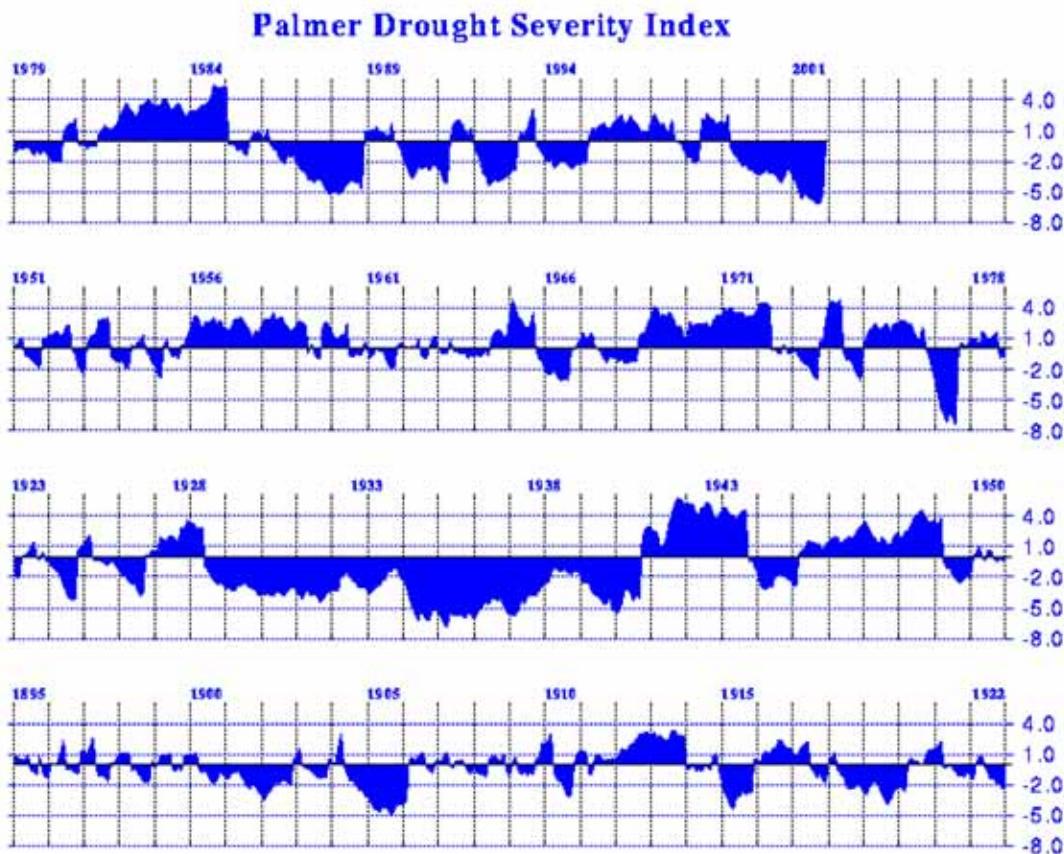
Subecoregion	2-Yr. 24-Hr. Precip. (inches)	Basin Description	Runoff Patterns of Avg. Monthly Streamflows	Peak Flow Generating Processes	Peak Flow Magnitude	Historical Crown Closure
Canyons and Dissected Highlands	1.4–2.0	Northward orientation	highest in late spring/early summer months	Primarily spring rain, spring rain-on-snow, and snowmelt	10 to 60 cfs/mi ² , with a few less than 10 cfs/mi ²	>30% on north-aspect slopes
Canyons and Dissected Uplands	1.4–2.0	Northward orientation with canyons 2,000–5,000 feet deep	highest in the spring months	Rainfall	6 to 20 cfs/mi ² , with a few greater than 20 cfs/mi ²	<30%
Blue Mountain Basins	1.6–1.8	Basins are areas of depressions and have variable orientation; streams are slow and meandering.	highest in the spring months	Primarily spring rain, spring rain-on-snow, and snowmelt	6 to 10 cfs/mi ² , with a few greater than 10 cfs/mi ²	<30%
Mesic Forest Zone	1.8–2.4	These basins are in the higher elevations with varying orientations.	highest in the spring months	Primarily spring rain, spring rain-on-snow, and snowmelt	6 to 20 cfs/mi ² , with a few greater than 20 cfs/mi ²	>30%
Subalpine Zone	2.0–2.6	Streams are perennial depending on snowpack; most are headwaters to Imnaha River and Big and Little Sheep creeks.	highest in the spring months	Primarily spring rain, spring rain-on-snow, and snowmelt	6 to 20 cfs/mi ² , with a few greater than 20 cfs/mi ²	>30% below alpine zone

Modifications to vegetation represent another factor influencing peak/base flows in the Imnaha subbasin. These changes include the effects of fire, windstorms, and insect/pathogen outbreaks on forest canopies. As discussed in the vegetation section, several large (>100 acres) fires have occurred in the subbasin over the last few decades. Since 1970, over 500 wildfires have occurred in the Imnaha subbasin, 100 of which were located in the Big Sheep Creek subwatershed (USFS 2000). Most recently, the Corral Fire of 2000 burned a considerable portion of the lower river areas (Figure 32). The effects of the 2000 complex on vegetation in the lower subbasin was somewhat ameliorated by the fact that grassland dominates the area, although much of the shrubs and brush in ephemeral draws was lost. The Canal Creek Fire of 1989 was considered to be of significant consequence to peak/base flow regimes in the Big and Little Sheep Creek subwatersheds due to its size (23,846 acres) and amount and type of vegetation burned. The Big Sheep Creek Watershed Analysis (USFS 1995) determined that two of the management units, 7J and 7R, were “functioning at risk” and that management unit 7O was “functioning at an unacceptable risk” with respect to peak flows. The assessment attributes flow problems to the Canal Fire, insect outbreak, and windstorms.

Macroclimate and Base Flows

As discussed in section 1.1.1.6, the Imnaha subbasin is subject to considerable variation in the amount of precipitation it receives. The snowpack and rainfall that occurs in the subbasin over the course of a year is largely what drives streamflow in the subbasin, as only a small percentage of Imnaha tributaries are spring-fed.

Also as described in section 1.1.1.6, considerable interannual variation in precipitation recorded at the various climate stations has occurred, producing both “wet” and “dry” years. In an effort to record these climatic phenomena, the National Climate Data Center (NCDC) has developed a regional drought severity index. The Palmer Drought Severity Index (PDSI) is a meteorological index used to assess the severity of dry or wet weather periods by measuring the duration and intensity of drought-inducing circulation patterns. The index is calculated monthly and is based on the principles of a balance between moisture supply and demand. The index generally ranges from -6 to $+6$, although values to ± 7 may occur. Negative index values indicate dry periods (drought), and positive values indicate wet periods. Long-term drought is cumulative, so the intensity of drought during the current month is dependent on the current weather patterns plus the cumulative patterns of previous months. Since weather patterns can change almost overnight from a long-term drought pattern to a long-term wet pattern, the PDSI can respond fairly rapidly. The drought severity index used for the Imnaha is based on Climate Zone 8, which encompasses the northeastern corner of Oregon and occupies all of Wallowa, Baker, and Union counties, as well as portions of Umatilla and Grant counties (Figure 28).



Oregon - Division 08: 1895-2001 (Monthly Averages)

Figure 28. Palmer drought severity index for Oregon Climate Zone 8 (NCDC unpublished data 2001).

The utility of climatic indices, from a fisheries standpoint, provides researchers and resource managers with a perspective of “natural” factors that may be limiting fisheries production. For example, Anderson (as cited in Taylor and Southards 1997) used the Pacific Northwest Index (PNI) to distinguish cool, wet periods in the coastal region from warm, dry ones and then correlated annual spring chinook returns to respective periods (Figure 29). He found a positive relationship between higher returns during wet periods and lower returns during dry periods. While there are undoubtedly human-induced effects on the fish (including dam construction and habitat destruction), Figure 29 indicates that natural variability may be a very significant influence as well and should be considered in any salmon restoration plan.

Climatic Effects on Columbia River Chinook

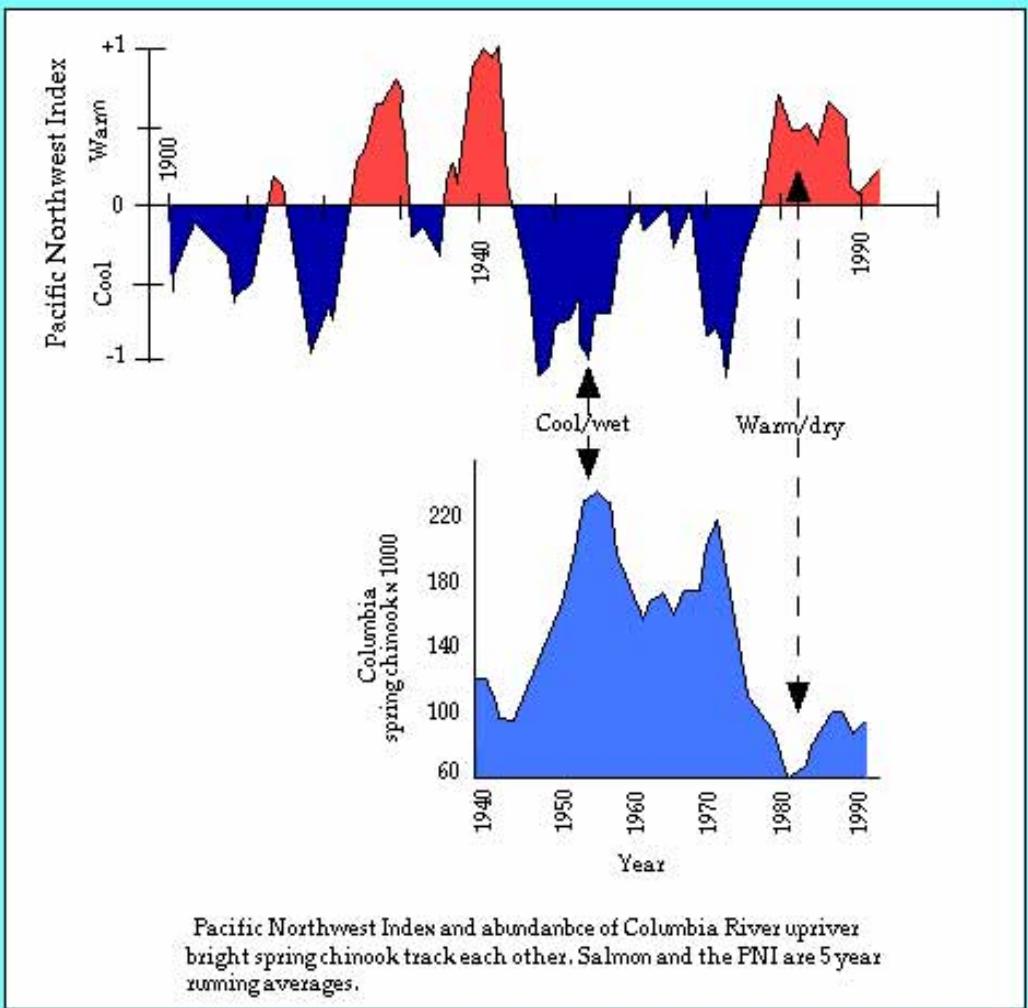


Figure 29. Pacific Northwest Index (PNI) and spring chinook returns for Oregon Climate Zone 1 (coastal) (reproduced from Taylor and Southards [1997]).

The relationship between precipitation and spring/summer chinook returns for the Imnaha is less defined than that demonstrated by Anderson, which is likely due to the fact that the data available for analysis either are not specifically exclusive to the subbasin (i.e., PDSI data relative to the entire Zone 8) or are estimated (i.e., spawn/recruit data). Relationships do exist, however, as shown in Figure 30. For example, “wet” years occur between 1945 and 1948. The number of recruits per spawner responds favorably over the subsequent four-year period (1949–1953), which corresponds to the mean age at return for spring/summer chinook in the Imnaha. A similar trend in recruits per spawner occurs between 1959 and 1963 following a previous wet period (1955–1959). Precipitation–recruitment relationships become less defined from 1968 to 1990. This disassociation may be due to a number of human-induced factors including the construction of Ice Harbor, John Day, Lower Monumental, Little Goose, and Lower Granite dams between 1960 and 1976.

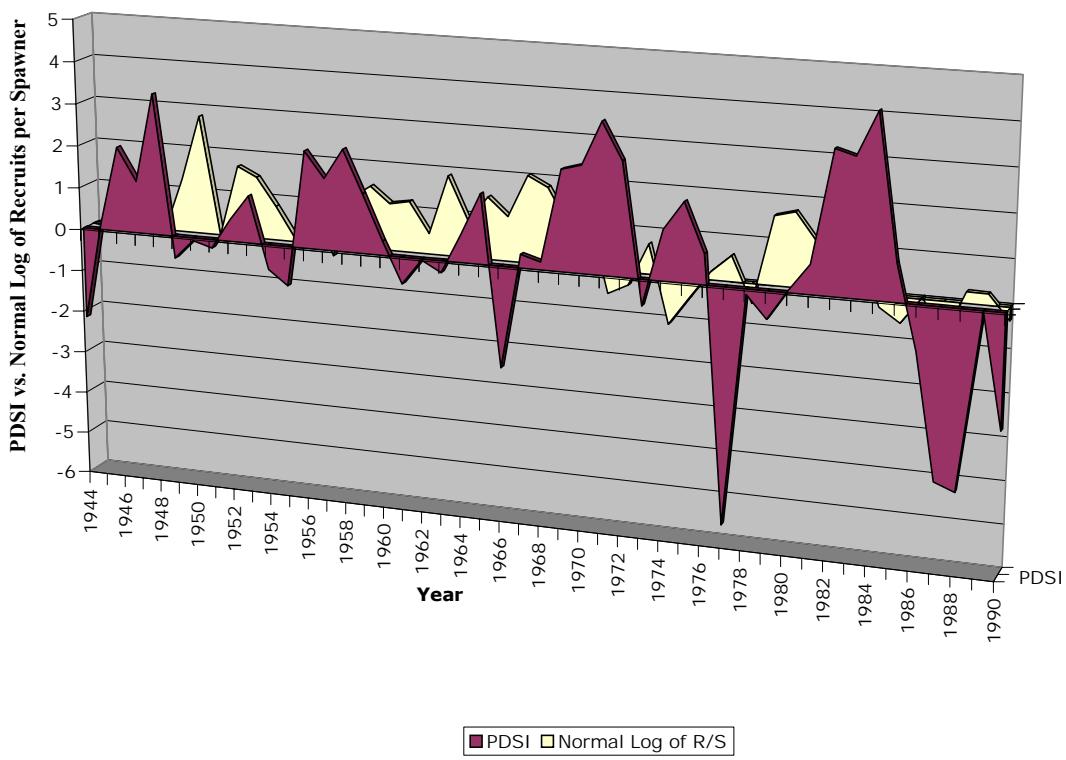


Figure 30. PDSI and spring/summer chinook recruits per spawner relationship for the Imnaha subbasin. (Recruit per spawner data and methods used in its derivation are from Beamesderfer et al. [1996]).

Erosion Processes

The primary vehicle for the transport of sediment in the Imnaha is water. Rainfall, snowmelt, and streamflow each play a function in erosion processes throughout the subbasin, albeit at differing times and levels of magnitude. Mass-wasting, which most often results from supersaturated ground, is also an important mechanism for sediment delivery to streams in certain portions of the subbasin.

As discussed previously, sedimentation rates are naturally higher in the upper portion of the subbasin due to the instability of the barren granite mountain peaks. Primary mechanisms of sediment delivery to aquatic habitats in these areas include debris flows and other processes of mass wasting, which are commonly triggered by thunderstorms or rain-on-snow events (USFS 1993). For example, in August 1992, a thunderstorm triggered a debris flow in a wilderness area tributary to the North Fork Imnaha. A debris fan formed at the confluence of the tributary and North Fork Imnaha, shifting the thalweg of the North Fork and initiating a landslide (USFS 1993). A January 1997 storm also resulted in landslides and debris flows within tributaries to the Imnaha River. High flows and available bedload increased the amount of sediment transported, which contributed to the creation of midchannel and lateral gravel and cobble bars (USFS 1993). This material will continue to move in pulses downstream until stabilized by large woody

material (LWM), riparian vegetation, or channel processes resulting in elevated levels of sediment.

Streambank erosion represents another naturally occurring source of fine sediment to streams in the Imnaha subbasin (USFS 2003b). The rate of streambank erosion is accelerated following thunderstorms or winter/spring rain-on-snow events, during which high magnitude flow events scour stored sediment from channels and accrue fines through streambank destabilization. It is common to see “rock flower” in the mainstem during runoff periods. The source of the suspended sediment is from the crushed rock and fine sediment found in terminal moraines located in the uppermost portions of the subbasin. The effects of streambank/channel erosion are most notable in the mainstem Imnaha River below Nine Point Creek, which received the large pulse of bedload following the 1997 Flood (USFS 2003b). Mainstem reaches in this area are classified as “functioning at risk” by the USFS.

Big Sheep and Little Sheep Creek are geomorphologically young systems with active erosion in the oversteepened headwalls of the Wallowa Mountains. Snow avalanches and debris flows occur frequently contributing sediment and LWM to downstream reaches (USFS 1995).

1.1.3.2 Historical Conditions and Processes in Terrestrial Systems

Disturbances processes have worked in conjunction with the geology, soils, topography, and climate of the subbasin (see section 1.1.1 for a discussion of the subbasins physical characteristics) to shape the composition, structure, and distribution of its terrestrial communities. The primary natural disturbance processes in the Imnaha subbasin are fire, disease, insect outbreaks, and grazing. The characteristics and role that these disturbances play in the ecosystem vary depending on the physical features of the landscape and the composition and structure of the vegetative communities that it supports. Changes in these disturbance regimes, through human activities, have altered the ecosystem of the Imnaha subbasin. This section outlines the historical disturbance regime in the subbasin, and section 1.1.3.3, discusses the changes to these regimes and the resultant impacts to the ecosystem since settlement. The discussion of disturbance processes is organized by the WHTs developed by the Northwest Habitat Institute and introduced in section 1.1.1.9.

Climate

Variation in the climate of the subbasin over millennia has helped to shape its terrestrial communities. For tens of thousands of years valley glaciers covered the Imnaha Area. Around 12,000 years before present, these glaciers retreated, but have since advanced and retreated numerous times.

The subbasin and surrounding region is currently in a period of glacial retreat. Glaciers influence the terrestrial ecosystem by removing all vegetation in their path, and upon retreat, they leave behind rocks and soils that determine the patterns of vegetation that eventually emerge. They form ice dams that, when they break, create floods, often of great magnitude (Johnson et al. 1994).

As discussed in sections 1.1.1.4 and 1.1.1.9, both the location of vegetative types and WHTs in the Imnaha subbasin are a reflection of its temperature and precipitation patterns. Climatic events

of unusual intensity are an important part of this regime; windstorm and flood are two that particularly impact the Imnaha subbasin.

Windstorms often break or uproot trees where wind is channeled by local topography, and severe windstorms can overturn trees across large areas. Trees in overcrowded stands snap off or break at their root collars in windstorms or uproot, if they are in shallow soils. Trees blown over by winds create conditions that favor other disturbances such as insects and fires. Where only some trees blow over the partial shade of remaining trees promotes shade-tolerant species such as true firs. Windstorms generally favor advance regeneration of true fir species. Windstorms create downed, woody material, important to many wildlife species, but it can also form barriers to the movement of large animals (Johnson et al. 1994).

Flooding is critical to the maintenance of wetland ecosystems. It creates new microsites for colonization and delivers nutrients to the community. Floods also result in erosion and mass wasting, which creates new landforms and adds to the diversity of the landscape. Deposition of these materials to streams can have negative consequences to aquatic plant and animal species, in the short-term but over time this is a necessary process preventing stream channels from becoming scoured. At natural levels, floods, erosion and mass wasting replenishing the gravel, sand and silt in the stream and add to the floodplain soils (Johnson et al. 1994).

Historical Fire Regimes

Fire has always been an integral force for structuring and maintaining the communities of the Imnaha subbasin. The probability of fire in any given place in the subbasin was determined by chance, its position relative to storm building topographic features and the vulnerability of the plant community. Once a fire ignited on the landscape its duration and intensity will depend on topography weather stand structure and fuels (Johnson et al. 1994). Susceptibility to fire, fire characteristics, and return intervals vary by the WHTs in the subbasin. Available data on natural conditions follow.

Montane Mixed Conifer Forests

Fire return intervals ranged from 70 to 150 years with moderate to high intensity fires resulting in stand replacement on 70 to 100% of the affected area. Fires encouraged the persistence of Lodgepole pine, western larch and Douglas-fir (USFS 1995).

Eastside Mixed Conifer Forests

Fire return intervals on these WHTs were highly variable and ranged from 15 to 30 years on warm, dry sites to 150 years on cool, moist sites. In areas of longer fire return intervals, fire intensity was higher and shade tolerant species were more prevalent (USFS 1995).

Ponderosa Pine Forests and Woodlands

Ponderosa pine forests are characterized by a very short fire regime; tree ring data suggest that the average historical fire return interval between fires in the ponderosa pine forests of eastern Oregon was 13 to 18 years (USFS 1995). Fire intensities were low with ground fires periodically burning through stands, removing much of the down woody material and keeping stock levels low. Many stands consisted of park-like stands of mature ponderosa pine at low stocking levels (USFS 1995).

Subalpine Parkland

Historically, these sites had long fire return intervals. Fire intensities were low due to incontinuous fuel loads, but isolated pockets may have experienced heavy mortality because of the low crowns of subalpine fir, the lower branches growing down into the duff layer.

Eastside Grasslands

Historical fire ignitions in these communities typically occurred as a result of late summer and early fall thunderstorms with a return interval of approximately 10 years. Fires burned across the bunchgrass slopes in an interfingering manner, depending on daily temperatures, wind velocity, and the microrelief of the slope. The effects of fire were not uniform; areas of dense, dry, standing biomass burned intensely while the fire moved through other areas of the landscape rapidly, leaving the crowns of grasses alive. Of the three primary bunchgrasses of this WHT, fescue is considered the most sensitive to fire. When burned intensely, grassland areas regress to earlier succession stages where forbs dominate the landscape (USFS 1995).

Historical Insects and Disease

Insects and disease are natural processes that help to shape forests and provide snags and other beneficial features for wildlife. Typical outbreaks on the common tree species of the subbasin are described below.

Defoliation from western spruce budworm outbreaks appeared on a cyclic basis. These outbreaks were heavier at lower elevations and in stands containing higher levels of grand fir or Douglas-fir. Outbreaks of Douglas-fir tussock moth were also short in duration but since they can feed on older needles, caused heavier defoliation in individual years. Due to a less continuous food source than is common today, outbreaks were short in duration and small in extent. Defoliation seldom resulted in long-term growth or mortality effects (USFS 1995).

Mountain pine beetle, spruce beetle and fir engraver were the major insect forces in lodgepole forests. Mortality from mountain pine beetle generally occurred in suppressed stands of lodgepole pine starting at about 60 years old, and mainly affected large diameter trees. Spruce beetle and fir engraver mortality in Engelmann spruce and subalpine fir occurred regularly but at low intensities, although increased mortality was evident during periods of drought. Bark beetle outbreaks historically were of low intensity and short duration, due to frequent underburning that maintained lower stocking levels and reduced competition (USFS 1995).

Annosus root disease, brown cubical butt rot, Indian paint fungus, laminated root rot, and Armillaria root disease were also agents of natural disturbance in the subbasin historically (USFS 1995). Due to the mixed species and multistoried nature of historical stands, disease did not threaten entire stands but chose selective hosts, resulting in increased structural diversity.

Historical Grazing

Early trappers speak of deer, elk, mountain sheep, antelope, and even bison in the valleys and canyonlands of eastern Oregon (Evans 1991, as cited in Johnson et al. 1994). These animals likely had light to moderate effects on vegetation. Natural predators of these species were varied and numerous and helped keep populations in balance (Johnson et al. 1994).

1.1.3.3 Human Influence on Conditions and Processes in Aquatic Systems

Focal salmonid species in the Imnaha subbasin are most susceptible to mortality during or following excessively high and low flow periods. And while Imnaha salmonids have adapted to the normal high and low flow events, the magnitude and/or frequency of these processes have increased in portions of the subbasin from land use activities, causing a subsequent reduction in the amount and quality of instream habitat. The land use activities affecting peak and base flow processes in the Imnaha are discussed below.

Peak Flow Generating Processes

Excessive flows are especially disruptive to salmonids during incubation and/or fry colonization life history stages, and can effectively scour a channel of cover and/or substrate that are needed by fish during their entire lives. And while peak flows are a normal part of any hydrograph, excessively high flows, such as those that occurred in the Imnaha in 1996–1997, aren't.

Changes in land cover and land use related to forestry, grazing, and irrigated agriculture are those most frequently cited as potentially altering runoff patterns in the Imnaha subbasin and are discussed below.

Timber Harvest

Forestry practices can have substantial influences on the natural hydrograph under certain conditions. Removal of forest canopy from extensive areas within a watershed may result in increased runoff magnitude resulting from rain-on-snow events; it has been shown to produce increased spring snowmelt peak flows in the Rocky Mountains (Troendle and King, as cited in Watershed Professionals Network 1999). Timber harvest and/or stand replacing wildfire influences hydrology by altering the distribution of precipitation that reaches the ground, amount intercepted by foliage, and water storage capacity of local soils (Chamberlin et al. 1991). Harvested areas that may be most susceptible to changes in peak/base flows are those occurring in rain-on-snow areas and that historically had a canopy >30% and currently have a canopy of less than 30% (Watershed Professionals Network 1999).

At the time of this documents preparation, stand structure data of a sufficient resolution in the Imnaha were limited, thereby limiting effective assessment of canopy closure. Information describing stand age (amount of timber <30 years old) on National Forest land was available and provided a surrogate measure for canopy closure (assuming a tree <30 years old will provide ≤30% canopy). A total of 31% of National Forest lands in the subbasin are currently present as stands less than 30 years old (USFS 2001). Past timber harvest, losses to insects and disease, and wildfires have produced stands less than 30 years old on 27,152 acres throughout the upper and lower Imnaha and 9,319 acres in the Big Sheep subwatershed. Of these lands, very few areas are dominated by rain-on-snow runoff patterns (assuming a rain-on-snow elevation of 3,600 feet), and once had a historical crown closure of more than 30%. Many of the USFS administered lands in the Canyons and Dissected Highlands subecoregion and in the Mesic Forest and Subalpine Zones had historical crown closures greater than 30% (north aspect only in the Canyons and Dissected Highlands subecoregion); however, these areas are generally at higher elevations.

If less emphasis is placed on the rain-on-snow elevation zone (i.e., it is more variable), then harvested areas most likely to affect peak/base flow runoff patterns would occur on north-facing slopes in Cow, upper Lightning, and Horse Creeks, the mainstem and its tributaries from Freezeout Creek upriver to Dry Creek, and in the Big and Little Sheep Creek subwatersheds upstream from the confluence of Griffith and Divide Creeks (respectively). Other areas in the subbasin are not known for their forestry potential, as they were, and currently are, dominated by grasses, shrubs, and some hardwoods, making crown closure influence negligible.

Overall, timber harvest *alone* does not appear to have substantially altered the peak or base flows in the Imnaha subbasin; however, finer-scale canopy closure data and subsequent analysis would provide a more in-depth and conclusive assessment of the effects of canopy removal on peak/base flow processes.

Grazing and Agriculture

Past livestock grazing has resulted in the reduction of the amount and variety of upland and streamside vegetation (USFS 2000). These losses may potentially influence runoff and/or water storage processes, which in turn may affect peak and base flows, respectively. The majority of grazing in the Imnaha occurs on National Forest lands, which have been allotted into specific grazing units. In all there are thirty-four allotments for domestic cows, horses, and sheep in the Imnaha subbasin (USFS 2000). In bull trout consultation for the Imnaha subbasin (section 7 assessment), the USFS gaged the condition of peak/base flows in the various allotment units. Peak and base flows in a total of three allotments/allotment groups are functioning inappropriately; however, livestock is related to only one of these designations. Allotments for which peak/base flows are “functioning at risk” but not related to livestock occur in the Carroll Creek/Middlepoint Allotments and in the Bear Gulch Allotment.

Livestock may potentially be impacting peak and base flows in the Marr Flat/Big Sheep/Divide allotment (see Figure 16). Specifically, historical livestock grazing pressure in the Marr Flat and Big Sheep allotments has been problematic with regards to meeting grazing utilization standards, as excessive vegetation removal and soil compaction are evident and have created a concern for increased peak flows (USFS 2000). Problems with base flows in the Sheep Creek watershed are related to water diverted by the Wallowa Valley Improvement District Canal, and not grazing (USFS 2000). According to the USFS (2000), changes in streamflow in the Divide Allotment are related to other factors such as the Canal Creek Fire and are not the result of livestock use, trailing, or trampling.

A commonly used parameter that aids in the definition of where range and/or agricultural practices may potentially affect hydrology is the characterization of hydrologic soil groups (HSGs) that occur across a given landscape (WPN 2001). Grouping soils by their hydrologic characteristics is a means to describe the minimum rate of infiltration obtained for bare soil after prolonged wetting, and provides an indication toward those areas that may be most hydrologically responsive to grazing or agricultural pressures. The definition of a particular HSG does not in itself, however, determine the effects that range and/or agricultural practices may have on flow regimes, although it does provide runoff potential.

Three HSGs are common throughout the Imnaha subbasin. These include B, C, and D soil types, the relative percentage of which differs spatially. B-type HSGs have moderate infiltration rates

when thoroughly wetted and range from moderately deep to deep, moderately drained to well-drained (WPN 1999). C-type HSGs tend to have slow infiltration rates when thoroughly wetted. These soils usually have a layer that impedes downward movement of water or have moderately fine to fine-textured soils (i.e., sandy clay loam). D-type HSGs have a very low infiltration rate when thoroughly wetted and represent the HSG with the highest runoff potential. They consist of clay soils with a high swelling potential and are characterized by soils with a high permanent water table, soils with a clay layer near the surface, or shallow soils over near-impervious materials (WPN 1999).

Overall, C-type HSGs are dominant in the subbasin, with B and D HSGs occurring in relatively equal but lesser amounts (Table 20). When considering grazing and agricultural practices at the subcoregion scale, the intensity of both is most concentrated in areas with longer growing seasons (agriculture/range lands were defined using 1998 USGS land use layers (30-meter DEM); any areas defined by the USGS as shrublands, grasslands, pasture, row crops, small grains, or fallow were deemed agricultural/range areas). These are coincident with the Canyons and Dissected Highlands (11f) and Canyons and Dissected Uplands (11 g) subcoregions (see Figure 4 for location). Granted, only a portion of each subcoregion is grazed and a much smaller portion farmed. Nevertheless, subcoregions 11f and 11g represent those areas with the greatest proportional area of range and/or agricultural use and also represent the two areas with the greatest potential for peak flow increases based on HSG infiltration capacities (WPN 1999). Finer scale cover type data (i.e., 30-meter digital elevation model data) and subsequent analysis would provide a more in-depth and conclusive assessment of the effects of grazing and agricultural practices on peak/base flow processes.

Table 20. Area in square miles for hydrologic soil groups of rangeland and/or agricultural ground at the subcoregion-scale in the Imnaha subbasin.

Hydrologic Soil Group	Canyons and Dissected Highlands	Canyons and Dissected Uplands	Blue Mountain Basins	Mesic Forest Zone	Subalpine Zone
B	23.3	65.8	6.4	6.4	5.1
C	32.6	144.6	18.9	8.4	5.7
D	16.6	79.9	8.7	8.1	9.9

Base Flow Depleting Processes

Similar to the various processes or activities that may exacerbate high flows, there are activities that may reduce flows during low flow periods and negatively influence aquatic biota. Water withdrawals and water rights are the primary land use activities in the Imnaha that are most likely to affect salmonids and their habitat during base flow periods.

Water Withdrawals

The Imnaha subbasin has one large diversion and various smaller irrigation projects. No known water storage structures exist large enough to require inspection by the county watermaster because of their potential threat to people or property (S. Hattan, OWRD, personal communication, February 2, 2001).

Water diversions in the subbasin date back to the late 1800s (Wallowa County and NPT 1993). Early diversions enabled people to irrigate and more successfully farm land along streams and in the subbasin's valleys (Wallowa County and NPT 1993). McCully Creek, Big Sheep Creek, Little Sheep Creek, Imnaha River, and their tributaries all had water diverted from them for agriculture (Wallowa County and NPT 1993). Many of the smaller water diversion projects in the subbasin were abandoned during the World War II era, as people left to join the war effort and industrialized agriculture replaced the reliance on canal systems (Wallowa County and NPT 1993). Current water withdrawals are used primarily for livestock and irrigation and are regulated by the county watermaster (USFS 1998a).

The Wallowa Valley Improvement Canal is the only major irrigation diversion in the subbasin (NPT et al. 1990). The project was started in the early 1900s. By the time the project was completed, a canal was built from Big Sheep Creek in the Imnaha subbasin to Prairie Creek in the Wallowa Valley (Wallowa County and NPT 1993). Downstream of the Big Sheep Creek forks, water is diverted from Big Sheep Creek and sent via a canal to Little Sheep Creek (NPT et al. 1990). A diversion dam in Little Sheep Creek leads to a second canal that transports the water to the Wallowa Valley where it is used for irrigation (NPT et al. 1990). Along the course of the canal, water from Big Sheep Creek, Salt Creek, Little Sheep Creek, Redmont Creek, Cabin Creek, Canal Creek, and Ferguson Creek is diverted (USFS 2000). Most of the canal supports populations of resident bull and rainbow trout.

In 1983, three small hydropower production facilities—upper Little Sheep Creek, Canal Creek, and Ferguson Ridge—were constructed along the Wallowa Valley Improvement Canal in the Sheep Creek subwatershed (Mason et al. 1993, USFS 2000). A separate canal, known locally as the “Power Canal”, was constructed above the Wallowa Valley Improvement Canal in an effort to obtain the necessary head required for electricity generation. Dropping diverted water rapidly through a penstock to the powerhouse, and then returning flows to the canal generated electricity. The facilities and canal, which were operated and maintained by Joseph Hydro Associates, were eventually removed in 1997 (USFS 2000). During its removal, approximately 3 miles of ditch was dewatered, necessitating a bull trout salvage operation by the USFS and ODFW during which an estimated 600 fish were saved (USFS 2000). The 600 bull trout that were saved from the dewatered ditch were later released into the Wallowa River, above Wallowa Lake (USFWS 2002b).

It has been determined by Forest and Wallowa Zone hydrologists/soil scientists that pond construction within draw bottoms (includes all perennial and intermittent streams) could affect hydrology and flow within watersheds (USFS 2003b). Extensive trough installations on springs located within draw bottoms could be another effect to flow within watersheds. However, based on the quantity of flow intercepted, it is assumed that the effect of trough installations on flow is minor in significance (USFS 2003b). Within this subbasin, a total of 17 ponds and 121 troughs are located within draw bottoms. These are spread over 13 and 29 subwatersheds, respectively (USFS 2003b). Due to the low occurrence of ponds and the small amount of flow that is intercepted from the trough installations, it is assumed that there are immeasurable effects to flow patterns in fish habitat (USFS 2003b).

Water Rights

There are 59 water rights on the Imnaha River mainstem for a total of 37.33 cfs (NPT and ODFW 1990). All rights to divert water in this area drop to $\frac{1}{2}$ of their rate and $\frac{1}{3}$ of the duty after August 1. Out of this total, the Lower Snake River Compensation Program (LSRCP) chinook hatchery facility will use 15 cfs in a nonconsumptive manner. There are an additional 69 water rights on tributaries (excluding the Big Sheep system) for a total of 24.98 cfs (NPT and ODFW 1990). There are 18 water rights on Big Sheep Creek for a total of 6.36 cfs and 5 additional water rights on tributaries (excluding Little Sheep Creek) for a total of 1.65 cfs (this does not include the Wallowa Valley withdrawals). There are four additional water rights filed on springs for 0.29 cfs. In Little Sheep Creek, there are 13 claims for 22.47 cfs, 19.6 cfs of which will be used by the LSRCP steelhead facility in a nonconsumptive manner (NPT and ODFW 1990). There are an additional 11 claims on tributaries for 26.55 cfs and 8 claims on springs for 0.41 cfs. This equals a combined water right of 279.61 cfs (including the Wallowa Valley diversions), 34.6 cfs of which is nonconsumptive (NPT and ODFW 1990).

In 1955, the legal means to reserve instream flows was created with the passage of the “minimum stream flow law” (ORS 536.300-310). This law recognizes water requirements of fish and wildlife as a beneficial use of water and establishes a “public water right” to minimum stream flows to be designated by the state Water Resources Board (Nelson et al. 1978). In 1961, minimum flows of 85 cfs were established at the USGS gage in the Imnaha River. Prior to 1987, established minimum flows were not, technically speaking, water rights and could be revised, suspended, or withdrawn by administrative rule. Since 1987, these minimum flows could be converted to legal water rights with a priority date the same as the date the flows were established. Minimum flows were established for Big Sheep and Little Sheep creeks in 1993 (Table 21), but they are ungaged. All minimum flows were converted to instream water rights on February 1, 1989.

Table 21. Minimum instream water rights (cfs) at the confluence of Big Sheep Creek and the Imnaha River (reproduced from Wallowa County and NPT 1993).

Stream	Minimum Monthly Flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Big Sheep	25	25	30	45	45	37	55	55	55	37	37	25
Little Sheep Creek	10	10	13	20	20	13	13	10	10	10	10	10

Erosion (Reproduced from USFS 2003d)

Sediment availability and rerouting has been altered by private land influences on Big Sheep Creek RM 31.9, and lower and middle Little Sheep Creek (predominately livestock grazing, rural home sites, and pasture creation); decreased flows caused by the operation of the Wallowa Valley Improvement District Canal on Big Sheep Creek (RM 31.9–RM 33.7); soil structure (ash deposits) in low-gradient meadow areas within RM 3.4 of Lick Creek; and Canal and Twin Lakes Fires. The Big Sheep Creek Watershed Analysis (USFS 1995) documents accelerated sheet and rill erosion in five subwatersheds (07J, 07O, 07P, 07Q, 07R) as a result of the Canal Fire, Twin Lakes Fire, and timber management. Accelerated gully erosion hazard was noted in

subwatersheds 07J, 07O, 07R, again the result of fires and timber management. Landslide and debris flow hazard ratings were found to be at natural levels.

The lower reaches of Big Sheep Creek are deposition zones due to reduced channel gradient. Stream bottom pavement has formed in the absence of “flushing flows” related to the Wallowa Valley Improvement Canal and hydropower operations. In 1997, hydropower operations were ceased. Hydropower operations used to divert water into the irrigation canal during April, May, and June. Without Hydropower operations in the spring, the additional flows in the lower reaches of Big Sheep Creek are available to transport and process sediment.

Percent fines are measured by quantifying the percentage of silts and clays (not sand) within a specific stream habitat unit (pool, riffle, glide). The only data available for this measurement are from RM 0.0 to RM 26.2 of Big Sheep Creek, obtained in a 1991 stream survey. The range of percent fines found between RM 0.0 and RM 26.2 for all habitat types was 8 to 20%. The average percent fines for Big Sheep Creek between RM 0.0 and RM 26.2 in riffle habitats were 7%. Big Sheep Creek was resurveyed during the 2003 field season. The percent fines data was obtained using the Wolman pebble count method. This information was not available for incorporation into this assessment.

Because of the mixed classification, the lower Imnaha and Big Sheep watersheds have been classified as “functioning at risk”, while the upper Imnaha watershed has been classified as “functioning appropriately”.

1.1.3.4 Human Influence on Condition and Processes in Terrestrial Systems

Fire

Most Native American groups are thought to have used fire to manipulate the environment for improved hunting, growing crops, livestock grazing, clearing trails for travel and to fireproof villages and campsites (USFS 1995). The extent and intensity of these manipulations is unclear but undoubtedly they had an impact on the ecosystem of the Imnaha subbasin. Early settlers also used fire to clear land and promote nonforest vegetation. This practice irreparably altered the vegetation in many areas of high settlement density (Johnson et al. 1994).

Wildfire suppression in the Imnaha subbasin has occurred since the early 1900s (USFS 2003d). It was employed primarily in attempt to protect settlements and timber resources. This practice has severely impacted the composition and structure of the subbasins vegetative communities and increased their susceptibility to other disturbances including insects and disease. The intensity and nature of these changes varies with the WHTs of the subbasin (see section 1.1.1.9 for WHT descriptions).

Impacts of Fire Suppression and Current Fire Regime

In Montane and Mixed Conifer Forest WHT, the exclusion of wildfire from stands has allowed late seral species tolerant of shade (grand fir, Engelmann spruce, and subalpine fir) to develop multi-layered structures at the expense of early seral species (western larch, ponderosa pine, lodgepole pine). Increased amounts of living and dead vegetative material have accumulated in the understory. Spacing between overstory trees has been reduced creating an overstocked condition. These stands are at risk to damage from wildfires, and are more susceptible to insect

and disease damage due to overstocked, multi-layered conditions. Consequently, forest stand health has declined (USFS 1995, 2003d).

Fire suppression in the ponderosa pine WHT of the subbasin has resulted in a shift from the open, park-like stands of ponderosa that once dominated to denser stands of shade-tolerant Douglas-fir where this species can survive. In areas of this WHT that are too arid to support Douglas-fir, stands of ponderosa have become denser and more multistoried (USFS 1995). These changes have reduced forage production in these stands and reduced their suitability for to support livestock or grazing wildlife (USFS 1998d).

Fire suppression has dramatically lengthened the fire return interval in the Subalpine Parkland WHT. Whitebark pine woodland fire intervals in the Columbia Basin varied from 50 to 300 years before 1900. The current “average” whitebark pine stand will burn every 3,000 years or longer because of fire suppression. During wet cycles, fire suppression can lead to tree islands coalescing and the conversion of parklands into a more closed forest habitat. Fire suppression can also contribute to the expansion of treed areas into surrounding subalpine grasslands (IBIS 2003).

The Upland Aspen WHT in the subbasin occurs as a seral stage in areas where conifers are climax. Aspen reproduces vigorously by root suckers following fire (USFS 1998d). With fire suppression and change in fire regimes, the Aspen Forest habitat is less common than before 1900 (IBIS 2003).

In the Interior Grassland WHT of the lower subbasin, fires are rarer but tend to be more intense than historical fires because of the buildup of dry, dense litter in the grass bases (Johnson et al. 1994). Because of past fire suppression efforts, only 26% of grassland habitat in the HCNRA burned between 1970 and 1994. Historically in this time period, it is likely all 300,000 acres of grassland within the HCNRA would have been burned, with most areas having burned twice (USFWS 2003a).

Fuel Model Distribution and Properties

Fuel models are a general method for describing fuel properties and can help predict fire ignition and behavior based on tree size class, fuel depth, and moisture of extinction. Fuel models have been identified and mapped on the National Forest lands within the subbasin (Figure 31). Private lands are not mapped but best estimates indicate that fuel models 2 and 8 best represent these lands. Fires burning in fuel models 9 or 10 are of greatest concern to the land managers of the subbasin. Fires burning in these areas can have much higher intensities with more long-term ecological impacts and be much more difficult to suppress. Currently, a greater extent of the forested areas in the subbasin can be classified as Fuel Models 9 and 10 than were present historically (USFS 1998d). Wildfire intensities have increased dramatically over historical levels (USFS 1995).

Since 1970, over 500 wildfires have occurred in the Imnaha subbasin, resulting from lightning strikes or human activities. Figure 32 shows the locations and year burned of fires greater than 100 acres in size on the National Forest portion of the subbasin. Table 22 lists fires over 100 acres that burned with high or medium intensity on the National Forest portion of the subbasin since 1970. The numbers and sizes of fires that have burned on private land is unknown

but are expected to be similar in number and distribution as those on the National Forest lands (USFS 2003d).

Table 22. Wildfires over 100 acres with high- or moderate-intensity burns (USFS 2003d).

Year	Fire Name	High Intensity (acres)	Medium Intensity (acres)
1986	Grouse Creek	78	45
1986	North Fork Dry Creek	40	20
1986	Pumpkin Creek	1,712	856
1989	Gumboot	60	30
1989	Lookout	127	119
1989	Canal Fire	5,996	3,323
1989	Summit Creek	3,520	2,112
1994	Twin Lakes	521	3,389
2000	Carrol Creek	330	260
2000	Eastside Complex	1,540	3,484
2001	Horse Creek	0	2,803
Totals		13,924	16,441

Some of these fires have seriously damaged portions of the subbasin for instance. The 1989 Canal Fire that burned the upper portion of the Big Sheep watershed damaged riparian areas and degraded fish habitat (USFS 1995).

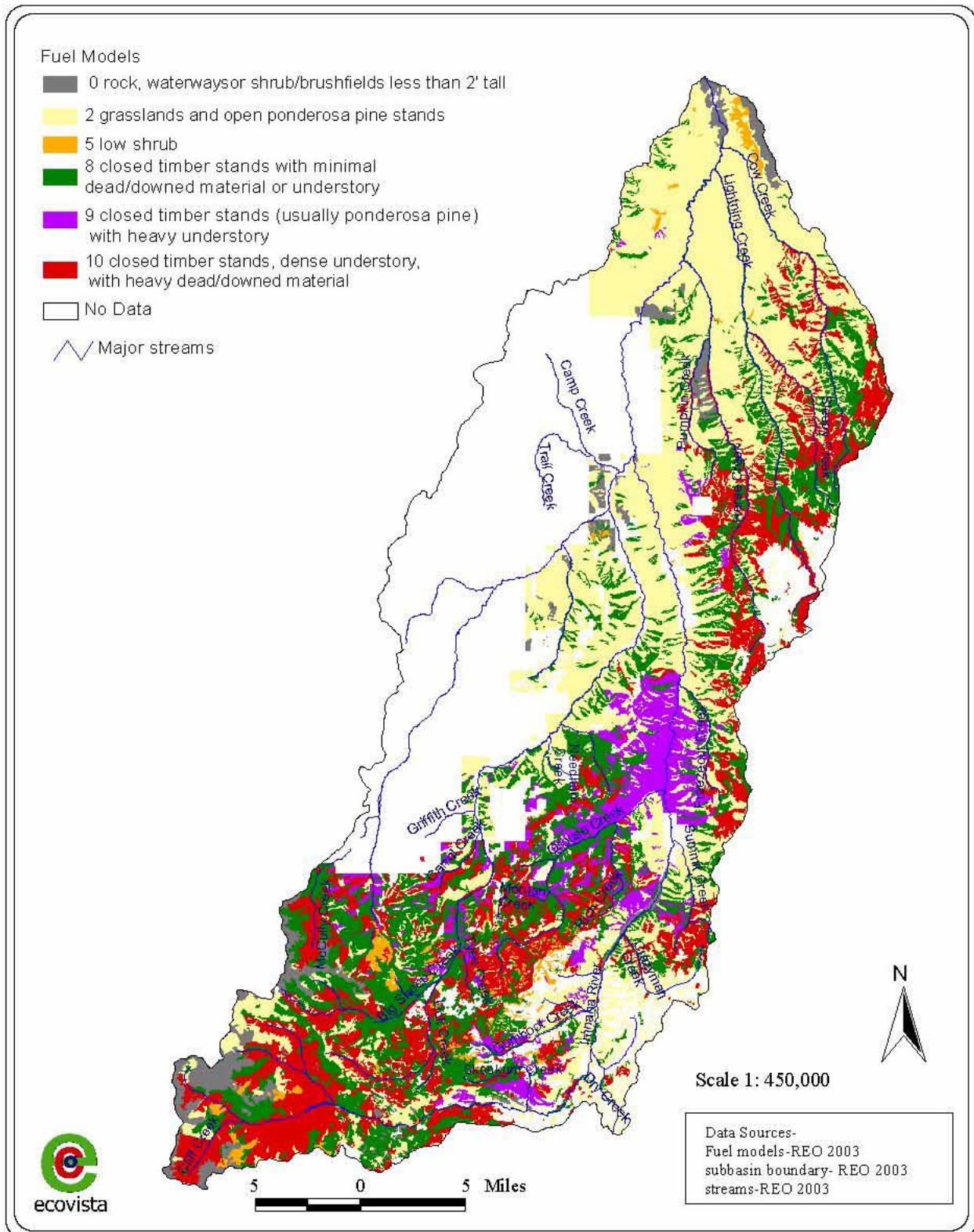


Figure 31. Current fuel models of the Imnaha subbasin.

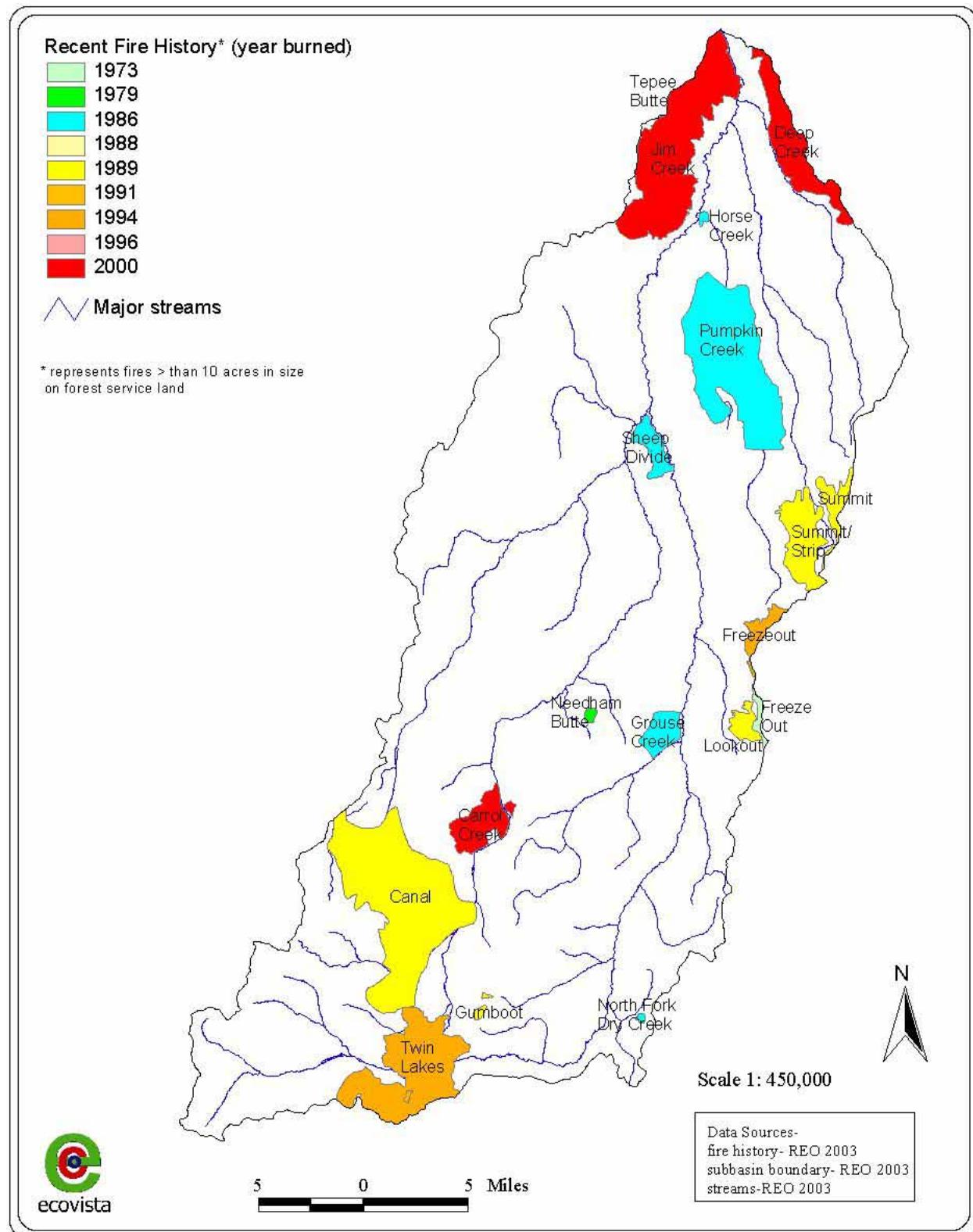


Figure 32. Location and year of occurrence of recent large fires (> 10 ac) in the Imnaha subbasin.

Managers in the subbasin are looking for ways to reduce the impacts of fire suppression on the ecosystem and restore vegetative stands to more natural conditions and fire regimes. Minimal-impact suppression tactics have been employed in the subbasin since 1989. A prescribed natural fire program has been implemented within the Eagle Cap Wilderness since 1982 and within the Hells Canyon Wilderness since 1985. On February 4, 1994, a Prescribed Natural Fire Environmental Assessment was approved and addressed the program on the Wallowa-Whitman National Forest. Prescribed fires will be consulted on a project by project basis, often included as part of a vegetative management proposal (USFS 2003a).

Insects and Disease

Increased stocking levels and the replacement of early seral species with grand fir, Douglas-fir, and Engelmann spruce has resulted in an increase in insect and disease damage over historical levels. Grand fir-dominated sites were historically found as isolated stands on wetter sites, resulting in a discontinuous distribution. Fire suppression has resulted in increased abundance and continuity of grand fir stands (USFS 1995).

The increased supply and distribution of host species has resulted in increased defoliation by western spruce budworm, a greater incidence of bark beetle outbreaks and root rots when compared with historical levels. Especially on drier sites where trees are more susceptible to stress during drought conditions (USFS 1995).

Timber Harvest

Timber harvest in the subbasin has concentrated on removing large trees usually the early seral species—western larch and ponderosa pine (USFS 2003d). In conjunction with fire suppression these activities reduced the abundance of these species in the subbasin and further contributed to the development of overstocked stands of shade tolerant species.

Grazing

Heavy grazing in the late 1800s and early 1900s caused structural and compositional changes to some of the grassland communities of the subbasin. These disturbed communities are simpler in composition and dominated by either annual grasses or forbs in early seral stages. In disturbed fescue communities, densities of fescue decrease while perennial forbs and annual grasses increase (Johnson et al. 1994). These effects are especially pronounced on the more gentle slopes of the ridge tops, benches and bottomlands. For instance on the benches of the Imnaha Canyon Kentucky bluegrass, red threeawn, annual bromes (cheatgrass, Japanese brome, rattlesnake brome) and goatweed all may be found in large patches (Johnson et al. 1994). Historical heavy grazing has also increased the susceptibility of portions of the subbasin to invasion by noxious weeds.

Introductions of Noxious Weeds and Exotic Plant Species

Areas where herbaceous cover has been removed or disturbed provide the most potential and actual sites for infestation by noxious weeds. Weed infestation sites include roadways, rock pits, timber harvest areas and where grazing, fire, or mining have disturbed the soil, trailheads off-road vehicle use sites, dispersed recreation campsites and locations where heavy vehicular traffic occurs (USFS 2003a). Recent inventories for noxious weeds in the subbasin conducted by the

Wallowa-Whitman National Forest have detected the presence of 14 species of noxious weeds (Table 23). The areas that have been surveyed are well distributed across the subbasin but there are many areas that still need to be surveyed (G. Yates, USFS personal communication 2003). Noxious weeds are not yet as well established in the Imnaha subbasin as they are in many other parts of the Columbia Basin.

Table 23. Areas infested with noxious weeds documented in recent surveys of portions of the Imnaha subbasin.

Common Name	Scientific Name	Acres Infested	Priority
Bugloss	<i>Anchusa</i> sp.	11,278	High
Canada thistle	<i>Cirsium arvense</i>	738	Low
Dalmatian toadflax	<i>Linaria dalmatica</i>	3	Low
Diffuse knapweed	<i>Centaurea diffusa</i>	88	High
Hoary cress-whitetop	<i>Cardaria draba</i>	129	High
Medusahead rye	<i>Taeniatherium caput-medusae</i>	26	Low
Poison hemlock	<i>Conium maculatum</i>	2	Low
Scotch broom	<i>Cytisus scoparius</i>	115	—
Scotch thistle	<i>Onopordum acanthium</i>	198	Low
Spotted knapweed	<i>Centaurea maculosa</i>	49	High
Tansy ragwort	<i>Senecio jacobaea</i>	1	High
Yellow hawkweed	<i>Hieracium pratense</i>	0	—
Yellow starthistle	<i>Centaurea solstitialis</i>	71	High
Yellow toadflax	<i>Linaria vulgaris</i>	4	—

1.1.4 Regional Context

1.1.4.1 Relation to the Columbia Basin

The Imnaha subbasin is located near the center of the Columbia Basin, in the farthest northeast corner of Oregon (Figure 1). It is one of the smallest of the 62 subbasins delineated by the NPCC, for use in the subbasin planning process, 16 subbasins are smaller while 45 are larger. The Imnaha River joins the Snake at RM 191.7, approximately 48 river miles upstream from Lewiston and 3.4 miles upstream of the Salmon River confluence.

1.1.4.2 Relation to the Province

The Columbia Basin has been divided into 11 provinces by the NPCC to aid in the subbasin planning process. The grouping of subbasins into provinces was based on physical similarities between subbasins. The Imnaha subbasin is one of four subbasins in the Blue Mountain Province; it is bordered to the west by the Grande Ronde subbasin and to the east by the Snake Hells Canyon subbasin (Figure 1).

1.1.4.3 Relation to Other Subbasins in the Province

As discussed previously, the Imnaha subbasin shares the Blue Mountain Province with three other subbasins—the Grande Ronde, the Snake Hells Canyon, and Asotin Creek. Together, the three subbasins provide aquatic resources of considerable regional and national significance.

Similar to the other subbasins, the Imnaha has a semi-arid climate and a snowmelt-driven hydrograph. The topography of all four subbasins is similar in that all are defined to some extent by deeply incised river canyons. None of the subbasins are densely populated. Factors that are commonly cited in the four subbasins as limiting resident and anadromous salmonid production include water withdrawals, channel modification, geomorphic instability, compromised riparian function, sedimentation and out-of-basin effects.

1.1.4.4 Unique Qualities of the Subbasin

Aquatic Qualities

The Imnaha subbasin provides a substantial component of the total spawning and rearing habitat available to imperiled fish species in the Snake River Basin. Because of this, the Imnaha represents one of the most productive subbasins in the Snake River ESU and Blue Mountain ecological province with relation to summer steelhead, spring/summer chinook, and bull trout. According to StreamNet fish distribution data, although the Imnaha subbasin comprises only 0.4% of the area of the U.S. portion of the Columbia Basin it contains 2.7% of reaches used by steelhead for spawning and rearing (Table 24). It also possesses a disproportionate amount of the reaches used for spawning and rearing habitat by spring/summer and fall chinook. Although distribution information for bull trout is not available from StreamNet (2003) across the entire U.S. portion of the subbasin the Imnaha provides a disproportionate amount of the habitat in the Blue Mountain Province. The Imnaha subbasin comprises almost 14% of the Blue Mountain Province, yet contributes almost 26% of the reaches used by bull trout for spawning and rearing in the province (Table 24).

Table 24. Comparison of reaches used by fish species of concern in the Imnaha subbasin (IS) vs. the Blue Mountain Province (BMP) and the U.S. portion of the Columbia Basin (CB) (based on StreamNet 2003¹).

Species	Use Type	U.S. portion of CB (mi of stream)	BMP (mi of stream)	IS (mi of stream)	% of CB distribution within IS	% of BMP distribution within IS
Spring/summer chinook	Primarily spawning and rearing	4,113.7	298.7	66.2	1.6	22.2
	Primarily rearing and migration	2,736.8	546.6	80.1	2.9	14.7
	Primarily migration	1,900.1	56.2	0.0	0.0	0.0
	Total spring/summer chinook distribution	8,750.6	901.5	146.3	1.7	16.2
Steelhead	Primarily spawning and rearing	11,836.4	1,770.7	325.0	2.7	18.4
	Primarily rearing and migration	1,456.8	539.5	25.5	1.8	4.7
	Primarily migration	2,965.1	51.1	17.0	0.6	33.3
	Total steelhead distribution	16,258.3	2,361.3	367.5	2.3	15.6
Fall	Primarily spawning and rearing	1,272.1	224.3	17.6	1.4	7.8

Species	Use Type	U.S. portion of CB (mi of stream)	BMP (mi of stream)	IS (mi of stream)	% of CB distribution within IS	% of BMP distribution within IS
chinook	Primarily rearing and migration	285.2	0.0	0.0	0.0	0.0
	Primarily migration	1,092.6	6.2	0.0	0.0	0.0
	Total fall chinook distribution	2,649.9	230.5	17.6	0.7	7.6
Bull trout	Spawning, rearing, or resident	NA ²	325.4	83.8	NA	25.8
	Migration	NA	520.4	106.7	NA	20.5
	Total bull trout distribution	NA	845.8	190.5	NA	22.5

¹StreamNet data was collected at the relatively coarse 100,000 scale, and data quality is dependent on level of survey effort and reporting. Finer scale information may be available in some locations; StreamNet data was used due to its widespread availability in the Columbia Basin.

²NA-Not available, bulltrout distribution was not available across the entire Columbia Basin

Terrestrial Qualities

Grasslands

The extent of grassland habitats lost in the Imnaha subbasin has been less significant than in the rest of the Blue Mountain Province or Columbia Basin, and the Imnaha now provides a greater percentage of the distribution of this WHT than it did historically (Table 25 and Table 26). Conversion of grassland habitats in the neighboring Grande Ronde subbasin to agriculture has likely affected dispersal and migration patterns for many grassland dependent species in both subbasins (see Appendix D for maps of the current and historical distribution of the major WHTs in the subbasin).

- The Zumwalt Prairie, in the western portion of the subbasin, is one of the best remaining examples of Palouse bunchgrass prairie in North America. The Zumwalt Prairie supports the highest known concentrations of breeding hawks and eagles in North America and populations of the endangered Spalding's catchfly. Columbian sharp-tailed grouse, once extirpated from Oregon, have been reintroduced on the Zumwalt Prairie (TNC 2002).
- The canyon grassland habitats of the Imnaha subbasin support one of the largest and healthiest Rocky Mountain bighorn sheep herds within Oregon. The lower Imnaha River is a major lambing area for the herd, and the upper Imnaha River area is part of a migration corridor (USFS 1995).

Forests

Due in large part to the high level of protection and relatively low level of disturbance many of the forest communities in the Imnaha subbasin are in better condition than other forests in the region. The Imnaha provides a greater percent of the Montane and Eastside Mixed Coniferous Forests in the Columbia Basin than it did historically (Table 26). Fire suppression and timber harvest have altered the composition and structural makeup of these forests, but these alterations are thought to be less pronounced in the Imnaha subbasin, as a result of harvest restrictions in the wilderness and uneven-age management prescriptions on the HCNRA (USFS 2003a).

- The Wallowa Mountains have been identified as one of Oregon's important bird areas. Reasons for this designation include its comprising the entire range of spruce grouse in Oregon, being the only area with regular confirmed breeding of pine grosbeak in Oregon, and comprising the entire breeding range of the Wallowa rosy-finches (Hunter 2003).
- The upper Imnaha subbasin may form part of a unique ecological corridor linking the Wallowa and Blue Mountains with the Rocky Mountains (USFS 2000a). This corridor may be critical in maintaining the genetic viability of populations of wide ranging forest species. Edelmann and Copeland (1999) found that the corridor was likely the only suitable travel corridor linking subpopulations of wolverine in Oregon and Idaho.

Table 25. Comparison of the historical and current distribution of wildlife habitat types (WHTs) in the Imnaha subbasin (IS), the Blue Mountain Province (BMP), and the Columbia Basin (CB) (based on data from NHI 2003).

WHT	Historical Distribution of WHT			Current Distribution of WHT		
	CB (acres)	BMP (acres)	IS (acres)	CB (acres)	BMP (acres)	IS (acres)
Eastside (Interior) Grasslands	20,696,084	1,293,214	330,562	6,013,723	919,701	275,555
Alpine Grasslands and Shrublands	675,865	25,065	9,927	2,612,993	133,242	28,365
Montane Mixed Conifer Forest	6,887,884	108,947	16,627	11,535,522	283,929	52,661
Eastside (Interior) Mixed Conifer Forest	19,085,891	522,894	96,042	23,620,021	1,136,847	162,903
Montane Coniferous Wetlands	0	0	0	295,923	3,193	420
Ponderosa Pine Forest and Woodlands	16,788,196	1,090,459	47,649	8,758,550	676,902	25,154
Lakes, Rivers, Ponds, and Reservoirs	1,131,394	9,430	3,226	1,620,589	9,915	82
Agriculture, Pasture, and Mixed Environ	0	0	0	23,349,523	389,527	1,189
Herbaceous Wetlands	703,346	1,985	0	942,303	11,321	16
Shrub-Steppe	39,198,948	657,154	6,452	35,794,864	397,314	50
Lodgepole Pine Forest and Woodlands	10,670,749	113,662	4,715	3,625,771	2,894	0
Western Juniper and Mountain Mahogany	1,716,153	11,664	0	3,618,291	954	0
Urban and Mixed Environ	0	0	0	1,131,534	16,042	0
Eastside (Interior) Riparian Wetlands	839,509	43,926	248	672,859	1,972	0
Eastside (Interior) Canyon Shrublands	0	0	0	360,302	67	0
Upland Aspen Forest	1,384,410	13,401	248	1,338,518	0	0
Subalpine Parklands	2,399,693	86,611	30,277	1,110,484	0	0

Table 26. Changes in percentage of wildlife habitat types (WHTs) distribution in the Columbia Basin (CB) and Blue Mountain Province (BMP) contributed by the Imnaha subbasin (IS) (bold figures indicate an increase in contribution from historical to current) (based on data from NHI 2003).

WHT	% of historical WHT distribution in CB within the IS	% of current WHT distribution in CB within the IS	% of historical WHT distribution in BMP within the IS	% of current WHT distribution in BMP within IS
Eastside (Interior) Grasslands	1.60	4.58	26	30
Alpine Grasslands and Shrublands	1.47	1.09	40	21
Montane Mixed Conifer Forest	0.24	0.46	15	19
Eastside (Interior) Mixed Conifer Forest	0.50	0.69	18	14
Montane Coniferous Wetlands	—	0.14	—	13
ponderosa pine Forest and Woodlands	0.28	0.29	4	4
Lakes, Rivers, Ponds, and Reservoirs	0.29	0.01	34	1
Agriculture, Pasture, and Mixed Environs	—	0.01	—	0
Herbaceous Wetlands	0.00	0.00	0	0
Shrub-Steppe	0.02	0.00	1	0
Lodgepole Pine Forest and Woodlands	0.04	0.00	4	0
Western Juniper and Mountain Mahogany	0.00	0.00	0	0
Urban and Mixed Environs	—	0.00	—	0
Eastside (Interior) Riparian Wetlands	0.03	0.00	1	0
Eastside (Interior) Canyon Shrublands	—	0.00	—	0
Upland Aspen Forest	0.02	0.00	2	—
Subalpine Parklands	1.26	0.00	35	—

Biodiversity and Endemism

Two recent regional assessment efforts have identified portions of the Imnaha subbasin as being areas of regional conservation importance based on high biodiversity and/or the presence of rare or endemic organisms. The Interior Columbia Basin Ecosystem Management Project (ICBEMP) mapped centers of biodiversity and endemism/rarity, across the interior Columbia Basin in 1994. In 2003, the Nature Conservancy used the SITES model to develop a conservation portfolio for the Middle Snake-Blue Mountain Ecoregion. These regional efforts, which help to establish the importance of the Imnaha subbasin in efforts to protect and restore the fish and wildlife species of the region, are discussed in the following section.

ICBEMP Centers of Biodiversity and Endemism

As ICBEMP project expert panels of agency and nonagency scientists were convened between October 1994 and May 1995 to identify areas of rare and endemic populations of plant, invertebrate, and vertebrate species (ICBEMP 1997). The panels of experts produced maps showing areas having unusually high biodiversity, and areas containing high numbers of rare or locally or regionally endemic species (Figure 33 and Figure 34). The centers of concentration were developed at the coarse scale, in a short time frame and were mostly based on the panel's personal knowledge of areas and species locations. These developers suggested that they be considered a first approximation of identifying areas with particularly diverse collections of rare or endemic species, or areas with high species richness. Centers of concentration might be candidates for research natural areas or other natural area designations pending further local assessment and refinement (ICBEMP 1997). Twenty-one percent of the subbasin was identified as a center of plant biodiversity (Table 27). These areas occurred in the high Wallowa Mountains and in areas on the east side of the subbasin that border the Hells Canyon subbasin. Twenty percent of the Imnaha subbasin was selected as a center of plant endemism and rarity (Table 27). These areas roughly correspond with those selected as centers of plant biodiversity, the Wallowa Mountains and Hells Canyon area. Areas selected as centers of animal endemism and rarity occur in the Zumwalt prairie area of the subbasin and extend into the Wallowa Mountains.

Table 27. Areas selected as centers of biodiversity or centers of endemism and rarity in the Imnaha subbasin.

Interior Columbia Ecosystem Management Project Designation	Area of Imnaha subbasin selected (acres)	% of Imnaha subbasin selected
Centers of Biodiversity—Plants	114,826	21
Centers of Biodiversity—Animals	0	0
Centers of Endemism and Rarity—Animals	175,546	32
Centers of Endemism and Rarity—Plants	110,248	20

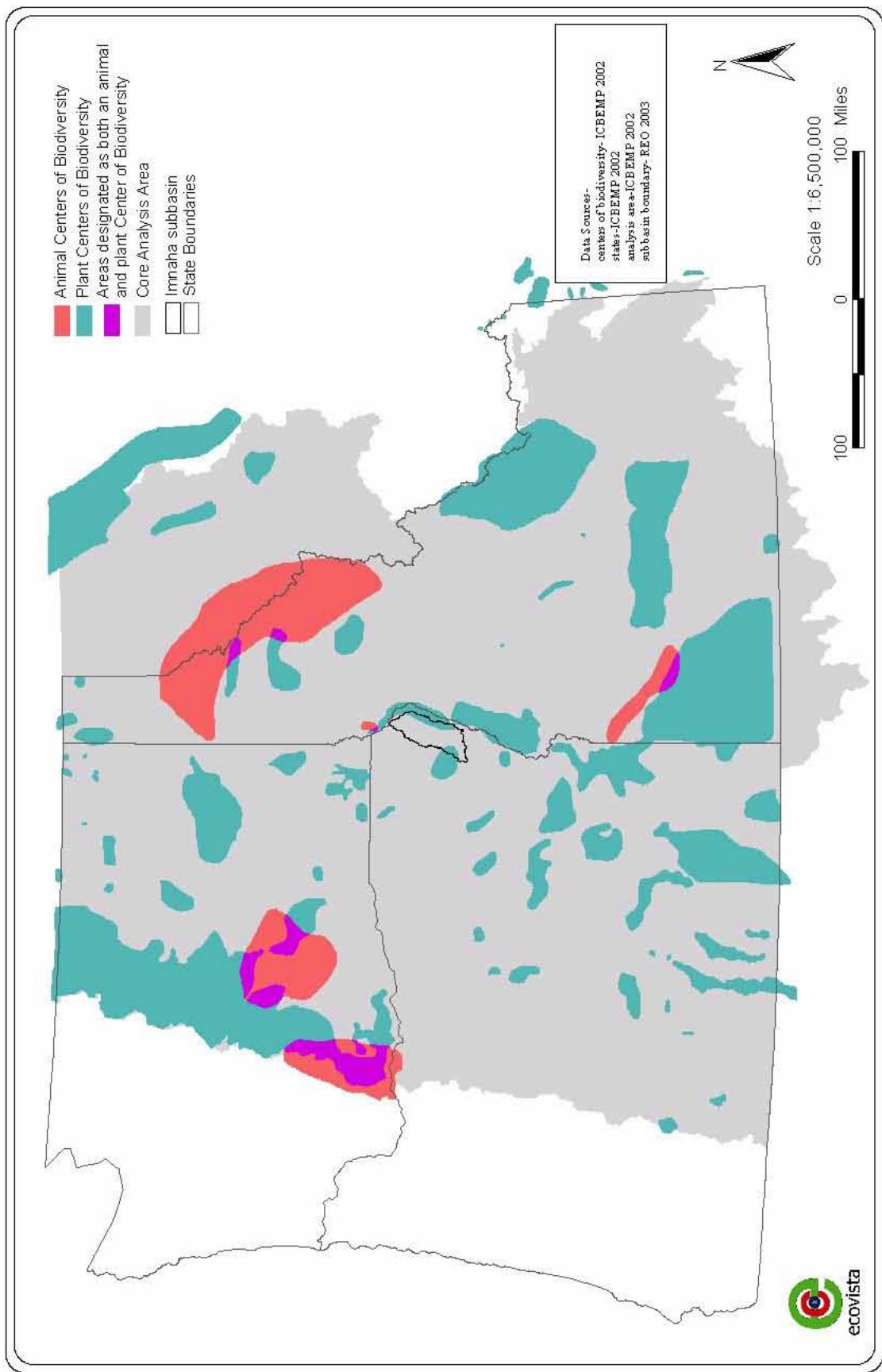


Figure 33. Centers of biodiversity in the ICBEMP analysis area and the Imnaha subbasin.

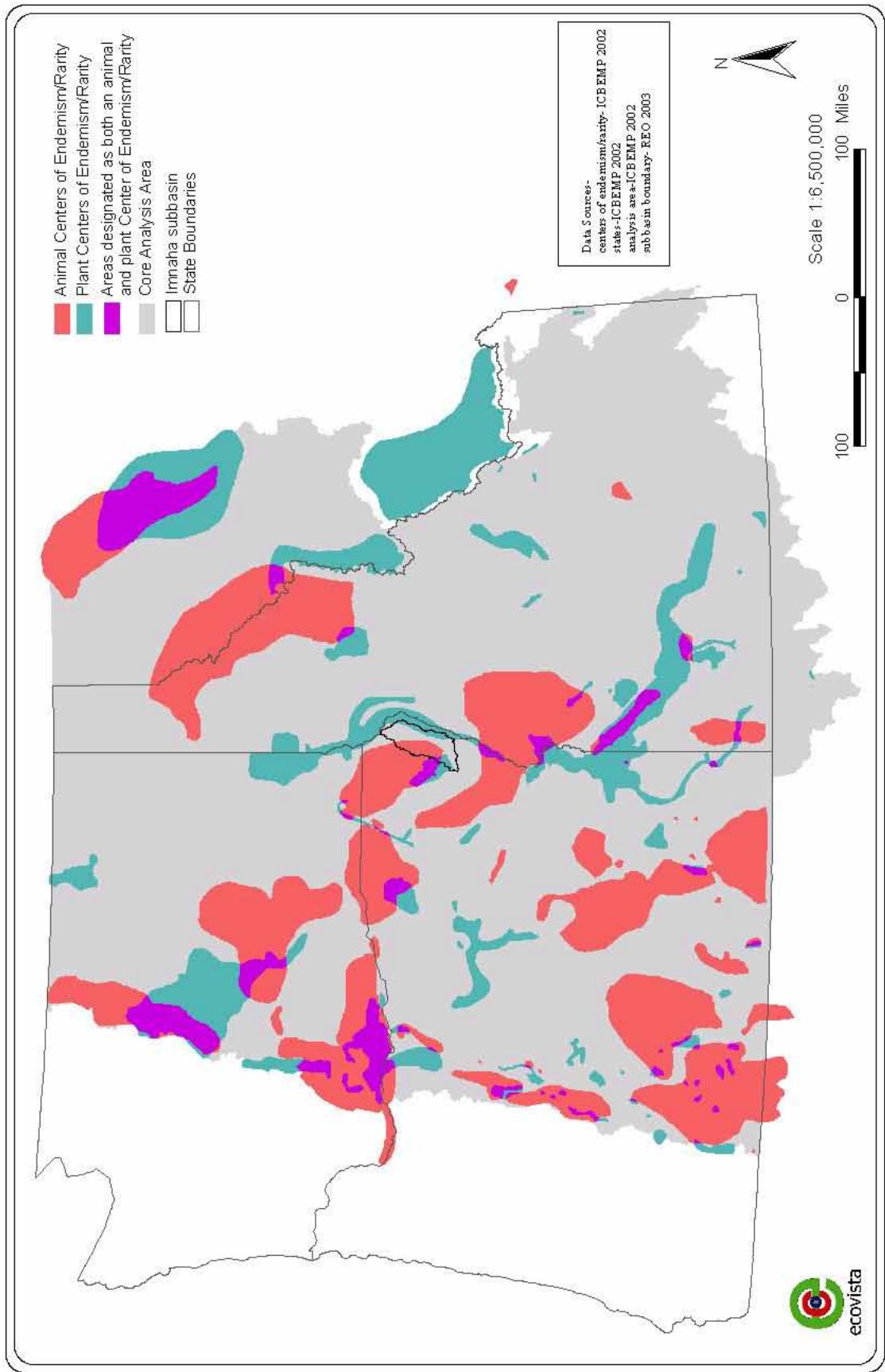


Figure 34. Centers of endemism and rarity in the ICBEMP analysis area and the Imnaha subbasin.

The Nature Conservancy's Sites Model

The Nature Conservancy has recently completed an ecoregional conservation plan for the Middle Rockies-Blue Mountain Ecoregion, which covers 81,587 square miles (52,215,958 acres) in Oregon, Idaho, Montana, and a small part of Washington. The Imnaha subbasin is contained within this ecoregion. The goal for the Middle Rockies-Blue Mountains ecoregion conservation plan was to identify the suite of conservation sites and strategies that will ensure the long-term survival of all viable native plant and animal species and natural communities in the ecoregion. Due to the complexity of the Middle Rockies-Blue Mountains ecoregion, a site selection model was used to help design a portfolio that will achieve this goal in the most cost effective manner possible. The site selection model used in this project is an optimization model that applies a combination of simulated annealing and iterative improvement to the portfolio design problem (SITES). The simulated annealing used by SITES is a minimization method, where biodiversity is a constraint and the goal is to minimize the cost or size of the portfolio. The model was run at the 6th field HUC scale (TNC 2003).

Preparing to run the SITES model involves three main steps:

- Identifying the conservation targets that will help to maintain the biodiversity of the area
- Identifying the desired representation of the conservation targets in the ecoregion
- Identifying the costs and suitability of protection of different areas

Conservation Targets

The Middle Rockies-Blue Mountain Planning Team utilized a coarse filter/fine filter approach to biodiversity conservation. The coarse filter is a community-level conservation strategy whereby natural community types are used as conservation targets to represent 85 to 90% of species and ecological processes, in a community. However, given current knowledge, this ecosystem approach cannot be counted on to maintain and protect all biodiversity. Some species, especially the rarest, will fall through the pores of the coarse filter. Therefore, a fine filter of rare species conservation planning is needed as a complement (Noss and Cooperrider 1994, as cited in TNC 2003).

The Nature Conservancy planning team selected 978 coarse and fine filter conservation targets for the Middle Rockies Blue Mountain Ecoregion (Table 28). Most data, such as the distribution of all plant and animal species targets in the ecoregion, were obtained from the four state Natural Heritage programs. Species are classified into five classes based on their global distribution G1=critically imperiled globally, G2=imperiled globally, G3=globally rare or uncommon, G4=globally widespread and apparently secure, G5=globally widespread and secure. The following conservation ranks were considered in the selection of conservation targets from this database:

- All G1, G2, and federally listed species were included.
- G3 species were considered individually.
- G4 and G5 species were included if the species were declining over all or part of their range, the populations were disjunct from distant ecoregions, or they were endemic.

Data obtained from other sources included the predicted distribution maps for wide-ranging birds and mammals such as the greater sage-grouse, wolverine, gray wolf, and lynx were obtained from the state GAPs. The distribution data for wide-ranging fish were obtained from StreamNet. Aquatic community distribution data were developed by the planning team using a physically based classification model that was applied in a GIS to represent aquatic communities in the ecoregion (TNC 2003).

Representation Goals

The Nature Conservancy planning team developed conservation goals for the representation of each target element or surrogate in the portfolio. Portfolio representation goals were developed based on three primary factors:

- Distribution of the targets across the ecoregion
- Number of occurrences or amount of area occupied
- Degree of endangerment for the conservation target

Table 28. Type, distribution sources, and representation goals for the 978 coarse and fine scale conservation targets selected for the Middle Rockies-Blue Mountain Ecoregion SITES run.

Conservation Targets	Number of Targets	Source of Distribution Data	Representation Goal for Portfolio
Fine Filter Targets			
Plant	127	EOR ¹	Dependent on conservation rank and degree of endemism
Terrestrial Animals	54	EOR ¹	Dependent on conservation rank and degree of endemism
		GAP models	20% of distribution per section for species of high conservation concern, 10% for others
Aquatic Animals	33	EOR ¹	Dependent on conservation rank and degree of endemism
		StreamNet	Dependent on rarity and degree of historical decline
Rare Plant Communities	55	EOR ¹	Dependent on conservation rank and degree of endemism
		6 th field HUC	Dependent on degree of rarity
Total Fine Filter Targets	269		
Coarse Filter Targets			
Aquatic Macrohabitats	207	Modeled	Dependent on Abundance of type in Ecoregion
Riparian Plant Communities	209	Modeled	10% of distribution
Nonriparian Plant Communities	293	GAP cover types	Dependent on biodiversity and rangewide distribution and ecoregional abundance
Total Coarse Filter Targets	709		
TOTAL TARGETS	978		

¹ EOR = Element Occurrence Record database that is maintained by state Natural Heritage Programs/Conservation Data Centers

Cost and Suitability

The following are factors considered in determining the cost and suitability of conservation of terrestrial habitats for the Middle Rockies-Blue Mountain Ecoregional Plan:

- The conservation suitability of private land was considered to be somewhat lower than the same area of public land. Cost would rise faster as private land area increased in a 6th field HUCs than for a similar increase in public land area.
- The Nature Conservancy Planning Team wanted the model to choose areas of public land that were less roaded. So, they chose a parameter that would cause the first few roads in a 6th field HUC to dramatically increase the cost, but the rate of increase declines beyond a certain density threshold. In other words, it is the first roads that decrease the suitability the most and, after a point, the cumulative effect of additional roads becomes less.
- The opposite is true of private land. They did not want the model to automatically shy away from private land, they chose a parameter where a low level of roads and converted land does not dramatically increase the cost (decrease suitability). The cost rises slowly at first for private land, but more rapidly as the percentage of converted and roaded land increases in a 6th field HUC.

Several factors were considered when rating the cost and suitability of conservation in aquatic habitats:

- ICBEMP aquatic integrity scores
- Dams within the HUC
- Length of the §303(d)-listed segment within the HUC
- Number of point sources within the HUC

To account for the relatively low cost of continuing to protect areas with existing protection, 6th field HUC watersheds that were completely or partially contained by a protected area greater than 25 acres in size were locked into the portfolio selection (i.e., these areas were always selected in the development of the conservation strategy) (TNC 2003).

SITES Outputs

The model begins by generating a completely random portfolio. Next, it iteratively explores trial solutions by making sequential random changes to this portfolio. Either a randomly selected selection unit (6th field HUC watershed), not yet included in the portfolio, is selected, or a selection unit already in the system is deleted. At each step, the new solution is compared with the previous solution, and the best one is accepted.

The modeled solution constituted the first draft of the conservation portfolio. The Nature Conservancy planning team and an independent review team then reviewed the first draft and modified it based on personal experience in the ecoregion. The final recommended portfolio

encompasses 37% of the ecoregion and meets the representation goal for over 90% of the terrestrial community targets, aquatic community targets, invertebrate species targets, and federally listed targets (TNC 2003).

Imnaha Subbasin's Contribution to Selected Conservation Portfolio

Eighty-nine percent of the Imnaha subbasin was selected as part of the conservation portfolio for the Middle Rockies-Blue Mountain Ecoregion (Figure 35). This is a reflection both of the areas biological importance and the large amount of land in the subbasin that is protected. Because of the low cost of continuing to protect these areas, they were locked into the conservation portfolio. Areas selected for the Middle Rockies-Blue Mountain conservation portfolio within the Imnaha subbasin contributed to meeting the representation goals for 24 fish and wildlife species target, 19 rare plant species targets, and 25 rare plant association or habitat type species targets (Appendix E).

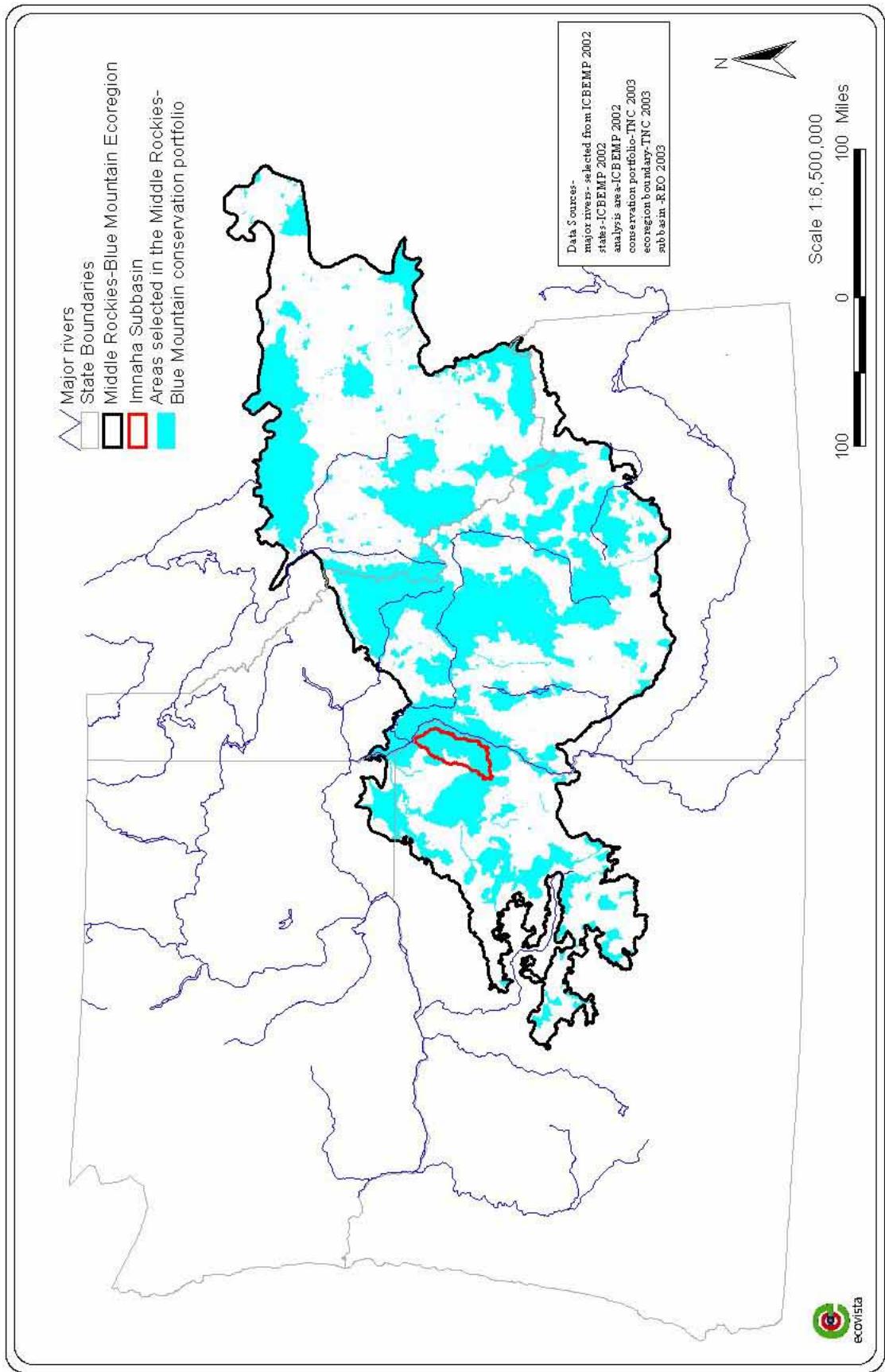


Figure 35. Areas selected for the Middle Rockies-Blue Mountain conservation portfolio.

1.1.4.5 NMFS Evolutionarily Significant Units

The Imnaha subbasin falls within the evolutionarily significant unit (ESU) designated by the National Oceanic and Atmospheric Administration's Fisheries Service (NOAA Fisheries, also known as the National Marine Fisheries Service or NMFS) for the Snake River. The listed ESU includes all natural populations of fall- and spring-run chinook salmon and summer steelhead in the mainstem Snake River and any of the following subbasins: Tucannon River, Grande Ronde River, Imnaha River, Salmon River, Asotin Creek, and Clearwater River.

1.1.4.6 USFWS Designated Bull Trout Planning Units

The Imnaha subbasin has been defined by the USFWS as one of three core areas within the Imnaha-Snake Rivers Bull Trout Recovery Unit. For the purposes of recovery planning, a core area represents the closest approximation of a biologically functioning unit (USFWS 2002b). Based on survey data and professional judgment, as well as Kostow (1995) and Buchanan et al. (1997), the Imnaha-Snake Rivers Recovery Unit Team has also identified local subpopulations of bull trout that currently exist within each core area (USFWS 2002b). In the Imnaha Core Area (which is entirely in Oregon), local subpopulations include the Imnaha River (above the mouth of Big Sheep Creek), upper Big Sheep Creek (above the Wallowa Valley Improvement diversion and in the canal), lower Big Sheep Creek (below the Wallowa Valley Improvement diversion), Little Sheep Creek, and McCully Creek. Proposed critical habitat sub-units (CHSUs) for bull trout populations within the Imnaha subbasin include approximately 285.6 stream km (177.4 mi) or 18.6% out of the approximately 1532 stream km (952 mi) in this subbasin (Table 29).

Table 29. Proposed bull trout Critical Habitat Subunits (CHSUs) in the Imnaha subbasin (USFWS 2002b)

Imnaha	Proposed CH	Big Sheep	Proposed CH
Bear Creek	Mouth to rkm 0.4, rm 0.3	Big Sheep Creek	Mouth to rkm 65, rm 40.4
Blue Creek	Mouth to rkm 0.4, rm 0.3	Lick Creek	Mouth to rkm 15.1, rm 9.4
Cliff Creek	Mouth to rkm 6.7, rm 4.2	MF Big Sheep Creek	Included in Big Sheep Creek
Imnaha River	Mouth to rkm 115.3, rm 71.6	Salt Creek ¹	Mouth to rkm 1.9, rm 1.2, then upstream from WVIC 0.5 rkm, 0.3 rm
MF Imnaha	Mouth to rkm 1.3, rm 0.8	Little Sheep	Proposed CH
NF Imnaha	Mouth to rkm 9.7, rm 6	Cabin Creek	Mouth to rkm 0.4, rm 0.3
Soldier Creek	Mouth to rkm 0.4, rm 0.3	Little Sheep Creek	Mouth to rkm 41.7, rm 25.9, then upstream from WVIC 0.9 rkm, 0.6 rm
SF Imnaha	Mouth to rkm 9.2, rm 5.7	Redmont Creek	Mouth to rkm 1.8, rm 1.1, then upstream from WVIC 0.5 rkm, 0.3 rm
McCully	Proposed CH		
McCully Creek	WVIC upstream 10.8 rkm, 6.7 rm		

¹/ Salt Creek represents an addition to CHSUs previously identified in USFWS 2002b

1.2 Species Characterization and Status

1.2.1 Species of Ecological Importance

1.2.1.1 *Species Designated as Threatened or Endangered*

Federal

In 1973, the Endangered Species Act (ESA) was passed, building on and strengthening the provisions of the Endangered Species Preservation Act of 1966, the Endangered Species Conservation Act of 1969, and the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; USFWS 2004).

The purpose of the ESA is to “conserve the ecosystems upon which threatened or endangered species depend” and to conserve and recover listed species. Under the law, species may be listed as either “threatened” or “endangered”. Endangered means that a species is in danger of becoming extinct throughout all or a significant portion of its range. Threatened means that a species is likely to become endangered within the foreseeable future. All species of animals and plants are eligible for listing (Kilpatrick 2001).

The ESA makes it illegal for any person subject to the jurisdiction of the United States to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered species of fish or wildlife, within the United States without authorization from the responsible federal agency. The Interior Department’s USFWS and NOAA Fisheries (or NMFS) jointly administer the act. The USFWS administers terrestrial, fresh water species, and migratory birds, while NMFS administers marine species (Kilpatrick 2001). Eight species listed as threatened under the ESA occur or potentially occur in the subbasin and three additional species are candidates under consideration for listing (Table 30). Federal concern species that have been identified for Wallowa County are listed in Appendix F.

Table 30. ESA-listed or candidate species known to or that potentially occur in the Imnaha subbasin.

Status	Common Name	Scientific Name
Threatened	Bald eagle	<i>Haliaeetus leucocephalus</i>
Threatened	Bull trout	<i>Salvelinus confluentus</i>
Threatened	Chinook (spring/summer and fall)	<i>Oncorhynchus tshawytscha</i>
Threatened	Gray wolf	<i>Canis lupus</i>
Threatened	Lynx	<i>Lynx canadensis</i>
Threatened	MacFarlane's four o'clock	<i>Mirabilis macfarlanei</i>
Threatened	Spalding's catchfly	<i>Silene spaldingii</i>
Threatened	Steelhead	<i>Oncorhynchus mykiss</i>
Candidate	Columbia spotted frog	<i>Rana luteiventris</i>
Candidate	Slender moonwort	<i>Botrychium lineare</i>
Candidate	Yellow-billed cuckoo	<i>Coccyzus americanus occidentalis</i>

State

The State of Oregon also maintains a list of threatened and endangered fish and wildlife, in order to help fulfill the State of Oregon's policy of preventing the serious depletion of any indigenous species (ORS 496.012). The Oregon Endangered Species Rules (OAR 635-100-100 to 635-100-130) allow for the classification of native species as threatened or endangered and the implementation of appropriate measures to recover them. Two species listed by the State of Oregon as endangered, and three species listed by the State of Oregon as threatened occur or potentially occur within the Imnaha subbasin (Table 31).

Table 31. Species that occur or potentially occur in the Imnaha subbasin that are listed as threatened or endangered by the State of Oregon.

Oregon Status	Common Name	Scientific Name
Endangered	American peregrine falcon	<i>Falco peregrinus anatum</i>
Endangered	Gray wolf	<i>Canis lupus</i>
Threatened	Bald eagle	<i>Haliaeetus leucocephalus</i>
Threatened	Chinook salmon	<i>Oncorhynchus tshawytscha</i>
Threatened	California wolverine	<i>Gulo gulo luteus</i>

Status of Federally or State Listed Endangered or Threatened Species

American Peregrine Falcon

The American peregrine falcon (*Falco peregrinus anatum*) was federally delisted on August 20, 1999, due to accomplishment of recovery goals. It is still considered endangered by the State of Oregon, but change in this status is being considered. The bird has made a remarkable comeback in Oregon after being considered extirpated in the 1960s. In 1994, there were 37 known nest sites in the state that produced 60 young.

A *Pacific States Peregrine Recovery Plan* was completed in 1982 for the Pacific Recovery Zone. The plan identified certain recovery objectives that needed to be met in order to have a self-sustaining population. The recovery objective for the Imnaha and surrounding area is to have two breeding pairs. In response to these goals, the Wallowa-Whitman National Forest began placing young peregrine falcons at potential nest sites in 1987 to establish a nesting pair. National Forest monitoring of these efforts has led to the detection of three natural peregrine nests on the forest. None of these nest sites occurred in the Imnaha subbasin. However, potential nest site habitat for peregrine falcons occurs in the Imnaha River corridor and at Marble Mountain (USFS 1998d). Cliffs above Big Sheep Creek were rated for their potential use as peregrine eyries. No sites received a high rating, and nesting potential in this area is thought to be low (USFS 1998d). Foraging habitat for peregrine falcons in the subbasin is abundant (USFS 1995).

Bald Eagle

Because of concern over declining populations of bald eagle (*Haliaeetus leucocephalus*) primarily due to habitat destruction, human-caused mortality, and DDT-caused eggshell thinning, the bald eagle was designated as threatened in the conterminous (lower 48) states on March 11, 1967, under a law that preceded the ESA of 1973. On July 4, 1976, the USFWS

officially listed the bald eagle as a national endangered species under the ESA. In July 1995, the USFWS upgraded the status of bald eagles in the lower 48 states to threatened. The USFWS is currently evaluating the bald eagle for delisting (USFWS 2003c). The bald eagle has been selected as a focal species for this assessment. Information on the bald eagle's habitat use and status in the Imnaha subbasin can be found in section 1.2.9

Bull Trout

The USFWS published a final rule listing the bull trout (*Salvelinus confluentus*) in the Columbia River distinct population segment (DPS) as a threatened species under the ESA (Federal Register Volume 63, p. 31647). The rule became final on July 10, 1998. The USFWS has proposed critical habitat for bull trout for the Klamath River and Columbia River Distinct Population Segments (DPS) and is currently reviewing public comments and developing a draft economic analysis on the proposed rule. Additionally, the FWS has developed a draft recovery plan for the Klamath, Columbia, and St. Mary-Belly Rivers DPS's and is undergoing review and revision on those plans. Both the bull trout final critical habitat designation and final recovery plan are expected to be completed in 2004. Bull trout have been selected as a focal species for this assessment. Information on this species' habitat use and status in the Imnaha subbasin can be found in section 1.2.6.

Chinook

Snake River spring/summer chinook was listed as a threatened species in 1992, 57 FR 14653. The ESU includes all natural populations of spring/summer-run chinook in the mainstem Snake River downstream of Hells Canyon Dam and any of the following subbasins: Tucannon, Grande Ronde, Imnaha, and Salmon. Some or all of the fish returning to several of the hatchery programs are also listed, including those returning to the Tucannon River, Imnaha River, and Grande Ronde River hatcheries, and to the Sawtooth, Pahsimeroi, and McCall hatcheries on the Salmon River. Critical Snake River spring/summer chinook habitat was designated in December 1993, 58 FR 68543 and 10/25/99 64 FR 57399. Essential Fish habitat was identified on December 19, 1997.

Snake River fall chinook (*Oncorhynchus tshawytscha*) was listed as a threatened species under the Endangered Species Act in 1992, 57 FR 14653. The ESU includes all natural populations of fall-run chinook in the mainstem Snake River and any of the following subbasins: Tucannon River, Grande Ronde River, Imnaha River, and Salmon River, and Clearwater River. Critical habitat was designated in December 1993, 58 FR 68543.

Both the fall and spring/summer races of chinook have been selected as a focal species for this assessment. Information on their habitat use and status in the Imnaha subbasin can be found in section 1.2.3.

Columbia Spotted Frog

The Columbia spotted frog (*Rana luteiventris*) has been a candidate for listing since December 14, 1992 (Federal Register, Volume 57, 59257; HCNRA). In Oregon, the Columbia spotted frog is found in parts of the Cascade Mountains and throughout areas of eastern Washington. The subbasin and surrounding areas provide suitable habitat for the species, but its presence is not well documented. An observation of Columbia spotted frog in the Middle Snake subbasin was

reported to the Oregon Natural Heritage Program in 1992; the observation occurred within a mile of the Imnaha subbasin boundary (ONHP 2003).

Lynx

The Canada lynx (*Lynx canadensis*) was listed as a threatened species by the USFWS on March 24, 2000 (65 FR 16051) (ODFW 2003a). The USFWS recently completed a reevaluation of the original listing in which the agency considered changing the listing of lynx to endangered. However, the USFWS concluded that this change was not warranted and the lynx remains listed as threatened. Critical habitat has not been designated for the lynx (ODFW 2003a).

County Court records of bounties paid for predators between 1899 and 1922 indicate that lynx once existed in Wallowa County, but densities or numbers cannot be determined from these records. A lynx was shot on the Imnaha River in 1969. Soon after, the species was believed to have been extirpated from Oregon until a documented trapping occurred near Heppner in 1994. Over the past decade, numerous unconfirmed sightings have been recorded, suggesting that lynx may still inhabit portions of the interior Blue Mountains region but in extremely low numbers (USFWS 2003a).

Recent surveys have attempted to establish the presence of lynx in the subbasin without success. Hair snare surveys have been conducted in the Big Sheep Creek and upper Imnaha River watersheds each year from 1999 to 2001. Similar surveys were conducted throughout the Blue Mountains region, as well as in the rest of Oregon; no evidence of lynx occupancy was detected. Snow tracking surveys from snowmobiles and/or cross-country skis were conducted in the Big Sheep Creek watershed each year between 1992 and 1994. Track surveys were reinitiated in 1999 and 2000. Additionally, remote-controlled camera stations baited with road-killed ungulates and furbearer trapping lure were operated in the Wallowa Mountains each winter between 1992 and 1994. Although predator tracks and photos were recorded during these survey efforts, no lynx were identified along any of the routes/stations (USFWS 2003a).

In accordance with the interagency LCAS (Ruediger et al. 2000), the USFWS, BLM, and USFS have cooperated to identify lynx analysis units (LAUs) in Idaho where suitable habitat for lynx is present. These LAUs encompass forested lands that meet vegetation characteristics and elevation limits described in the LCAS, and they extend from the northern panhandle of Idaho to the Snake River plain in the south, east to the Wyoming boundary. Three LAUs have been delineated in the Imnaha subbasin; these LAUs follow the boundaries of the three major watersheds: lower Imnaha, upper Imnaha, and Big Sheep Creek (USFWS 2003a). Collectively, the LAUs encompass the entire Imnaha subbasin.

In the northern Rocky Mountains, the majority of lynx occurrences are associated within Rocky Mountain Conifer Forest. Within this type, most of the occurrences are in moist Douglas-fir (*Pseudotsuga menziesii*) and western spruce/fir forest. Most of the lynx occurrences are in the 1,500- to 2,000-meter (4,920- to 6,560-feet) elevation class (McKelvey et al. 2000). Canada lynx habitat includes a mosaic of early seral stages that support snowshoe hare populations and late seral stages of dense old growth forest that provide ideal denning and security habitat. The results of an analysis of lynx habitat conditions conducted by the Wallowa-Whitman National Forest are displayed in Table 32.

Each of the lower Imnaha and Big Sheep Creek LAUs currently contains more than 30% unsuitable habitat. This is above the threshold for lynx habitat outlined in the LCAS. It is anticipated that this number will decrease and threshold criteria will be met in the near future as regenerating stands reach sufficient stature for use by lynx as foraging habitat. The Eagle Cap Wilderness is believed to be core lynx habitat although lynx are not known to occur there (USFWS 2003a).

Table 32. Disposition of lynx habitat within the Imnaha subbasin (USFWS 2003a).

LAU	Primary Forage		Marginal Forage		Denning		Unsuitable		Total acres of lynx habitat in LAU (Total acres in LAU)
	Acres	% of total lynx habitat	Acres	% of total lynx habitat	Acres	% of total lynx habitat	Acres	% of total lynx habitat	
Upper Imnaha	4,077	12	1,723	5	22,597	69	4,499	14	32,896 (177,984)
Lower Imnaha	500	3	467	3	11,097	62	5,960	33	18,024 (147,136)
Big Sheep	1,069	7	1,513	10	7,620	52	4,499	31	14,701 (218,692)
Total	5,646	9	3,703	6	41,314	63	14,958	23	65,621

MacFarlane's Four O'Clock

MacFarlane's four o'clock (*Mirabilis macfarlanei*) is a long-lived herbaceous perennial with a deep-seated thickened root. It has bright pink funnel-shaped flowers up to 1 inch long and 1 inch wide, the flowers occur in groups of 3 to 7.

MacFarlane's four o'clock was originally listed as endangered in 1979 (44 FR 61912). Due to the discovery of additional populations and ongoing recovery efforts, the species was downlisted to threatened in March 1996. MacFarlane's four o'clock is endemic to the low-elevation grassland habitats in the Imnaha, Snake and Salmon river canyons of Wallowa County, Oregon, and Idaho County, Idaho. It is currently found in 11 populations in Idaho and Oregon. Two of the 11 known populations of MacFarlane's four o'clock occur along the lower Imnaha River (USFWS 2000).

Slender Moonwort

The slender moonwort (*Botrychium lineare*) is a candidate species (66 FR 54808). The USFWS published a 12-month finding for a petition to list this small perennial fern. The USFWS determined that sufficient information is currently available to support a finding that listing slender moonwort is warranted but precluded by other higher priority actions (66 FR 30338; USFS 2003a)

Slender moonwort has widespread but spotty distribution and is currently known from northeastern Oregon, northern Idaho, Montana, California, Colorado, Quebec, and New Brunswick. Habitat for the species is deep grass/forb meadows with lodgepole pine and/or

Engelmann spruce forest. It tends to occur in areas that are moist in the early season but dry out by midsummer. The species has not been documented in the subbasin. The two known occurrences of the species in Oregon occur west of the subbasin in the Lostine and Hurricane creek drainages. However, potential habitat for this species has been identified in the upper Imnaha river corridor, from the boundary of the Eagle Cap Wilderness downstream to where private land is encountered and in the Duck Lake/Twin Lakes area of the subbasin's upper rim (USFS 2003a).

Spalding's catchfly

Twelve observations of Spalding's catchfly, sometimes referred to as Spalding's silene, (*Silene spaldingii*) have been documented in the subbasin by the Oregon Natural Heritage Program. These sightings all occur within the Little Sheep Creek drainage. The largest populations are protected on land recently purchased by The Nature Conservancy in the Camp Creek drainage, but five are on private land and one is located on land administered by the BLM (ONHP 2003). Another population of Spalding's catchfly is reported by the USFWS to occur in the upper Imnaha River watershed (USFWS 2003a).

Steelhead

Snake River steelhead was listed as a threatened species in 1997, 62 FR 43937. The ESU includes all naturally spawned populations of steelhead in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, downstream of Hells Canyon Dam. Major tributary subbasins of this ESU are the Tucannon, Clearwater, Grande Ronde, Imnaha, and Salmon Rivers. Critical habitat for the ESU was designated in February 2000, 65 FR 7764 but has since been removed. On April 30, 2002, the United States District Court for the District of Columbia adopted a consent decree resolving the claims in the National Association of Homebuilders, et al. v. Evans, Civil Action No. 00-2799 (CKK) (D. D.C., April 30, 2002). Pursuant to that consent decree, the court issued an order vacating critical habitat designations for a number of listed salmonid species. NOAA Fisheries expects to propose revised critical habitat designations in the spring of 2004. Steelhead were selected as a focal species for this assessment. Information on steelhead habitat use and status in the Imnaha subbasin can be found in section 1.2.5.

Wolf

Wolves (*Canis lupus*) are considered to have been extirpated from Oregon by 1972. Due to the current success of gray wolf reintroduction by the USFWS in central Idaho and Yellowstone National Park, the numbers of wolves and the range they cover are expanding.

Numerous recent wolf sightings have been reported in Oregon; however, only three of these reports have been verified. These wolves were either killed (one was illegally shot, the other hit by a car) or returned to Idaho. The subbasin contains healthy ungulate populations and a large wilderness, both of which provide requirements sufficient for wolf habitation. It is anticipated that, with continual expansion of the wolf population in Idaho, resident wolves may become established in the area in the near future. Oregon's Fish and Wildlife Commission identified a 14-member state-appointed citizen committee in 2003 to help study all the issues surrounding wolves in Oregon and to recommend management actions that will be used if a permanent

population establishes itself. The status of wolves in Oregon was recently changed from endangered to threatened under the ESA (USFWS 2003a).

Wolverine

Though not federally listed, the California wolverine (*Gulo gulo luteus*) is listed as threatened in Oregon under the state ESA. The wolverine was never common in Oregon and does not occur in high densities anywhere in its range.

Ten wolverine sightings in the subbasin (or within 1 mile outside) were reported to the Oregon Conservation Data Center between 1979 and 1992. The reliability of these reports ranges from fair to good. Most of the observations occurred in the high-elevation areas of the Eagle Cap Wilderness, but three of the sightings were at more moderate elevations near the center of the subbasin (ORNHIC 2003). The Wallowa-Whitman National Forest undertook a large effort to survey for wolverine and lynx from 1991 through 1994. Winter track counts were conducted mostly by snowmobile and skis in a variety of habitats and elevations. Bait stations with remote sensing camera were also used. The surveys detected the presence of wolverines in the watershed but indicated that they were very rare (USFS 2003d).

Yellow-Billed Cuckoo

The yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is a candidate species. In 2001, the USFWS determined that sufficient information is currently available to support a finding that listing the yellow-billed cuckoo is warranted but precluded by other higher priority actions (USFWS 2002a).

Only 22 sightings of yellow-billed cuckoo have ever been reported in eastern Oregon (Gabrielson and Jewett 1970, Csuti et al. 2001, Oregon Natural Heritage Program 2002, all cited in USFS 2003a). Most of these sightings occurred in large riparian areas in Lake, Harney, and Malheur counties (HCNRA). In 1980, a yellow-billed cuckoo was sighted in the town of Imnaha. This is the only recorded observation of the species in the subbasin (Oregon Natural Heritage Program 2002). Suitable habitat is not thought to occur in the subbasin.

1.2.1.2 Species Recognized as Rare or Significant to the Local Area

Oregon Sensitive Species

A sensitive species classification was created under Oregon's Sensitive Species Rule (OAR 635-100-040), to encourage actions that will prevent additional species from having to be listed as threatened or endangered. Sensitive species constitute those naturally reproducing native animals that may become threatened or endangered throughout all or any significant portion of their range in Oregon. Factors considered in listing species as sensitive include the potential for natural reproductive failure because of limited population numbers, disease predation or other natural or manmade factors, imminent or active deterioration of range or primary habitat, overutilization, and inadequate existing state or federal regulations or programs for species or habitat protection (ODFW 2003b). Oregon sensitive species with habitat in the Imnaha subbasin are listed in Table 33.

Sensitive species are broken into four categories defined below:

Critical—Species for which listing as threatened or endangered is pending or those for which listing as threatened or endangered may be appropriate if immediate conservation actions are not taken. Also considered critical are some peripheral species that are at risk throughout their range and some disjunct populations.

Vulnerable—Species for which listing as threatened or endangered is not believed to be imminent and can be avoided through continued or expanded use of adequate protective measures and monitoring. In some cases, populations are sustainable and protective measures are being implemented; in others, populations may be declining and improved protective measures are needed to maintain sustainable populations over time.

Undetermined Status—Species for which status is unclear. They may be susceptible to population decline of sufficient magnitude that they could qualify for endangered, threatened, critical, or vulnerable status, but scientific study would be needed before a judgment could be made.

Peripheral or Naturally Rare—Peripheral species refer to those species whose Oregon populations are on the edge of their range. Naturally rare species are those that had low population numbers historically in Oregon because of naturally limiting factors. Maintaining the status quo is a minimum necessity. Disjunct populations of several species that occur in Oregon should not be confused with peripheral species.

Table 33. ODFW sensitive species with potential habitat in the Imnaha subbasin (species with potential habitat from IBIS 2003; sensitive species ODFW 2003b).

Category	Common Name	Species Name	USFS 1995 ¹	ONHP (2003) element occurrence records (year last detected)
Critical	Pallid bat	<i>Antrozous pallidus</i>		
	Northern goshawk	<i>Accipiter gentilis</i>	P	1992
	Burrowing owl	<i>Athene cunicularia</i>	P	1974
	Upland sandpiper	<i>Bartramia longicauda</i>	P	
	Ferruginous hawk	<i>Buteo regalis</i>	P	1980
	Northern pygmy-owl	<i>Glaucidium gnoma</i>	S	
	Flammulated owl	<i>Otus flammmeolus</i>	P	
	White-headed woodpecker	<i>Picoides albolarvatus</i>	P	
	Black-backed woodpecker	<i>Picoides arcticus</i>	P	
	Three-toed woodpecker	<i>Picoides tridactylus</i>	P	1992
	Red-necked grebe	<i>Podiceps grisegena</i>	S	
	Northern leopard frog	<i>Rana pipiens</i>		
	Bull trout	<i>Salvelinus confluentus</i>	P	
	Pygmy nuthatch	<i>Sitta pygmaea</i>	P	
Vulnerable	Inland tailed frog	<i>Ascaphus montanus</i>	P	1993

Category	Common Name	Species Name	USFS 1995 ¹	ONHP (2003) element occurrence records (year last detected)
	Pygmy rabbit	<i>Brachylagus idahoensis</i>		
	Western toad	<i>Bufo boreas</i>	S	
	Swainson's hawk	<i>Buteo swainsoni</i>	P	1985
	Greater sage-grouse	<i>Centrocercus urophasianus</i>		
	Olive-sided flycatcher	<i>Contopus cooperi</i>	P	
	Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	P	
	Western rattlesnake	<i>Crotalus viridis</i>	P	
	Bobolink	<i>Dolichonyx oryzivorus</i>	S	
	Pileated woodpecker	<i>Dryocopus pileatus</i>	P	
	Greater sandhill crane	<i>Grus canadensis tabia</i>		
	Pacific lamprey	<i>Lampetra tridentata</i>		
	American marten	<i>Martes americana</i>	P	1992
	Fringed myotis	<i>Myotis thysanodes</i>		1990
	Steelhead/redband trout	<i>Oncorhynchus mykiss</i>	P	
	Desert horned lizard	<i>Phrynosoma platyrhinos</i>		
	Horned grebe	<i>Podiceps auritus</i>	S	1983
	Great gray owl	<i>Strix nebulosa</i>	P	
Undetermined	Boreal owl	<i>Aegolius funereus</i>		
	Bufflehead	<i>Bucephala albeola</i>	P	
	Barrow's goldeneye	<i>Bucephala clangula</i>	P	
	Willow flycatcher	<i>Empidonax traillii</i>	P	
	Spruce grouse	<i>Falculipennis canadensis</i>	P	
	Harlequin duck	<i>Histrionicus histrionicus</i>	S	1929
	Silver-haired bat	<i>Lasionycteris noctivagans</i>	P	
	White-tailed jackrabbit	<i>Lepus townsendii</i>	S	
	Western small-footed myotis	<i>Myotis ciliolabrum</i>	P	
	Long-eared myotis	<i>Myotis volans</i>	P	
	Mountain quail	<i>Oreortyx pictus</i>	P	
	Columbia spotted frog	<i>Rana luteiventris</i>	P	1992
	Bank swallow	<i>Riparia riparia</i>	S	
	Williamson's sapsucker	<i>Sphyrapicus thyroideus</i>	P	
Naturally	Black swift	<i>Cypseloides niger</i>		
Rare	Franklin's gull	<i>Larus pipixcan</i>		

¹ P = present, S=suspected

USDA Forest Service, Region 6, Regional Forester's Sensitive Species List

The Region's Sensitive Species Program provides goals and objectives to manage sensitive species and their habitats. This program includes the Regional Forester's sensitive species list (Table 34) to prevent the need for federal listing at a future date. It is the policy of the Region that 1) all actions and programs authorized, funded, or carried out by the USFS are reviewed to determine their potential effect on threatened and endangered species, sensitive species, and species proposed for listing and 2) sensitive species on the current Regional Forester's sensitive species list are given the same management consideration as federally listed species (USFS 1995).

Table 34. USFS Region 6 sensitive species (USFS 1995).

Common Name	Scientific Name
American peregrine falcon	<i>Falco peregrinus anatum</i>
Bald eagle	<i>Haliaeetus leucocephalus</i>
Ferruginous hawk	<i>Buteo regalis</i>
Long-billed curlew	<i>Numenius americanus</i>
Yellow-billed cuckoo	<i>Coccyzus americanus occidentalis</i>
Harlequin duck	<i>Histrionicus histrionicus</i>
Greater sandhill crane	<i>Grus canadensis tabia</i>
Upland sandpiper	<i>Bartramia longicauda</i>
Black rosy-finches	<i>Leucosticte atrata</i>
Townsend's big-eared bat	<i>Corynorhinus townsendii townsendii</i>
California wolverine	<i>Gulo gulo luteus</i>
Lynx	<i>Lynx canadensis</i>
Blue Mountain cryptochian caddisfly	<i>Cryptochia neosa</i>

Partners in Flight Focal Species

Partners in Flight (PIF) was established in 1990 as a conservation effort to focus on land birds and their habitats. Concern over continental and local declines in numerous bird populations due in part to habitat loss, degradation, and fragmentation on breeding and wintering grounds and along migratory routes as well as reproductive problems associated with nest predation, brood parasitism, and competition with exotic species initiated the PIF collaborative effort.

Partnerships among many agencies including federal, state and local government agencies, philanthropic foundations, professional organizations, conservation groups, industry, the academic community, and private individuals have contributed to the great success of PIF. Partners in Flight works to enhance cooperation between private and public sector efforts in North America and the Neotropics in order to improve monitoring and inventory, research, management, and education programs involving birds and their habitats.

The development of bird conservation plans (BCPs) for the entire continental U.S. is one of the primary activities of Partners in Flight. The goal of the Bird Conservation Plans is to ensure

long-term maintenance of healthy populations of native landbirds. The planning process for the BCPs has four steps: 1) identify species and habitats most in need of conservation (i.e., prioritization); 2) describe desired conditions for these habitats based on knowledge of species life history and habitat requirements; 3) develop biological objectives that can be used as management targets or goals to achieve desired conditions; and 4) recommend conservation actions that can be implemented by various entities at multiple scales to achieve biological objectives.

Bird conservation plans are organized by physiographic areas and state. The Imnaha subbasin is within the Central Rocky Mountains physiographic area and is included in the Bird Conservation Plan for Oregon/Washington. This conservation plan emphasizes an ecosystem management approach to landbird preservation but includes components of single-species and indicator species management. The most important habitat features and conditions for landbirds within the planning area were identified and then focal species considered representative those habitats were selected to help guide conservation planning (Table 35).

Table 35. Priority habitat features and associated landbird species for conservation in habitats of the Northern Rocky Mountains Landbird Conservation region of Oregon and Washington.

Habitat Type	Focal Species Blue Mountain Province	Habitat Feature/Conservation Focus
Dry Forest (ponderosa pine and ponderosa pine/Douglas-fir/grand fir)	white-headed woodpecker (<i>Picoides albolarvatus</i>)	large patches of old forest with large trees and snags
	flammulated owl (<i>Otus flammeolus</i>)	old forest with interspersion grassy openings and dense thickets
	chipping sparrow (<i>Spizella passerina</i>)	open understory with regenerating pines
	Lewis's woodpecker (<i>Melanerpes lewis</i>)	patches of burned old forest
Mesic Mixed Conifer (late-successional)	Vaux's swift (<i>Chaetura vauxi</i>)	large snags
	Townsend's warbler (<i>Dendroica townsendi</i>)	overstory canopy closure
	varied thrush (<i>Ixoreus naevius</i>)	structurally diverse; multilayered
	MacGillivray's warbler (<i>Oporornis tolmiei</i>)	dense shrub layer in forest openings or understory
	olive-sided flycatcher (<i>Contopus cooperi</i>)	edges and openings created by wildfire
Riparian Woodland	Lewis's woodpecker (<i>Melanerpes lewis</i>)	large snags
Riparian Shrub	willow flycatcher (<i>Empidonax tralii</i>)	willow/alder shrub patches
Unique Habitats	hermit thrush (<i>Catharus guttatus</i>)	subalpine forest
	upland sandpiper (<i>Bartramia longicauda</i>)	montane meadows (wet/dry)
	vesper sparrow (<i>Pooecetes gramineus</i>)	steppe shrublands
	red-naped sapsucker (<i>Sphyrapicus nuchalis</i>)	aspen
	gray-crowned rosy-finches (<i>Leucosticte tephrocotis</i>)	alpine

1.2.1.3 Managed Terrestrial Species

The Imnaha subbasin is home to many valuable game species. The subbasin contains potential habitat for 1 amphibian, 42 birds, and 7 mammals that are classified as game species by the state of Oregon (IBIS 2003) (Table 36) Four game species were selected as focal species for this assessment: the Rocky Mountain elk, mountain goat, bighorn sheep, and mule deer (see section 1.2.2 for more information).

Table 36. Oregon game species with potential habitat in the Imnaha subbasin (IBIS 2003).

Common Name	Scientific Name
Amphibians	
Bullfrog	<i>Rana catesbeiana</i>
Birds	
Greater white-fronted goose	<i>Anser albifrons</i>
Snow goose	<i>Chen caerulescens</i>
Ross's goose	<i>Chen rossii</i>
Canada goose	<i>Branta canadensis</i>
Wood duck	<i>Aix sponsa</i>
Gadwall	<i>Anas strepera</i>
Eurasian wigeon	<i>Anas penelope</i>
American wigeon	<i>Anas americana</i>
Mallard	<i>Anas platyrhynchos</i>
Blue-winged teal	<i>Anas discors</i>
Cinnamon teal	<i>Anas cyanoptera</i>
Northern shoveler	<i>Anas clypeata</i>
Northern pintail	<i>Anas acuta</i>
Green-winged teal	<i>Anas crecca</i>
Canvasback	<i>Aythya valisineria</i>
Redhead	<i>Aythya americana</i>
Ring-necked duck	<i>Aythya collaris</i>
Greater scaup	<i>Aythya marila</i>
Lesser scaup	<i>Aythya affinis</i>
Harlequin duck	<i>Histrionicus histrionicus</i>
Surf scoter	<i>Melanitta perspicillata</i>
Bufflehead	<i>Bucephala albeola</i>
Common goldeneye	<i>Bucephala clangula</i>
Barrow's goldeneye	<i>Bucephala islandica</i>
Hooded merganser	<i>Lophodytes cucullatus</i>
Common merganser	<i>Mergus merganser</i>
Ruddy duck	<i>Oxyura jamaicensis</i>
Chukar	<i>Alectoris chukar</i>
Gray partridge	<i>Perdix perdix</i>
Ring-necked pheasant	<i>Phasianus colchicus</i>

Common Name	Scientific Name
Ruffed grouse	<i>Bonasa umbellus</i>
Greater sage-grouse	<i>Centrocercus urophasianus</i>
Spruce grouse	<i>Falcipennis canadensis</i>
Blue grouse	<i>Dendragapus obscurus</i>
Wild turkey	<i>Meleagris gallopavo</i>
Mountain quail	<i>Oreortyx pictus</i>
California quail	<i>Callipepla californica</i>
Northern bobwhite	<i>Colinus virginianus</i>
American coot	<i>Fulica americana</i>
Common snipe	<i>Gallinago gallinago</i>
Band-tailed pigeon	<i>Patagioenas fasciata</i>
Mourning dove	<i>Zenaida macroura</i>
Mammals	
Muskrat	<i>Ondatra zibethicus</i>
Black bear	<i>Ursus americanus</i>
Mountain lion	<i>Felis concolor</i>
Rocky mountain elk	<i>Cervus elaphus nelsoni</i>
White-tailed deer	<i>Odocoileus virginianus ochrourus</i>
Rocky Mountain goat	<i>Oreamnos americanus</i>
Bighorn sheep	<i>Ovis canadensis</i>

1.2.1.4 Species Recognized by Tribes (Cultural/Spiritual Significance)

The Imnaha subbasin was the homeland of the Joseph (Wellamotkin) Band of the Nez Perce Tribe (Chalfant 1974). Although the Nez Perce Tribe believes in the inherent value of all plant and animal species, certain species have particular significance to tribal members due to their historical and current importance for sustenance and/or ceremonial purposes.

Archaeological excavations conducted in the Downey Lake Area of the Big Sheep watershed indicate that the subbasins early inhabitants made extensive use of bighorn sheep (USFS 1995). Deer and elk also were and continue to be important game species for tribal members. Salmon and steelhead were and are very important to the Nez Perce Tribe, and tribal members timed seasonal migrations around the runs (NPT 2003).

The basic roots gathered for winter storage included camas bulb (kehmmes), bitterroot (thlee-tahn), khouse (qawas), wild carrot (tsa-weetkh), wild potato (keh-keet), and other root crops. Fruits collected in the area include service berries, gooseberries, hawthorn berries, thorn berries, huckleberries, currants, elderberries, chokecherries, blackberries, raspberries, and wild strawberries. Other food gathered includes pine nuts, sunflower seeds, and black moss (NPT 2003). Lomatiums, like biscuitroot and khouse, are known to occur in the watershed on the rocky soils characteristic of ridgeline environments. Camas is usually found associated with wet meadow environments and may occur in the Zumwalt prairie (USFS 1995).

1.2.1.5 Locally Extirpated and Introduced Species

Human activities have altered the species composition of the Imnaha subbasin. Some species such as the grizzly bear, and gray wolf are known to have occurred in the subbasin historically but don't occur in the subbasin now. Others like the sharp-tailed grouse and bighorn sheep occurred in the subbasin historically, were extirpated as a result of human activities and have since been reintroduced. The historic status of the pronghorn, bison, and Rocky Mountain goat in the subbasin is not entirely clear, but archaeological evidence indicates, that they were used as prey species by the Native American groups that inhabited the subbasin. It is possible that these animals were not harvested within the subbasin but rather were killed in neighboring areas and transported into the subbasin (Table 37). Rocky Mountain goats and bighorn sheep have been selected as focal species for this assessment, more information on their populations in the subbasin can be found in section 1.2.9.4.

Ten non-native terrestrial vertebrate species are thought to occur within the subbasin. The majority of these species are native to Asia or Europe and were not introduced directly to the Imnaha subbasin but colonized from surrounding areas (Table 38). Four species of introduced game birds inhabit the subbasin these species are economically important as they provide hunting opportunities but may compete with native birds for food and nest sites (Table 38; Johnson and O'Neil 2000). The remainder of the introduced species are generally considered undesirable and make have negative impacts on native wildlife, for instance starlings have been documented to usurp nest sites from many species of native birds and bullfrogs have been shown to outcompete and prey on native amphibian species. Introduced wildlife species are not considered to be a significant factor limiting native wildlife populations in the subbasin.

Table 37. Species extirpated from the Imnaha subbasin (from Johnson and O'Neil 2001, with exceptions noted).

Common Name	Scientific Name	Comments
Bighorn sheep	<i>Ovis canadensis</i>	Successfully reintroduced (see section 1.2.9.4)
Bison?	<i>Bos bison</i>	Imnaha just outside historical range in Johnson and O'Neil, remains have been found in subbasin (USFS 1998d)
Yellow-billed cuckoo	<i>Coccycuz americanus</i>	Extirpated? Rare observations occasionally occur. Breeding pair in LaGrande in 1992
Gray wolf	<i>Canis lupus</i>	May be recolonizing from ID
Grizzly bear	<i>Ursus arctos</i>	Last grizzly in Oregon shot in Wallowa County in 1931
Sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	reestablished in Zumwalt Prairie
Pronghorn?	<i>Antilocarpa americana</i>	Archaeological evidence indicates historical presence in subbasin (USFS 1998d)
Rocky Mountain goat	<i>Oreamos americanus</i>	Many sources (Verts and Carraway 1998, Johnson and O'Neil 2001) consider the mountain goat to be an introduced species in Oregon but local information suggests it was extirpated at or prior to European settlement and reintroduced (see section 1.2.9.3) (ODFW 2003c)

Table 38. Introduced wildlife species of the Imnaha subbasin (Johnson and O'Neil 2001).

Common Name	Scientific Name	Origin	Reason for Original Introduction
Chukar	<i>Alectoris chukar</i>	Eurasia	game
Gray partridge	<i>Perdix perdix</i>	Eurasia	game
Ring-necked pheasant	<i>Phasianus colchicus</i>	Eurasia	game
California quail	<i>Callipepla californica</i>	southwestern United States	game
Rock pigeon	<i>Columba livia</i>	Eurasia	aesthetics, racing, messengers,
European starling	<i>Sturnus vulgaris</i>	Eurasia	aesthetics
House sparrow	<i>Passer domesticus</i>	Eurasia	aesthetics, insect control
Bullfrog	<i>Rana catesbeiana</i>	eastern and central United States	insect control, aesthetics, hunting, food
Norway rat	<i>Rattus norvegicus</i>	Asia	stowaway
House mouse	<i>Mus musculus</i>	Europe	stowaway

1.2.2 Focal Species Selection

1.2.2.1 List of Species Selected

A total of 19 focal species were selected for assessment in the Imnaha subbasin. The list of aquatic species includes spring/summer chinook (*Oncorhynchus tshawytscha*), fall chinook (*O. tshawytscha*), summer steelhead (*O. mykiss*), bull trout (*Salvelinus confluentus*), and Pacific lamprey (*Lampetra tridentata*). The list of terrestrial species is shown in Table 39.

Table 39. Terrestrial focal species to be assessed in the Imnaha subbasin.

Common Name	Scientific Name	Habitat to Represent	Specific Structure, Habitat Elements, or Issues to Represent
Flammulated owl	<i>Otus flammmeolus</i>	Ponderosa Pine Forest	mature structural stage
White-headed woodpecker	<i>Picoides albolarvatus</i>	Ponderosa Pine Forest	mature structural stage
American marten	<i>Martes Americana</i>	Montane Mixed Conifer Forest and Eastside Mixed Conifer Forest	mature structural stage, snags
Boreal owl	<i>Aegolius funereus</i>	Montane Mixed Conifer Forest	
Olive-sided flycatcher	<i>Contopus cooperi</i>	Montane Mixed Conifer Forest and Eastside Mixed Conifer Forest	

Common Name	Scientific Name	Habitat to Represent	Specific Structure, Habitat Elements, or Issues to Represent
Rocky mountain elk	<i>Cervus elaphus</i>	Montane Mixed Conifer Forest	summer and fall ranges
Rocky Mountain goat	<i>Oreamnos americanus</i>	Alpine Grasslands and Shrublands	
Bighorn sheep	<i>Ovis Canadensis</i>	Eastside Grasslands	canyon lands
Grasshopper sparrow	<i>Ammodramus savannarum</i>	Eastside Grasslands	bunchgrass communities
Mule deer	<i>Odocoileus hemionus</i>	Agriculture, Pastures	landowner conflicts
Mountain quail	<i>Oreortyx pictus</i>	Wetland and Riparian Areas	shrub and brush cover
Yellow warbler	<i>Dendroica petechia</i>	Wetland and Riparian Areas	riparian
Long-toed salamander	<i>Ambystoma macrodactylum</i>	Wetland and Riparian Areas	water quality
Bald eagle	<i>Haliaeetus leucocephalus</i>	Open Water	salmon

1.2.2.2 Methodology for Selection

Aquatic

Focal species were chosen according to guidelines provided in NPPC (2001). These guidelines suggested inclusion of species that met the following criteria in order of importance: 1) designation as a Federal endangered or threatened species; 2) ecological significance; 3) cultural significance; and, 4) local significance.

Considering their federal status listing, the Imnaha Aquatics Technical Team (IATT) agreed that the selection of the four threatened salmonids and Pacific lamprey was appropriate. Ecological considerations in the selection of the focal species were based on the unique genetic characteristics, roles and habitat types occupied by the respective fishes. The various focal species selected by the IATT were considered to be locally important to the Imnaha subbasin based on their economic value (e.g., spring/summer chinook and steelhead fisheries), ecologic value (e.g., genetic uniqueness, contribution to respective Environmentally Significant Units/Recovery Units), and cultural significance.

The Interior Columbia Basin Technical Recovery Team (TRT; 2003) identifies two independent populations of spring/summer chinook in the subbasin; the Imnaha mainstem (IRMAI) and Big Sheep Creek (IRBSH; refer to Section 1.2.3.1 for additional information), the Snake River fall chinook population (SNMAI; refer to Section 1.2.4.1 for additional information), which represents a distinct unit when compared to populations occurring elsewhere throughout the Columbia Basin, and a unique spawning aggregate of summer steelhead (IRMST-s; refer to Section 1.2.5.1 for additional information).

The input and dispersal of marine-derived nutrients represents a unique ecological function facilitated by the anadromous species. The importance of adult salmon/steelhead and lamprey carcasses upon terrestrial (*e.g.*, common merganser, bald eagle, and northern river otter) and aquatic (*e.g.*, bull trout, juvenile salmon) food webs is well documented (*e.g.*, Cederholm et al. 2000). Also important, is the role (or lack thereof) anadromous species play as a prey base for piscivorous species (*e.g.*, bull trout).

Distribution is unique for the various aquatic focal species, which supported the IATTs selection. Fall chinook and lamprey represent a mainstem-oriented species occupying low gradient stream reaches. Key spring/summer chinook spawning and rearing areas are also on mainstem reaches, yet occur farther upstream in the subbasin. Summer steelhead represent the most widely distributed salmonid, and spawn and rear throughout most accessible reaches in the subbasin. Bull trout represent a headwater-oriented species, with a fluvial component that occupies various distinct habitat types throughout the year.

All focal species selected have important cultural significance to the Nez Perce Tribe. As a fishing-oriented tribe, the Nez Perce have relied upon the Imnaha subbasin to harvest salmon and steelhead for consumptive and religious purposes. Although currently depressed, Pacific lamprey were also sought after by the Nez Perce. Bull trout, although currently not harvested, also represent a species historically harvested by Nez Perce peoples.

Terrestrial

Terrestrial species for the subbasin were selected during a meeting of the Imnaha subbasin terrestrial subcommittee. Due to the wide variety of wildlife species that use the Imnaha subbasin it is generally not appropriate to manage using a species based approach. Wildlife management in the subbasin focuses on creating high quality habitat that can support the full contingent of native wildlife species in the subbasin. In the case of species with very specific requirements that can not be adequately addressed through a habitat based approach to management a more fine filter species based approach may be employed. In keeping with this habitat based approach, focal species were selected to represent the current WHTs that have been identified to occur in the Imnaha subbasin by the Northwest Habitat Institute. Preference was given to species designated as threatened, endangered, sensitive, Partners in Flight priority or focal, functional link, functional specialist, culturally important or managed, when these species were considered good representatives of habitat quality. More focal species were selected to represent widely distributed or disproportionately important habitat types, compared with habitats that are only a minor component of the landscape. Species were selected to represent structural conditions or habitat elements that are particularly important to a variety of wildlife species in the subbasin and that are thought to be less common than they were historically. Susceptibility to current and historical management, data availability, monitoring potential were also factors considered during the selection process.

1.2.3 Spring/Summer Chinook Population Delineation and Characterization

1.2.3.1 Population Data and Status—Spring/Summer Chinook

Abundance and Trends

Imnaha subbasin spring/summer chinook salmon population abundance and trends should be characterized using the following key performance measures (see also RME section); adult escapement, index of spawner abundance (index area redds), spawner abundance, index of juvenile abundance (parr density), juvenile emigrant abundance, and hatchery production abundance. Additional performance measures of; fish per redd, hatchery fraction, in-tributary harvest, and smolt equivalents support calculation of derived performance measures further characterizing population abundance and productivity. Given the existence of a spring/summer chinook salmon hatchery program in the Imnaha subbasin, performance measures should characterize both natural and hatchery-origin aspects.

Adult Escapement

Historically, the Imnaha subbasin supported one of the largest runs of spring/summer chinook salmon in Wallowa County (Wallowa County and NPT 1993). Prior to the construction of the four lower Snake River dams, the estimated maximum escapement of adult chinook salmon to the subbasin was 6,700³ fish (USACE 1975). Annual adult escapement of adult chinook salmon has been indirectly quantified since 1982 (Figure 36; Table 40). Returns of natural origin chinook salmon (not including jacks) have declined to levels below 150 individuals during some years (Ashe et al. 2000), which is notable because it is estimated that up to 10% of the annual escapement of wild/natural Snake River spring/summer chinook salmon are of Imnaha origin (NMFS 2001). In the past four years (2000-2003), returns have increased to 2,364 – 6,543 individuals (ODFW unpublished data provided by P. Kinery). This escapement total represents both natural and hatchery origin adults.

³ LSRCP used 55% of the chinook escapement over McNary Dam to estimate the number of fish returning to the Snake River, then took 5.5% of that value to estimate spring/summer chinook returns into the Imnaha

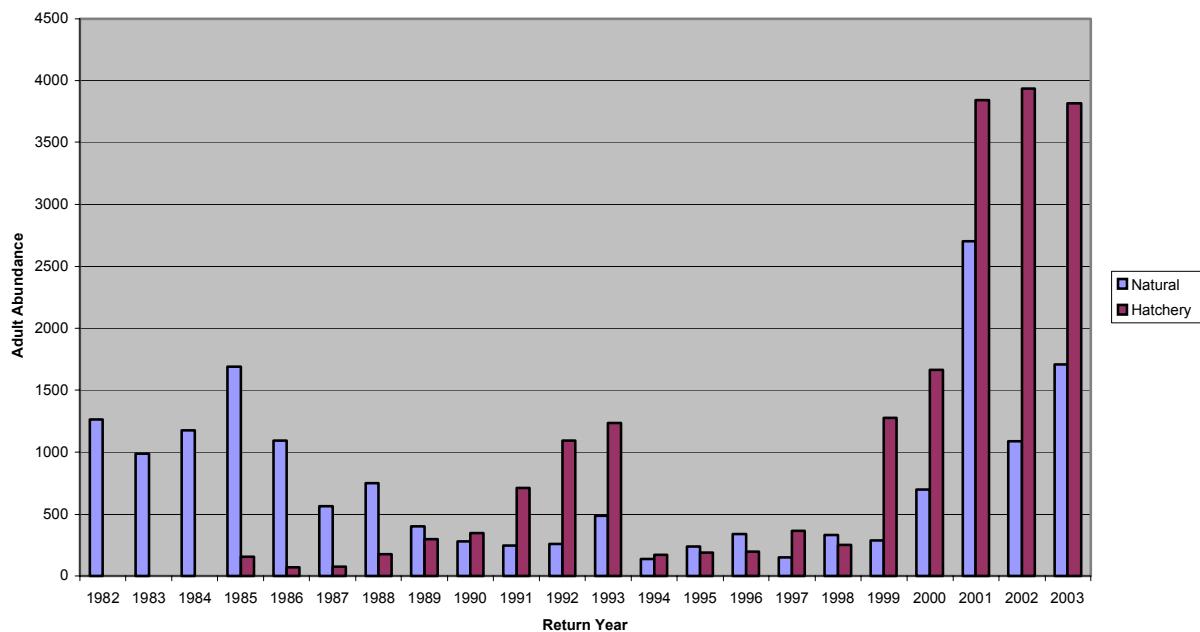


Figure 36. Estimated abundance of natural and hatchery-origin adult chinook salmon to the Imnaha River subbasin 1982 – 2003 (ODFW unpublished data provided by P. Kinery)

Table 40. Total escapement, number of broodstock collected, and number and origin of natural spawners in the Imnaha River (1979–2003)

Year	Total Escapement ¹	Broodstock Collected		Natural Spawners		Natural Spawners of Hatchery Origin (%)
		Natural	Hatchery	Natural	Hatchery	
1979 ²	192	0	0	192	0	0
1980 ²	125	0	0	125	0	0
1981 ²	307	0	0	307	0	0
1982	1,262	28	0	1,234	0	0
1983	990	64	0	926	0	0
1984	1,178	36	0	1,142	0	0
1985	1,844	115	14	1,573	142	8
1986	1,165	315	21	788	51	6
1987	644	83	22	484	55	10
1988	928	140	68	609	111	15
1989	697	105	187	297	108	27
1990	627	81	159	199	188	49
1991	959	51	262	198	448	70
1992	1,353	54	331	205	763	79
1993	1,724	58	394	430	842	66
1994	311	20	31	118	142	55
1995	432	38	30	204	160	44
1996	535	72	61	266	136	34
1997	517	23	149	129	216	63
1998	586	77	57	255	197	44

Year	Total Escapement ¹	Broodstock Collected		Natural Spawners		Natural Spawners of Hatchery Origin (%)
		Natural	Hatchery	Natural	Hatchery	
1999	1,676	22	254	287	1,113	80
2000	2,364	49	282	647	1,364	68
2001	6,356	86	169	2,465	3,134	56
2002	5,269	38	276	1,042	3,311	76
2003	5,387	75	304	1,623	3,020	65

1/ Jacks are included in the estimates. Total escapement is the sum of total natural spawners estimated from redd counts and fish retained for hatchery broodstock

2/ Estimates prior to 1982 are based on redd counts above the location of the weir and not expanded for those fish spawning below the weir location.

Estimation of adult escapement for the mainstem Imnaha River is determined via mark-recapture techniques for the area upstream of the weir and expanded to the entire subbasin by fish/redd estimates. Operation of the weir across the entire run with capture efficiencies at or near 100% would improve the accuracy and precision of the fish per redd estimates. Currently escapement estimates for Big Sheep Creek rely on fish/redd expansion using Imnaha mainstem data. Direct enumeration would be desirable if increased escapement into Big Sheep Creek is realized.

Index of Spawner Abundance (Redd Counts)

Trends in chinook salmon relative abundance have been monitored since 1957 via redd counts. Spring/summer chinook redd count surveys have been conducted in various portions of the Imnaha subbasin for several decades. Surveys have typically occurred in index areas, such as Big Sheep Creek, Lick Creek, and the upper Imnaha; however, additional “supplemental” surveys have recently occurred in an effort to identify previously undefined spawning locations.

The trend in redd counts has been variable over the period for which data collection has occurred. In the Big Sheep Creek index area, the number of redds observed declined significantly in the mid-1970s, and has remained at low (<20) levels ever since (Figure 37). Supplemental surveys conducted in the Big Sheep drainage in 2000–2001 identified only one additional redd (in 2001) over the course of 9 additional stream miles surveyed. Escapement in the Lick Creek index area was highest in the mid-1960s to early 1970s, then peaked again in 1978 and in 1997, a result of outplanting hatchery adults (Figure 38). No additional redds were found following supplemental surveys in 2000–2001. The number of spring chinook redds identified in index areas on the mainstem Imnaha were substantially higher prior to the 1980s and 1990s (Figure 39); however, a total of 261 redds were identified following supplemental redd surveys in 2000, while 612, 1105, and 727 redds were observed in 2001- 2003, respectively.

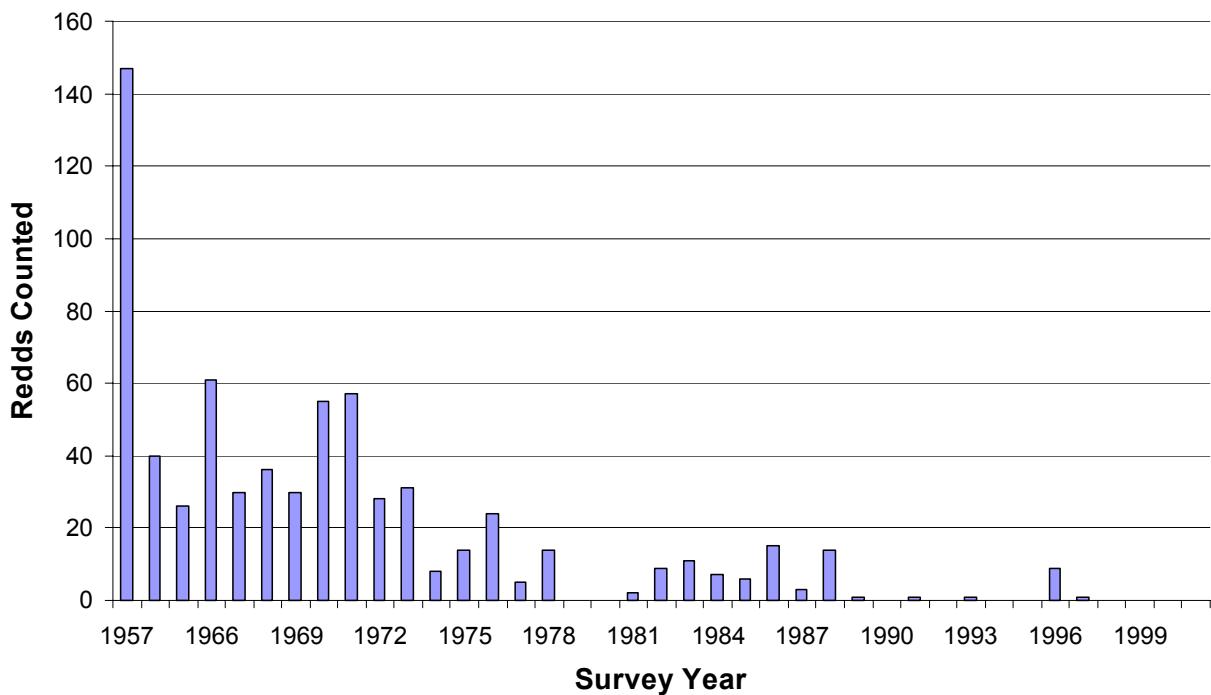


Figure 37. Big Sheep Creek spring/summer chinook redd counts (StreamNet data, downloaded August 2003).

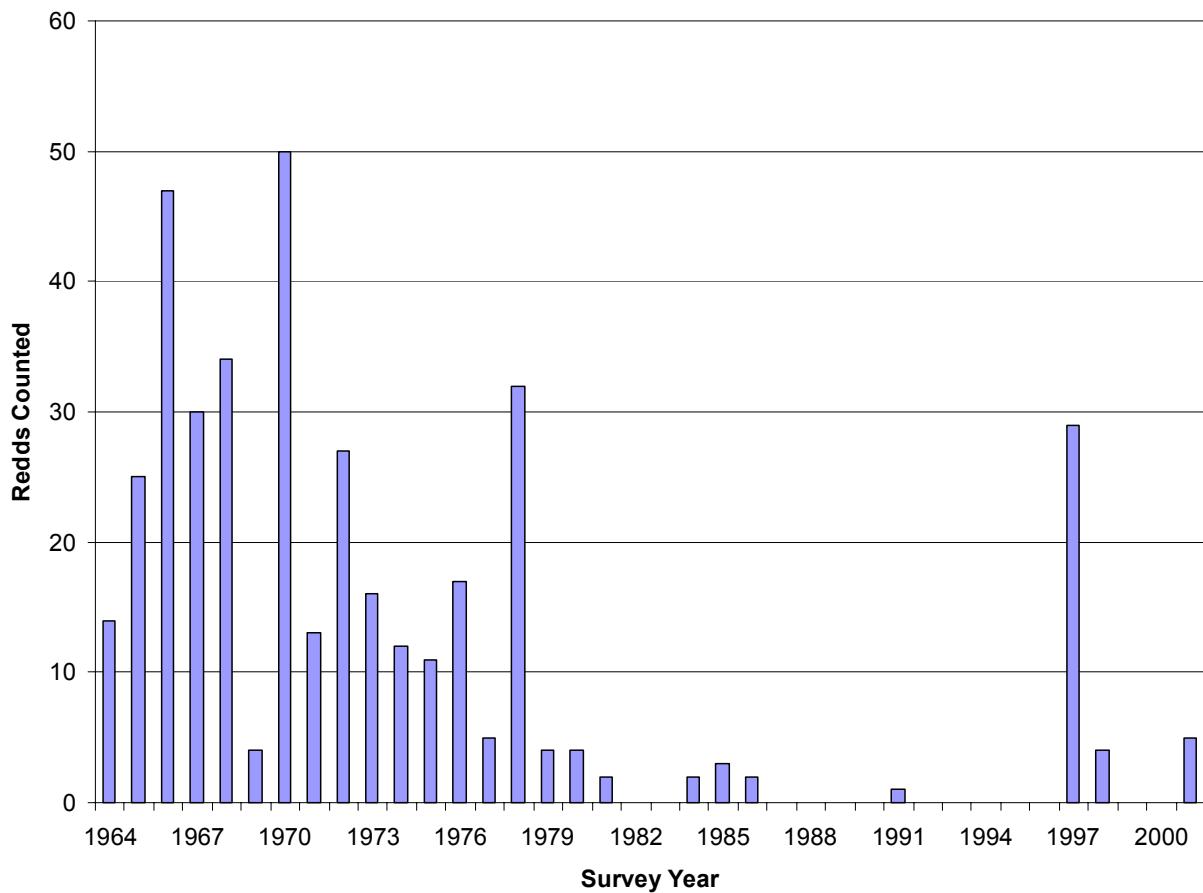


Figure 38. Lick Creek spring/summer chinook redd counts (StreamNet data, downloaded August 2003).

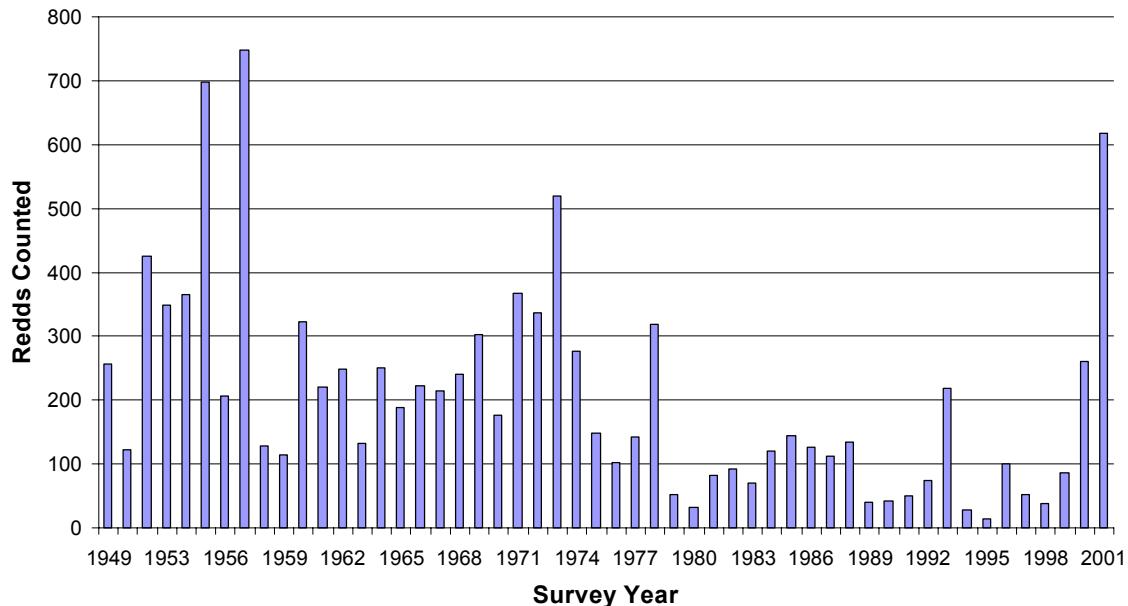


Figure 39. Spring/summer chinook redd counts on the mainstem Imnaha River (StreamNet data, downloaded August 2003).

Spawner Abundance

Estimates of spawner abundance have not been directly assessed in the Imnaha subbasin. Derived estimates can be generated by adjusting escapement estimates by prespawning mortality rate estimates for the area upstream of the weir. Redd counts provide an index of spawner abundance with unknown/quantified sources of bias and precision.

Index of Juvenile Abundance (Density)

Juvenile density estimates provided here have been summarized from Blenden and Kucera (2002). In their report they provide a baseline relative index of juvenile abundance and fish species composition information. Big Sheep Creek was snorkeled approximately 4.5 stream kilometers (skm) above Carroll Creek from 1992-1995 and also just above Lick Creek in 1994. Lower Lick Creek was snorkeled at approximately skm 0.6 in 1994 and upper Lick Creek was snorkeled from between skm 2.4 and 5.9 from 1994-2000 excluding 1995. The Imnaha River was snorkeled at approximate river kilometer (rkm) 84 and 90 from 1991 to 1996.

Average density of age 0+ natural chinook salmon in Big Sheep Creek pool habitat varied from 17.2 to 22.2 fish/100m² from 1992 to 1994 (Blenden and Kucera 2002). No natural chinook salmon were observed in lower Big Sheep Creek in 1995 in either pool or run habitat. Age 0+ chinook salmon mean density in run habitat ranged from 5.6 to 24.7 fish/100m² (Figure 40). Annual variation in subyearling chinook salmon density in run habitat varied as much as three fold. Age 1+ natural chinook salmon mean density (5.3 fish/100m²) was highest in 1993 run habitat and followed the relative higher densities of chinook salmon parr observed in 1992.

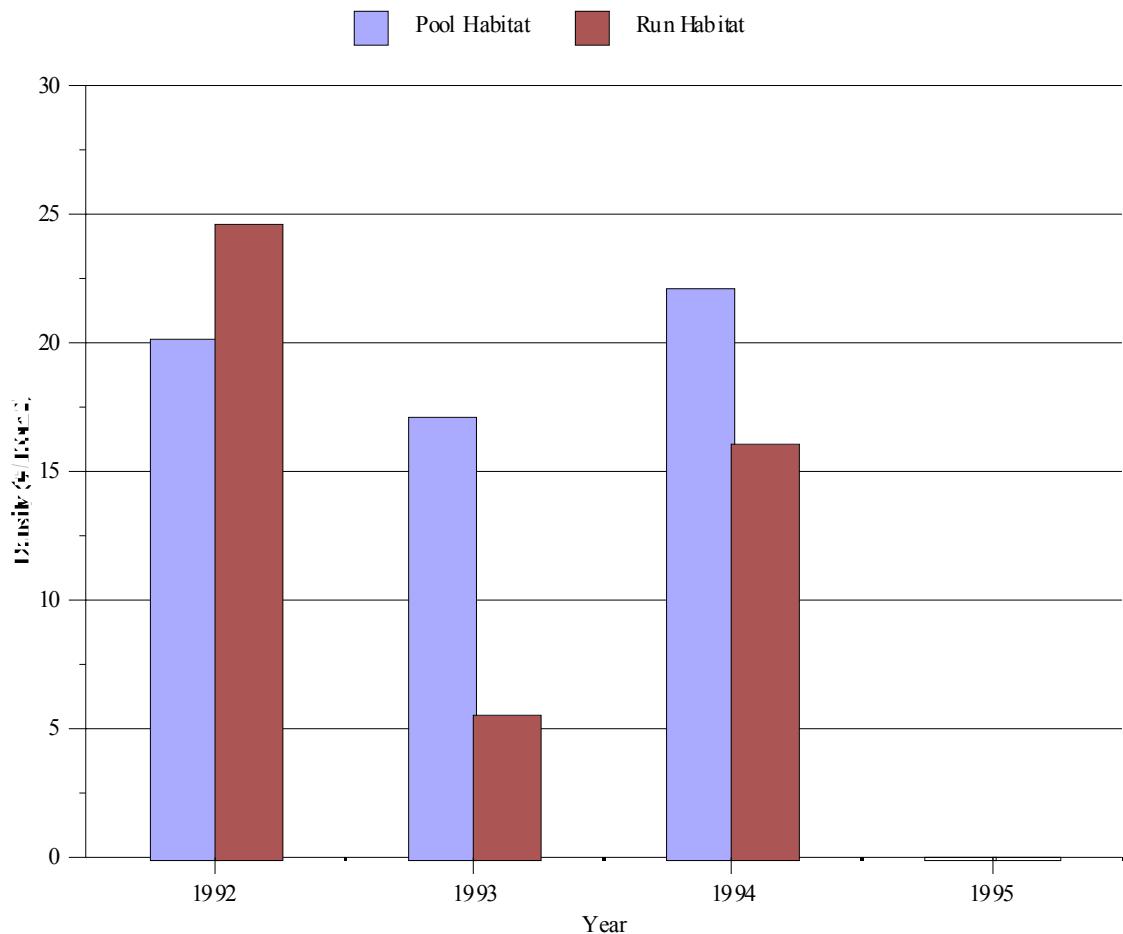


Figure 40. Average density ($\text{fish}/100\text{m}^2$) of age 0+ chinook salmon in pool and run habitat in lower Big Sheep Creek from 1992 to 1995 (Blenden and Kucera 2002).

Juvenile chinook salmon density information was collected in Lick Creek, in the Imnaha River subbasin, to document the reproductive success of adult hatchery chinook salmon releases. The natural salmon spawning aggregate in Lick Creek is essentially locally extirpated. Chinook salmon parr densities in Lick Creek ranged from 32.5 to 224 fish/ 100m^2 the year after adult hatchery salmon releases during three different years. During three years when no adult hatchery chinook salmon were released, age 0+ chinook salmon densities the following year were zero. Outplanted adult hatchery chinook salmon were able to successfully spawn and produce progeny in Lick Creek.

The Imnaha River snorkeling sites were located within the chinook salmon redd count index area from Indian Crossing to Mac's Mine. Juvenile natural chinook salmon was the most abundant fish species observed, followed by mountain whitefish, steelhead and bull trout. Mean densities of age 0+ chinook salmon ($72.4/100\text{m}^2$) were highest in 1994 pool habitat and were lowest in 1996 run habitat ($9.8/100\text{m}^2$). Average density of age 0+ chinook salmon was highest in pool

habitat, and ranged from 30.4 to 72.4 fish/100m² from 1992 to 1995 (Figure 41). Mean densities of subyearling chinook salmon within pool habitat differed substantially between years, varying as much as 100%. Confidence intervals (95% C.I.'s) around pool habitat mean densities were substantial, ranging from 56% to 101.6%. Between year statistical comparison of pool habitat mean density was not performed due to low sample sizes of snorkeled habitat (n=5 to 6). In each year, observed densities of age 0+ chinook salmon in pool habitat was two to 3.4 times higher than run habitat average densities. Pool habitat appeared to be preferred over run habitat by age 0+ chinook in the Imnaha River. The mean density of age 0+ chinook salmon in run habitat ranged from 9.8 to 38 fish/100m² over the study period (Figure 41). Average densities of subyearling chinook salmon in run habitat types did not vary substantially between years. The exception occurred in 1994 when density (38 fish/100m²) was twice that of any other years' observed average density. Ninety five percent confidence intervals surrounding age 0+ chinook salmon average densities (run habitat) ranged from 29.8% to 86.7%. Age 1+ chinook salmon mean densities were highest in 1996 pool habitat (5.3/100m²) and lowest in 1994 run habitat (0.1/100m²). Juvenile emigrant trapping investigations in the upper Imnaha River (rkm 74) in 1992 and 1993 indicated that thousands of age 0+ chinook salmon had emigrated from natural production areas prior to initiation of snorkeling activities in mid August (Blenden - unpublished data).

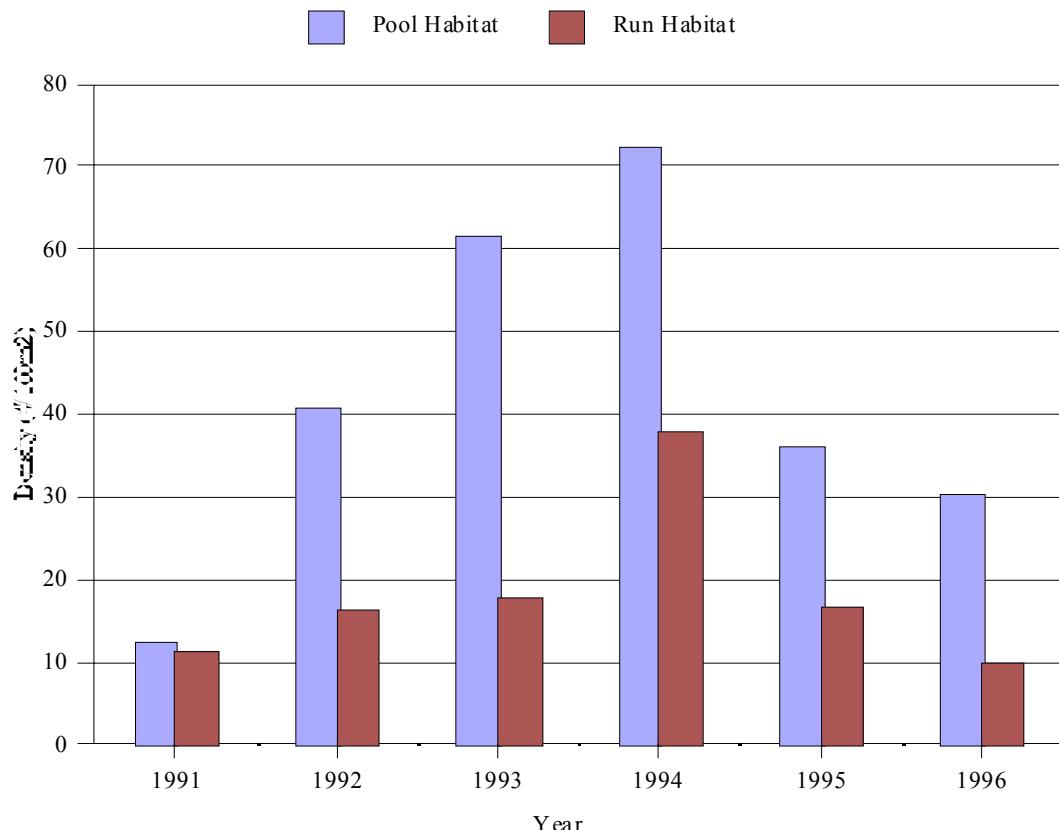


Figure 41. Average density of age 0+ chinook salmon in pool and run habitat in the Imnaha River from 1991 to 1996 (Blenden and Kucera 2002).

Juvenile Emigrant Abundance

Juvenile emigrant abundance data is not available for the Imnaha River subbasin. The performance measure represents a critical data gap. Seasonal estimates for portions of the emigration period are available (Gaumer 1968, Cleary et al 2003, Ashe et al 1995); however, in only one migration year (1992 - 1993) was trapping conducted across over the entire emigration period.

Population Risk Assessment

Snake River spring/summer chinook salmon (including the Imnaha River) have suffered from a severe decline in population size. Fish return sizes, particularly from 1980-2000, were less than 1% of those from about 1955-1970 (Hyun and Talbot 2004). The National Marine Fisheries Service (NMFS) listed evolutionarily significant units (ESU) of these fish as ‘threatened’ on April 22, 1992 and August 18, 1997 respectively under the Endangered Species Act. However return sizes from 2001-2003 showed a significant increase.

Hyun and Talbot (2004) conducted a viability analysis for Snake River spring/summer chinook salmon using time series data of abundance index (Figure 42). We provide here a much abbreviated summary of their paper to describe extinction risk of the Imnaha River chinook salmon populations. They developed an integrated risk metric that incorporates estimates of the Diffusion Approximation (DA) model parameters and the viability of the current population size relative to that from pre-1980. The status of ESUs and populations was assessed over two time series: (1) the entire time series of available data, and (2) time series after 1980. To address an issue concerning whether the current population viability is comparable to those from the healthy time, the entire time series was used. To assess whether the current population viability is at extinction risk, recent data series was used because salmonid longevity is typically five or six years and thus population sizes from 10 or more years ago is less correlated to the current population size.

An abundance index of naturally origin fish at return year t was calculated as follows:

$$I_t = [(\text{escapement index}) + (\text{harvest estimate})] \times (\text{fraction of natural origin fish})$$

The current viability of all Snake River spring/summer chinook salmon ESU and populations (including the Imnaha) was significantly poor, compared to that from the healthy time period. Table 41 shows probability of population growth rate ($\Pr \hat{\mu} < 0$) of all spring/summer chinook salmon ESU and populations are larger than 0.5. Hyun and Talbot assigned 0.5 to be an *ad hoc* threshold for $\Pr(RVC < 1)$. They assumed that, if the bad event ‘ $RVC < 1$ ’ (i.e., the current population size is less than those from the pre-1980 period) occurs with possibility of 50% or more, a population of interest is at risk. The resultant threshold of integrated risk metric becomes 0.25 because $0.5 \text{ for } \Pr(\hat{\mu} < 0) \times 0.5 \text{ for } \Pr(RVC < 1) = 0.25$. Based on the integrated risk metric, the Big Sheep Creek and Imnaha River mainstem spring/summer chinook salmon population are at risk (Table 42). These results may differ when data from 2002 and 2003 are included.

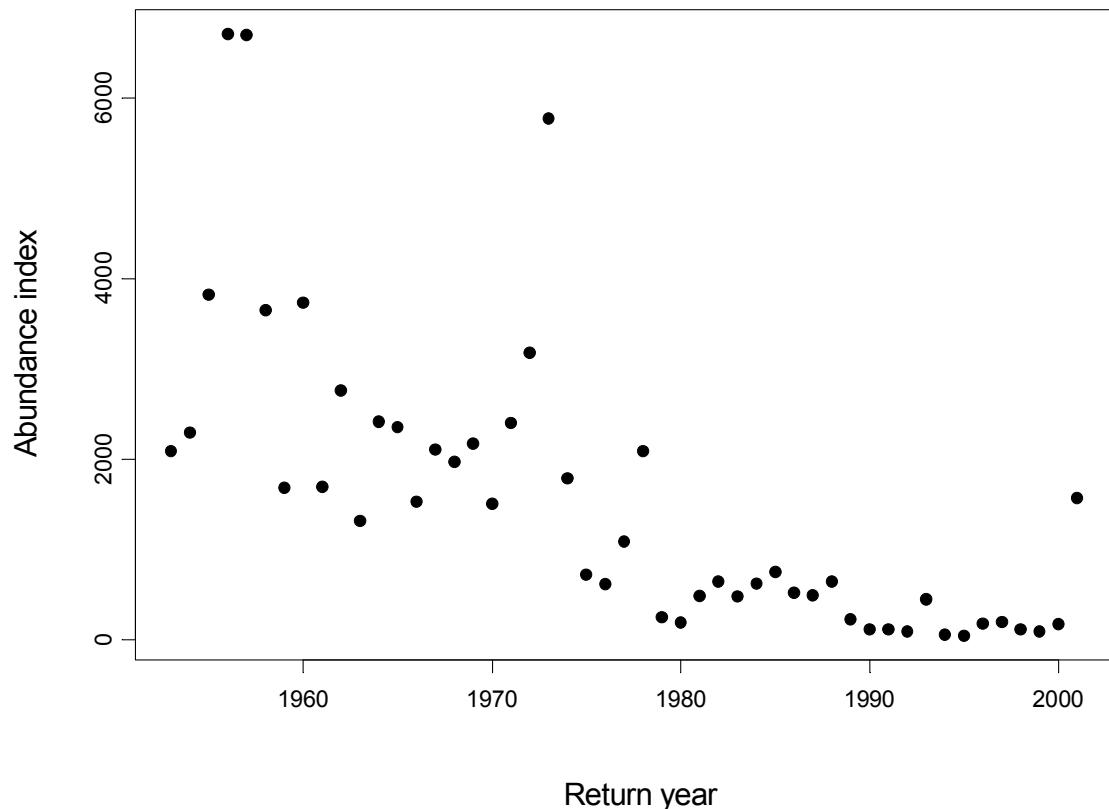


Figure 42. Abundance index (expanded redd counts adjusted for estimated Columbia River harvest) over time of Imnaha River mainstem spring/summer chinook salmon population.

Table 41. Summary of $\Pr(\hat{\mu} < 0)$ estimated with available data series of spring/summer chinook salmon ESU and Imnaha populations (Code: mainstem Imnaha (7) and Big Sheep Creek (6); n: the length of annual time series data; y1 and y2: the range of annual time series data; and DA risk: $\Pr(\hat{\mu} < 0)$).

Code	n	yr1	yr2	$E(\hat{\sigma}^2)$	$E(\hat{\mu})$	DA risk
ESU	20	1980	1999	0.020	-0.032	0.815
7	49	1953	2001	0.030	-0.054	0.982
6	39	1957	2001	0.045	-0.191	1.000

Table 42. Summary of integrated risk metric for spring/summer chinook salmon ESU and Imnaha subbasin populations (Code: mainstem Imnaha (7) and Big Sheep Creek (6). The first row under the table header has results for the ESU, and the other rows have results for the populations; n: the length of data used for calculation of $\Pr(\hat{\mu} < 0)$; y1 and y2: the range

of annual time series data used for calculation of $\Pr(\hat{\mu} < 0)$; DA risk: $\Pr(\hat{\mu} < 0)$; m: the length of data used for calculation of $\Pr(RVC < 1)$; α and β : shape and scale parameters in a Gamma density; p: p-value of K-S goodness of fit test for the Gamma density; RVC risk: $\Pr(RVC < 1)$; and Integ. risk: Integrated risk metric.

Code	n	Yr1	yr2	$E(\hat{\sigma}^2)$	$E(\hat{\mu})$	DA risk	m	α	β	p	RVC risk	Integ. risk
ESU	20	1980	1999	0.020	-0.032	0.815	NA	NA	NA	NA	NA	NA
6	22	1980	2001	0.060	-0.209	1.000	NA	NA	NA	NA	NA	~ 1
7	22	1980	2001	0.050	0.005	0.466	24	1.701	0.641	0.21	0.559	0.261

The Big Sheep Creek population is currently considered to have too few individuals available to maintain its viability as a naturally reproducing population (USFS 2003d). Some managers consider populations approaching or less than 300 breeding adults to be in need of corrective strategies to bring the population into compliance with the *Wild Fish Management Policy* (Chilcote et al. 1992). NPT considers a minimum spawner abundance threshold of 500 required to support long-term population persistence in the Imnaha River subbasin (Jay Hesse, pers. Com). The interim recovery goal (NMFS 2002) is 2,500 natural-origin spawners. Assessment of goal achievement is based on an eight year geometric mean, which has not been met once during the last eight years.

Productivity and Survival

Imnaha River Subbasin spring/summer chinook salmon population productivity and survival should be characterized using the following key performance measures (see also RME section); progeny-per-parent ratio, juvenile recruit-per-spawner ratio, egg-to-emigrant survival rate, smolt-to-adult return rate, pre-spawn mortality, juvenile survival to Lower Granite Dam, in-hatchery life stage specific survival, and relative reproductive success between natural and hatchery-origin fish. Additional performance measures of; juvenile survival to all mainstem dams, ocean and Columbia River harvest rate, and post-release survival rate support calculation of derived performance measures characterizing population productivity and survival. Given the existence of a spring/summer chinook salmon hatchery program in the Imnaha River Subbasin, performance measures should characterize both natural and hatchery-origin aspects.

Progeny per parent ratio

Run reconstructions for Imnaha spring/summer chinook salmon have been derived from spawning ground surveys, age frequencies, mainstem and tributary harvest rates, and mainstem conversion rates for upstream passage of adults available from the 1940s to 1990 (Carmichael et al.1998). Each of the estimated performance measures used in run reconstruction have associated error (unknown and know). The progeny-per-parent (P:P) ratios presented are based on point estimates only. Progeny-to-parent ratios for natural spawning spring/summer chinook salmon have been well below replacement for most brood years since 1983 and as low as 0.2 (Carmichael et al.1998; Figure 43).

Table 43. Mean \pm coefficient of variation (and range) for spawners, recruits, and recruit per spawner numbers in aggregate and index populations of wild spring and summer chinook in the Imnaha subbasin (1949–1990). Values for recruits per spawner represent geometric means and standard deviations (coefficient of variation is standard deviation divided by the mean and expressed as a percentage) (reproduced from Beamesderfer et al. 1996).

Population	N^1	Spawners	Recruits to Freshwater	Recruits per Spawner
Mainstem (1949–1990)	41	$1,110 \pm 69\%$ (169–3,462)	$2,845 \pm 90\%$ (125–10,720) ²	$2.0 \pm 139\%$ (0.3–16.3)
Big Sheep/Lick (1962–1990)	27	$201 \pm 93\%$ (0–644)	$349 \pm 140\%$ (0.0–1,895) ³	$0.9 \pm 332\%$ (0.0–13.7)

¹ Number of brood years for which data were collected

² Represents the maximum and minimum number of freshwater recruits over 41 years

³ Represents the maximum and minimum number of freshwater recruits over 27 years

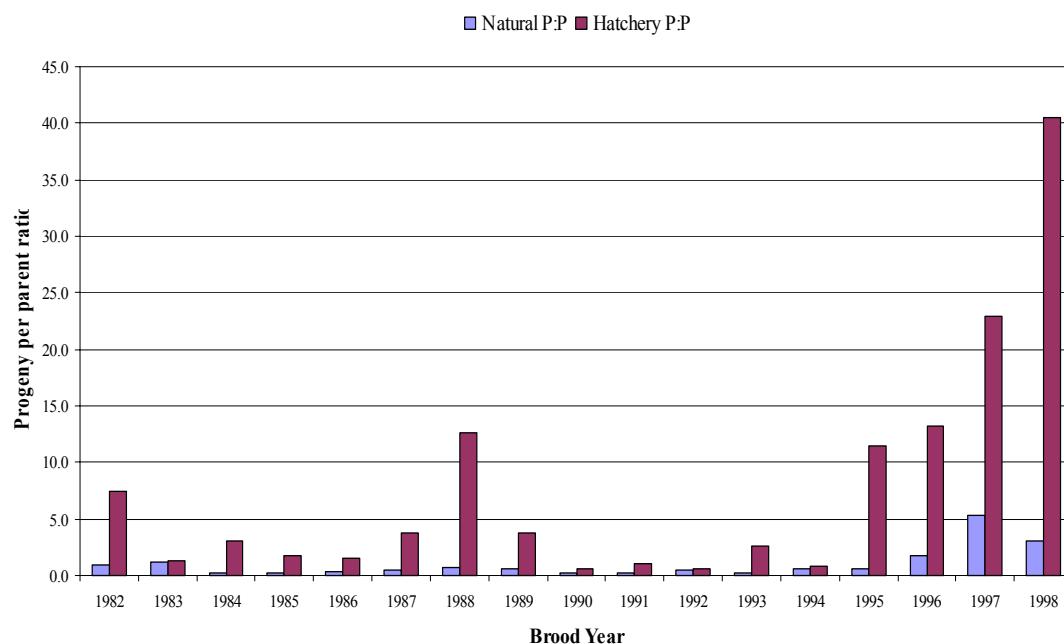


Figure 43. Annual progeny-parent ratio for natural and hatchery-origin chinook salmon in the Imnaha River Subbasin for brood years 1982 – 1998 (ODFW LaGrande data files P. Kinery)

Juvenile Recruit-per-Spawner

Direct assessment of juvenile recruit-per-spawner has not been accomplished in the Imnaha subbasin.

Egg-to-Emigrant Survival Rate

Egg-to-emigrant survival rate has not quantified for Imnaha River subbasin spring/summer chinook salmon. This represents a critical uncertainty (data gap).

Smolt-to-Adult Return Rate

Smolt-to-adult return rate (SAR) was calculated for two groups of PIT tagged juvenile natural-origin chinook salmon emigrants from the Imnaha River, for brood years 1996 to 1998 (Cleary et al. 2003). The two groups are represented by: 1) juvenile chinook salmon tagged during the fall of the year which emigrated past the lower Imnaha River trap (termed presmols), and 2) chinook salmon smolts which emigrated past the lower Imnaha River trap during the spring (termed smolts). Estimated SAR's for these two groups represent in-river migrating fish (although a few smolts were inadvertently diverted to the transportation system) defined as those fish that were bypassed (C_1) or migrated by either spill or turbine routes (C_0). The estimated SAR provides a SAR index of inriver migrating Imnaha River chinook salmon. A season wide juvenile survival rate from the lower trap to Lower Granite Dam (LGR) for the life stage and migration year of interest was used to generate comparable estimated smolt equivalents at LGR, which was then used to estimate SAR's from LGR to LGR. The LGR to LGR SAR was calculated as it provides a more comparable SAR rate given life stage differences.

Natural-origin chinook salmon presmols evidenced a higher LGR to LGR SAR index for all brood years examined when compared to smolts (Table 12). The LGR to LGR SAR index for fall tagged pre-smolts ranged from 2.41% to 3.08%. The LGR to LGR SAR index for spring tagged smolts ranged from 1.75% to 2.94% for the same brood years. The 1996 brood year pre-smolt SAR of 3.08% appeared substantially different from the smolt SAR of 1.75%. Observed differences between presmolt and smolt SAR indexes for brood years 1997 and 1998 were relatively small (0.17% - brood year 1997, and 0.04% - brood year 1998).

The observed SAR index for presmolt chinook salmon from the lower Imnaha River trap to LGR ranged from 1.00% to 1.86% for the three brood years examined (Figure 44, Table 44). The SAR index for smolts from the lower Imnaha River to LGR varied from 1.49% to 2.49%.

Ongoing attempts at defining hatchery-to-hatchery smolt-to-adult survival rates (SAR) adjusted for harvest have been made by DeHart et al. (2003). As part of the Comparative Survival Study (CSS) for upriver (above LGR) hatchery chinook, DeHart et al. (2003) is conducting a multi-year program to develop (among other objectives) a long-term index of survival rates from release of yearling chinook smolts at hatcheries to return of adults to hatcheries. Associated tasks include (1) partitioning survival rates from hatchery (smolts) to LGR (smolts); (2) partitioning survival rates from LGR (smolts) back to LGR (adults); and (3) partitioning survival rates from LGR (adults) back to the hatchery of origin (adults).

Estimated survival rates for hatchery smolts emigrating from the Imnaha to LGR are shown in Table 45. Survival rates from the Imnaha to Lower Granite have essentially remained similar for the period evaluated (1997-2000). Weighted SARs for LGR-to-LGR have improved during the evaluation period, and most notably during 1999-2000 (Table 45). Survival from LGR to the Imnaha hatchery was unavailable due to discrepancies between the SARs estimated from total production release and the PIT tag SARs (refer to DeHart et al. 2003 for a more complete discussion), but were estimated to be approximately 50% after accounting for harvest. Hatchery to hatchery SARs are shown in Figure 44.

Table 44. Detections of PIT tagged Imnaha River adult chinook salmon and estimated smolt to adult return rate indices (SAR) of in-river migrating fish from the lower Imnaha River trap to Lower Granite Dam (LGR) and from LGR to LGR for brood years 1996 to 1998. All pre-smolts were tagged in the fall and all smolts were tagged in the spring (Cleary et al. 2003).

Brood Year	Life Stage	Number PIT Tagged	Estimated Smolt Equivalents at LGR	Number of Adult Detections at LGR	Age at Return			SAR Trap to LGR (%)	SAR LGR to LGR (%)
					III	IV	V		
1996	Pre-Smolt	1,453	878	27	5	15	7	1.86	3.08
1997		2,000	830	20	3	16	1	1.00	2.41
1998		2,009	739	22	2	12	8	1.10	2.98
1996	Smolt	3,956	3,370	59	3	41	15	1.49	1.75
1997		5,306	4,696	105	8	69	28	1.98	2.24
1998		4,369	3,705	109	3	62	44	2.49	2.94

Table 45. Estimated number of chinook smolts at Lower Granite Dam and returning adults (age 4 and only) to Lower Granite Dam for Imnaha hatchery fish during migration years 1997-2000 (reproduced from DeHart et al. 2003).

Migr. Year	Hatchery Release	Survival: Hat-to-LGR (S_1)	Estimated # smolts at LGR (in 1000s)	Weighted LGR-to-LGR SAR ¹	Estimated # Adults at LGR
1997	50,911	0.581	30.8	0.0047	145
1998	93,108	0.685	63.8	0.0067	426
1999	184,725	0.664	122.7	0.0228	2,792
2000 ²	179,797	0.685	123.2	0.0230	2,834

¹/ Weighted estimated LGR-to-LGR SARs are obtained by taking proportion of total population of smolts (tagged and untagged) at Lower Granite Dam in each study category (Study categories: T₀=transported hatchery chinook smolts; C₀= smolts that were never collected or bypassed at Snake River collector dams; C₁= smolts that were collected and bypassed at one or more Snake River collector) and multiplying by the respective study category's LGR-to-LGR SAR (refer to DeHart et al. 2003, Table 28, Chapter 2)

²/ Only 2-ocean returning adults were used in 2000 to match the hatchery rack PIT tag data available at the time of the study

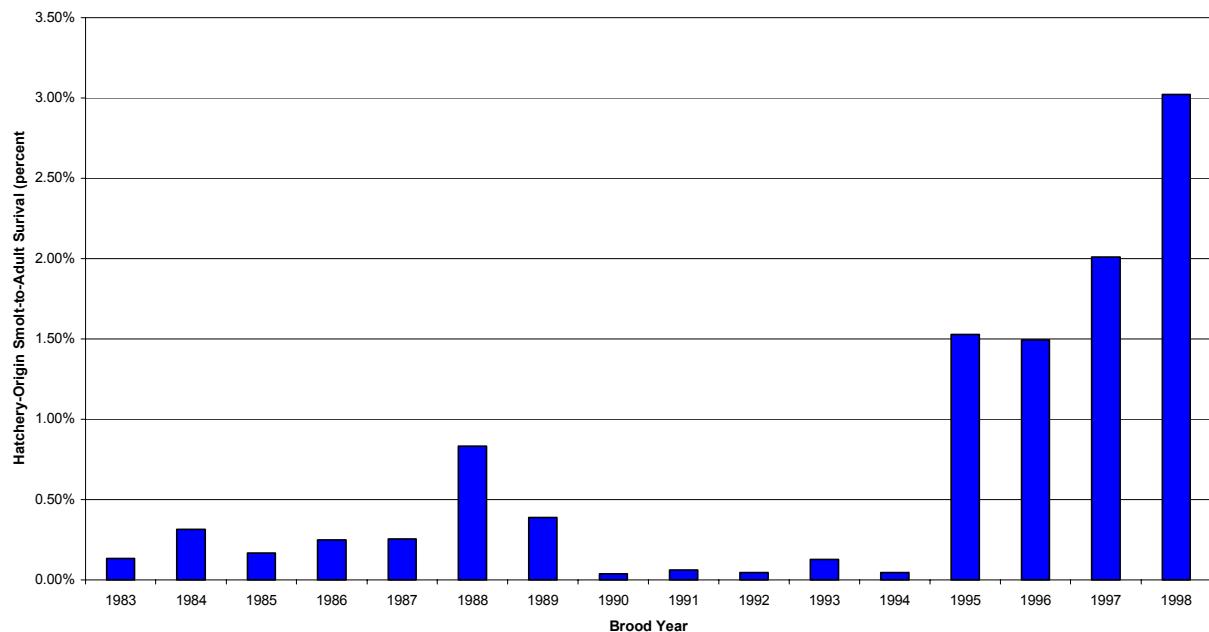


Figure 44. Imnaha River hatchery-origin spring/summer chinook salmon smolt-to-adult survival rate (release to tributary) by brood year. Estimates based on total number of smolts released and estimated number of returning adults at ages 3 to 5 (ODFW data files from P. Kinery).

Representative annual estimates of Imnaha Subbasin natural-origin chinook salmon smolt-to-adult survival estimates are lacking. These estimates require either emigrant abundance or representative PIT tagging along with tributary specific adult abundance.

Prespawning Mortality

Prespawning mortality has been monitored since 1987 (Figure 45); ranging from 0% to 32% (ODFW data files from P. Kinery). These estimates characterize only females during the spawning period. As such, comprehensive assessment of in-basin prespawn mortality is lacking.

Juvenile survival to Lower Granite Dam

Seasonwide estimates of juvenile chinook salmon (presmolt and smolt) survival from the mouth of the Imnaha River to Lower Granite Dam have been made since 1993 (Table 45; Cleary et al 2003 and Cleary et al in press). Survival estimates from emigrating presmolt to smolt at Lower Granite Dam have ranged from 25% to 61% (Figure 46). Survival estimates of spring emigrating natural chinook salmon have ranged from 76% in 1994 to 91% in 1995 (Figure 47). Survival estimates of hatchery chinook salmon smolts have ranged from 67% in 1994 to 80% in 1997 (Figure 48). Post release survival (release to mouth of the Imnaha River) has ranged from 88 to 100% (Figure 49). Representative trapping and tagging across the entire emigration period has not been conducted to date and represents a data gap. Representative trapping tagging across the spring seasonal periods has been maintained with the exception of high debris load periods.

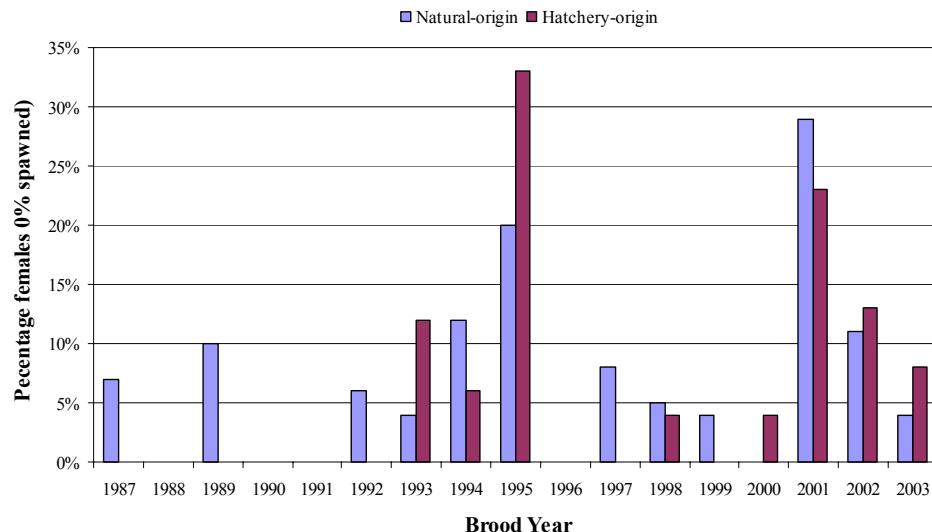


Figure 45. Annual prespawning mortality frequency for natural and hatchery-origin chinook salmon. Insufficient data for years 1990 and 1991 (ODFW LaGrande data files).

Table 46. Season-wide estimates of survival from the lower Imnaha River trap to Lower Granite Dam from 1993 to 2003. Ninety-five percent confidence intervals are shown in parentheses (Modified from Cleary et al. 2003; updated with NPT data files from P. Cleary).

Migration Year	Natural Chinook Salmon Survival (%)	Hatchery Chinook Salmon Survival (%)	Natural Steelhead Survival (%)	Hatchery Steelhead Survival (%)
1993	80.9 (11.8)			
1994	76.2 (5.3)	67.1 (10.2)		
1995	90.9 (6.7)	72.1 (6.3)	83.7 (7.1)	77.5 (3.1)
1996	81.2 (5.3)	71.4 (9.4)	86.5 (3.9)	64.6 (4.7)
1997	89.5 (12.9)	80.4 (8.0)	90.1 (3.9)	81.4 (2.0)
1998	85.2 (2.0)	75.7 (3.1)	86.0 (2.2)	82.9 (2.3)
1999	88.5 (2.0)	71.6 (4.7)	87.7 (3.1)	85.4 (2.0)
2000	84.8 (2.3)	74.4 (4.3)	84.4 (2.7)	85.8 (2.4)
2001	83.7 (0.8)	80.3 (1.6)	82.7 (1.4)	82.0 (1.6)
2002	86.9 (4.4)	77.3 (4.4)	83.0 (5.4)	81.8 (3.5)
2003 ¹	75.9 (2.3)	72.4 (6.8)	82.0 (2.5)	89.4 (3.3)

¹ Hatchery chinook salmon estimates based on the release of captured PIT tagged fish released from the chinook salmon acclimation facility.

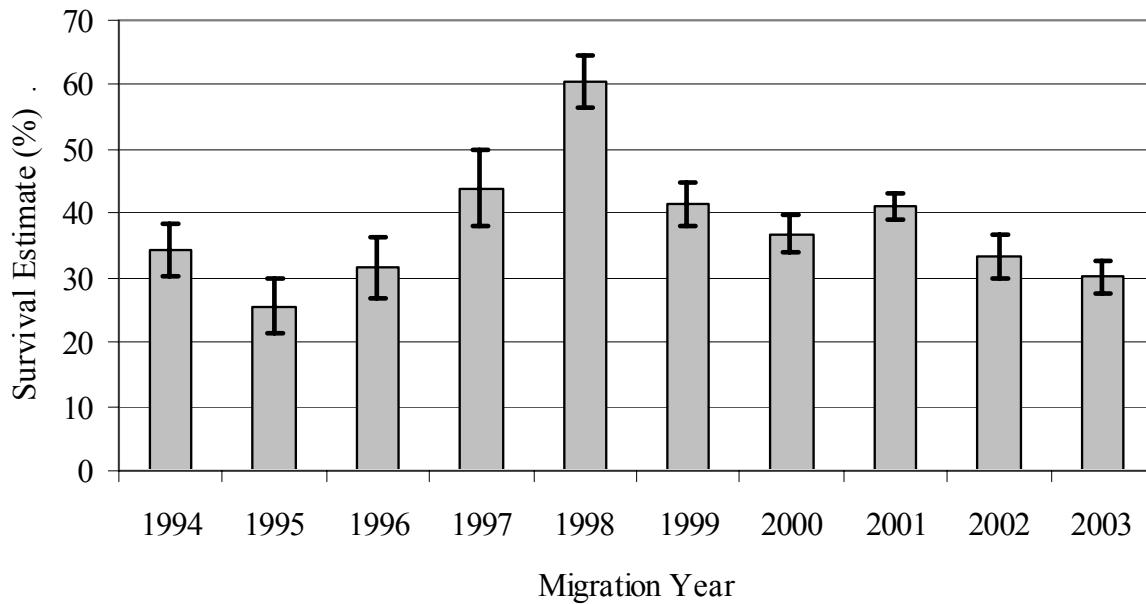


Figure 46. Estimated survival from the trap to Lower Granite Dam of natural chinook salmon pre-smolts, tagged in the fall, from for migration years 1994 to 2003 (Cleary et al 2003 and Cleary et al in press).

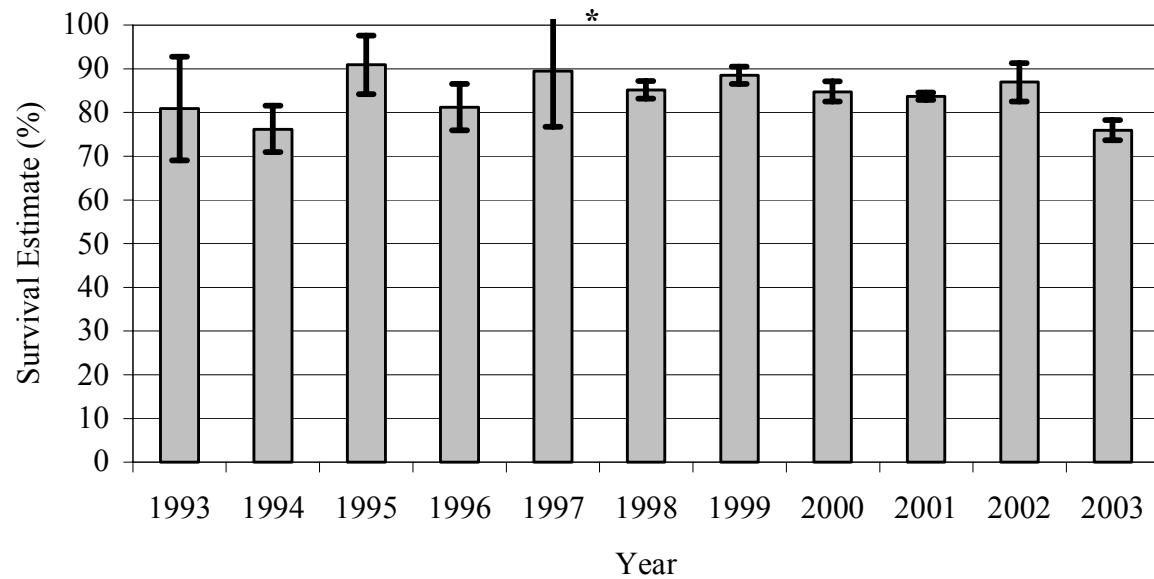


Figure 47. Seasonwide survival estimates for natural chinook salmon smolts (tagged in spring) released from the Imnaha River trap to Lower Granite Dam, from 1993 to 2000. Error bars indicate 95% confidence limits. Asterisks indicate upper confidence levels greater than 100% (Cleary et al 2003 and Cleary et al in press)

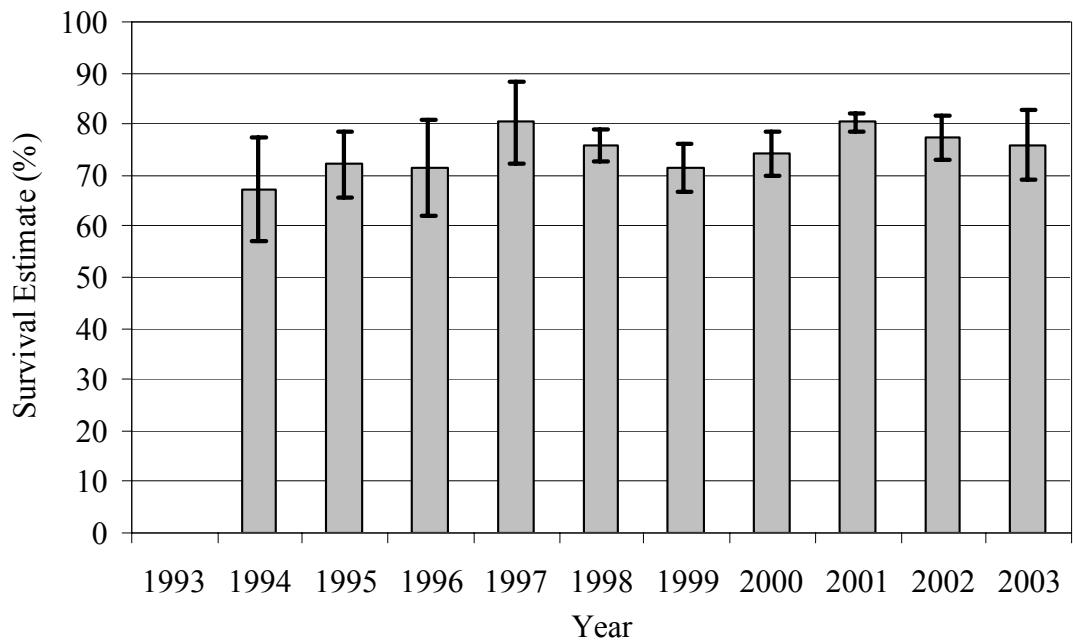


Figure 48. Seasonwide survival estimates for hatchery chinook salmon smolts (tagged in spring) released from the Imnaha River trap to Lower Granite Dam, from 1993 to 1999. Error bars indicate 95% confidence limits (Cleary et al. 2003 and Cleary et al in prep)

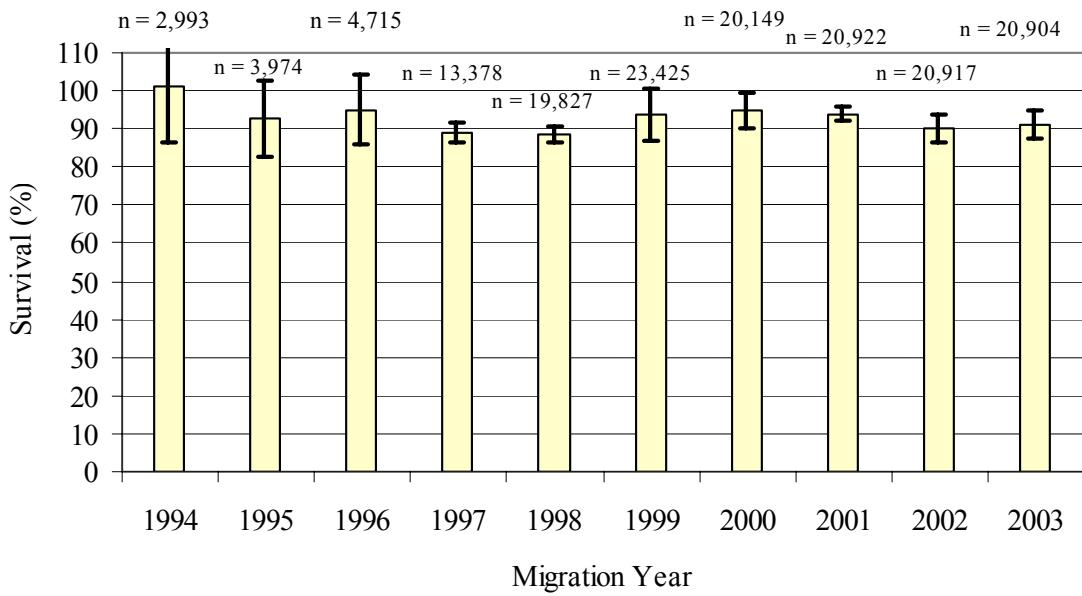


Figure 49. Annual survival of hatchery chinook salmon from the Imnaha River acclimation facility to the Imnaha River trap from 1994 to 2003. The size of annual PIT tag release groups are shown above for each year and error bars indicate the 95% C.I. (Cleary et al 2003 and Cleary et al in press).

In-hatchery Life Stage Specific Survival

In-hatchery life stage specific survival for Imnaha River spring/summer chinook salmon is monitored annually for green egg to eye-up, eye-up to smolt, and green egg to smolt survival rate. Green egg to eye-up survival has ranged from 61.7 to 97.6% and averaged 82.0% from 1983 through 2003. Eye-up to smolt survival has ranged from 66.6 to 99.7% and averaged 90.3% from 1983 through 2003. Green egg to smolt survival has ranged from 58.5 to 91.0% and averaged 73.2% from 1983 through 2003.

Table 47. Life stage specific abundance and survival for Imnaha River spring/summer chinook salmon hatchery production program 1982 – 2003 (ODFW LaGrande data files).

Year	Numbers			Survival		
	Egg take	Eyed Eggs	Smolts	% Egg to Eye	% Eye to Smolt	% Green to Smolt
1982			24,920	#DIV/0!	#DIV/0!	#DIV/0!
1983	163,862	125,000	115,830	0.763	0.927	0.707
1984	51,800	38,400	35,264	0.741	0.918	0.681
1985	156,721	126,728	123,530	0.809	0.975	0.788
1986	280,431	208,466	198,535	0.743	0.952	0.708
1987	187,395	142,683	142,320	0.761	0.997	0.759
1988	521,938	439,556	253,042	0.842	0.576	0.485
1989	412,008	402,000	267,670	0.976	0.666	0.650
1990	326,612	272,721	246,386	0.835	0.903	0.754
1991	193,206	165,384	157,659	0.856	0.953	0.816
1992	524,005	453,264	438,627	0.865	0.968	0.837
1993	1,047,064	1,011,464	873,115	0.966	0.863	0.834
1994	111,794	96,143	91,240	0.860	0.949	0.816
1995	68,121	52,658	50,911	0.773	0.967	0.747
1996	110,146	103,317	93,108	0.938	0.901	0.845
1997	282,823	206,744	184,725	0.731	0.893	0.653
1998	308,572	229,886	179,716	0.745	0.782	0.582
1999	168,930	128,725	123,014	0.762	0.956	0.728
2000	333,824	315,464	303,769	0.945	0.963	0.910
2001	459,276	283,373	268,510	0.617	0.948	0.585
2002		382,256	398,458		1.042	
2003	498,001	438,240	374,400	0.880	0.854	0.752
				0.820	0.903	0.732
				Averages		

*1988 - unusual smolt number based on eyed eggs

*1993 - smolts (590,069) plus parr (283,046)

*2003 - estimated smolt release in 2005

Relative Reproductive Success

Direct assessment of relative reproductive success of hatchery and natural-origin Imnaha River subbasin spring/summer chinook salmon has not been quantified to date.

Life History and Genetic Diversity

Imnaha subbasin spring/summer chinook salmon population diversity should be characterized using the following key performance measures (see also RME section); adult spawner distribution, juvenile rearing distribution, genetic diversity, age-at-return, age-at-emigration, adult run timing, and spawn-timing. Additional performance measures of; stray rate, disease frequency, age class structure, size-at-return, size-at-emigration, condition factor of juveniles, adult spawner sex ratio, fecundity by age, juvenile emigration timing, and mainstem arrival timing support calculation of derived performance measures further characterizing population diversity.

Adult Migration

After residing in the Pacific Ocean for two to four years, adult spring/summer chinook salmon enter the Columbia River from February through May. They proceed up the Columbia 522 kilometers (324 miles), enter the Snake River during the spring and proceed upriver an additional 308 kilometers (191 miles), then enter the Imnaha River between late May and early July (Table 48) where they generally will have another 74 kilometers (46 miles) to navigate prior to reaching the fish weir that diverts them to a temporary holding area. Total distance traveled is 904 kilometers (about 562 miles) from the ocean. Peak migration into the upper portion of the subbasin generally occurs during June through the first part of July (Table 49). Annual age-class structure for natural-origin chinook salmon has averaged 5% 1-ocean (jacks), 53% 2-ocean, and 42% 3-ocean from 1987 to 2000 (ODFW LaGrande data files). Less than one percent of the mature adults have been comprised of 4-ocean age fish during this period. Observations of precocial (yearling) males spawning have occurred, but have yet to be quantified. Hatchery-origin age class structure annually has averaged 11% 1-ocean (jacks), 62% 2-ocean, and 26% 3-ocean (ODFW LaGrande data files). Maintaining representative age-at-return from historic conditions has been identified as a challenge with the ongoing hatchery program.

Adult Holding

Spring/summer chinook typically use the upper-third of the mainstem and Big Sheep Creek below Lick Creek for holding (Ashe et al. 2000), but may use the lower portion of the river as well. Those that occupy the mainstem below Big Sheep Creek will hold based on temperature suitability (Table 48), while those that rely on habitat in the upper subbasin hold from June through the end of August (Table 49). Channelization has adversely affected some holding areas in Big Sheep Creek (i.e., from Carol Creek to Coyote Creek and from Muley Creek to the mouth of Big Sheep Creek), but habitat is generally good in the upper reaches (Ashe et al. 2000).

Table 48. Life history timing for anadromous focal species in the Imnaha subbasin, from the confluence with the Snake River to the confluence with Big Sheep Creek (ODFW, unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).

Life Stage/Activity/Species		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upstream Adult Migration													
Summer steelhead		1	1										
Spring/summer chinook salmon				1	1	1	1						
Fall chinook salmon						1							
Adult Spawning													
Summer steelhead		1	1										
Spring/summer chinook salmon				1	1	1	1	1	1	1	1	1	1
Fall chinook salmon					1	1	1	1	1	1	1	1	1
Adult Holding													
Summer steelhead		1	1	1	1	1	1	1	1	1	1	1	1
Spring/summer chinook salmon				1	1	1	1	1	1	1	1	1	1
Fall chinook salmon					1	1	1	1	1	1	1	1	1
Egg Incubation through Fry Emergence													
Summer steelhead													
Spring/summer chinook salmon													
Fall chinook salmon													
Juvenile Rearing													
Summer steelhead		1	1	1	1	1	1	1	1	1	1	1	1
Spring/summer chinook salmon		1	1	1	1	1	1	1	1	1	1	1	1
Fall chinook salmon													
Downstream Juvenile Migration													
Summer steelhead							1	1	1	1	1	1	1
Spring/summer chinook salmon							1	1	1	1	1	1	1
Fall chinook salmon								1	1	1	1	1	1

Represents periods of peak¹ use based on professional opinion.

Represents lesser² level of use based on professional opinion.

Represents periods of presence, either with no level of use OR uniformly distributed level of use indicated

¹ Based on professional opinion, peak use equates to 70% of life stage activity occurring in this time frame.

² Based on professional opinion, lesser use equates to 30% of life stage activity occurring in this time frame.

Table 49. Life history timing for anadromous focal species in the Imnaha subbasin, upriver from the confluence with Big Sheep Creek (ODFW, unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upstream Adult Migration												
Summer steelhead												
Spring/summer chinook salmon												
Adult Spawning												
Summer steelhead												
Spring/summer chinook salmon												
Adult Holding												
Summer steelhead												
Spring/summer chinook salmon												
Egg Incubation through Fry Emergence												
Summer steelhead												
Spring/summer chinook salmon												
Juvenile Rearing												
Summer steelhead												
Spring/summer chinook salmon												
Downstream Juvenile Migration												
Summer steelhead												
Spring/summer chinook salmon												

Represents periods of peak use based on professional opinion.

Represents lesser level of use based on professional opinion.

Represents periods of presence, either with no level of use OR uniformly distributed level of use indicated

¹ Peak use equates to 70% of life stage activity occurring in this time frame.

² Lesser use equates to 30% of life stage activity occurring in this time frame.

Spawning

Peak spawning for spring chinook is in the late summer, occurring usually in late August to early September (Ashe et al. 2000) (Table 49). Spawning ground surveys conducted by the Oregon Fish Commission established peak spawning in the Imnaha slightly prior to August 24, although peaks may occur earlier or later depending on the run year (Thompson and Haas 1960). More recent (1986–1989) surveys validate the spawn timing findings documented by the Oregon Fish Commission.

Adult Spawner Distribution

The Interior Columbia Technical Recovery Team (TRT; 2003) defines the core spawning area for mainstem Imnaha spring/summer chinook (IRMAI) to occur from the Blue Hole (RM 69) downstream to Grouse Creek (RM 34.7; Figure 50). Others contend that the primary spawning area is slightly smaller, occurring between Summit Creek (RM 37.5) and the Blue Hole (Mundy and Witty 1998). Mainstem chinook spawning has been documented as far downstream as Freezeout Creek (RM 29.4) and as far upstream as Imnaha Falls (RM 73). Fewer numbers of fish spawn in primary tributaries, including the South Fork Imnaha, Big Sheep Creek and Lick Creek. Although spawning has been observed in the South Fork Imnaha, it is not known if it occurs on an annual basis.

The core spawning area defined by the TRT for the Big Sheep Creek (IRBSH) population occurs from the Road 39-140 Bridge to Coyote Creek, and the lower 3 miles of Lick Creek (Figure 50). ODFW has defined spawning locations in the lower 4.5 miles of Lick Creek and has observed spawning activity lower in the mainstem Big Sheep during years with lower temperatures and higher flows (B. Knox, ODFW, personal communication, February, 2004). There are reports stating that spring/summer chinook may have historically spawned further downstream than currently (Freezeout Creek to Keeler Creek), 1.5 miles further upstream on Big Sheep Creek, and 0.6 mile further upstream on Middle Fork Big Sheep Creek (USFS 2003d).

Incubation

Based on research conducted by the USFWS at Ollokot Campground (RM 48.5) in 1987 and 1988, spring chinook eggs deposited in early August would result in emergence of free-feeding fry in early to mid-November (Mundy and Witty 1998). Eggs deposited by fish in mid-August would emerge in mid-April; eggs deposited in early September would emerge in late May; and eggs deposited in mid-September would emerge in mid-June. It is important to note, however, that the research was based exclusively on water temperature data and standard thermal units used in fish culture, and that one should assume natural conditions to be much more variable. According to ODFW, spring chinook incubation may last as long as 7 months after the fish spawn because much of the spawning habitat is iced over from November to March.

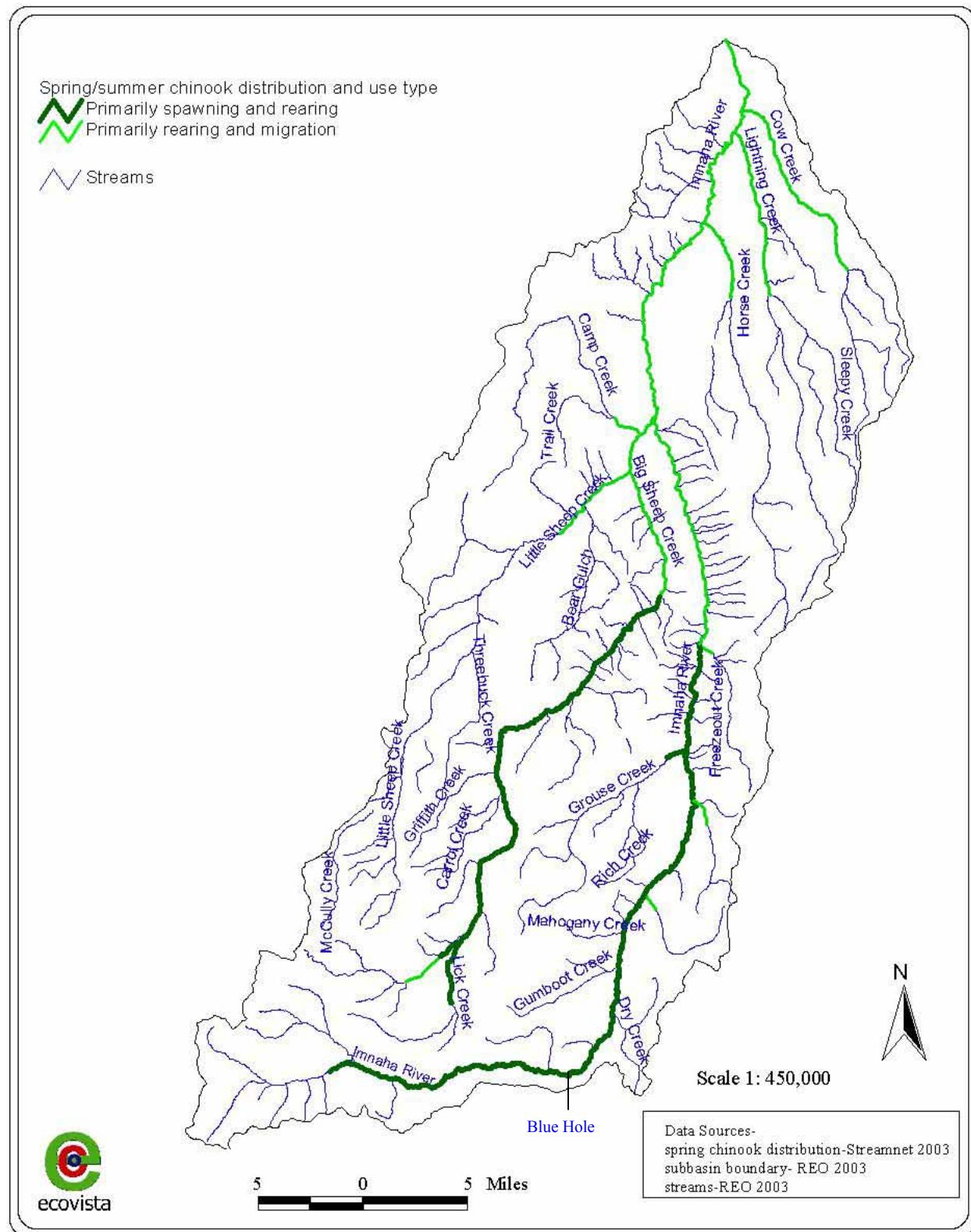


Figure 50. Spawning and rearing locations of Imnaha spring/summer chinook.

Juvenile Rearing Distribution

Prior to their emigration in April, parr and pre-smolts will distribute throughout Big Sheep Creek and the upper, middle and lower Imnaha, and Snake River from September through February (Schwartzberg et al. in prep; Ashe et al. 2000). Juvenile chinook use portions of the mainstem for rearing, but are also present in lower Cow, lower Lightning, lower Horse, Big Sheep, and Lick Creeks (Gaumer 1968; Huntington 1994), and are suspected to use the lower reaches of Skookum (RM 53.7), Gumboot (RM 46.8), Mahogany (RM 45.0), Crazyman (RM 42.8), Summit (RM 37.5), Grouse (RM 34.7), and Freezeout creeks (RM 29.4) (Mundy and Witty 1998). Gaumer (1968) documented some movement of fry and small parr into the lower Imnaha and lower Big Sheep Creek during spring months; however, Gaumer also determined that the peak movement of parr into lower Big Sheep Creek occurred in November, while peak movement into the lower Imnaha occurred during October and November. The fact that little or no movement of juvenile fish occurred during summer months could be due to elevated water temperatures from July into September (Ashe et al. 2000), which also coincides with peak water withdrawals by irrigation diversions in upper portions of Big and Little Sheep Creek. Similar to adults, spring chinook juveniles may have reared further downstream in the mainstem Imnaha and used more tributary habitat than they currently do, yet evidence documenting their historical distribution is unavailable (USFS 2003d).

Smolt Migration

As shown in Table 48, peak emigration of spring chinook residing in the mainstem Imnaha below Big Sheep Creek initiates in late February and extends through early May, whereas fish residing in the upper portion of the subbasin don't exhibit peak downstream migration until April (Table 49). The movement of fish to the lower subbasin in the fall is considered to represent more of a redistribution of fish rather than a true downstream migration, which helps explain why there's juvenile migration without spawning in this area and why downstream migration initiates sooner than it does in the upper subbasin (B. Knox, ODFW, personal communication, May 2003).

Length-at-smolt data are provided in Ashe (et al. 1995), Blenden (et al. 1996, 1997, 1998) and Cleary et al. (2000 and 2003). Natural chinook salmon captured during the spring of 2000 averaged 110 mm in fork length, 14.1 grams, with a condition factor of 1.05 (Table 50). Median fork lengths for natural chinook salmon have been significantly smaller ($p < 0.05$) than median fork lengths for hatchery chinook salmon. In 2000, hatchery chinook salmon averaged 132 mm in fork length and weighed an average of 26.7 grams, with a condition factor of 1.15 (Cleary et al. 2000).

Table 50. Mean lengths, weights, and condition factors of natural and hatchery chinook salmon captured from the Imnaha River trap (RM 4) from February 26 to June 15, 2000 (Cleary et al. 2000).

Statistic	Natural	Hatchery
Mean Fork Length (mm)	110	132
Sample Size	4,330	2,399
Range	69–150	101–219
Standard Deviation	9.5	9.6

Statistic	Natural	Hatchery
Mean Weight (g)	14.1	26.7
Sample Size	4,065	1,989
Range	4.1–35.3	10.8–94.1
Standard Deviation	3.83	6.8
Mean Condition Factor (K)	1.05	1.15
Sample Size	4,042	1,976
Range	0.71–1.69	0.63–1.69
Standard Deviation	0.08	0.07

Out-of-Basin Distribution

Arrival timing of Imnaha subbasin natural and hatchery-origin chinook smolts at Snake River dams has been documented since 1992. Overall, downstream movement of Imnaha chinook to the lower four Snake River dams, appears to be earlier than for other Snake River Basin populations (Mundy and Witty 1998; Ashe et al. 2000).

The NPT has collected five to ten years of arrival timing data for natural and hatchery chinook salmon and steelhead from the Imnaha River (Table 51; Cleary et al. 2003 and in prep.). The annual first, median, 90%, and last arrival times were averaged for future modeling. Ninety five percent confidence intervals for arrival times are presented in parenthesis in the remainder of this section. The mean arrival timing range for natural chinook salmon pre-smolts from 1998 to 2003 at Lower Granite Dam (LGR) is from March 31 (\pm 8 days) to May 16 (\pm 19 days), with mean median and 90% arrival timing of April 17 (\pm 9 days) and May 2 (\pm 27 days), respectively. Mean median arrival times at Lower Granite Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN) for natural chinook salmon pre-smolts are April 24 (\pm 11 days), April 27 (\pm 17 days), and May 1 (\pm 17 days), respectively. Mean 90% arrival timing for natural chinook salmon pre-smolts was May 1 (\pm 12 days) at LGO, May 5 (\pm 17 days) at LMO, and May 8 (\pm 15 days) at MCN.

Natural chinook salmon smolts mean arrival times at LGR from 1993 to 2003 are as follows: mean arrival time range of April 5 (\pm 15 days) to July 1 (\pm 56 days), mean median arrival time of April 28 (\pm 9 days), and mean 90% arrival of May 14 (\pm 11 days). Mean median arrival times at LGO, LMO, and MCN for natural chinook salmon smolts are May 1 (\pm 8 days), May 5 (\pm 13 days), and May 9 (\pm 11 days). Mean 90% arrival timing is May 14 (\pm 18 days) at LGO, May 22 (\pm 15 days) at LMO, and May 22 (\pm 12 days) at MCN.

Mean arrival timing of hatchery chinook salmon smolts from 1992 to 2003 represents the PIT tagged hatchery chinook salmon used to estimate the survival from the trap to LGR, LMO, and MCN. Mean arrival ranges are April 12 (\pm 13 days) to May 26 (\pm 12 days) at LGR, April 20 (\pm 10 days) to May 31 (\pm 12 days) at LGO, April 25 (\pm 6 days) to June 2 (\pm 13 days) at LMO, and April 29 (\pm 11 days) to June 1 (\pm 13 days) at MCN. Mean median arrival timing is as follows: May 3 (\pm 10 days) at LGR, May 8 (\pm 9 days) at LGO, May 12 (\pm 7 days) at LMO, and May 14 (\pm 8 days) at MCN. Mean 90% arrival timing from 1992 to 2003 is as follows: May 13 (\pm 7 days), May 17 (\pm 10 days), May 21 (\pm 6 days), and May 22 (\pm 6 days), at LGR, LGO, LMO, and MCN, respectively.

Table 51. Mean first, median, 90%, and last arrival timing for natural chinook salmon presmols and smolts, and hatchery chinook salmon smolts, at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN). All fish were captured in the Imnaha River Trap. Mean arrival timing is presented with the 95% C.I. (\pm days) (Cleary et al. in prep).

Rearing, Species, Life Stage, Dam	First Arrival		Median Arrival		90% Arrival		Last Arrival	
	Mean	(\pm days)	Mean	(\pm days)	Mean	(\pm days)	Mean	(\pm days)
Natural Chinook Salmon Pre-Smols (1998 to 2003)¹								
LGR	31-Mar	(8)	17-Apr	(9)	2-May	(27)	16-May	(19)
LGO	11-Apr	(14)	24-Apr	(11)	1-May	(12)	18-May	(28)
LMO	19-Apr	(16)	27-Apr	(17)	5-May	(17)	19-May	(18)
MCN	20-Apr	(16)	1-May	(17)	8-May	(15)	17-May	(15)
Natural Chinook Salmon Smolts (1993 to 2003)								
LGR	5-Apr	(15)	28-Apr	(9)	14-May	(11)	1-Jul	(56)
LGO	15-Apr	(10)	1-May	(8)	14-May	(18)	1-Jul	(48)
LMO	21-Apr	(13)	5-May	(13)	22-May	(15)	2-Jul	(49)
MCN	20-Apr	(14)	9-May	(11)	22-May	(12)	18-Jun	(35)
Hatchery Chinook Salmon Smolts (1992 to 2003)								
LGR	12-Apr	(13)	3-May	(10)	13-May	(7)	26-May	(12)
LGO	20-Apr	(10)	8-May	(9)	17-May	(10)	31-May	(12)
LMO	25-Apr	(6)	12-May	(7)	21-May	(6)	2-Jun	(13)
MCN	29-Apr	(11)	14-May	(8)	22-May	(6)	1-Jun	(13)

¹ Median and 90% arrival timing does not include data from migration year 2001 due to the sample size.

² Median and 90% arrival timing does not include data from migration year 2002 due to the sample size.

The data in Table 51 is the cumulation of 10 years of emigration studies in the Imnaha River. It provides a baseline for evaluating the performance of hatchery produced fish and the effects of hatchery production on natural populations. There is a lot of variation in the data but it does show that the hatchery produced fish for the Imnaha River arrive at LGR, LGO, LMO, and MCN at times similar to naturally produced fish but that hatchery fish consistently tend to arrive later. However, these differences are within days and are probably not statistically or biologically different given the 95% confidence intervals.

Carrying Capacity

No information currently exists on spring/summer chinook carrying capacity in the Imnaha subbasin. By all accounts the subbasin remains underseeded. Technical Advisory Committee has described that the resource managers agree the natural environment has been significantly underseeded for the past thirty years (LeFleur, 2000).

Spring chinook carrying capacity in the Imnaha subbasin has been estimated by the Northwest Power and Conservation Council (NPPC 1990) via the Smolt Density Model (SDM). Although estimates are considered subjective (B. Knox, ODFW, personal communication, February, 2004), the total estimated smolt capacity in the Imnaha is 1,154,499 fish. Carmichael and Boyce (1986) estimated spawning ground capacity for adult chinook salmon to be 3,821.

Genetic Integrity—Unique Population Units

Imnaha River spring chinook appear to be a genetically distinct population from other Snake River fish. In 1989 and 1990, samples of subyearling chinook were taken from the Salmon, Grande Ronde, and Imnaha subbasins and electroporetically analyzed for genetic differences in enzymatic frequencies associated with 35 loci (Waples et al. 1993). Results from the analysis indicate that Imnaha fish initially grouped with natural populations from the Grande Ronde subbasin before grouping with fish from the Salmon subbasin, and upon further definition, differed significantly from both Grande Ronde and Salmon populations (Waples et al. 1993). Waples (et al. 1993) further established that Imnaha River hatchery-produced chinook were genetically similar to naturally produced fish, a fact due in large part to the substantial degree of integration of the hatchery and natural components of the Imnaha population. Similar findings are presented in the Interior Columbia Basin Technical Recovery Team (TRT; 2003) stating that hatchery and wild collections from the mainstem Imnaha River were genetically indistinguishable.

The TRT identifies two independent populations of spring chinook in the subbasin; the Imnaha mainstem (IRMAI) and Big Sheep Creek (IRBSH). Genetic samples from the IRMAI mainstem Imnaha population fell within the cluster containing most of the Grande Ronde collections, and were distinct from all other populations (TRT 2003). Geographical distance between primary spawning areas (48 km) distinguishes Imnaha mainstem fish from Big Sheep Creek fish, as does the historically poor demographic correlation between the groups. The Big Sheep Creek population is considered to be functionally extirpated based on (1) limited natural escapement since 1982 (see index area redd count figures 40 and 41; 0 to 6 redds annually from 1992 to 1996); and (2) outplanting of surplus hatchery origin adults into Big Sheep and Lick creeks (1993, 1997, 2000-2003). Hatchery management actions are implemented as if a single population.

1.2.3.2 Spring/summer Chinook Harvest

Current In-Basin Harvest

Spring chinook harvest in the Imnaha has fluctuated over the years, as shown in Table 52. Sport harvest restrictions were first imposed by the State of Oregon on spring chinook anglers in 1916, where the daily bag limit was set at 50 pounds of chinook per day (Mundy and Witty 1998). This limit was reduced to 20 pounds per day in 1925 and eventually reduced to two fish or ten jacks per day at the close of the fishing season in 1978 (Ashe et al. 2000).

Accompanying bag limits were restrictions on season of harvest and location of harvest. Fishing was prohibited above Grouse Creek circa 1944–1954 in an effort to protect spawning chinook. The upper boundary gradually moved downstream to Freezeout Creek, restricting anglers to waters below Freezeout Creek Bridge. Between 1974 and 1979, the sport-fishing season was

closed three times due to declines in adult returns (Table 52). Sport harvest for Imnaha River spring chinook was closed for the better part of the past ten years, but was opened in 2001 - 2003. Estimated sport and tribal harvest was 335 chinook in 2001 and 395 in 2002, and 332 in 2003.

Table 52. Historical sport and tribal harvest of Imnaha River chinook salmon between 1953 and 2003 (Beamesderfer et al. 1996; B. Knox, ODFW, personal communication, April 2003; J. Oatman , NPT, personal communication, April 2004).

Year	Sport	Tribal	Total	Year	Sport	Tribal	Total
1953	149	149	298	1972	17	17	34
1954	15	15	30	1973	107	107	214
1955	20	20	39	1974	Closed	0	0
1956	21	21	41	1975	Closed	0	0
1957	187	187	374	1976	Closed	0	0
1958	117	117	234	1977	44	44	88
1959	168	168	336	1978	Closed	0	0
1960	201	201	402	1979	Closed	0	0
1961	42	42	84	1980	Closed	0	0
1962	9	9	18	1981	Closed	0	0
1963	14	14	28	1982	Closed	0	0
1964	0	0	0	1983	Closed	0	0
1965	3	3	6	1984	Closed	0	0
1966	24	24	49	1985	Closed	0	0
1967	10	10	21	1986	Closed	0	0
1968	61	61	121	1987	Closed	0	0
1969	9	9	19	1988–2000	Closed	0	0
1970	4	4	7	2001	302	33	335
1971	19	19	37	2002	152	243	395
				2003	125	207	332

1.2.3.3 Spring/summer Chinook Hatchery Program

(The following discussion is taken from USFWS 2001 where not otherwise specified).

Historical artificial production of spring/summer chinook in the Imnaha subbasin dates back to 1949 when the Oregon Game Commission initiated a spring/summer chinook egg-take program in an effort to supplement Imnaha chinook into the Umpqua subbasin in southwest Oregon (Ashe et al. 2000). Between July and August 1951, 152 male and 6 female chinook were collected from spawning beds in the mainstem Imnaha and from a weir constructed at Coverdale (Mundy and Witty 1998). Fifteen years later, 119 adult spring/summer chinook collected from Hells Canyon Dam were outplanted into the Imnaha (Neeley et al. 1993). In 1976, Congress authorized the production of hatchery spring/summer chinook under the auspices of the *Lower Snake River Compensation Plan* (LSRCP; Ashe et al. 2000). The LSRCP was initiated in the Imnaha subbasin in 1982. The first releases of hatchery-produced juvenile spring/summer chinook occurred in 1984.

The authorized purpose of the LSRCP program is to provide adult return compensation for Snake River dams. And while the Northeast Oregon Hatchery program is still being operated as a mitigation program with production goals designed to provide for tribal, sport, and commercial harvest, its current management emphasis is for spring/summer chinook population recovery and genetic conservation. The Federal salmon recovery strategy (Conservation of Columbia Basin Fish, Final Basinwide Salmon Recovery Strategy, Dec 2000) specifically states “the overarching goal.....is to reduce or eliminate adverse genetic, ecological, and management effects of artificial production on natural production while retaining and enhancing the potential of hatcheries to contribute to basin wide objectives for conservation and recovery. The goal still includes providing fishery benefits to achieve mitigation mandates, but now must also incorporate an increased emphasis on conservation and recovery.....”.

Current production goals are the same as when it was a mitigation program and all returning adults are released to spawn in the basin – some in the Imnaha and some in Big Sheep and Lick Creeks. The current program is operated under section 10 ESA permit authorization and Nez Perce Tribe/ODFW co-management agreement.

The LSRCP supplementation program was initiated using only adult salmon returning to the Imnaha River and each year naturally produced fish are incorporated into the hatchery broodstock (NPT et al. 1990). Until recently, two facilities were used for the chinook production program; the Imnaha River satellite facility (located near Gumboot Creek) for adult collection, adult holding, and smolt acclimation, and Lookingglass Fish Hatchery (LFH) for incubation and rearing of juveniles. The LFH, operated by the ODFW, was originally designed to produce 1.4 million spring/summer chinook salmon smolts weighing 69,000 pounds; however, based on recent agreements between co-managing entities, the facility has reduced its fish rearing densities.

Adults collected at the Imnaha weir are held or transported to LFH, where they are held and spawned. The weir and associated acclimation pond is an adult trapping facility and juvenile acclimation facility (respectively) operated by ODFW on the mainstem Imnaha (RM 46). The weir is normally placed in the Imnaha River after flows recede to the point that anchors and weir sections can be installed without them washing out (DeHart et al. 2003). The timing of the weir installation may contribute to some uncertainty regarding adult escapement assessment, as up to 40% of the chinook run could pass upstream prior to its installation (DeHart et al. 2003).

LFH was designed to serve as the incubation and rearing facility; however, because of substantial changes to the original program which resulted in the need to incubate listed fish on treated (or disease free) water, facility limitations (i.e. lack of chilled well water), equipment failure, and malfunction at Lookingglass Hatchery all eggs are currently shipped to Oxbow Fish Hatchery (near Bonneville Dam) or Irrigon Fish Hatchery for incubation and early rearing of juveniles. Following rearing for about five months, juveniles are transported back to LFH for another 9 months before smolts are transported back to the acclimation facility, where they are held for one month prior to release in April. Exceptions to releases of fish from the acclimation facility or directly into the mainstem Imnaha occurred in 1987 when Imnaha smolts were released at LFH because of disease concerns, in 1990 when smolts were also released in Big Sheep Creek, and in 1994 when pre-smolts were released in Big Sheep Creek, Little Sheep Creek, and the Imnaha River (Beamesderfer et al. 1996).

Wild chinook adults were initially collected for broodstock beginning in 1982. Wild fish comprised the majority of the broodstock until 1989 when significant numbers of hatchery fish began to return. Currently, hatchery and natural fish are used for broodstock each year.

Broodstock management is guided by a sliding scale management plan that places emphasis on minimizing demographic risk at escapement levels below a minimum adult spawner escapement threshold and minimizing genetic risk of the hatchery program at escapement levels above threshold. The TRT (2003) states that the IRMAI chinook population has a ‘genetic affinity to locally-derived broodstock’, whereas there is no genetic evidence of hatchery introgression in the IRBSH population. To date, the co-managers have used the sliding scale guidelines for broodstock collection and have implemented constraints on hatchery fish spawning in the wild through harvest and adult outplanting into Big Sheep and Lick creeks.

Life history and genetic characteristics are similar for hatchery and natural fish, with the exception of age composition at return. Hatchery fish return a greater proportion of age 3 males and fewer age 5 fish. Progeny-to-parent ratios for natural fish have been below replacement (1.0) throughout most of the eighties and nineties, but recent (last 3-4 years) have been above 1.0. The ratio for hatchery fish has been above 1.0 in most years and has averaged 4.0. Model results indicated that presently a greater number of total fish and natural spawners return to the basin, which is attributable to the hatchery program. Comanagers have made a substantial number of adaptive management changes to improve the program including reduced emphasis on smolt production goals and increased emphasis on genetic conservation, gene banking, implementation of sliding scale management plan, aggressive fish health protection, low density rearing, and more natural smolt size-at-release (25/lb.).

Smolt production levels have been highly variable and typically well below the goal of 490,000 because of the abundance of natural fish, broodstock management criteria, and hatchery facility constraints (Table 53). Currently smolt production has been reduced by 25% due to the facility limitations at Lookingglass FH. Smolt-to-adult survival rates have been below the goal of 0.65% with a maximum value of 0.58% for the 1988 brood year. Substantial smolt mortality occurs from release through the mainstem river corridor, which is a major constraint on smolt-to-adult survival.

Table 53. Hatchery releases of spring/summer chinook in the Imnaha subbasin (reproduced from TRT 2003)

Population	Code	% natural origin spawners 1998-2002**	% natural origin spawners 1980-1997	Average annual releases				Total Releases		
				Stock	1979-1986	1987-1994	1995-2002	1979-1986	1987-1994	1995-2002
Big Sheep Cr	IRBSH	unknown	unknown	--	--	--	--	--	--	--
Imnaha R	IRMAI	unknown	unknown	Imnaha	22,498	325,882	203,355	179,987	2,607,054	1,626,843

** Average among those years in the indicated period for which data was available

The release of hatchery chinook smolts into streams geographically removed from the acclimation facility, or outplanting, is currently considered to be moderate (TRT 2003). Over the

last ten years an average of 50,000 to 500,000 fish have been outplanted annually in the Imnaha, all of which have been from in-population broodstock (TRT 2003).

In 2001, a total of 3,503 adult spring/summer chinook salmon were trapped at the Imnaha River trap, compared with 1,106 adults trapped in 2000. Of the fish trapped in 2001, 1,503 were unmarked and 2,003 were of hatchery origin. A total of 2,643 adult spring/summer chinook salmon were passed above the weir for natural spawning and 253 and 201 were stocked into Lick Creek and Big Sheep Creek (respectively). Fish designated for broodstock were transported to the LFH and held until spawned. Ninety-eight Imnaha River females were spawned resulting in 441,000 green eggs. Approximately 123,112 BY1999 spring/summer chinook smolts were released in the in the spring of 2001 into the Imnaha River.

The run of spring/summer chinook salmon in 2001 was more than sufficient to meet broodstock and escapement goals so consequently a sport fishery was opened. The 2001 opening of the spring/summer chinook fishery in the Imnaha marked the first that has occurred in over 25 years.

Future Plans

Co-managers plan to continue managing the chinook salmon hatchery program as a compensation program emphasizing the conservation/restoration tool to prevent extinction, enhance natural production, and assess supplementation as a tool for recovery. The program will be operated under ESA authorization and future decisions resulting from Columbia River Fisheries Management Plan negotiations will, in part, determine changes in future direction. Co-managers also plan to place increased emphasis on conservation hatchery management, genetic analysis (DNA), continued gene banking, improved rearing, and rearing natural size smolts.. The Northeast Oregon Hatchery project is designing new facilities and identifying modifications to LFH and new facilities necessary to get production back up to 490,000 fish – the original LSRCP goal. The LSRCP Program is also addressing disease-free water issues at Lookingglass Hatchery and methods to meet chinook compensation goals.

Northeast Oregon Hatchery will incorporate some components of Natural Rearing System (NATURES) techniques. NATURES techniques provide juvenile hatchery fish with conditions more similar to those experienced in a natural stream. Juveniles will be raised to smolts from incubation to release in variable water temperature conditions mimicking the natural regime. Rearing conditions will also include low density (0.1 to 0.13 lb/cf/in), cryptic substrate coloration, instream/water surface structure, and natural photo-period (indoors). Smolts will be acclimated and volitionally released into known natural production areas in their natal stream with the intent that the returning adults will spawn in their natural habitat rather than solely supporting hatchery production and harvest.

Artificial propagation of chinook salmon from the Imnaha River will be supported by adult collection, holding and spawning at the Imnaha Satellite Facility. Eggs will be incubated at this site until eye-up then transferred to Lookingglass Fish Hatchery and Lostine Hatchery location(s) for final incubation and early rearing. Transportation of smolts from Lookingglass Fish Hatchery and the Lostine Hatchery to the Imnaha Satellite Facility (Gumboot) will occur in mid-March for acclimation and release.

1.2.4 Fall Chinook Population Delineation and Characterization

1.2.4.1 Population Data and Status—Fall Chinook

Abundance and Trends

Fall chinook salmon are present in the Imnaha subbasin; however, their abundance has likely been reduced from historical levels. Prehistoric and early historic run sizes are unknown. Some estimate that as many as 300 fall chinook salmon may have entered the Imnaha subbasin annually prior to construction of the four lower Snake River dams (NPT 1990) but this is uncertain.

Fall chinook redd surveys, which have occurred periodically since 1964, document the occurrence of spawners along the lower 21 miles of the Imnaha (Figure 51 and Figure 52). Current (1993 to present) redd survey efforts involve the use of helicopters and are conducted on an annual basis through cooperation between the USFWS, Washington Department of Fisheries, USFS, ODFW, Idaho Power, Idaho Department of Fish and Game (IDFG), and Nez Perce Fisheries. Fall chinook redd counts have recently increased, during 2001–2003 a total of 38, 72, and 41 redds, respectively, were observed.

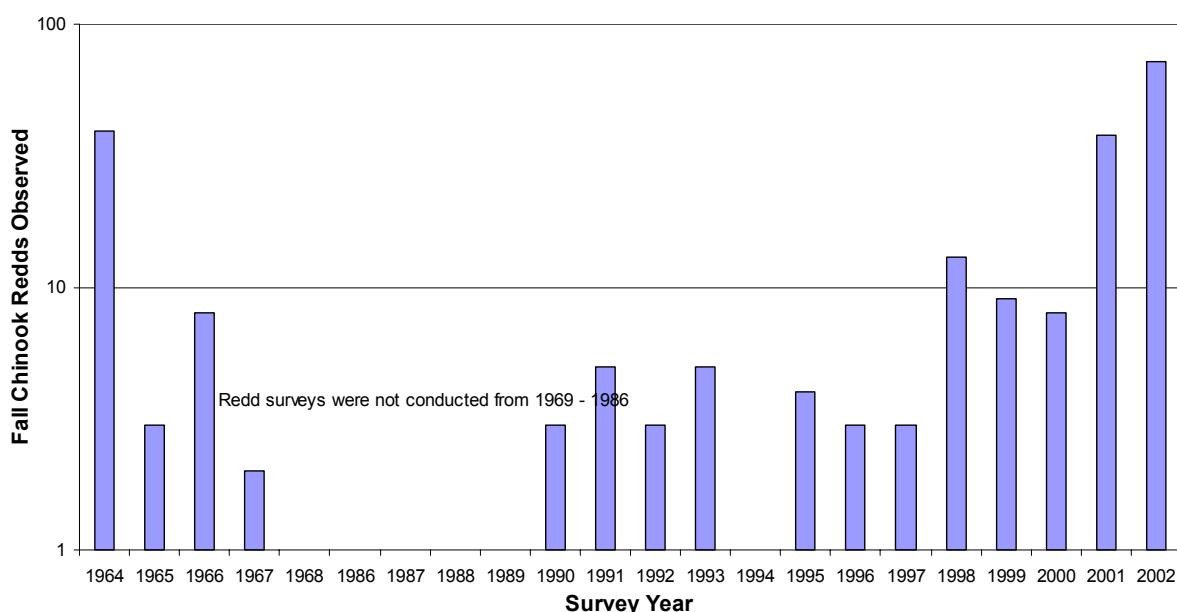


Figure 51. Number of fall chinook salmon redds counted in the Imnaha River between the years 1964 and 2002 (from Mundy and Witty 1998, Garcia 2000, H. Burge, USFWS, personal communication, 2003).

Due to the low escapement, the contribution of spawning to brood-year recruitment has not been demonstrated (Chapman and Witty 1993), and it is likely that some of the spawners represent hatchery strays (Neeley et al. 1993, USFS 1998b), or Snake River fish using the Imnaha for temporary refugia.

Productivity

Information used to define fall chinook productivity in the Imnaha subbasin is not available. Some have suggested that excessively low temperatures may limit embryonic development of Imnaha fall chinook and consequently reduce production (Mundy and Witty 1998), although supporting data are limited. Others (e.g., Mundy and Witty 1998) suggest that juvenile fish may be swept out of the system during spring runoff; however, this theory is also speculative and currently unfounded.

Life History Diversity

Adult Migration

Little is known about adult migration patterns of fall chinook that spawn in the Imnaha River (Mundy and Witty 1998). Provided that Imnaha fall chinook are the same stock that use the Snake River for spawning, adults spend three to five years in the Pacific Ocean (USFS 2003d) prior to the initiation of their upstream spawning migration. Adults enter the Columbia River from August through November (USFS 2003d) and proceed upstream through the Snake River until reaching the Imnaha River from October through November.

Spawning

Spawning takes place almost immediately after the salmon enter the river (Oct. 15–Nov. 30). For Snake River fish occurring above the Salmon River confluence, spawning was determined to initiate when water temperatures dropped below 16.0 °C, and terminated when temperatures approached 5.0 °C. Groves (2001) found the relationship between spawn timing and temperature to be less predictable, however, as fish were observed initiating spawning activities when temperatures were as high as 17.0 °C or delaying activities at temperatures around 12 °C. Based on survey data from 1991–2000, Groves (2001) proposes that fall chinook spawn timing between Asotin and Hells Canyon Dam is equally influenced by the total number of fish within the population and how clumped their distribution is upon arrival upstream of Lower Granite Dam. Groves (2001) concludes that, as the escapement past Lower Granite Dam increases, spawning tends to begin earlier, peak within a short time, and end earlier than when escapement is depressed.

Groves and Chandler (1999) determined that redd depths for Snake River fall chinook salmon ranged from 0.2 to 6.5 meters, mean water column velocity ranged from 1.3 to 6.8 feet per second, and substrate-level water velocity ranged from 0.3 to 6.6 feet per second. Substrate sizes used for spawning ranged between 1.0 and 5.9 inches (Groves and Chandler 1999). Groves and Chandler (2001) determined that the average redd encompassed an area equal to 45.8 square meters ($n = 8$; standard error = 3.87).

Incubation

Because of their ESA listing, little applied research has been conducted regarding the incubation life history stage of fall chinook in the Imnaha subbasin. Methods used to define habitat and water quality criteria relative to incubation life history stages generally require unnecessary and unacceptable levels of direct “take” (in the form of mortality) and are prohibited under the ESA.

The rate of egg development and emergence timing of fall chinook is positively correlated with water temperature (Connor et al. 2002). In the Imnaha, water temperatures during the winter–spring incubation period are typically warmer than other downriver Snake tributaries supporting fall chinook (i.e., Salmon and Clearwater rivers), allowing for an earlier emergence of fry in mid- to late-April (Connor et al. 2002).

Juvenile Rearing

Development of fall chinook parr in the Imnaha is considered to be rapid, with fish initiating their seaward migration in July and August as zero-aged (subyearling) smolts (Mundy and Witty 1998). Timing of growth to parr size (> 45 mm) is largely based on emergence timing (Connor et al. 2002), and unlike spring/summer chinook, is independent of photoperiod, suggesting it may be a heritable trait (Myers et al. 1998). Mundy and Witty (1998) suspect that, if fry do swim up in May and June, most would be swept downriver and into the Snake River because of spring flushing flows common in the Imnaha.

As described above, Imnaha fall chinook emerge in the spring, rear for two to three months and then emigrate seaward. It is likely that Imnaha fall chinook emigrate from the subbasin upon attaining a suitable size and use the warmer and more productive mainstem Snake River for additional rearing prior to their downstream migration. While in the Snake River, fall chinook juveniles inhabit the sandy littoral areas (Tiffan et al. 1999, BLM 2000) for up to two months or until water temperatures are no longer suitable (i.e., Curet [1994] found that juvenile fall chinook remained along the shoreline of Lower Granite Reservoir until water temperatures exceeded 18 °C). The movement away from the littoral zone signifies the progression from parr to smolt stages, which for fall chinook occurs earlier in life than for other anadromous salmonids. Connor (et al. 1993, as cited in Mundy and Witty 1998) established the upper and lower size limits for differentiating juvenile fall and spring/summer chinook (Table 54).

Table 54. Maximum and minimum fork lengths for in-season race identification of fall chinook salmon seined on the Snake River (Connor et al. 1993, as cited in Mundy and Witty 1998).

Limit	Estimated Fall Chinook Salmon Size (mm) by Date								
	5/21	5/28	6/4	6/11	6/18	6/25	7/2	7/9	7/16
Maximum	70	73	76	78	81	84	87	89	92
Minimum	55	55	55	55	55	58	61	64	66

Smolt Migration

Unlike spring/summer chinook, juvenile fall chinook outmigrate the summer following spawning, rather than rearing in freshwater for 13–14 months before outmigrating. Similar to spring/summer chinook, the downstream migration of subyearling fall chinook from the Imnaha is protracted, occurring from late spring (June) through midsummer (August; Rondorf and Miller 1993; Connor et al. 2002), or soon after yolk resorption at 30 to 45 mm in length (Healey 1991, as cited in Connor 2002). Connor et al. (2002) found late emigration timing to be detrimental to production as smolt survival to Lower Granite Dam decreased with reduced summer flows, higher water temperatures, and decreases in turbidity.

Studies have shown that outmigrating fall chinook juveniles are capable of moving substantial distances during the day as well as at night, but average 2.3 kilometers per day through the Hells Canyon reach of the Snake River. At this rate subyearlings from the Imnaha typically reach Lower Granite Dam in late July (Connor et al. 1993, as cited in Mundy and Witty 1998). During their outmigration, fall chinook will swim actively only at low water velocities, rarely drifting passively (Rondorf and Miller 1993, 1994, 1995). The subyearlings have a biological requirement for food and may consume terrestrial insects and zooplankton in reservoir reaches and aquatic insects in the free-flowing reaches.

Carrying Capacity

The suitability and availability of fall chinook spawning substrate does not appear to be a factor limiting production of the species. Surveys conducted by Thompson and Hass in 1959 identified 2,566 square yards of good, and 12,967 square yards of marginal fall chinook spawning gravel in the Imnaha River between Imnaha and the mouth (Mundy and Witty 1998). Thompson and Haas (1960) reported enough gravel was available for the construction of 600 fall chinook redds in the mainstem between Horse Creek and the mouth. In 1998 NPT mapped fall chinook spawning habitat on the lower 15 miles of the Imnaha River. Potential spawning sites were based on suitable spawning criteria for fall chinook as reported in Arnsberg et al. (1992). Spawning criteria for depths were 0.5 ft to infinity, mean column water velocities between 0.5 ft/s to 4.0 ft/s, and dominant substrate sizes of 2-6". A total of 68 potential spawning areas were identified, which included some prior and current documented fall chinook spawning sites. Spawning sites ranged from 5-2,268 square meters with a total measured area of 18,527 square meters. Using an estimated 20.4 square meters per redd (Burner 1951), the Imnaha River could support about 900 fall chinook redds in the lower 15 miles of the Imnaha.

Unique Population Units

As discussed above, the Imnaha fall chinook population is considered to be part of the Snake River population (SNMAI) and occurs in the Snake River Evolutionarily Significant Unit (TRT 2003).

Genetic Integrity

Based on geographic separation, habitat differences, and apparent demographic independence, the Snake River fall chinook population represents a distinct unit (SNMAI) when compared to populations occurring elsewhere throughout the Columbia Basin (TRT 2003). Fall chinook occurring in the mainstem Imnaha were not separated from those occurring in the Snake, due in part to a lack of data, and also because Imnaha fish represent one of many aggregates that are currently considered to make up the larger Snake River population (TRT 2003).

Currently, the mainstem run of fall chinook up to Hells Canyon Dam consists of hatchery-reared stock, natural fish (fish born to hatchery-reared parents that spawned in the wild), and wild fish. Genetic analysis of samples collected from 1995 to 1997 determined that the majority of all wild fry and parr inhabiting these mainstem areas were the progeny of fall chinook salmon (Connor et al. 2002).

1.2.4.2 Distribution–Fall Chinook

Current In-Basin Distribution

It is estimated that after adjusting for spawning/rearing suitability, only 20% or less of historical Snake River habitat is currently available to fall chinook (TRT 2003). Fall chinook currently rear and spawn in the lower 5 miles of the Imnaha River. Designated Critical Habitat includes the 23 miles of the Imnaha River from its mouth to the town of Imnaha.

Historical Distribution

Accounts from Nez Perce tribal elders suggest that fall chinook historically used the lower 19.5 miles of the Imnaha mainstem (from the confluence to the town of Imnaha) for spawning, and generally did not occur above the town of Imnaha (Chapman 1940). Others contend that fall chinook spawning occurred as far upstream as the confluence of Freezeout Creek (Fernan Warnock, personal communication, as cited in Mundy and Witty 1998). Fall chinook have never been reported to occur in the Big Sheep watershed.

It is possible that fall chinook were once exclusively reliant on the mainstem Snake River for spawning and rearing and historically never occurred in tributary habitat. As reported in Mundy and Witty (1998), the blockage of Snake River habitat by the construction of Brownlee, Oxbow, and Hells Canyon dams during the late 1950s and early 1960s may have caused upper Snake River fall chinook to seek alternative spawning habitats, the majority of which occurred in primary tributaries to the Snake River. Connor et al. (2002) support this theory and point out that historical evidence documenting tributary spawning is not conclusive (Connor et al. 2002).

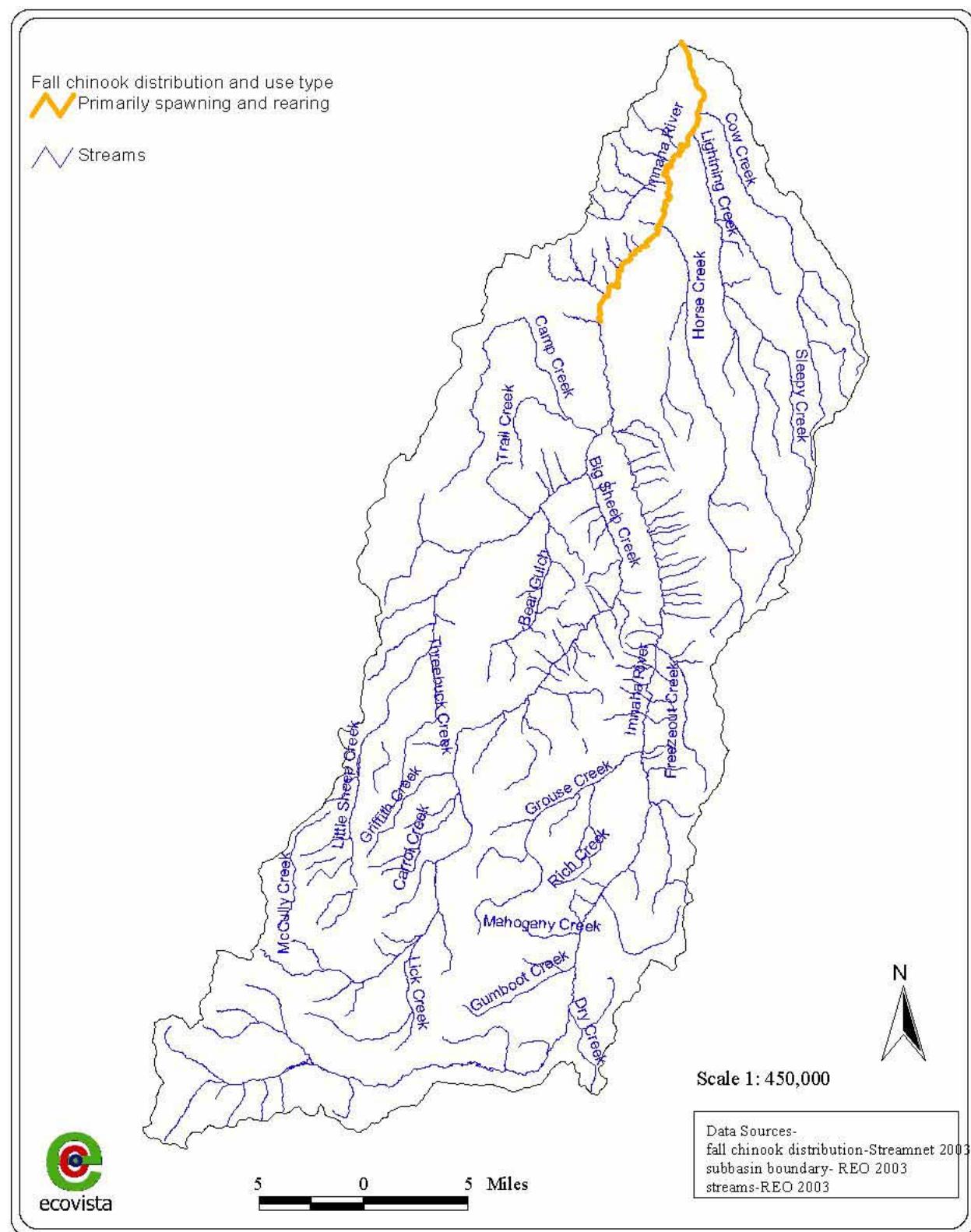


Figure 52. Fall chinook distribution and use type, Imnaha subbasin.

The TRT (2003) contend that since fish within the Snake River ESU currently tend to form aggregates in areas of suitable habitat quality, it is reasonable to assume that a similar structure existed historically, with the discontinuous aggregates functioning as elements of a metapopulation. Areas of unsuitable habitat quality likely served an isolation function to various spawning groups.

Identification of Differences in Distribution Due to Human Disturbance

Based on current and historical distribution, there is little reason to believe that human disturbance has had any significant influence on fall chinook distribution in the Imnaha subbasin. Changes in streamflow and water temperatures from the Wallowa Valley Improvement Canal may influence current distribution to some degree; however, the magnitude of effect is unknown.

1.2.4.3 Fall Chinook Harvest

Current In-Basin Harvest Levels (Direct/Indirect)

No harvest is currently allowed.

Historical In-Basin Harvest Levels

Historic fall chinook harvest levels are unknown.

1.2.4.4 Fall Chinook Hatchery Influence

Currently, the mainstem run of fall chinook up to Hells Canyon Dam consists of hatchery-reared stock, natural fish (fish born to hatchery-reared parents that spawned in the wild), and wild fish (Blankenship and Mendel 1997). Averaged over the last five years, an estimated 25% of natural spawning fish are of hatchery-origin, which represents a recent increase (TRT 2003). There is some genetic evidence of hatchery introgression, as Snake River fall chinook tend to have a high affinity to locally derived broodstock. All releases of hatchery fish are from in-population broodstock (Table 55).

Table 55. Hatchery releases of Snake River fall chinook (reproduced from TRT 2003)

Population	Code	% natural origin spawners 1998-2002*	% natural origin spawners 1980-1997*	Average annual releases				Total Releases		
				Stock	1979-1986	1987-1994	1995-2002	1979-1986	1987-1994	1995-2002
Snake River	SNMAI	36	66	Lyons Ferry	432,652	1,694,568	344,489	3,461,212	13,556,546	2,755,9
				Snake River	79,303	75,458	1,444,303	634,420	603,661	11,554,4
				All Stocks	511,954	1,770,026	1,788,792	4,095,632	14,160,207	14,310,3

* Average among those years in the indicated period for which data was available

1.2.5 Summer Steelhead Population Delineation and Characterization

1.2.5.1 Population Data and Status—Summer Steelhead

The Imnaha subbasin contains wild and natural populations of A-run Snake River summer steelhead (*O. mykiss*). Unlike the larger B-run fish, which average 5-8 kg (11-18 lbs.) and enter the Snake River later in the fall, A-run fish average 2-4 kg (4.4-8.8 lbs.) and begin to enter the river in August (Berryman et al. unknown date). Natural fish are hatchery-derived fish which spawn in the natural environment. Only the native Imnaha stock is used for the hatchery program and wild/natural fish are still being added to the hatchery broodstock (USFS 2003d).

The summer steelhead occurring in the mainstem Imnaha and all its tributaries represent a single, independent population (IRMMS-s) within the Snake River ESU (TRT 2003). Given a lack of clear genetic or geographic delineation, the TRT defined a single population in the subbasin rather than differentiating between the geographically proximal spawning aggregates that occur throughout the Imnaha.

Abundance and Trends

According to the U.S. Army Corps of Engineers (USACE 1975), historical peak escapement of A-run summer steelhead to the Imnaha subbasin was estimated to be 4,000 fish, based on the maximum count over McNary Dam of 172,600 in 1962–1963. Seven years of data are available from McNary prior to completion of Ice Harbor Dam in 1961. Steelhead counts for those seven years ranged from 40,660 to 111,288 (all lower than the 1962–1963 count). If LSRCP methods are applied to apportion these runs, the range of escapement into the Imnaha would have been 946 to 2,590 per year for the seven-year period.

Current trends in escapement are based on redd counts in Camp Creek, a tributary to Big Sheep Creek. Camp Creek, a spring-fed stream, is used for annual redd surveys due to its accessibility, flows, and water clarity during survey periods and its early spawning group of fish (B. Knox, ODFW, personal communication, April 12, 2001). Summer steelhead redd counts in the lower 6 miles of Camp Creek are shown in Figure 53. Redd counts have also been conducted in other portions of the subbasin since 1962 (Table 56).

As shown in Table 56, peak counts in Camp Creek occurred in 1966 and 1967 when 18.0 redds per mile were observed. Over the next decade (1968–1978), average counts declined significantly to 2.9 redds per mile, reaching a low point in 1975 and 1976 of 0.7 and 0.6 redds per mile, respectively. From 1979 to 1989, the counts averaged 6.2 redds per mile. The increase in the number of redds observed from 1985 to 1987 was consistent with trends observed during the same period throughout the Columbia Basin (B. Knox, ODFW, personal communication, April 19, 2001) but may also be related to the Lower Snake River Compensation Program (LSRCP) facility constructed on Little Sheep Creek in 1982 (D. Bryson, Nez Perce Tribe, personal communication, April 27, 2001). From 1990 to 2003, the average count was 6.5 redds per mile, an increase due in large part to the returns recorded from 2000–2003.

Steelhead redd counts can not be conducted in a representative manner throughout the subbasin due to physical conditions (high turbidity and limited access). In addition, the accuracy and precision of existing counts is unknown.

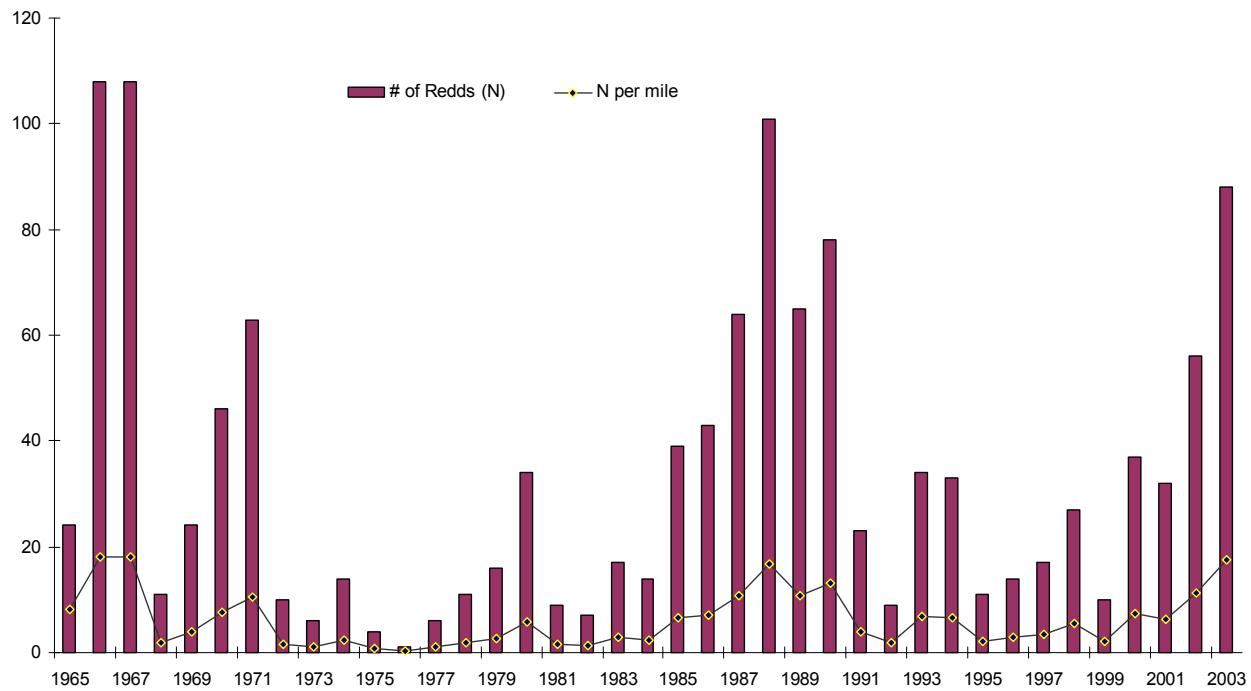


Figure 53. Summer steelhead redd counts in the lower 6 miles of Camp Creek for the run years 1965–2001 (USFS 2003d; ODFW unpublished data, 2004).

Adult escapement monitoring via upstream and downstream portable picket weirs was initiated in Lightning Creek in 2000 and Cow Creek in 2001(Hesse et al. *in press*). Tributary specific estimated abundance in Lightning Creek has been 36 (35 – 41 95% CI), 141 (103 – 186 95% CI), 231 (136 – 264 95% CI), from 2000 to 2002. Estimated abundance in Cow Creek has been 86 (70 – 105 95% CI), 63 (54 – 71 95% CI), and 102 (88–116 95%CI) adults annually through 2003. Adult run-timing into spawning areas spans from early-March through early-June. Sex ratios have been highly skewed, ranging from 62 to 87 percent female. Stray hatchery origin adults have comprised two to 32 percent of the total escapement. Vital statistics for steelhead in Little Sheep Creek are presented in Table 57.

Adult steelhead abundance information for the Imnaha subbasin represents a critical data gap. It is unknown if the redd count trend data or escapement information from Cow, Lightning, and/or Little Sheep is representative/suitable as an index for the subbasin.

Juvenile rearing density monitoring has also occurred throughout various portions of the subbasin. Snorkeling observations of steelhead density and habitat have been conducted in Big Sheep Creek, Lick Creek, and the mainstem Imnaha River from 1992 to 1999 (Table 58; Blenden and Kucera 2002). Densities of juvenile *O. mykiss* (multiple year classes) were highest in lower Lick Creek, yet never exceeded 0.5 fish per square meter. Multiple pass electrofishing surveys were conducted in Lightning, Big Sheep, Little Sheep creek, and Gumboot creeks in 1999 and 2000. Densities of wild *O. mykiss* age 0+ were highest in Reach 1 of Gumboot Creek in 2000 (1.86 fish/m^2), age 1+ were highest in Reach 6 of Gumboot Creek in 1999 (0.35 fish/m^2) and age 2+ densities were also highest in 1999 in Reach 6 of Gumboot Creek (0.25 fish/m^2) Table 59). Densities of age 0+ hatchery steelhead were highest in Reach 4 of Big Sheep Creek in 1999 (2.10 fish/m^2), age 1 densities were highest in Reach 4 of Little Sheep Creek (0.15 fish/m^2), while age 2+ densities were highest in Reach 1 of Little Sheep Creek in 1999 (0.14 fish/m^2) (Table 59).

Table 56. Summer steelhead redd counts (#/mile) for various years and tributaries in the Imnaha subbasin (ODFW data, recd. 02/04)

Stream	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1986	1992	1999
Bear Gulch																	0.0		
Carroll Cow			1.0														4.0		
Devils Gulch						1.0				1.5									
Freezeout	1.5			0.0			1.0				0.0					0.0	1.8		
Gumboot (NF)					2.0	0.0	0.0												
Horse Lick											0.0					0.3		0.5	
Lightning (Imnaha)			2.0															9.6	
Lightning (L. Sheep)	5.0	0.3	1.0	2.7	0.3	2.0	3.0	4.0	2.3	0.0	0.0	0.0	0.7	2.3					
L. Sheep					2.2		3.4	2.0	1.4	4.2					4.2			8.8	
Summit	1.0				0.5		0.0												

Table 57. Vital statistics for adult steelhead collected at the Little Sheep Creek trapping facility (ODFW unpublished data). M = males, F = females, W = wild fish, H = hatchery fish.

Return Year	Trapped		Prespawn Mortality			Passed Above Trap			Killed not Spawned			Spawned			
	Total	M	F	M	F	%W	M	F	M	F	%W	M	F	%W	
1982	53	9	44											25	100.0
1983	45	15	30											24	100.0
1984	72	27	45											34	100.0
1985 W	163	40	123	98	40	6	21		3	2				75	
1985 H	52	26	26	a42	14	1	0	96.4	1	0				19	79.8
1986 W	49	14	35	a17	3	1	1		1	0				32	
1986 H	23	7	16	a13	9	0	0	100.0	1	0				10	75.5
1987 W	110	60	50	14	9	34	38		0	0				11	
1987 H	620	255	365	66	47	149	186	17.7	5	14	107	151	7.2		

Return Year	Trapped		Prespawn Mortality		Passed Above Trap		Killed not Spawned		Spawned	
	Total	M	F	M	F	M	F	%W	M	F
1988 W	47	26	21	0	0	14	16		1	2
1988 H	b808	366	442	74	68	159	195	7.8	51	35
1989 W	56	19	37	25	0	10	16		1	1
1989 H	306	71	235	115	44	31	121	14.6	1	3
1990 W	57	20	37	4	0	7	11		1	3
1990 H	924	456	468	74	30	293	305	2.9	4	2
1991 W	29	11	18	0	0	6	8		1	1
1991 H	366	221	145	19	3	23	18	25.5	59	5
1992 W	128	52	76	0	17	c37	38		0	0
1992 H	661	348	313	85	13	52	57	40.8	70	107
1993 W	99	21	78	0	0	17	60		0	0
1993 H	1773	756	1017	18	5	60	17	50.0	535	881
1994 W	53	25	28	1	0	d21	20		0	0
1994 H	141	30	111	1	0	e19	17	53.2	0	0
1995 W	17	3	14	0	0	2	10		0	0
1995 H	278	175	103	7	0	28	6	26.1	39	2
1996 W	48	22	26	0	0	f22	19		0	0
1996 H	g443	169	274	2	0	36	32	34.0	2	41
1997 W	29	11	18	0	0	9	15		0	1
1997 H	937	516	421	2	12	32	21	31.2	300	206
1998 W	33	9	24	0	0	7	18		0	0
1998 H	686	261	425	0	0	44	72	17.7	25	13
1999 W	11	5	6	0	0	2	3		0	0
1999 H	i332	157	175	2	0	42	33	6.3	0	1
2000 W	77	39	38	0	1	j36	23		0	0
2000 H	k445	159	286	1	2	m49	92	29.5	2	3
2001 W	128	38	90	0	0	n38	74		0	0
2001 H	o1,224	601	623	1	0	328	344	14.3	2	2
2002 W	204	63	141	0	1	p63	130		0	1
2002 H	q3,260	1,256	2,004	9	2	359	646	19.2	9	5

Return Year	Trapped		Prespawn Mortality		Passed Above Trap		Killed not Spawned		Spawned		
	Total	M	F	M	F	M	F	%W	M	F	%W
2003 W	99	47	52	0	0	147	46		0	0	6
2003 H	81,905	825	1,080	0	0	163	157	22.5	6	10	78

- a. Includes mortality of spawned males held for additional spawning
- b. (30) males and (30) females outplanted to Gumboot Cr
- c. Includes (12) wild males spawned and released
- d. (12) live spawned then released
- e. (10) live spawned then released
- f. (6) live spawned then released
- g. (22) males and (46) females outplanted to ponds
- h. produced 1,598,340 green eggs
- i. (25) males and (17) females outplanted to Big Sheep Cr.
- j. (13) live spawned then released
- k. (55) males and (83) females outplanted to Big Sheep Cr.
- m. (11) live spawned then released
- n. (12) live spawned then released
- o. (170) males and (184) females outplanted to Big Sheep Cr.
- p. (7) live spawned then released
- q. (775) males and (1,254) females outplanted to Big Sheep Cr.
- r. (3) live spawned then released
- s. (568) males and (835) females outplanted to Big Sheep Cr.

Table 58. Snorkeling observations of steelhead density (fish/100m²) by habitat conducted in Big Sheep Creek, Lick Creek, and the Imnaha River (1992–1999) (Blenden and Kucera 2002).

Stream	Year	Habitat Type (Number of Transects)	Mean Density of Steelhead (fish/100m²)
Big Sheep Creek	1992	Pool (3)	12.6
		Run (4)	24.1
Big Sheep Creek	1993	Pool (2)	25.4
		Run (3)	15.5
Upper Big Sheep Creek (7/7)	1994	Pool (2)	36.2
		Run (2)	26.2
Upper Big Sheep Creek (8/16)	1994	Pool (2)	24.9
		Run (2)	16.0
Lower Big Sheep Creek (7/8)	1994	Pool (2)	28.0
		Run (4)	20.8
Lower Big Sheep Creek (8/17)	1994	Pool (2)	19.5
		Run (4)	25.5
Big Sheep Creek	1995	Pool (3)	18.9
		Run (3)	22.0
Imnaha River	1992	Pool (5)	2.0
		Run (8)	2.8
Imnaha River	1993	Pool (5)	2.9
		Run (8)	1.5
Imnaha River	1994	Pool (5)	0.4
		Run (8)	0.5
Imnaha River	1995	Pool (5)	1.8
		Run (7)	1.6
Imnaha River	1996	Pool (5)	2.5
		Run (7)	2.4
Upper Lick Creek (7/7)	1994	Pool (3)	13.4
		Run (3)	19.5
Upper Lick Creek (8/16)	1994	Pool (3)	23.9
		Run (3)	30.2
Lower Lick Creek (7/7)	1994	Pool (3)	41.4
		Run (3)	29.4
Lower Lick Creek (8/16)	1994	Pool (3)	38.0
		Run (3)	37.7
Lick Creek	1996	Pool (7)	19.0
		Run (7)	9.8
Lick Creek	1997	Pool (6)	21.3
		Run (5)	15.9
Lick Creek	1998	Pool (6)	24.0
		Run (4)	13.9
Lick Creek	1999	Pool (6)	11.7
		Run (4)	13.7

Table 59. Juvenile *O. mykiss* rearing density (number/m²) estimates for Lightning, Big Sheep, Little Sheep, and Gumboot creeks in the Imnaha River subbasin, 1999 and 2000 (ODFW and NPT unpublished data collected under LSRCP evaluation studies).

Year	Stream	Reach	Wild Age 0	Wild Age 1	Wild Age 2+	Hatchery Age 0	Hatchery Age 1	Hatchery Age 2+
1999	Little Sheep Creek	1	0.094	0.010	0.00	0.754		0.136
		2	0.198	0.005	0.005	0.166		0.005
		3	0.209	0.023	0.004	0.039		0.009
		4	0.020	0.020	0.031	1.552		0.060
		5				Not sampled in 1999		
		6	0.093	0.061	0.008	1.089		0.030
	Gumboot Creek	1	0.229	0.172	0.111			
		2	0.217	0.084	0.059			
		3	0.033	0.202	0.118			
		4	0.381	0.184	0.110			
		5	0.019	0.164	0.104			
		6	0.253	0.349	0.245			
	Big Sheep Creek	1	0.129	0.074	0.050	0.350		0.000
		2	0.039	0.177	0.078	0.624		0.008
		3	0.004	0.018	0.012	1.129		0.000
		4	0.004	0.042	0.011	2.101		0.004
	Lightning Creek	1	0.122	0.191	0.028			
		2	0.172	0.168	0.035			
		3	0.081	0.078	0.036			
		4	0.106	0.066	0.062			
2000	Little Sheep Creek	1	0.238	0.037	0.000		0.044	0.030
		2	0.355	0.022	0.000		0.000	0.008
		3	0.474	0.029	0.004		0.033	0.000
		4	0.358	0.005	0.019		0.150	0.005
		5	0.608	0.037	0.005		0.042	0.000
		6	0.111	0.011	0.011		0.071	0.000
	Gumboot Creek	1	1.859	0.125	0.066			
		2	0.956	0.081	0.000			
		3	0.259	0.219	0.084			
		4	0.259	0.104	0.025			
		5	0.202	0.061	0.074			
		6	0.000	0.085	0.000			
	Big Sheep Creek	1	0.326	0.040	0.004	0.000	0.036	0.009
		2	0.211	0.088	0.046	0.000	0.077	0.023
		3	0.111	0.019	0.003	0.000	0.123	0.000
		4	0.104	0.011	0.004	0.008	0.118	0.000
		5	0.167	0.035	0.006	0.000	0.004	0.061
		6	0.213	0.077	0.009	0.000	0.018	0.131
	Lightning Creek	1	0.000	0.162	0.017			
		2	0.191	0.123	0.037			
		3	0.140	0.080	0.060			
		4	0.253	0.103	0.053			

Seasonwide survival estimates of natural and hatchery juvenile steelhead smolts from the Imnaha River to the Snake River and Columbia River dams have been produced by the Nez Perce Tribe since 1995 (Table 46; Cleary et al. 2003). Steelhead smolts are captured using rotary screw traps at river kilometer (rkm)7 during the spring period from February through June. A portion of the fish are tagged weekly with passive integrated transponder (PIT) tags so that they could be detected at interrogation sites at Snake and Columbia river dams. Survival of PIT-tagged fish was estimated with the Survival Using Proportional model (SURPH model). Survival estimates of spring emigrating natural-origin smolts to Lower Granite Dam have ranged from 82 to 90% (Figure 55). While survival estimates of hatchery-origin smolts to Lower Granite Dam have ranged from 64 to 89% (Figure 56).

The biological characteristics of natural and hatchery steelhead have been evaluated from fish captured at the screw traps. Hatchery-origin fish are consistently larger than their natural-origin counterparts. For example, the median fork length for natural steelhead in 2000 was 182 mm, which was significantly ($p < 0.05$) smaller than hatchery fish (223 mm; Cleary et al. 2003). Mean weight for natural steelhead was 62 grams, compared with hatchery steelhead which weighed, on average, 106.8 grams. Although statistically smaller, natural steelhead had a mean condition factor (0.95) similar to their hatchery counterparts (0.93).

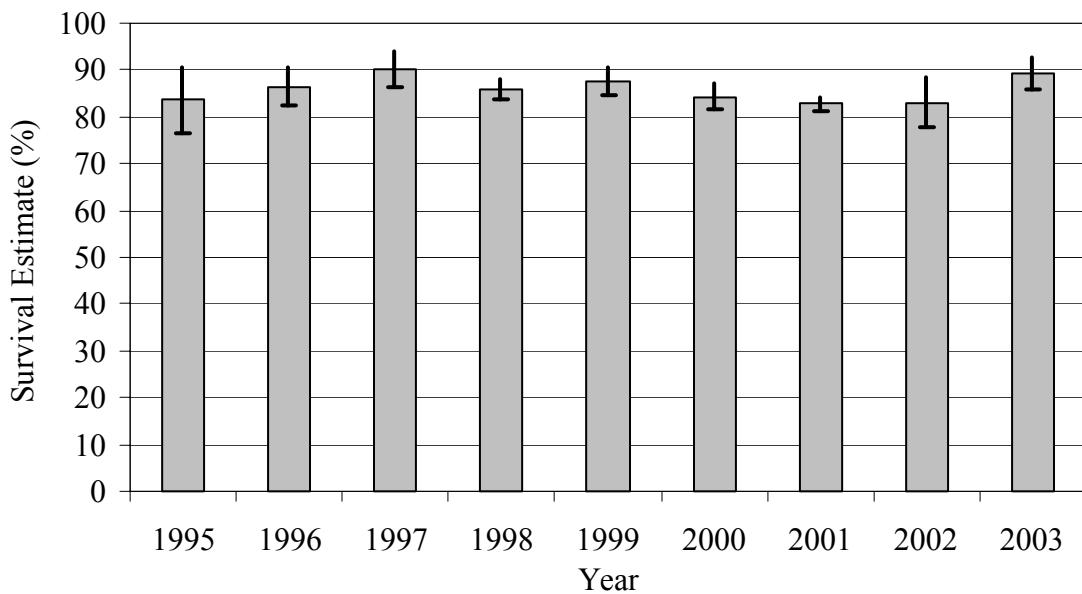


Figure 54. Seasonwide survival estimates for natural steelhead released from the Imnaha River trap to Lower Granite Dam, from 1995 to 2003. Error bars indicate the 95% confidence limit (modified from Cleary et al. 2000, Cleary et al. 2003, and Cleary et al. in prep.).

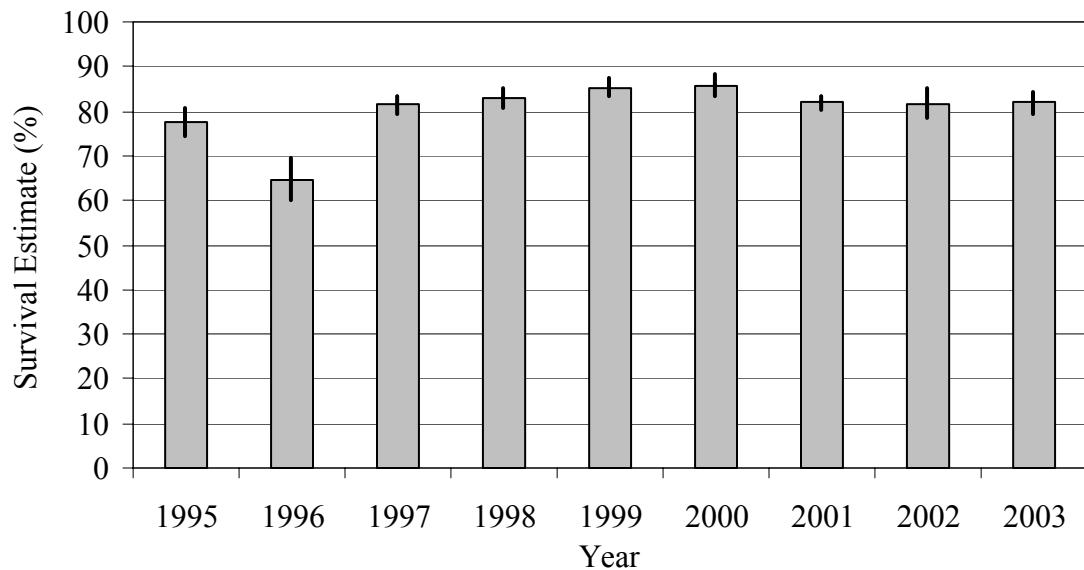


Figure 55. Seasonwide survival estimates for hatchery steelhead released from the Imnaha River trap to Lower Granite Dam, from 1995 to 2003. Error bars indicate the 95% confidence limit (modified from Cleary et al. 2000, Cleary et al 2003, and Cleary et al. in prep).

Natural and Hatchery Steelhead Arrival Timing

Median arrival timing of natural and hatchery Imnaha smolts to the four lower Snake River dams has been tracked since 1993 and is shown in Table 60. Historically, Imnaha natural steelhead have a ten year mean arrival date range of April 15 (\pm 26 days) to July 9 (\pm 63 days) at LGR (Table 13). The mean arrival date range for LGO, LMO, and MCN is as follows: April 19 (\pm 22 days) to July 7 (\pm 52 days) at LGO, April 24 (\pm 22 days) to July 9 (\pm 78 days) at LMO, and April 27 (\pm 26 days) to June 15 (\pm 36 days) at MCN. The ten year median arrival time at LGR, LGO, LMO, and MCN is as follows: May 11 (\pm 14 days) at LGR, May 14 (\pm 11 days) at LGO, May 16 (\pm 14 days) at LMO, and May 18 (\pm 13 days) at MCN. The mean 90% arrival timing for natural steelhead is as follows: May 27 (\pm 17 days) at LGR, May 27 (\pm 12 days) at LGO, June 7 (\pm 41 days) at LMO, and May 28 (\pm 15 days) at MCN.

The ten year mean range of arrival for Imnaha hatchery steelhead at LGR is April 23 (\pm 18 days) to July 26 (\pm 53 days). Downstream mean arrival ranges for hatchery steelhead are as follows: April 26 (\pm 17 days) to July 28 (\pm 73 days) at LGO, April 30 (\pm 16 days) to August 4 (\pm 85 days) at LMO, and May 7 (\pm 19 days) to July 5 (\pm 41 days) at MCN. The ten year median arrival time at LGR, LGO, LMO, and MCN is as follows: May 21 (\pm 12 days), May 25 (\pm 8 days), May 30 (\pm 14 days), and June 2 (\pm 25 days), respectively. Mean 90% arrival occurred on June 6 (\pm 21 days) at LGR, June 14 (\pm 26 days) at LGO, June 19 (\pm 34 days) at LMO, and June 18 (\pm 35 days) at MCN.

Table 60. Mean first, median, 90%, and last arrival timing for natural and hatchery steelhead smolts, at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN). All fish were captured in the Imnaha River Trap. Mean arrival timing is presented with the 95% C.I. (\pm days) (Cleary et al 2003 and Cleary et al in prep).

Rearing, Species, Life Stage, Dam	<u>First Arrival</u>	<u>Median Arrival</u>	<u>90% Arrival</u>	<u>Last Arrival</u>		
	Mean	(\pm days)	Mean	(\pm days)	Mean	(\pm days)
Natural Steelhead Smolts (1993 to 2003)¹						
LGR	15-Apr	(26)	11-May	(14)	27-May	(17)
LGO	19-Apr	(22)	14-May	(11)	27-May	(12)
LMO	24-Apr	(22)	16-May	(14)	7-Jun	(41)
MCN	27-Apr	(26)	18-May	(13)	28-May	(15)
Hatchery Steelhead Smolts (1993 to 2003)¹						
LGR	23-Apr	(18)	21-May	(12)	6-Jun	(21)
LGO	26-Apr	(17)	25-May	(8)	14-Jun	(26)
LMO	30-Apr	(16)	30-May	(14)	19-Jun	(34)
MCN	7-May	(19)	2-Jun	(25)	18-Jun	(35)

1 Median and 90% arrival timing does not include data from migration year 2002 due to the sample size.

Index of Juvenile Abundance

Juvenile density estimates provided here have been summarized from Blenden and Kucera (2002). In their report they provide a baseline relative index of juvenile abundance and fish species composition information. Big Sheep Creek was snorkeled approximately 4.5 stream kilometers (skm) above Carroll Creek from 1992-1995 and also just above Lick Creek in 1994. Lower Lick Creek was snorkeled at approximately skm 0.6 in 1994 and upper Lick Creek was snorkeled from between skm 2.4 and 5.9 from 1994-2000 excluding 1995.

Lower Big Sheep Creek average densities of multiple age groups of steelhead, in pool habitat, ranged from 12.6 to 25.4 fish/100m² from 1992 to 1995 (Figure 6). Steelhead density increased by 100% between 1992 and 1993, from 12.6 to 25.4 fish/100m², and remained at approximately 19 fish/100m² in 1994 and 1995. Juvenile steelhead density was higher in run habitat, compared to pool habitat, in three out of the four years snorkeling was conducted in lower Big Sheep Creek. Subyearling steelhead were not abundant in pool and run habitat types during any year, and did not contribute significantly to the density estimates.

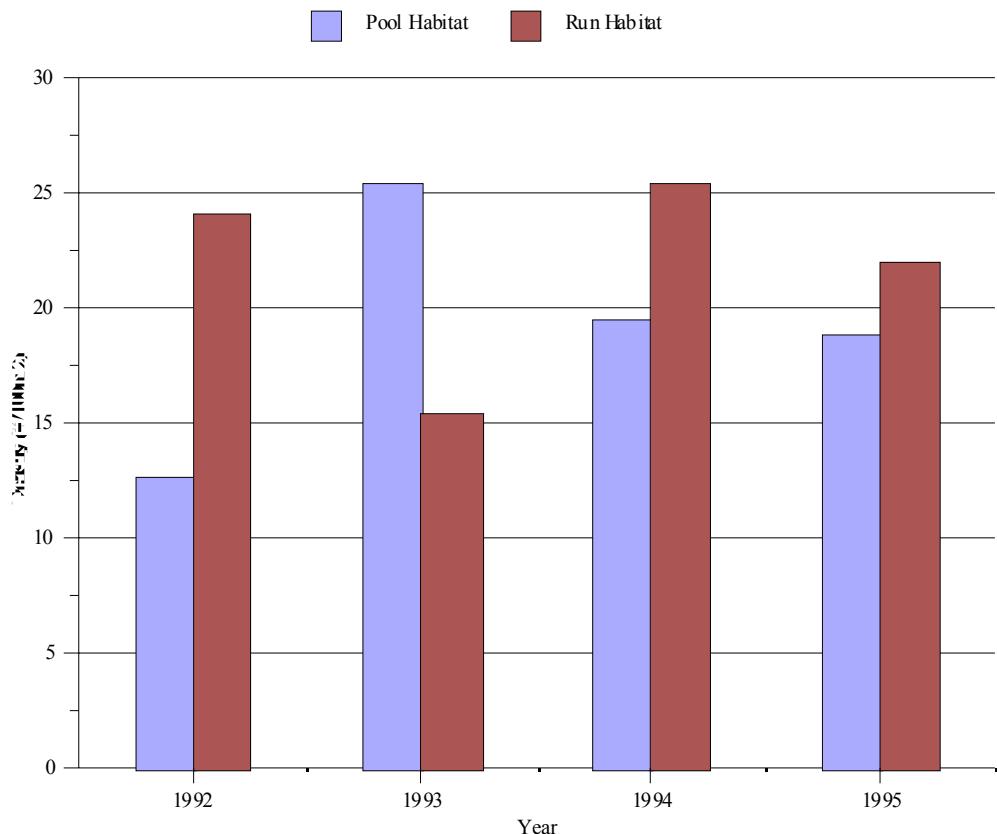


Figure 6. Average density of juvenile steelhead in pool and run habitat in lower Big Sheep Creek from 1992 to 1995.

Lick Creek natural steelhead mean densities in pool habitat ranged from 11.7 to 23.9 fish/100m² from 1994 to 2000 (Figure 7). Densities in pool habitat generally ranged between 17.9 to 23.9 fish/100m² over the study period. The exception occurred when average density varied by 100% (declined) from 1998 to 1999 (Figure 7). Average steelhead density in run habitat ranged from 9.8 to 30.2 fish/100m² (Figure 10). Steelhead densities generally ranged between 9.8 and 15.9 fish/100m² from 1996 to 2000. Young-of-the-year steelhead made up 52.8% and 64.6% of all steelhead observed in 1997 and 2000, and contributed significantly to estimated densities in those years. Three hatchery steelhead were observed in 2000 pool habitat for a mean density of 1.0 fish/100m². They most likely represent residual hatchery steelhead that dispersed upstream from the Little Sheep Creek acclimation facility.

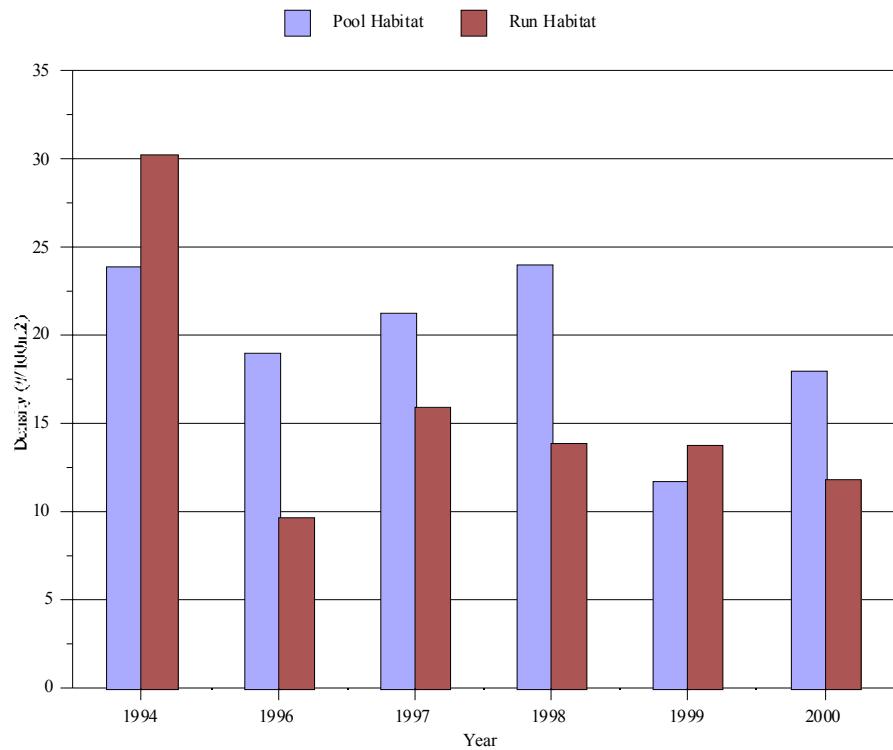


Figure 10. Average density of juvenile steelhead in pool and run habitat in upper Lick Creek from 1994 to 2000.

Productivity

Quantitative estimates of summer steelhead productivity at the subbasin scale are not available.

Life History Diversity

Adult Migration

Two strains of steelhead ascend the Snake Rivers each fall: A-run fish averaging 2-4 kg begin to enter the river in August while the larger B-run fish (averaging 5-8 kg) enter a month or so later (Berryman et al. unknown date). Adult A-run fish leave the Pacific Ocean after one to three years of residence (typically adults return to the Imnaha after only one year of ocean residence) and enter the Columbia River from June through September. They proceed up the Columbia and Snake rivers until reaching the Imnaha. Migration of adult steelhead to the Imnaha subbasin may initiate as early as the first part of September and extend through the end of November (Table 48). Peak upstream migration into the lower portion of the subbasin typically occurs in mid-February and extends through early April (Table 48), while peak movement into the upper portion of the subbasin occurs from late February until early April (Table 49).

Adult Holding

Seasonal positioning of adult Imnaha steelhead occurs in the lower Snake River, upstream to Pittsburgh Landing (RM 215) (Mundy and Witty 1998). Fish that move into the lower Imnaha (below the Big Sheep Creek confluence), will use deep pool habitats for holding through the winter (late October through early March) (Table 48) prior to initiation of spawning in the spring. Adults that spawn in the upper Imnaha will typically hold [stage] only temporarily (February through early March) (Table 49). Although some holding areas in Big Sheep Creek (i.e., from Carol Creek to Coyote Creek and from Muley Creek to the mouth of Big Sheep Creek) occur in channelized reaches, the effect is currently unknown.

Spawning

Peak spawning for summer steelhead is in the spring, occurring usually from mid-April to early June (Table 48 and Table 49). Spawning timing is strongly correlated to water temperatures. Steelhead will use the warmer tributaries, such as Camp Creek, earlier in the year and will spawn in the cooler, high-elevation tributaries (i.e., Gumboot Creek) later in the year. Most steelhead will spawn just after spring runoff, especially in smaller tributaries.

Imnaha steelhead are highly fecund. The fecundity of natural steelhead at the Little Sheep Creek weir, 1990–1993, averaged 3,927 eggs for 1-salt fish and 5,412 eggs for the 2-salt females (Carmichael et al. 1995).

Incubation

Depending upon spawn timing, peak incubation for summer steelhead begins in late April and extends through early July (Table 48 and Table 49). Fry in tributaries with warmer water may emerge from the gravel before spawning in higher tributaries is completed.

Juvenile Rearing

Juvenile steelhead may spend one to three years in fresh water before smolting (see Table 48, Table 49, and Table 59). Juveniles of three age classes were observed year-round throughout the subbasin (ODFW and NPT unpublished data).

Smolt Migration

Peak downstream juvenile migration of Imnaha steelhead initiates in late April and extends through early May (Table 48 and Table 49). Some steelhead may outmigrate from the Imnaha as pre-smolts, initiating downstream movement in September and extending through late April (*refer also to previous discussion of emigration research being conducted by the NPT*).

Carrying Capacity

Recent estimates of steelhead carrying capacity in the Imnaha subbasin are not available. In a 1987 report, Carmichael and Boyce (as cited in Mundy and Witty 1998) estimated that 165,199 summer steelhead smolts could be produced in the Imnaha subbasin.

Genetic Integrity

Recent genetic information for Imnaha summer steelhead is presented in TRT (2003). Based on genetic samples taken seven spawning areas, two distinct clusters of spawners occur in the Imnaha; fish from Big Sheep, Little Sheep, and Horse Creek clustered together and were distinct from spawners occurring in Cow and Lightning Creeks (Moran 2003 cited in TRT 2003). However, because the two clusters do not neatly correspond to geographic segments of the drainage, the two separate clusters were lumped as a single spawning aggregate (the TRT-defined IRMMT-s population).

A sample collection strategy was developed and implemented by co-managers in 1999 - 2002 to allow for DNA genetic analysis of stock structure of Imnaha steelhead, Nez Perce Tribe monitoring and evaluation personnel responsible for sample collection in eight streams, and the staff share sample collection responsibility with ODFW in two other streams. Sample analysis is being conducted by NMFS with LSRCP funding.

1.2.5.2 Distribution—Summer Steelhead

Current Distribution

Currently, Imnaha steelhead maintain widespread distribution throughout most of the subbasin, and generally occur in *all* tributaries that do not have vertical falls near their mouths (Mundy and Witty 1998). Approximately 397.6 river miles of summer steelhead spawning and rearing habitat have been identified in the Imnaha subbasin (Figure 56).

Although his samples were restricted to various portions of the subbasin, Gaumer (1968) found that juvenile steelhead of the 1965 brood year occurred in highest densities in the upper reaches of Horse, Lightning, and Cow creeks during fall sampling. Electrofishing catches remained high in the upper areas and increased at the middle and lower sampling stations during the winter and spring (Gaumer 1968).

Historical Distribution

Snake River summer steelhead population distribution in the Imnaha subbasin was historically more widespread than current conditions, a difference that is likely a result of land management activities.

Historical (pre-1900) distributions of steelhead in Little Sheep and Big Sheep creeks were likely similar to current distributions, with the exception of fish occurring above the Wallowa Valley Irrigation District Canal, which eliminated access to approximately 12.5 miles of habitat upon its construction (USFS 2003). Habitat that was eliminated includes that (above the canal) in McCully, Ferguson, Redmont, Salt, Big Sheep, South Fork Big Sheep, and North Fork Big Sheep Creeks, much of which is characterized by unfavorable steelhead habitat (i.e. high gradients, high elevation, large substrate with little gravel and low stream temperatures).

Landuse activities in the mainstem Imnaha (upper and lower) are considered to have modified flow regimes in perennial tributaries from historical conditions. Current steelhead distributions in tributary habitats may have included additional streams than presently identified, but more likely distributions extended further upstream in streams currently containing habitat (USFS 2003). The extent of habitat may have been greater due to the more perennial nature of streams prior to intensive management such as logging, road building, and grazing (USFS 2003). It could also be due to the competition for food and space that would have occurred when greater fish numbers were present (USFS 2003). This competition may have forced steelhead further upstream to escape competition (USFS 2003).

In the absence of historical distribution data, it is difficult to determine specifically which streams were inhabited by summer steelhead; however, based on the lack of residual rainbow trout above Imnaha Falls (RM 73), it is likely that steelhead have always been restricted to accessible areas downstream from this probable migration barrier (Mundy and Witty 1998).

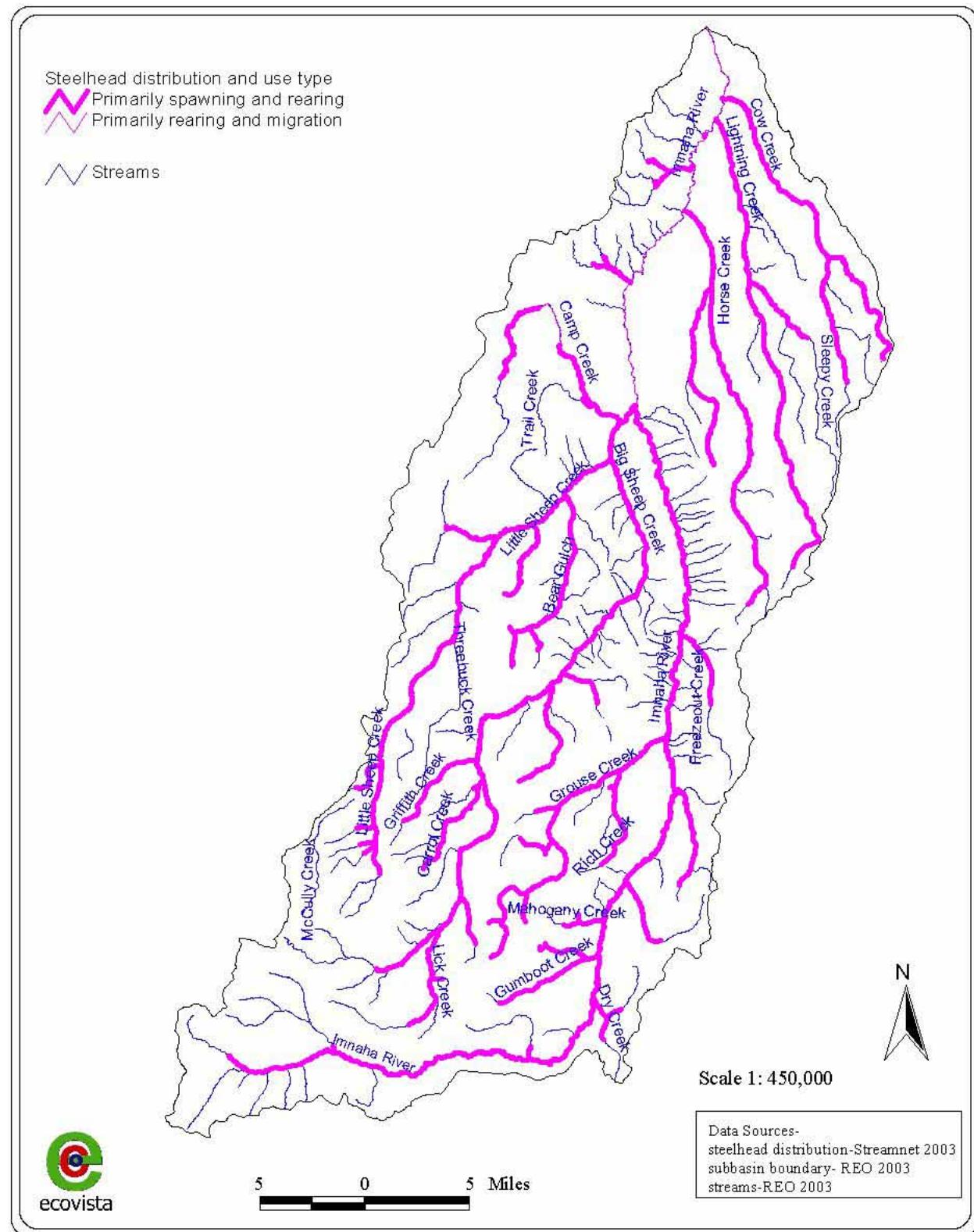


Figure 56. Steelhead distribution and use type, Imnaha subbasin.

1.2.5.3 Summer Steelhead Harvest

Current In-Basin Harvest Levels (Direct/Indirect)

The summer steelhead fishery on the Imnaha was closed in 1974 due to declining adult returns, as indicated by adult counts at Ice Harbor Dam on the Snake River (USACE 1990) and low redds counts at index sites. Under the auspices of the Lower Snake River Compensation Program (LSRCP), a steelhead supplementation program was initiated in 1982 to help restore a tribal and recreational fishery (Carmichael 1989). A consumptive-based recreational summer steelhead fishery on adipose-clipped hatchery origin fish was subsequently re-opened in 1986 due to increased returns from the hatchery program (Flesher et al. 1993) (Figure 57).

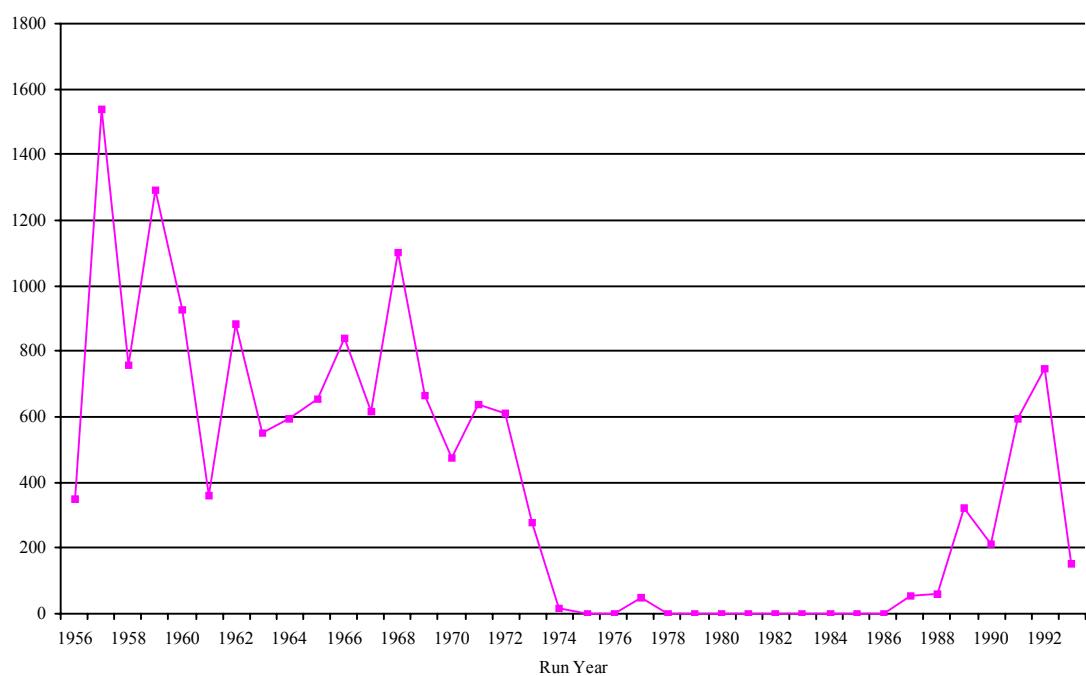


Figure 57. Estimated annual steelhead harvest in the Imnaha subbasin for the run years 1956–1993 (StreamNet database 2001).

Annual creel surveys for Imnaha steelhead have been conducted by the ODFW since the fishery reopened in 1986. The surveys, which are conducted only in the spring, provide managers with annual harvest information needed to assess LSRCP objectives and compensation goals. Results from creel surveys for the run years 1986–1998 are shown in Table 61. Contemporary tribal harvest activities within the drainage directed toward removing harvestable surpluses of hatchery origin fish has not occurred.

Table 61. Creel survey results for summer steelhead caught in the Imnaha River for the run years 1987–1998 (ODFW data presented in Carmichael et al. 1989a,b; Carmichael et al. 1991; Flesher et al. 1993; Flesher et al. 1994a,b; Flesher et al. 1995, 1996, 1997, 1999).

Run Year	Number of Anglers ¹	Effort (hours)	Catch		Catch Rate Index (hours/fish)	
			Number Wild	Number Hatchery Kept		
1986–1992						
			Punchcard Data Only			
1992–1993	789	2,910	130	171	8.0	
1993–1994	298	1,336	72	29	13.0	
1994–1995	219	1,048	39	24	17.0	
1995–1996	588	2,599	210	112	7.0	
1996–1997	209	N/A	N/A	97 ¹	6.0	
1997–1998	111	N/A	N/A	27 ¹	10.0	

¹ Value represents a subsample of total.

Historical In-Basin Harvest Levels

Historical steelhead harvest data specific to the Imnaha subbasin extend back only to 1953. Native Americans harvested salmon and steelhead in the Imnaha river drainage before the time of colonization by peoples of European descent in the eighteenth century (Mundy and Witty 1998). Within the cultures active in the Imnaha subbasin, traditional fishing practices served to provide for conservation of salmon by limiting the times and areas of harvest (Mundy and Witty 1998).

1.2.5.4 Summer Steelhead Hatchery Influence

Summer steelhead production efforts in the Imnaha subbasin have occurred through the *Lower Snake River Compensation Plan* (LSRCP) since 1982. The preferred stock for hatchery use is Little Sheep stock and no outside introductions are planned (NPT et al. 1990).

Three facilities are used for the steelhead production program. The adult collection/smolt acclimation facility is located in the Imnaha River subbasin on the Little Sheep Creek. Adults are collected and spawned at Little Sheep Creek. Embryos are initially incubated at Wallowa Hatchery and then transported to Irrigon Hatchery. Final incubation and rearing to the smolt stage occurs at Irrigon FH. Following 10 to 13 months of rearing, smolts are transferred back to the acclimation facility for 30 days of acclimation prior to release in April and May. The Little Sheep Creek facility is designed to accommodate up to approximately 250,000 smolts.

Beginning in 1982, wild summer steelhead were collected from Little Sheep Creek for broodstock. Little Sheep Creek was chosen because it contained a healthy run of wild steelhead. The goal of the program was to incorporate naturally produced fish into the broodstock on an annual basis, to ensure adequate escapement of natural fish to Little Sheep Creek. Since 1987, returns of naturally produced adult steelhead to Little Sheep Creek have amounted to less than 20% of the total return in spite of substantial supplementation with hatchery-produced adults. Further, since the program began, the numbers of natural adult returns have exceeded pre-

hatchery supplementation numbers only in 2002. Smolt production goals have, however, generally been achieved in all years except 1997.

Prior to 1998, releases had only occurred at the Little Sheep Creek facility and in the mainstem Imnaha River. In 1998, fry were planted in other tributaries, and since 1999, adults have been outplanted in Big Sheep Creek. The TRT (2003) defines the degree of hatchery outplanting in the Imnaha as ‘medium’, a rating which is based on an average of 50,000 to 500,000 fish released per year over the last ten years. Smolts have also been released in Big Sheep Creek since 2000. Smolt-to-adult survival rates have varied, but have typically been below the goal of 0.61%. Life history and genetic characteristics of adult hatchery and natural fish have remained similar in the Little Sheep Creek drainage, although characteristics of fish throughout other portions of the subbasin are unknown.

Averaged over the last five years, an estimated 10-25% of natural spawning fish are of hatchery-origin (TRT 2003). There is some genetic evidence of hatchery introgression, as Imnaha steelhead tend to have a high affinity to locally derived broodstock. The majority of releases of hatchery fish are from in-population broodstock (Table 62).

Table 62. Hatchery releases of Imnaha summer steelhead (reproduced from TRT 2003)

Population	Code	% natural origin spawners 1998-2002*	% natural origin spawners 1980-1997*	Average annual releases				Total Releases		
				Stock	1979-1986	1987-1994	1995-2002	1979-1986	1987-1994	1995-2002
Imnaha River	IRMMT-s	79	88	Imnaha	36,395	296,999	172,948	291,158	2,375,992	1,383,580
				Wallowa	5,022	-	-	40,179	-	-
				L.Sheep	-	-	139,751	-	-	1,118,005
				All Stocks	41,417	296,999	312,698	331,337	2,375,992	2,501,585

* Average among those years in the indicated period for which data was available

A total of 1,354 adult steelhead returned to the Little Sheep Creek trap in 2001, compared with 520 in 2000. Of these, 127 were unmarked. State and tribal cooperators worked together to release 785 adults above the weir into Little Sheep Creek and 354 into Big Sheep Creek. A total of 457,800 green eggs were collected from 109 females. A total of 358,630 BY2001 eyed steelhead eggs were sent from the Irrigon FH to the Little Sheep Creek facility in 2001. In 2001, 242,456 steelhead smolt were delivered from the Irrigon FH to the Little Sheep Creek satellite facility for release. Big Sheep Creek received a direct release of 100,216 steelhead smolts from the Irrigon FH in 2001.

A consumptive steelhead recreational fishery was re-opened in 1986 after being closed since 1974. Catch rates in the Imnaha River are high and better than historical values, due in large part to the success of the mitigation program. Imnaha hatchery steelhead contribute to fisheries throughout the Columbia Basin. Despite meeting many production goals, the following obstacles to achieving management objectives remain: low smolt-to-adult survival, low success with hatchery fish supplementation, apparently low carrying capacity of Little Sheep Creek, low

abundance of natural fish in the Little Sheep Creek, and lack of information on steelhead population dynamics in the Imnaha River.

Evaluations of stock status of wild steelhead in the Imnaha River subbasin were initiated in 2000 with operation of an adult escapement weir in Lightning Creek. This effort has been expanded to Cow Creek in 2001.

Future Plans

The steelhead program will continue to be managed to mitigate for lost sport and tribal harvest resulting from construction of lower Snake River dams. Co-managers will continue to monitor the success of the program at meeting LSRCP goals and the success of supplementing Little Sheep Creek with hatchery steelhead.

1.2.6 Bull Trout Population Delineation and Characterization

1.2.6.1 Population Data and Status—Bull Trout

Bull trout (*Salvelinus confluentus*) occurring in the Imnaha subbasin belong to the Imnaha-Snake Rivers Recovery Unity, which is a part of the Columbia River DPS, which includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60% of the Columbia River Basin, and presently occur in 45% of the estimated historical range (ICBEMP 1997b). The Columbia River Basin DPS has declined in overall range and numbers of fish. The population segment is composed of 141 subpopulations indicating habitat fragmentation, isolation, and barriers that limit bull trout distribution and migration within the basin.

Bull trout occupy portions of 14 major tributaries in the Snake River Basin of Idaho, Oregon, and Washington. The USFWS identified 34 bull trout subpopulations in the Snake River basin, four of which occur in the Imnaha subbasin. These subpopulations are the Imnaha River, Big Sheep Creek, Little Sheep Creek, and McCully Creek and include both resident and migratory fish. Bull trout have also been found throughout the Wallowa Valley Improvement Canal (Buchanan et al. 1997). Because resident fish found within the canal have no downstream passage opportunities and could originate from the Big Sheep, Little Sheep, or McCully creek subpopulations, bull trout found here have not been recognized as a distinct subpopulation.

Abundance and Trends

The status of the bull trout was first assessed in 1991 (Ratliff and Howell 1992), and all subpopulations within the Imnaha subbasin except the Imnaha River were rated of “special concern” because of passage barriers, downstream losses of migrants, and in Big Sheep and Little Sheep creeks, habitat degradation (USFWS 2002b). The Imnaha River subpopulation was rated at “low risk”. Additional monitoring led to a downgrading of the Little Sheep Creek subpopulation to “high risk of extinction”. McCully Creek was downgraded to “moderate risk of extinction” because of the isolation of this population caused by the canal (USFWS 2002b).

Based on sampling of bull trout densities (Table 63) ODFW believes there are greater than 2,000 bull trout in the upper Imnaha River and Big Sheep Creek and fewer than 500 in Little Sheep Creek (Smith, as cited in USFS 2003d). The resident population in Big Sheep Creek, estimated at

less than 2,000 individuals, exists above and below the Wallowa Valley Improvement Canal in both the North and South forks of Big Sheep Creek, Salt Creek and Lick Creek (USFS 2001).

Bull trout redd counts have only occurred in the Imnaha River since 1998 (Table 64) (USFS 2003d), thereby precluding the establishment of any meaningful population trends. USFS and ODFW biologists will continue to conduct bull trout redd counts in the future.

Table 63. Estimated density of bull trout in selected streams in the Imnaha subbasin that were sampled in 1992 (ODFW data presented in Buchanan et al. 1997).

Stream	Site Number	Estimated density (fish/100 m ² by size class ¹)	
		1 to 75 mm	76 to 300 mm
Big Sheep Creek	1	0.00	0.00
	2	18.32	5.61
	3	0.00	7.40
Salt Creek	1	5.87	18.77
Lick Creek	1	0.66	0.00
	2	55.49	15.76
Little Sheep Creek	1	0.00	0.00
	2	0.00	0.00
McCully Creek	1	1.74	7.84
	2	0.57	7.35
	3	0.00	5.79

¹ Size class 1 to 75 mm are considered to be 0+ age, while fish 76 to 300 mm are considered to be older than 0+ age.

Table 64. Spawning survey results for bull trout in the Imnaha subbasin (reproduced from USFWS 2002b, USFS 2003d)

Stream	Year	Redds	Miles Surveyed	Redds/Mile	Comments
Mainstem Imnaha ¹	1998	18	2.6	6.9	
	1999	16	22.9	0.7	
	2000	18	18.0	1.0	
	2001	30	13.6	2.2	
	2002	17	14.2	1.2	Survey occurred from the Blue Hole to the fish weir (14.2 miles) (USFWS 2002b)
Mainstem Imnaha Tributaries ²	1999	0	0.0	0	Bear, Cliff, Soldier, N. & M. Forks
	2000	30	2.8	10.9	Bear, Cliff, N. & M. Forks
	2001	261	17.1	15.3	Bear, Cliff, Soldier, upper Imnaha (Blue Hole to N. Fork), N., S., & M. Forks
	2002	96	16.3	5.9	Upper Imnaha—survey occurred from the headwaters to the Blue Hole (16.3 miles) (USFWS 2002b)
Big Sheep Creek ¹	1999	13	5.2	2.5	
	2000	2	2.0	1.0	

Stream	Year	Redds	Miles Surveyed	Redds/Mile	Comments
	2001	6	1.9	3.2	
	2002	40	9.1	4.4	Survey included Big Sheep Creek and its tributaries (9 miles) (USFWS 2002b)
Big Sheep Creek Tributaries ¹	1997	9	0.7	12.9	Lick Creek only
	1999	7	14.0	0.5	Lick, Salt, and Little Sheep creeks and canal above Little Sheep Creek
	2000	12	8.0	1.5	Lick and Salt creeks
	2001	18	6.7	2.7	Lick and Salt creeks

¹ Includes fluvial and resident bull trout

² Includes resident bull trout only

Except where the Wallowa Valley Improvement District Canal has prevented connectivity, the populations in many of the tributaries are resilient (USFS 2003d). All but the Little Sheep Creek subpopulation are stable, and have a high potential to produce surplus individuals due to the presence of large neighboring subpopulations (USFS 2003d). The probability of hybridization with other species is low to nonexistent in any of these subpopulations.

Life History Diversity

Adult Migration

In the lower Imnaha (below the Big Sheep Creek confluence), peak upstream migration of fluvial bull trout occurs in May and extends through the first half of June (Table 65). Adult upstream migration into the upper portion of the subbasin also initiates in May but extends through the first half of July, and sometimes into early August (Table 66). Fluvial adults appear to move downstream in the Imnaha River during the months of August, September, October, and perhaps November (USFWS 2002b).

Seasonal movements of fluvial fish may range up to 300 kilometers as migratory fish move from spawning and rearing areas into overwintering habitat in downstream reaches of larger basins (Bjornn and Mallet, as cited in USFS 2003d; Elle, as cited in USFS 2003d). It is certain that some fluvial bull trout from the Imnaha River migrate out of the Imnaha River and overwinter in the Snake River and, given recent radiotelemetry data (Chandler and Richter, as cited in USFWS 2002b), fish found in the Imnaha River below Summit Creek are probably moving between summer or spawning habitat and overwinter habitat in the lower Imnaha or Snake Rivers.

Table 65. Life history timing for nonanadromous species in the Imnaha subbasin, from the confluence with the Snake River to the confluence with Big Sheep Creek (ODFW unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Fluvial Migration												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Adult Spawning												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Adult/Subadult Rearing												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Egg Incubation through Fry Emergence												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Juvenile Rearing												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Juvenile/Subadult Migration												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												

■ Represents periods of peak¹ use, based on professional opinion

▨ Represents lesser² level of use, based on professional opinion

▨▨ Represents periods of presence, either with no level of use OR uniformly distributed level of use indicated

¹ Based on professional opinion, 70% of the life stage activity occurs during the time frame shown as the peak use period.
² Based on professional opinion, 30% of the life stage activity occurs during the time frame shown as the lesser use period.

Table 66. Life history timing for nonanadromous species in the Imnaha subbasin, from the Big Sheep Creek confluence to the headwaters (ODFW unpublished data, created May 30, 2003, by Brad Smith and Bill Knox).

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Fluvial Migration												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Adult Spawning												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Adult/Subadult Rearing												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Egg Incubation through Fry Emergence												
Bull Trout Fluvial							1	1	1	1		
<i>O. mykiss</i> Resident												
Juvenile Rearing												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												
Juvenile/Subadult Migration												
Bull Trout Fluvial												
<i>O. mykiss</i> Resident												

■ Represents periods of peak¹ use, based on professional opinion

▨ Represents lesser² level of use, based on professional opinion

▨ Represents periods of presence, either with no level of use OR uniformly distributed level of use indicated

¹ Based on professional opinion, 70% of the life stage activity occurs during the time frame shown as the peak use period.

² Based on professional opinion, 30% of the life stage activity occurs during the time frame shown as the lesser use period.

Spawning

In the upper Imnaha, spawn timing peaks from September through the first half of October, but may initiate in the second half of August and extend through the end of October (Table 66). Resident bull trout were found to be sexually fecund at 160 mm, based on a sample of fish from Big Sheep, Salt, Lick, and McCully Creeks in 1992 (Buchanan 1997).

Incubation

Bull trout incubation through fry emergence in the upper Imnaha subbasin initiates in the latter part of August (depending upon spawn timing) and extends through the end of May (Table 66). Hatching may occur in winter or early spring, but alevins may stay in the gravel for an extended period after yolk absorption (McPhail and Murray 1979). Fry generally emerge from the gravels by the end of April (USFS 2003d). Optimum temperatures for incubation and rearing have been cited between 2 and 4 °C (35.6–39.2 °F) and 7 and 8 °C (44.6–46.4 °F), respectively (Rieman and McIntyre 1993).

Juvenile Rearing

Juvenile rearing occurs throughout the subbasin during winter months, while it is restricted to headwater reaches, or those maintaining sufficiently cold water temperatures during summer months (Table 65 and Table 66). Most known summer rearing and holding areas in the Imnaha River are on National Forest or wilderness lands above Summit Creek. Fluvial forms rear in natal tributaries for one to four years before moving to larger rivers to mature. Fluvial bull trout will inhabit a wide range of habitats ranging from second to sixth order streams and varying by season and life stage. They live for another two to four years in these larger systems, growing to much larger sizes than resident forms, before returning to natal tributaries to spawn (Pratt 1992).

Juvenile/Subadult Migration

Juvenile and/or subadult migration of fluvial bull trout initiates in September and extends through the end of April in all portions of the subbasin (Table 65 and Table 66). Migration of juvenile resident fish is uncommon, as they are typically restricted to headwater streams throughout their life. Both fluvial and resident forms are believed to exist together in some areas, but migratory fish may dominate populations where corridors and subadult rearing areas are in good condition (Rieman and McIntyre 1993).

Carrying Capacity

No information is available regarding bull trout carrying capacity within the Imnaha subbasin.

Unique Population Units

All bull trout found within the Imnaha subbasin are considered part of Bull Trout Recovery Unit 11 (Imnaha-Snake River Basins) as defined by the USFWS (2002b). Distinct subpopulations of bull trout have been identified in the Imnaha River above and below Imnaha Falls, Big Sheep Creek, Little Sheep Creek, and McCully Creek, and encompass both resident and migratory fish.

Genetic Integrity

Samples for genetic analysis were taken in 1995 from the North Fork Imnaha River, McCully Creek, and Lick Creek, and compared with bull trout throughout Oregon, Washington, and elsewhere in the Columbia Basin (Buchanan 1997). Analysis of these data shows that populations from the John Day Basin and Northeastern Oregon (including the Imnaha River basin) comprise major genetic lineages (Spruell and Allendorf 1997). More recently, work by Spruell et al. (2003), establishes that the Imnaha bull trout population is most closely associated (by allelic frequency) with fish of the Grande Ronde subbasin. These populations are further grouped with populations from the John Day, Walla Walla, Pine Creek, and Powder subbasins.

Population Risk Assessment

The risk of the Imnaha River local population going extinct is low (Ratliff and Howell 1992). The risk of either the local populations above or below the diversion in Big Sheep Creek going extinct is of special concern (see Ratliff and Howell 1992). The risk of the McCully Creek local population going extinct is considered moderate (Buchanan et al. 1997). The risk of the Little Sheep Creek local population going extinct is considered high (Buchanan et al. 1997).

1.2.6.2 Distribution—Bull Trout

Current Distribution

Bull trout are found from the headwaters to the mouth in the mainstem Imnaha River and in numerous tributaries. Spawning and rearing habitat occurs mainly in the upper reaches of the Imnaha River, Big Sheep Creek, Little Sheep Creek, and their associated headwater tributaries (Figure 58). Migratory life stages of bull trout have access to the Snake River and may use this habitat at various times of the year when cooler water temperatures are available, or for overwintering purposes (M. Hanson, ODFW, personal communication, April 23, 2001).

The Imnaha bull trout recovery unit team, a group comprised of participants from ODFW, USFS, USFWS, Grand Ronde Model Watershed Group, and Nez Perce Tribe, suspects that the Imnaha/Snake Recovery Unit contains up to two core areas, but for the purposes of recovery should be considered as one core area. These areas include the Imnaha Core Area, which is comprised of all tributaries containing local populations (both current and potential as identified by the recovery unit team), and the mainstem Imnaha River from the headwaters downstream to the confluence with the Snake River (M. Hanson, ODFW, personal communication, April 23, 2001). Populations occurring in Snake River tributaries such as Sheep and Granite Creek likely represent a separate core area. The lack of understanding of Snake River utilization by Imnaha bull trout currently represents a research need (M. Hanson, ODFW, personal communication, April 23, 2001).

A mixture of both resident and fluvial forms of bull trout occur above and below Imnaha falls. Resident forms are most common in the North Fork and Middle Fork of the North Fork Imnaha (USFS 2000). The Wallowa Valley Irrigation Canal has isolated resident populations in Big Sheep, Little Sheep, McCully, Ferguson, Canal, and Redmont creeks, all of which are estimated to be less than 2,000 individuals in size (USFS 2003d). Connectivity between populations above the canal is reestablished annually during irrigation season (April 1 to October 15). It has been estimated that the McCully Creek population is in excess of 800 individuals. The resident

population in Big Sheep Creek exists above the diversion to the irrigation canal. This population is found in both the North and South Forks of Big Sheep Creek and is less than 2,000 individuals in size.

There may be some movement of bull trout into the Wallowa Valley Improvement Canal during certain times of the year but the canal does not promote connectivity among local populations. Some of the fish may move downstream, but there little opportunity for movement upstream. Fish from Big Sheep Creek may be the primary source of bull trout in the canal and some tributary segments above the canal. Bull trout in McCully Creek above the canal are isolated and can only move downstream. Although the miles of stream located above the canal is small compared to the total Imnaha system, these smaller streams are important spawning and rearing areas for bull trout, and would benefit from being more connected in an upstream and downstream direction.

Fluvial populations occur throughout the mainstem up to the junction of the South and North Forks of the Imnaha River (USFS 2000) (Figure 58). Fluvial forms are also found in Big Sheep Creek and Little Sheep Creek. The presence of fluvial fish, combined with a relatively high degree of connectivity between and within habitats, ensures genetic interchange and refounding potential between other spawning and rearing groups.

The migratory corridor for mainstem bull trout populations extends to just above the Grouse Creek confluence, at which point the habitat also becomes functional for rearing life history forms (Figure 58). Spawning occurs in Big Sheep Creek above its confluence with Carroll Creek (RM 25) and in Little Sheep Creek above the USFS boundary (RM 28) (USFS 2000). Presence of age 0+ fish has been documented in the South Fork Imnaha and its tributaries (Bear Creek, Blue Creek, Soldier Creek, Cliff Creek), the North Fork Imnaha, the Middle Fork Imnaha, in Big Sheep Creek and its tributaries (Lick and Salt Creek), and in McCully Creek, indicating that these streams are also used for spawning (Buchanan et al. 1997).

Historical Distribution

Historical accounts of bull trout populations in the Imnaha are limited. Short segments of historical resident bull trout spawning and rearing habitat have been identified in upper Little Sheep Creek and Cabin Creek (USFS 2000). Unlike other salmonids, it is doubtful that bull trout occupied all accessible streams at any one time (USFS 2000), due to their current patchy distribution in even pristine “stronghold” habitat types (Rieman and McIntyre 1993). In the Imnaha, historical distribution likely was similar to current distribution (M. Hanson, ODFW, personal communication, April 23, 2001).

1.2.6.3 Bull Trout Harvest

Current In-Basin Harvest Levels (Direct/Indirect)

Current, direct/indirect, in-basin harvest levels of bull trout in the Imnaha are not available. In some years, standard creel surveys are conducted between September and April for a summer steelhead fishery (Flesher in litt., as cited in USFWS 2002b); however, because the surveys are geared to steelhead, they are not done in a manner conducive to estimating angling influence on bull trout populations.

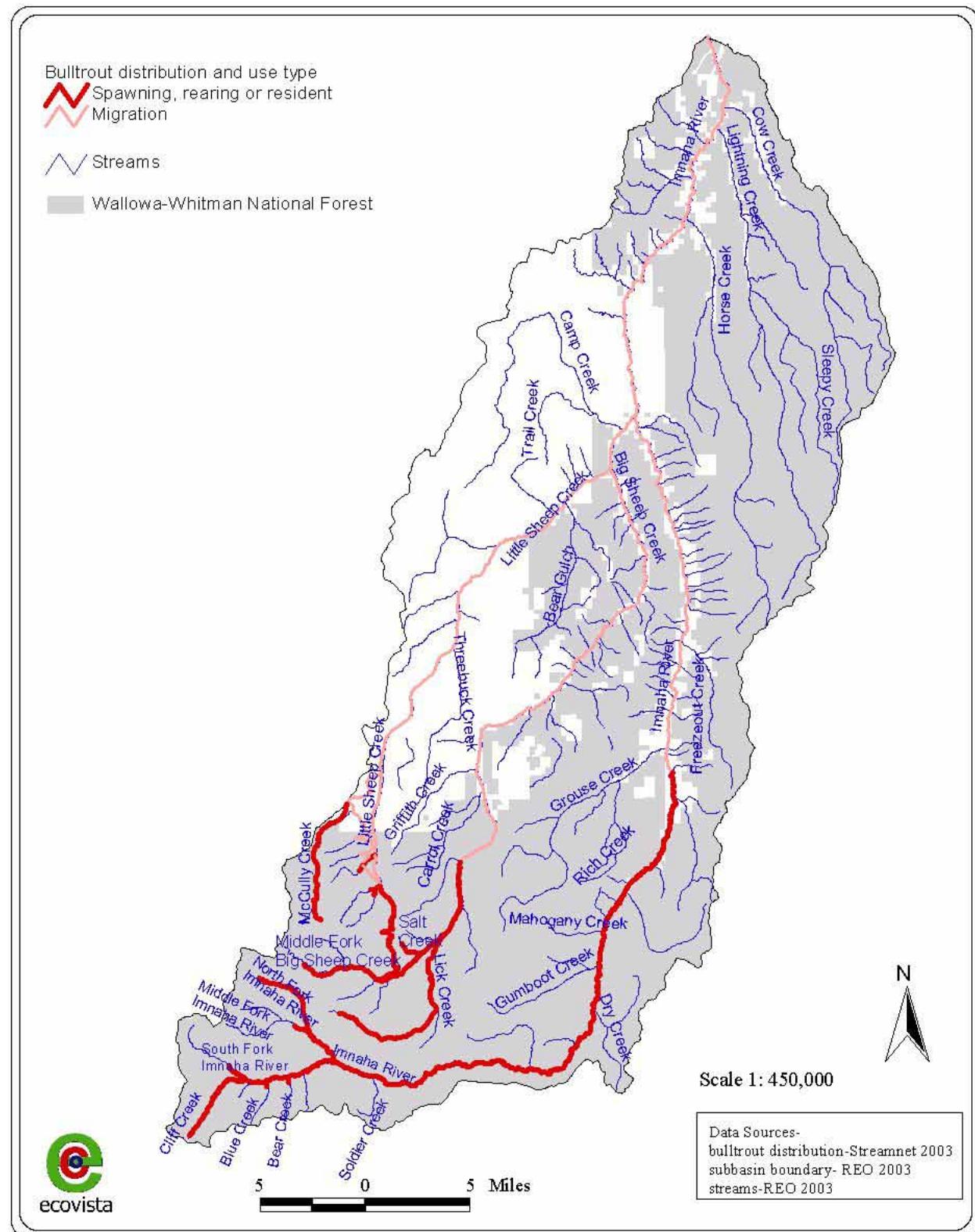


Figure 58. Bull trout distribution and use type, Imnaha subbasin

Regulations imposed in 1994 required the release of all bull trout caught by anglers. Despite these regulations, bull trout are still caught in the Imnaha subbasin. Angling pressure is highest near the many campground areas in the subbasin, but also occurs throughout other portions of the subbasin (USFWS 2002b). Incidental catches occur by anglers fishing for steelhead (USFWS 2002b). ODFW, Oregon State Patrol, the USFS, and local media work together to inform anglers of bull trout angling restrictions. Signs informing the public of fishing regulations have been placed at access sites near traditional bull trout fishing areas (Buchanan 1997).

Historical In-Basin Harvest Levels

Historical in-basin harvest levels of bull trout in the Imnaha subbasin are not available. Anecdotal accounts from anglers who fished the Imnaha River in the 1940s describe the river as “a good Dolly Varden stream” with large bull trout being caught frequently (Buchanan et al. 1997).

Historical harvest of bull trout may have reduced the total numbers of fish within populations in small tributaries and contributed to the overall decline in the subbasin. For example, before the 1990s, bull trout angling was permitted in the State of Oregon. Angling in the Imnaha subbasin was controlled by standard statewide seasons and limits for trout.

1.2.7 Lamprey Population Delineation and Characterization

1.2.7.1 Population Data and Status—Lamprey

Population and status information documenting Pacific lamprey (*Lampetra tridentata*) in the Imnaha subbasin is limited. Descriptions of species, sex, length, weight, or life history stage are generally not available. The following discussions are based on empirical, historical, and/or anecdotal information.

Abundance and Trends

Current information suggests that lamprey populations are declining, and in January 2003, four species of lamprey, including *L. tridentata*, were petitioned for listing under the Endangered Species Act.

Throughout their range in the Columbia River Basin, Pacific lampreys have declined to only a remnant of their pre-1940s populations. Lower Snake Dam counts numbered over 30,000 in the late 1960s but have declined to less than 500 fish in recent years (Table 67). As early as the 1980s, “a lot” of adult Pacific lamprey could be seen clinging to fish-viewing windows in Columbia River dams. Devices were installed at the ladders to keep them away from fish-counting windows, as they were often abundant enough to obscure counting of salmon (Ocker et al., as cited in Kostow 2003). Currently, an estimated 3% of the lamprey that pass Bonneville Dam are counted at Lower Granite Dam (Close 2000). Based on adult lamprey observations at Lower Granite Dam, the current status in the Imnaha subbasin is thought to be extremely depressed (CBFWA 1999).

Table 67. Trends in counts of Pacific lamprey in fish ladders at mainstem dams between the Pacific Ocean and the Salmon subbasin, Idaho (Source: Fish Passage Center, <http://www.fpc.org/adult.html>).

Dam	Early 1960's	1996	1997	1998	1999	2000	2001	2002
Bonneville	350,000	---	20,891	---	---	19,002	27,947	100,476
The Dalles	300,000	---	6,066	---	---	8,050	9,061	23,417
John Day	<i>No dam</i>	---	9,237	---	---	6,282	4,005	26,821
McNary	25,000	---	---	---	---	1,103	2,539	11,282
Ice Harbor	50,000	737	668	---	---	315	203	1,127
L.Monumental	<i>No dam</i>	---	---	---	---	94	59	284
Little Goose	<i>No dam</i>	---	---	---	---	4	104	365
Lower Granite	<i>No dam</i>	---	1,122	---	---	28	27	128

According to Kostow (2003), Pacific lamprey appear to be at dangerously low numbers in the Snake River Basin, with fewer than 200 adults seen annually at Lower Monumental, Little Goose, and Lower Granite dams during the 1990s. Pacific lamprey may be gone from the upper Grande Ronde subbasin (Kostow 2003) and extirpated from the Imnaha.

Current abundance estimates for Pacific lamprey in the Imnaha subbasin are unknown. Screen-trap records collected between September 1964 and June 1967 from the lower mainstem Imnaha, downriver from the Horse Creek confluence, are of sufficient detail, however, to provide some indication as to relative abundance (Figure 59). The highest number of lamprey captured during any one month was 106 in June 1965. A total of two lamprey were caught over the four month period in 1964, 326 in 1965, 235 in 1966, and 126 over the six-month period in 1967. Although the catch data are of limited utility for making abundance estimates, they do illustrate that lamprey were fairly common in the mainstem, especially during late spring and/or early summer months.

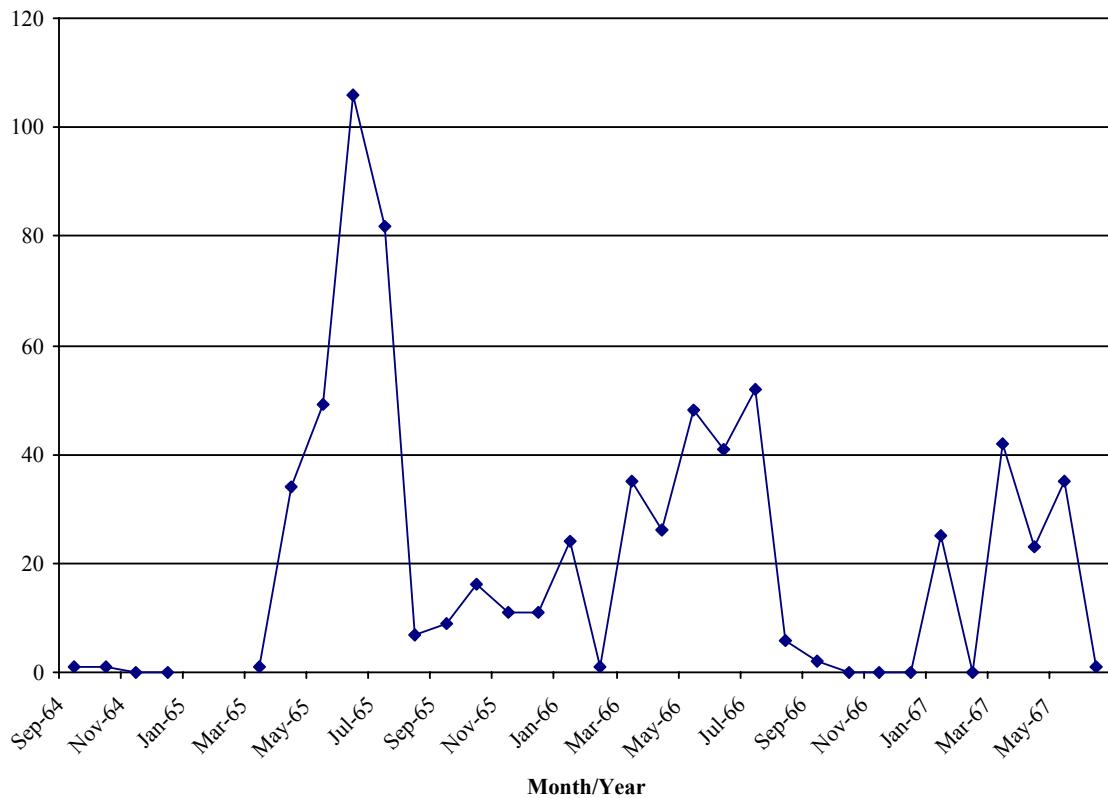


Figure 59. Summary of lamprey catch in the lower mainstem Imnaha River (Gaumer 1968).

Productivity

Productivity evaluations of lamprey populations in the Imnaha subbasin have not been made.

Life History Diversity

The following excerpts were taken from Kostow (2003).

Pacific lamprey is a member of the subgenus *Entosphenus*. It has the widest world distribution of any lamprey species in Oregon. It is the largest lamprey, as adults, in Oregon and represents the only species that is harvested.

Pacific lamprey is an anadromous, parasitic species with the period of parasitism occurring in the ocean. Ammocoetes live in fresh water where they are burrowing filter feeders. Lampreys undergoing metamorphosis and spawning adults do not feed.

Lampreys emerge from spawning gravels at about 1 cm in length. Ammocoetes will grow to 17 or 18 cm and may remain at this life stage for up to seven years.

Metamorphosis of Pacific lamprey is reported as occurring in July through November with out-migration to the ocean occurring November through June, peaking in the spring. Metamorphosis may vary regionally. Lamprey do not feed during metamorphosis since extensive changes in the gut are occurring. Rather they live on lipid reserves, and some individuals may shrink in size.

Most downriver movement occurs at night. Timing of migration may be based on temperature cues. Both eyed lamprey and ammocoetes will migrate. Ammocoetes move progressively downstream, eventually accumulating in the lower parts of basins while eyed lampreys are going to the ocean.

Pacific lamprey enter salt water and become parasitic, feeding on a wide variety of fish and also on whales. In turn, marine mammals and larger fish eat them. They move off-shore quickly and into waters up to 70 meters deep. The length of time spent in the ocean is not known, but ranges somewhere between 6 and 40 months.

Pacific lamprey are reported to return to fresh water between April and June but may enter the lower Columbia River as early as February. Long upriver migrations, such as up into the Snake River basin, can extend until as late as September. After entering fresh water and completing part of their migration, Pacific lamprey are thought to overwinter before spawning.

Spawning in the Snake River Basin is uncertain, but likely occurs between April and July. Lamprey select spawning gravels just upstream of riffles and often near ammocoete habitats (silty pools and banks). Spawners may be attracted to chemical stimuli produced by ammocoetes. Female fecundity is variable between individuals, ranging between 15,500 to 240,000 eggs per female.

Carrying Capacity

The capacity of lamprey habitat in the Imnaha subbasin has not been defined. It is agreed, however, that habitat availability in the Imnaha is not considered to be a factor limiting production and that underseeding is likely the primary cause for concern.

1.2.7.2 Distribution—Lamprey

Current Distribution

Current lamprey distribution in the Imnaha is unknown. As mentioned previously, it is possible that this species has been extirpated from the subbasin.

Historical Distribution

Historical distribution of Pacific lamprey in the Imnaha subbasin is unknown.

1.2.8 Aquatic Environmental Conditions

1.2.8.1 Habitat Conditions for Focal Species—Overview

General

The National Marine Fisheries Service has designated critical salmon and steelhead habitat for species endemic to the Snake River Basin to include all areas currently accessible to the species within the range of the Evolutionarily Significant Unit (U. S. Federal Register 2000). Critical habitat inherent to this definition includes “all waterways, substrate, and adjacent riparian zones below longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years)”, which functionally provide “spawning sites, food resources, water quality and quantity and riparian vegetation” (U. S. Federal Register, 2000).

Spring/summer chinook

There are 137.7 miles of spring/summer chinook salmon Designated Critical Habitat in the subbasin, including 130.6 miles of presently used habitat for the Imnaha River mainstem (IRMAI) and Big Sheep Creek (IRBSH) populations combined and 7.1 miles of historical spawning habitat. Ecoregion-based (Level 4) habitat characteristics for the Imnaha population include mesic forest in the headwaters, canyons and dissected highlands in the middle reaches, and canyons and dissected uplands in the lower reaches (*refer to Section 1.1.1.4 and Figure 4*). The upper reaches of the Big Sheep population are characterized by dissected highlands, while the lower reaches are almost entirely canyons and dissected uplands.

For the Imnaha population, high quality, ‘core’ spawning habitat occurs on the mainstem from the Blue Hole (RM 69) downstream to Grouse Creek (RM 34.7; *refer to Figure 50*). Based on StreamNet data, spring chinook spawning/incubation also occurs above (the lower reaches of the South Fork) and below (upriver from the Freezeout confluence) the core reach and in the South Fork Imnaha. Spring/summer chinook spawning/incubation habitat has been defined in approximately 23.9 miles of the mainstem Big Sheep population. Included within these reaches is the TRT-defined core spawning area.

Fall chinook

Fall chinook (SNMAI) Designated Critical Habitat includes the 23 miles of the Imnaha River from its mouth to the town of Imnaha. Twenty-one miles of this reach is currently used by fall chinook for spawning and early rearing life history stages (USDA Forest Service 1994; S. Rocklage, NPT, personal communication, April 2004).

Although not specifically identified in TRT (2003), the lower Imnaha represents part of the current core spawning areas for the Snake River fall chinook population. The Canyons and Dissected Uplands subecoregion (Level 4) is the dominant habitat type throughout Imnaha stream reaches used by the SNMAI population (*refer to Section 1.1.1.4 and Figure 4*).

Summer steelhead

The total number of stream miles in the subbasin that are inhabited by the IRMMT-s steelhead population is estimated to be 397; 263 of which are used for spawning and rearing (USFS

1998a). Habitat conditions vary for spawning and rearing, primarily due to the species widespread distribution.

Core spawning and rearing habitat includes accessible mainstem and perennial tributary reaches. Because of their subbasin-wide distribution, conditions in all five subcoreregions (Blue Mountain-11, Canyons & Dissected Highlands-11f, Canyons and Dissected Uplands-11g, Blue Mountain Basins-11k, Mesic Forest Zone-11l) are pertinent in describing habitat types for Imnaha steelhead (*refer to Section 1.1.1.4 and Figure 4*).

Bull trout

Bull trout habitat in the Imnaha subbasin has been modified largely as a result of legacy effects of land use activities. Timber harvest, road building, mining, grazing, irrigation development, and recreation have contributed to the current amount and condition of available bull trout habitat in the Imnaha (Buchanan et al. 1997). Most of these activities continue to take place, although to different degrees, locations, and manners from what occurred in the past.

Bull trout habitat in the mainstem Imnaha River is generally in good condition with respect to water quality, availability of spawning gravels, and suitability of rearing habitat (Buchanan et al. 1997). Water quality, specifically stream temperatures, may be compromised in some areas due to a lack of riparian vegetation. In the lower Imnaha, stream temperatures exceeding 20 °C have been recorded on occasion, which is nearing bull trout tolerance levels.

Bull trout habitat quality in the Big Sheep Creek subwatershed is mixed. The condition of riparian vegetation below the Wallowa Valley Improvement Canal, specifically that occurring along the lower 34 miles of Big Sheep and Lick creeks, is considered to be fair to poor (Buchanan et al. 1997). Riparian vegetation between Owl and Lick creeks, however, is unroaded and in excellent condition. Spawning and rearing habitat in Big Sheep Creek above the Wallowa Valley Improvement Canal occurs primarily within a wilderness area. Much of the habitat in this portion of the subwatershed suffers from legacy effects of heavy sheep grazing and effects from the Canal Fire of 1989. It is characterized by a relatively steep gradient. Land use activities, fires, flooding, and landslides have reduced the quality of bull trout habitat in Little Sheep Creek to what is characterized as the most at-risk population of fish in the subbasin (Buchanan et al. 1997).

Pacific lamprey

Habitat conditions for Pacific lamprey in the Imnaha are undefined. It is likely that habitat in the Imnaha is of sufficient quantity and quality to support spawning and rearing life history stages due to the abundance and diversity of spawning gravels and silty pools and banks (respectively).

1.2.8.2 Methods Used to Characterize Habitat Conditions

The Qualitative Habitat Assessment (QHA) model, developed by Mobrand Biometrics Inc., was used in conjunction with the Imnaha Multi-Species Biological Assessment (USFS 2003d) to characterize anadromous and resident fish habitat condition. The QHA represents a regionally accepted tool to guide planners in the identification and prioritization of where habitat protection and restoration efforts should occur. Results from the QHA model serve two purposes. First, they

provide an indication as to current and reference habitat condition for focal salmonid species. Secondly, the QHA output provides planners with a general idea of which habitat attributes should be considered to be limiting the overall condition of habitat, and where in the subbasin these conditions are occurring. The QHA output is therefore referenced in both the habitat conditions section (below) and in the limiting factors section.

Perhaps the most recent and comprehensive review of fish habitat conditions in the Imnaha subbasin is contained within the Multi-Species Biological Assessment (BA) recently completed by the Wallowa-Whitman National Forest (USFS 2003d). The BA was conducted in response to objectives outlined in the Wallowa-Whitman National Forest Land and Resource Management Plan (Forest Plan), as amended by the Interim Strategies for Managing Anadromous/Nonanadromous Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PacFish/InFish) (USFS 2003d). In a memo dated September 4, 1996, NMFS suggested the use of the Matrix of Pathways and Indicators (Matrix) for evaluations of aquatic habitat. The Matrix is a mix of Pacific Anadromous Fish (PACFISH) and Inland Fish (INFISH) habitat indicators. The indicator for each subwatershed is rated based on how the current baseline habitat condition compares with criteria given in the Matrix. Indicators are rated “properly functioning”, “functioning at risk”, or “not properly functioning” and recorded on a checklist (Appendix G).

Because the habitat characterization information contained within the 2003 BA was applicable to the entire subbasin, the Imnaha subbasin Technical Subcommittee felt it appropriate to include in this assessment. And because of the similarities between habitat attributes used in the BA and in the Qualitative Habitat Assessment (QHA) model, planning group participants agreed to use the results from the BA to initially populate the QHA model.

Results from the Matrix of Pathways and Indicators, as presented in the 2003 BA (USFS 2003d), were used to populate the QHA model at the 6th field HUC scale (see Appendix L Table 5). The subcontractor spatially summarized the BA data on a HUC-by-HUC basis based on the attributes called for in the QHA model (see Appendix L) for additional discussion regarding methods used). The GIS layers and associated spreadsheets were then presented to a panel of local fisheries biologists representing the ODFW, NMFS, Nez Perce Tribe, USFWS, and USFS. The “pre-populated” spreadsheets and GIS layers facilitated discussion between the biologists as to whether there was a consensus agreement with the BA data that were used in the model. In the event where the panel disagreed with the BA data or where documentation was not in accordance to the BA output, appropriate changes were made and incorporated.

1.2.8.3 Evaluation of Habitat Attributes

Riparian Condition—Characterization of Current Conditions

The condition of riparian vegetation is least favorable on private lands, areas that have always had a riparian community dominated by grasses, or in portions of the subbasin that have burned, been subjected to insect infestations, or have had extensive windthrow damage.

In their Multi-Species Biological Assessment (USFS 2003d), the USFS rated the entire Big Sheep Creek drainage as “functioning at risk” for riparian reserves. The 1989 Canal Fire, which burned several thousand acres in the upper Sheep Creek drainage, contributes to this rating, as

does the extensive amount of harvesting that occurred following the fire. Engelmann spruce is sparse in the Big Sheep Creek riparian zones, as they have suffered 50 to 100% mortality due to insect infestations (USFS 2001). The absence of spruce and other overstory species in Big Sheep Creek has resulted in a dominance of 6- to 10-foot high trees/shrubs along with grasses/forbs (USFS 2001). In the upper reaches of Big Sheep Creek, above the diversion canal, the river flows through steep-sided, unconsolidated, colluvial and glacial outwash material. The slope, coarse texture, and low water holding capacity in this area limits vegetation growth (USFS 2003d).

Riparian species, such as cottonwood and ponderosa pine, have been eliminated in portions of the lower Big Sheep Creek subwatershed by grazing, cultivation, homesteading/clearing, and road construction (USFS 2000). For example, the Little Sheep Creek Highway (Oregon State Highway 350) borders the naturally confined channel for approximately 75% of its length and in many areas is bounded by either pastures or cultivated land. These land uses have effectively limited floodplain function and ultimately riparian vegetation establishment. It is important to note, however, that primary riparian communities throughout many of the lower-elevation reaches in Big and Little Sheep Creek have historically never been comprised of shade-providing vegetation, and have always been bordered by basalt cliffs, shrubs, and/or grass/sedge plant communities.

The 2003 BA defines riparian condition as “functioning appropriately” for the upper and lower Imnaha watersheds, with some lower reaches of the mainstem Imnaha trending toward “functioning at risk”. In the upper watershed, a moderate loss of riparian function has occurred in areas such as the Gumboot, Summit, and Grouse Creek subwatersheds, which were subjected to the effects of the January 1997 flood event. Riparian vegetation bordering the mainstem Imnaha between the Cow Creek and Horse Creek confluence is largely dominated by grasses and forbs, but has been compromised in areas by grazing, the presence of the lower Imnaha River Road, and hazard tree harvesting near campgrounds. Reach-specific comments about riparian condition that were generated during the QHA modeling process are shown in Table 68.

Table 68. QHA-generated comments about riparian condition.

Subwatershed/Reach	HUC	Comment
Lightning	07G	Riparian condition is degraded
Squaw/mainstem	07L	Road runs up bottom of drainage—compromises riparian function
Squaw/South Fork	07L	Road runs up bottom of drainage—compromises riparian function
Marr Creek	07N	Road runs up bottom of drainage—compromises riparian condition
Imnaha (RM 4)/mainstem	08B	Road runs up bottom of drainage—compromises riparian condition
Imnaha (RM 4)/Stubblefield Fork	08B	Road runs up bottom of drainage—compromises riparian condition
Imnaha (RM 4)/Dodson Fork	08B	Road runs up bottom of drainage—compromises riparian condition

Subwatershed/Reach	HUC	Comment
Imnaha (RM 4)/Tulley Creek	08B	Road runs up bottom of drainage—compromises riparian condition
Grouse Creek/upper	09F	Grazing has degraded riparian condition and contributed to temperature problems in the upper end of Grouse Creek (plateau area primarily)

Riparian Condition—Characterization of Historical Conditions

Based on input from local biologists, riparian vegetation throughout the majority of the Imnaha subbasin was historically more diverse and functional than current conditions. Based on anecdotal accounts, mature cottonwood galleries historically dominated some of the lower-elevation stream reaches (i.e., lower Camp Creek and the mainstem Imnaha near the town of Imnaha) that are currently shade-limited, while medium-sized conifer species (Engelmann spruce, Douglas-fir, true fir, lodgepole pine, ponderosa pine) were comparatively dense in unconstrained, higher-elevation reaches (i.e., upper Big and Little Sheep Creeks) that are currently limited by windthrow, pathogens, and/or fire impacts. Additional descriptions of potential streamside vegetation are provided in section 1.1.2.4 (p. 70).

Characterization of Restoration Needs

Improvements to current riparian conditions in select areas are likely to produce long-term benefits to anadromous salmonids. Areas where riparian restoration efforts are most critical are primarily associated with stream reaches on private lands, and will therefore only be feasible provided there is sufficient landowner participation. The estimated restoration effort required in these areas is unknown. Restoration projects specifically designed to address riparian deficiencies in the Imnaha subbasin are provided in the Inventory of Existing Activities volume of the subbasin plan.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, numerous riparian enhancement/restoration efforts occurring in the Imnaha subbasin. The cessation of these activities would likely result in a marked overall reduction in riparian health, and would contribute to the decline in anadromous salmonid habitat condition. The specific degree to which a cessation of riparian restoration/enhancement efforts would affect anadromous salmonid populations in the future is unknown.

Channel Stability—Characterization of Current Conditions

Imnaha River streambank stability (percentage of both banks in a stable condition) was measured during stream surveys in 1991 and 1998. At the subbasin scale, bank stability was rated as moderate to high and streambank vegetation cover was rated as moderate (USFS 2003d). Reaches where channel stability is low occur in geologically unstable areas, in select portions of the Big Sheep Creek watershed, and in areas impacted by the January 1997 flood event.

Grande Ronde basalt flows form the canyon through which much of the lower 18.4 miles of the mainstem Imnaha flow, and contribute to its high degree of bank stability (USFS 2003d). In some areas, such as the central portions of the mainstem, quaternary alluvial deposits have formed natural river terraces comprised of river rock from upstream, colluvial basalt from the canyon side slopes, and Mazama ash and windblown silt. It is in these areas where bank stability is compromised due to the ability of the mainstem to meander through the unconsolidated sediment. Nevertheless, a study found that 84% of the riverbanks in the subbasin, including these terraces, are stable due mainly to establishment of vegetation and coarse (large boulder-sized) sediment (USFS 1993).

Some of the high-gradient, mainstem tributaries have channel instability issues due to their flashy flow regimes. For example, the upper reaches of Lightning, Sleepy, and Cow Creek (including tributaries) are defined by naturally occurring high flows, and contribute to considerable bedload movement at the bottom of the reach. Management effects are considered to be secondary to natural disturbance pressures in the majority of these areas.

The mainstem Imnaha River, from RM 20.1 to RM 49.6, flows primarily through private lands. Although pastures are found throughout these reaches (some within 30 feet of the river), there were few bank areas damaged by cattle, primarily due to the presence of riparian fencing (USFS 2003d). Evidence of moderate grazing activity on the west bank was found throughout the stretch from RM 53.7 to RM 56.9 (USFS 2003d). A powerline right-of-way follows the west bank of reach 16 through its length and is preventing development of riparian vegetation in some locations (RM 56.9–RM 60).

In the Big Sheep Creek drainage, streambank stability was rated moderate to high for the mainstem, and moderate for reaches above the diversion canal (USFS 2003d). The slope, coarse texture, and low water holding capacity in the upper reaches of Big Sheep Creek contribute to the lower channel stability rating, especially in areas where the river flows through steep-sided, unconsolidated, colluvial and glacial outwash material (USFS 2003d). In the Marr Flat area, streambank stability has been compromised due to livestock trampling. Riparian improvement projects specifically designed to discourage trailing were implemented between 1997 and 2001 in headwater portions of Skookum Creek, Mahogany Creek, Shadow Canyon, Marr Creek, and a tributary to Gumboot Creek (USFS 2003d). A marked improvement in streambank condition has been observed by Unit biologists since the projects have been completed.

Depending on the subwatershed and its associated land use, streambank condition typically ranges between the classification of “functioning appropriately” in the upper and lower Imnaha watersheds and “functioning at risk” in the Big Sheep Creek watershed. Reach-specific comments about channel stability that were generated during the QHA modeling process are shown in Table 69.

Table 69. QHA-generated comments about channel stability.

Subwatershed/Reach	HUC	Comment
Upper Camp Creek	07C	Pond on upper end; likely to blow out without management action
Bear Gulch/Summit Creek	07E	Channel stability in lower reaches is poor due to private ownership
Lightning Creek	07G	High-gradient channel limits channel stability
Middle Little Sheep Creek	07H	Portions of Little Sheep Creek have low channel stability due to historical hydro-operations; penstock blew out, resulting in considerable bedload movement
North Fork Imnaha River/mainstem	09O	Channel stability and fine sediment a problem due to blow-outs
North Fork Imnaha River/unnamed tributary	09O	Channel stability and fine sediment a problem due to blow-outs

Channel Stability—Characterization of Historical Conditions

Based on input from local biologists, the stability of Imnaha stream channels was historically greater than current conditions. Bank stability values used to define the reference conditions spreadsheet in the QHA model were all rated as 100% of normative, with the exception of the North Fork Imnaha 6th field HUC, which received an 80% of normative rating.

The high channel stability ratings reflect the inherent geologic stability of the Imnaha subbasin. The bedrock canyons and large boulder substrate that line the majority of the stream channels afford the Imnaha and its tributaries unique constancy with regards to natural disturbance pressures.

Characterization of Restoration Needs

Many of the areas where bank stability is considered a problem occur on private land, and will require landowner participation to restore. Restoration needs specifically related to bank stability problems in the Imnaha subbasin are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As presented in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, several streambank stability restoration efforts in the Imnaha subbasin. Although the effects associated with the cessation of these activities is unknown, it is likely that erosion rates would eventually increase and contribute to the decline in anadromous salmonid habitat condition.

Habitat Diversity⁴—Characterization of Current Conditions

Similar to other river systems, the diversity of habitat in the Imnaha is highest in lower-order, high-elevation stream reaches and generally declines with an increase in river size. Differences in habitat diversity between similar-sized river segments do exist, however, especially when comparing federally managed lands to privately owned lands.

Large woody material (LWM), which contributes substantially to habitat diversity, is functionally absent throughout the lower 16 miles of the mainstem Imnaha, and in the lower reaches of Lightning Creek (USFS 2003d). It is important to note, however, that the majority of the lower Imnaha is bordered by an arid grassland and basalt rock landscape, which has never been conducive to the generation of instream wood. LWM frequency is also considered to be “functioning at unacceptable risk” in the lower reaches of Big and Little Sheep creeks, Bear Creek, and the middle reach of Little Sheep Creek (USFS 2003d). Similar to the lower mainstem Imnaha, many of the lower-elevation reaches in the Sheep Creek system are arid and treeless; however, alteration of the riparian reserves has reduced the current condition below what is thought to be natural potential (USFS 2003d). Overall, LWM frequency in the upper Imnaha is considered to be “functioning appropriately”, with the exception of the first 19 miles of the mainstem above the town of Imnaha which are rated as “functioning at unacceptable risk”.

In terms of off-channel habitat, there are no areas in the Imnaha subbasin that are considered to be “functioning at unacceptable risk” (USFS 2003d). Off-channel habitat in the lower Imnaha is limited, however, and based on USFS stream surveys conducted in the early 1990s it comprises only 4% of the overall habitat (Mays 1992). The relatively low amount of off-channel habitat in this and other portions of the subbasin is likely due to a combination of steep gradient and conversion of floodplains to pastures and cultivated fields. Although, no recent information quantifies current amounts of off-channel habitat available in the watershed, off-channel habitat likely increased during the flood of 1997. Pending collection and review of this updated information, this indicator is “functioning at risk” at the subbasin scale (USFS 2003d).

Habitat refugia, as provided through undercut banks, large boulder substrate, overhanging riparian vegetation, bedrock shelves, etc., is abundant throughout the majority of federally managed lands and is rated as “functioning appropriately” at the subbasin scale. Refugium is notably lower in the Sheep Creek system, especially throughout the middle and lower mainstem reaches of Big and Little Sheep Creek. In the mainstem Imnaha, refugia is considered to be “functioning at risk” from RM 16 to RM 37, a factor possibly due to the presence of the Imnaha River road and/or the conversion of floodplain areas to cultivated fields. Reach-specific comments about habitat diversity that were generated during the QHA modeling process are shown in Table 70.

⁴ Incorporation of USFS BA data into the QHA model required several adjustments, including how habitat diversity was assessed. The USFS BA uses Physical Barriers, Large Woody Material, Pool Quality/Frequency, Off-Channel Habitat, and Refugia to define the habitat elements metric, while the QHA model relies on Multiple Channels and Large Woody Material in its habitat diversity metric. Based on discussions with the Imnaha Technical Subcommittee (09/09/2003), it was agreed that the USFS ratings of Large Woody Material, Off-Channel Habitat, and Refugia would be used to define the QHA habitat diversity metric. Pool Quality/Frequency was omitted due to inconsistencies in data collection and interpretation. The three USFS habitat attributes were averaged to come up with a single habitat diversity rating used in the model.

Table 70. QHA-generated comments about habitat diversity.

Subwatershed/Reach	HUC	Comment
Big Sheep Creek (RM 4)/lower	07K	Private land grazing contributes to lack of habitat diversity
Big Sheep Creek (RM 4)/upper	07K	Private land grazing contributes to lack of habitat diversity
Horse Creek	08G	No multiple channels

Habitat Diversity—Characterization of Historical Conditions

The diversity of habitat in the Imnaha subbasin was undoubtedly greater during presettlement times than currently. Habitat simplification has occurred through riparian harvest, conversion of floodplain areas, road construction, streambank fortification, and other land use activities.

Habitat diversity values used to define the reference conditions spreadsheet in the QHA model were rated as 100% of normative for all focal species, with the exception of the lower Camp Creek HUC, which was rated at 80% of normative due to the elimination of a historical cottonwood gallery that added complexity to the channel.

Characterization of Restoration Needs

Characterizations of restoration needs, as they relate to habitat diversity, are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, numerous enhancement/restoration efforts designed to improve instream habitat diversity throughout various portions of the Imnaha subbasin. If the efforts that are designed to mitigate for the effects caused by land use activities were to terminate, while land use practices continued, there would likely be a decline in the amount and type of diverse habitat units. This reduction would undoubtedly force focal salmonids into less desirable habitat, which would do little to further population restoration goals. The specific degree to which a cessation of projects designed to improve instream habitat diversity would affect anadromous salmonid populations in the future is unknown.

Fine Sediment—Characterization of Current Conditions

Fine sediment problems in the Imnaha are localized. The geology of the subbasin is a primary reason that instream sedimentation is only problematic in certain areas, as it is largely comprised of nonerodible Columbia River Basalt, metamorphosed volcanic rock, coarse alluvium, and hydrophyllic volcanic ash overlying upland areas.

Accumulation of fine sediment does occur in depositional areas, areas affected by wildfire, insects, and/or pathogens, reaches bordered by geologically unstable uplands, and in reaches that are subjected to various land use activities. The magnitude of which these and other sedimentation processes have affected salmonid habitat, as assessed by the Wallowa-Whitman National Forest (2003), is a “functioning at risk” classification for the Big Sheep and lower Imnaha watersheds and a “functioning appropriately” classification for the upper Imnaha

watershed. Reach-specific comments about fine sediment that were generated during the QHA modeling process are shown in Table 71.

Livestock grazing, rural home sites, and pasture creation are cited as among the primary land use activities causing alterations to sediment availability and routing to stream reaches in Big Sheep Creek (RM 31.9), and lower and middle Little Sheep Creek (USFS 2003d). Operation of the Wallowa Valley Improvement District irrigation canal on Big Sheep (RM 31.9–RM 33.7) has also led to a change in sediment availability and transport capacity due to decreased flows.

Several of the low-gradient reaches of Big Sheep Creek are defined by streambed “pavement”, which has occurred due to an absence of flushing flows related to the Wallowa Valley Irrigation Canal and hydropower operations (USFS 2003d). In 1997, hydropower operations were ceased. Hydropower operations used to divert water into the irrigation canal during April, May, and June. Without hydropower operations in the spring, the additional flows in the lower reaches of Big Sheep Creek are available to transport and process sediment (USFS 2003d).

Other important processes of sedimentation affecting focal species’ habitat in the Sheep Creek system include streambank erosion, sheet erosion, gully erosion, and rill erosion. Landslide and debris flow hazard ratings were found to be at natural levels (USFS 2003d). Low-gradient reaches in Lick Creek (RM 3.4) are impacted by fine sediments sloughing off the erodible streambanks. Accelerated sheet and rill erosion has been documented in various portions of the Big Sheep Creek watershed (subwatersheds 07J, 07O, 07P, 07Q, 07R; see Figure 3 for locations) and has been related to a combination of effects resulting from timber harvest and the Canal and Twin Lakes Fires (USFS 2003d). Accelerated gully erosion hazard was noted in subwatersheds 07J, 07O, and 07R, again the result of fires and timber management. Fire effects are also contributing to fine sediment problems in the upper reaches of Horse Creek.

The “functioning at risk” classification for the mainstem Imnaha River below Nine Point Creek is due in large part to the high quantity of bedload moved during the 1997 flood (USFS 2003d). Sedimentation in mainstem tributaries is most problematic in headwater reaches. Roading, timber, and grazing are cited as the primary land use activities in these areas, and have acted cumulatively to modify sediment transport and storage (USFS 2003d).

Although landslides are generally not considered a primary vehicle of sediment delivery to streams in the subbasin, there have been two notable occurrences that substantially altered fish habitat. On North Fork Imnaha River, inside the wilderness area, a thunderstorm in August 1992 triggered a debris flow in a tributary. The debris fan formed at the confluence of the tributary and North Fork Imnaha, shifting the thalweg of the North Fork and initiating a landslide (USFS 2003d). Then, on January 1, 1997, the Imnaha River reached a record high discharge of 20,200 cfs during a rain-on-snow flood event, triggering landslides and debris flows within its tributaries. The event modified stream channel morphology through mass movements of bedload material causing the formation of mid-channel and lateral gravel and cobble bars (USFS 2003d). This material will continue to move in pulses downstream until stabilized by large woody material (LWM), riparian vegetation, or channel processes resulting in elevated levels of sediment.

Table 71. QHA-generated comments about fine sediment.

Subwatershed/Reach	HUC	Comment
Lower Camp Creek/lower	07B	Fine sediment a problem due to alluvium
Devils Gulch	07F	Fine sediment a problem due to alluvium
Horse Creek	08G	Fines a problem due to fire effects
Rich Creek/mainstem	09E	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Rich Creek/Shadow Canyon	09E	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/mainstem	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/Morgan Creek	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 1	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 2	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 3	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek Creek/mainstem	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/North Fork	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/unnamed tributary 1	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/unnamed tributary 2	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
North Fork Imnaha River/mainstem	09O	Channel stability and fine sediment a problem due to blow-outs
North Fork Imnaha River/unnamed tributary	09O	Channel stability and fine sediment a problem due to blow-outs

Fine Sediment—Characterization of Historical Conditions

The amount and distribution of fine sediment in streams and rivers throughout the Imnaha subbasin was historically lower prior to the introduction of livestock, the removal of soil-stabilizing vegetation, or construction of road networks.

Fine sediment ratings used to define the reference conditions spreadsheet in the QHA model were rated as 100% of normative for all focal species, with the exception of the North Fork Imnaha HUC, which was rated at 80% of normative (all species).

Characterization of Restoration Needs

Characterizations of restoration needs, as they relate to fine sediment, are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, numerous enhancement/restoration efforts designed to reduce the amount of fine sediment throughout various portions of the Imnaha subbasin. If the efforts that are designed to mitigate for the effects caused by land use activities were to terminate, while land use practices continued, there would likely be a decline in the amount and availability of spawning and rearing habitat. This reduction would presumably force focal salmonids into marginal habitat, which would do little to further population restoration goals. The specific degree to which a cessation of projects designed to decrease fine sediment would affect anadromous salmonid populations in the future is unknown.

High Flow—Characterization of Current Conditions

Based on hydro data from the Imnaha and Gumboot stream gages, peak flow and flow timing characteristics of the Imnaha River appear to be comparable to, or slightly elevated above, an undisturbed watershed of similar size, geology, and geography (“functioning appropriately” or “functioning at risk”; USFS 2003d). As discussed previously (see section 1.1.3.3, p. 89), changes to vegetation, increases in drainage density from road construction, off-site watering, and irrigated agriculture have altered peak flow characteristics in some portions of the subbasin, which may be causing reductions in salmonid habitat quality and quantity.

Wildfire, pathogens, insect outbreak, and windstorms have acted cumulatively to modify vegetative characteristics within the Big Sheep Creek watershed, and have subsequently altered peak flow characteristics (USFS 2003d). The Canal Fire of 1989 burned an estimated 9,320 acres in the Sheep Creek watershed, 5,996 of which were burned at a high intensity level. The reduction of timber led to a reduction in hydrologic storage capacity in the upper Little Sheep and Big Sheep creek (RM 34) subwatersheds, resulting in a “functioning at risk” classification for increased peak flows (USFS 2003d). The Carroll Creek subwatershed was also affected by the Canal Fire, as well as insect outbreak and windstorms, resulting in a “functioning at an unacceptable risk” from increased peak flows classification. This indicator has recently been upgraded to “functioning at risk” because of vegetative regrowth, especially lodgepole pine, within the drainage (USFS 2003d).

The naturally high gradient of some tributary reaches, combined with effects from land use activities, produces a very flashy flow regime that is often capable of mobilizing bedload and disrupting salmonid habitat. According to local biologists, these problems are most common in perennial tributaries to the upper Imnaha (Table 72).

Table 72. QHA-generated comments about high flows.

Subwatershed/Reach	HUC	Comment
Lightning Creek	08H	High flows contribute to considerable bedload movement at bottom of reach
Lower Cow Creek	08K	Naturally occurring high flows contribute to considerable bedload movement at bottom of reach
Freezeout Creek/lower	09B	Naturally flashy flow regime contributes to high bedload movement

Subwatershed/Reach	HUC	Comment
Freezeout Creek/upper	09B	Naturally flashy flow regime contributes to high bedload movement
Rich Creek/mainstem	09E	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Rich Creek/Shadow Canyon	09E	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/Morgan Creek	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 1	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 2	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Upper Grouse Creek/unnamed tributary 3	09F	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/mainstem	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/NF	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/unnamed tributary 1	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition
Gumboot Creek/unnamed tributary 2	09K	Naturally flashy flow regime and high-gradient channel contributes to bedload movement and fine sediment deposition

High Flow—Characterization of Historical Conditions

Because of the nearly 75 years of flow records, it is reasonable to assume that we have sufficient information to characterize historical conditions in the Imnaha and establish whether high flow magnitude, frequency, and timing have changed. Based on analyses conducted by the Wallowa-Whitman National Forest, peak flows have remained relatively unchanged over the period of record, and are estimated to be slightly above high flows common in an unmanaged subbasin sharing similar biophysical characteristics (USFS 2003d). However, Thompson (1960, as cited in Mundy and Witty 1998) reported that flow records during the period 1929–1957 (28 years) indicate flow discharge was 21 times greater than which exists during the egg deposition period and that these flows occur every year during spring months. The ramifications of flows of this magnitude include the potential for fall chinook embryo dislodgement.

Prior to settlement, high flows in the Imnaha were likely ameliorated by denser stands of vegetation, and weren't subjected to the runoff-channeling effects caused by the current road network. In some drainages, such as Devils Gulch, it is likely that high flows had always restricted salmonid use.

All of lower and upper Camp Creek were rated as “80% of normative” in the QHA reference conditions assessment. Devils Gulch, Lightning Creek, Cow Creek, Freezeout, the mainstem Imnaha (from RM 37 to RM 55), Summit Creek, Crazymen Creek, and Mahogany Creek were considered to historically have high flow problems, and were all rated as 80% of normative.

High flow ratings used to define reference conditions for all other reaches and species in the QHA model were rated as 100% of normative.

Characterization of Restoration Needs

Characterizations of restoration needs, as they relate to high flow effects, are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently *no* enhancement/restoration efforts specifically designed to reduce the effects of high flows in the Imnaha subbasin. Based on the current lack of peak flow restoration activities, it is difficult to state what a continued lack of action would do to fish habitat. It is likely that high flow problems are being addressed indirectly through other projects, such as improvements to habitat diversity, and that a cessation of these activities would do little to further population restoration goals.

Low Flow—Characterization of Current Conditions

Excessively low base flow conditions in the Imnaha subbasin, and specifically in the Big Sheep Creek watershed, are considered to affect resident and anadromous habitat availability.

Operation of the Wallowa Valley Improvement District canal is considered to limit streamflow for bull trout during the peak irrigation season (NPT and ODFW 1990), and may act cumulatively during low precipitation years to limit anadromous spawning and rearing habitat availability (USFS 2003d). Decommissioning of three hydropower facilities from this canal has reduced the amount of water withdrawn from Big Sheep and Little Sheep creeks; however the ditch continues to be operated near or at capacity from June through September for irrigation purposes (USFS 2003d). During these months, a major portion of the flow of Big Sheep Creek is diverted into the canal. Seeps from the diversion and other downstream tributaries, such as Johnson Creek, reestablish minimum instream flows within a half-mile of the diversion.

The low flow problems that exist in other portions of the subbasin are primarily related to natural phenomenon as opposed to land use practices. As mentioned previously, coarse-grained alluvium is common in several portions of the subbasin. Streamflows occurring in these areas during summer months are said to “sub-out” or run subsurface. Subsurface base flows are most common in areas defined by a flashy flow regime, and/or near low-gradient confluence reaches at the base of otherwise high-gradient systems. The only QHA-based comment specifying a stream reach that is limited by low flow conditions was for Corral Creek, within which salmonid migration is likely impeded (during some years) at the confluence by low flows.

The Big and Little Sheep Creek watersheds have been identified as areas of high priority for streamflow restoration (Figure 60). ODFW and OWRD have established priorities for restoration of streamflow from consumptive users, as part of the Oregon Plan for Salmon and Watersheds (Measure IV.A.8). ODFW has identified the “need” for streamflow restoration through ranking of biological and physical factors, water use patterns and the extent to which water is a primary limiting factor. OWRD ranked the opportunities and likelihood for achieving meaningful streamflow restoration. Rankings were performed for subwatersheds at approximately the 5th field HUC. OWRD watermasters will incorporate the priorities into their fieldwork activities as a

means for implementing flow restoration measures. The “needs” priorities will be used by the Oregon Watershed Enhancement Board as one criterion in determining funding priorities for enhancement and restoration projects. Watershed councils and other entities may also use the needs priorities as one piece of information determining high priority restoration projects.

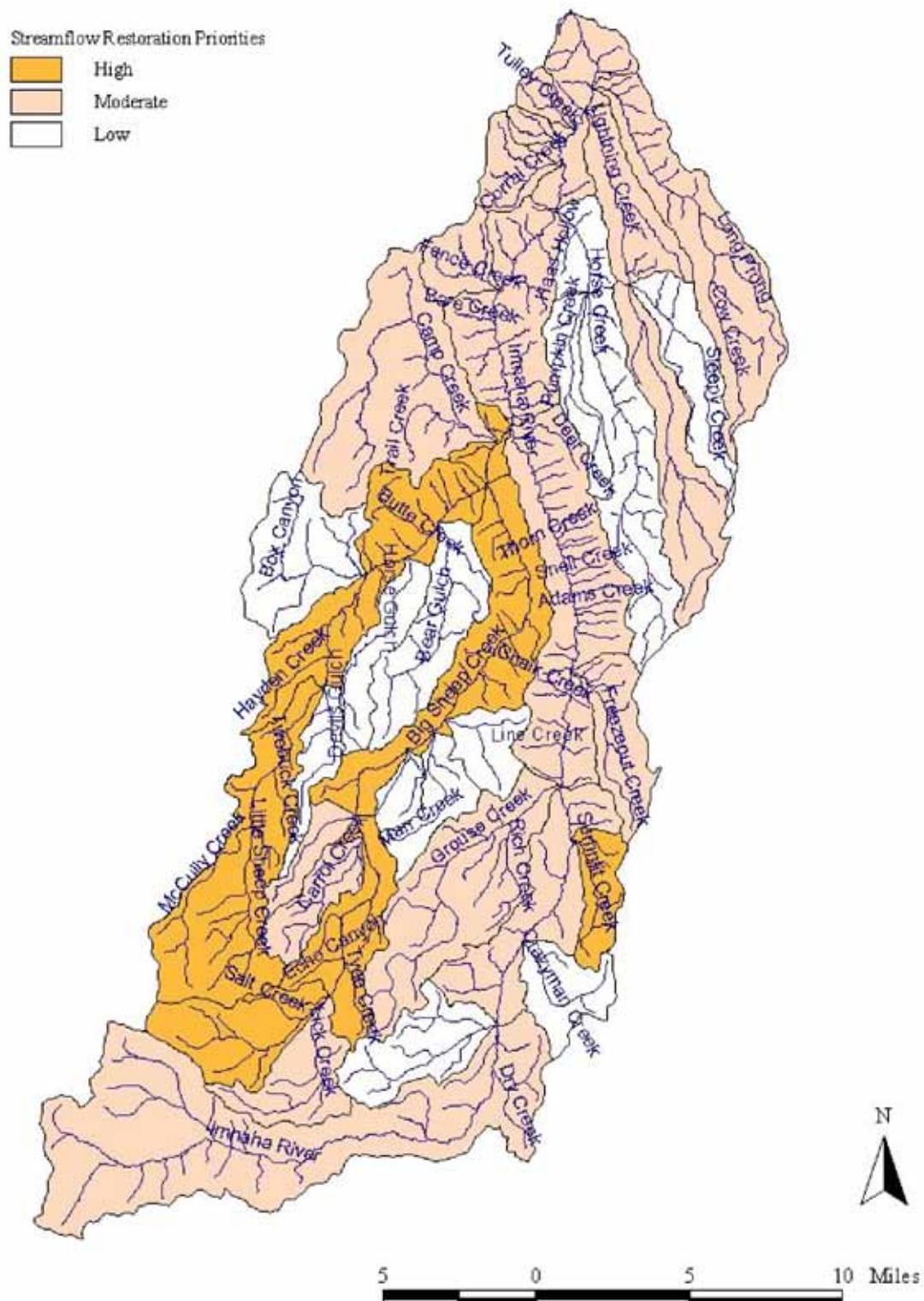


Figure 60. Streamflow restoration priorities in the Imnaha subbasin (ODFW 2001a).

Low Flow—Characterization of Historical Conditions

Natural base flows in Big Sheep Creek and in the lower mainstem Imnaha were historically higher prior to the arrival of settlers and irrigated agriculture. In 1930, a decree was filed for 23.16 cfs of water to be diverted out of McCully Creek from April 1–July 31 for irrigation, plus an undefined amount for stock and domestic use, which was estimated to be about 0.09 cfs (Bliss 2001). The decree of 1905 is considered to be the first water right filed associated with the Wallowa Valley Improvement Canal, granting an undefined contribution of as much as 162.74 cfs from McCully Creek, Little Sheep Creek, and all tributaries crossed by the ditch up to but not including Big Sheep Creek during the months April–July (Bliss 2001; NPT et al. 1990). In 1983, three small hydropower production facilities, upper Little Sheep Creek, Canal Creek, and Ferguson Ridge were constructed along the Wallowa Valley Improvement Canal in the Big Sheep Creek watershed, bringing the amount of water that could potentially be removed from the watershed to 200.53 cfs (Mason et al. 1993, USFS 2000; 2003d).

With the decommissioning of the hydropower facilities in 1997, the season of water withdrawal for irrigation purposes has been reduced to the June to September period (USFS 2003d). Thus, the opportunity for extended flushing spring flows is likely.

QHA-based discussions of historical low flow problems identified lower Camp Creek (HUC 07B) as an area where flows likely went subsurface during summer months, and Devils Gulch (HUC 07F) as an area that has always had low flow problems due to its inherently flashy flow regime.

Characterization of Restoration Needs

Restoration efforts throughout the subbasin should be coordinated with all ongoing prioritization efforts currently being implemented by OWRD and ODFW. Low flow restoration needs, as defined through the QHA modeling process, are provided in the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently *no* enhancement/restoration efforts specifically designed to increase low flows in the Imnaha subbasin⁵. Based on the current lack of “low flow restoration” activities, it is difficult to state what a continued lack of action would do to fish habitat. It is likely that low flow problems are being addressed indirectly through other projects, such as improvements to riparian areas, and that a cessation of these activities would do little to further population restoration goals.

Oxygen—Characterization of Current Conditions

Highly oxygenated water occurs in all habitats throughout the Imnaha subbasin year-round.

⁵ It is apparent that the streamflow prioritization efforts by OWRD and ODFW were omitted in the Inventory of Existing Activities volume of the subbasin plan; however, no other “low flow restoration” projects were identified at the time of this document’s preparation.

Oxygen—Characterization of Historical Conditions

Although historical water quality data are limited, there is little evidence suggesting that oxygen levels were once different from what they are currently.

Characterization of Restoration Needs

Because salmonid habitat throughout the subbasin is well-oxygenated year-round, there are no restoration needs that are based on this parameter.

Characterization of Future with No New Actions

(See information in the section above.)

Low Temperature—Characterization of Current Conditions

Low winter stream temperatures in the Imnaha are currently common in most reaches and are not considered to substantially impair the condition of habitat for focal salmonid species. According to Mundy and Witty (1998), there is some concern that water temperatures may be too cold for the sufficient development of fall chinook embryos. Mundy and Witty (1998) state that water temperatures at the confluence of the Imnaha and Snake River drop below 4 °C, which has been found to inhibit embryo survival, especially if the eggs were deposited late in the fall and had not advanced to a stage that is tolerant of prolonged cold temperatures (e.g., Cramer 1993, as cited in Mundy and Witty 1998). Ice floes are also common during winter months, and may or may not be responsible for dislodging some salmon embryos. Reach-specific comments about low stream temperatures were not made.

Low Temperature—Characterization of Historical Conditions

Historical [and current⁶] winter stream temperature data for the Imnaha are limited. It is likely that during presettlement conditions, winter stream temperatures weren't as severe as current due to the higher degree of insulation provided through the historically denser riparian canopy.

Characterization of Restoration Needs

Refer to the Limiting Factors section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently *no* enhancement/restoration efforts specifically designed to increase winter stream temperatures in the Imnaha subbasin. Based on the current lack of low temperature restoration activities, it is debatable to state what a continued lack of action would do to fish habitat. It is likely that low winter stream temperature problems are being addressed indirectly through other projects, such as improvements to riparian areas, and that a cessation of these activities would do little to further population restoration goals.

⁶ USFS temperature probes are not installed during winter months due to the amount of damage to these probes.

High Temperature—Characterization of Current Conditions

As discussed in the Water Quality section of this document (see section 1.1.2.3), the §303(d)-listed streams within the Imnaha subbasin, which includes the entire Imnaha River mainstem and some stream reaches in key tributaries (see Table 11 and Figure 25), exceed the numeric criteria of the water quality standard for temperature (see Table 12). Land use activities and/or natural environmental conditions act alone or in combination to cause reach listings.

Based on the PacFish and Bull Trout Matrix criteria used in the Wallowa-Whitman National Forest's *Multi-Species Biological Assessment* (2003d), most subwatersheds should be classified as "functioning at an unacceptable risk" for the high temperature indicator. The USFS does not believe that this rating is justified, however, and does think that most streams are at or near their environmental potential, justifying a "functioning appropriately" or "functioning at risk" classification (USFS 2003d).

According to the Wallowa-Whitman National Forest, these streams are at or near environmental potential because 1) temperature probes are not necessarily installed in cool water areas, 2) good shrub and tree cover exist within riparian areas, and 3) temperatures are suitable during spawning through emergence (USFS 2003d). See Table 73 and Appendix C for stream temperature observations within the subbasin.

Operation of the Wallowa Valley Irrigation District Canal has been a major influence on stream water temperature in the middle and lower reaches of Big Sheep Creek. As mentioned previously, the canal operates near or at capacity June through September, and diverts a major portion of Big Sheep Creek's flow (USFS 2003d). Downstream habitat is affected directly by the loss of potential flow volume, and indirectly by the accordant increases in stream temperature. As shown in Table 73, high stream temperatures occur near the end of July or first of August, which is coincident with low streamflows and warm ambient temperatures. By the end of August, stream temperatures are dropping. Above the irrigation canal, stream water temperatures are at environmental potential and "functioning appropriately" (USFS 2003d). The only influence to riparian vegetation above the diversion has been from the 1989 Canal Fire, insect damage, snow avalanches, and debris flows, all of which have had minimal influences on overall stream temperature.

In the Little Sheep Creek drainage, stream temperatures are considered to be below environmental potential for bull trout, and "functioning at risk" (USFS 2000). Elevated summer stream temperatures are naturally common in the lower-elevation portions of Little Sheep Creek due to its biophysical attributes. The inherently high July/August stream temperatures have been elevated, however, by riparian modification. Riparian species, such as cottonwood and ponderosa pine, have been eliminated in portions of the lower subwatershed by grazing, cultivation, homesteading/clearing, and road construction (USFS 2000), and have been reduced in upper portions of the watershed by fire, windthrow, and insect infestation. For example, the Little Sheep Creek Highway borders the naturally confined channel for approximately 75% of its length and in many areas is bounded by either pastures or cultivated land. These land uses have effectively limited floodplain function and ultimately riparian vegetation establishment. Compounding this problem are the effects from the Canal Creek Fire of 1989 and subsequent insect infestations, which have reduced effective stream shade-providing riparian vegetation in the upper portions of the subwatershed.

Table 73. Seven-day moving maximum stream temperatures (°F) recorded at USFS monitoring sites (USFS 2003d).

Location	Year	May	June	July	August	September	October
Sheep Creek Watershed (07)							
Big Sheep at Echo Canyon	89	36	38	40	42	45	46
	90	49	59	66	68	63	57
	91	47	52	65	67	62	56
	92	50	62	N/A	N/A	N/A	56
	93	51	55	60	65	61	54
	94	48	64	71	71	63	50
Big Sheep at Lick Creek	91	56	51	65	66	61	55
	92	N/A	67	67	68	59	50
	93	51	54	59	64	59	52
	94	N/A	63	70	69	61	N/A
	95	N/A	48	54	61	59	48
	96	N/A	N/A	64	64	60	52
Big Sheep below Canal	93	47	N/A	54	59	55	49
	94	N/A	57	65	65	57	N/A
	95	N/A	42	52	55	54	44
Big Sheep above Canal	96	N/A	N/A	51	51	50	46
	97	N/A	N/A	57	55	53	48
Lick Creek at Mouth	90	47	57	64	65	60	53
	91	45	50	63	64	56	N/A
	92	N/A	N/A	65	66	51	N/A
	94	46	61	67	67	58	46
	95	N/A	51	58	60	57	48
	96	N/A	N/A	63	62	58	51
	97	N/A	N/A	59	60	56	50
Little Sheep at USFS Boundary	96	N/A	N/A	59	58	57	54
Cabin Creek above Canal	96	N/A	N/A	51	51	50	46
McCully Creek at USFS Boundary	96	N/A	N/A	52	51	49	44
Redmont Creek above Canal	89	45	54	56	N/A	N/A	N/A
Lower Imnaha Watershed (08)							
Lightning Creek	93	57	57	61	67	63	57
Upper Lightning	94	N/A	N/A	59	N/A	51	51
Cow Creek	93	55	60	67	75	69	N/A
Fence Creek	91	64	68	69	70	66	60
Imnaha at Marr Ranch	91	55	69	N/A	67	71	55
Upper Imnaha Watershed (09)							
Grouse Creek	92	N/A	N/A	64	65	56	50
Gumboot Creek	92	N/A	66	65	66	59	55
	97	N/A	55	54	55	52	48
Rich Creek	97	N/A	53	58	60	57	51
Dry Creek	97	N/A	53	57	67	66	57
Skookum Creek	97	N/A	55	60	62	59	51
Imnaha at Nine Point Creek	93	N/A	N/A	57	62	60	55
	94	N/A	N/A	71	72	64	58
	96	N/A	N/A	60	62	61	55
Imnaha at Indian Crossing	94	N/A	N/A	63	63	56	46
	95	N/A	N/A	54	56	54	47
	96	N/A	N/A	56	57	55	49
	97	N/A	N/A	N/A	56	55	50

Summer stream temperatures in the lower mainstem Imnaha and associated perennial tributaries typically exceed the 50° F state standard (Table 73; Appendix C). In Lightning Creek, stream size, natural grassland vegetation, drainage size, and the limited amount of riparian area modifications are considered to be the primary drivers of high temperatures, which, according to the Wallowa-Whitman National Forest, justifies the stream to be delisted by the state (USFS 2003d). These concerns have yet to be addressed by ODEQ.

High stream temperatures in the upper Imnaha (RM 24 to headwaters) are also largely driven by natural conditions. Several subwatersheds/reaches on the §303(d) list for high temperatures, including Gumboot Creek, and the upper reaches of the Imnaha River, are arguably at or near their natural potential for this particular indicator due to the grassland ecosystem, the size of the drainage basin, and few riparian area modifications (USFS 2003d).

Other temperature-listed subwatersheds/reaches in the upper Imnaha are in excess of state standards due to land use activities. Riparian modification is known to have influenced stream temperatures throughout private land parcels bordering the mainstem (roughly from the town of Imnaha upriver to Gumboot Creek) (USFS 2000). Cultivation, farming, and settlement have reduced the occurrence of riparian species in certain areas, and are believed to be primary contributors to stream temperature increases. For instance, stream temperatures below the Imnaha River Woods Development (RM 50–RM 54) have increased following the removal of forest canopy for the establishment of a powerline right-of-way (RM 57–RM 60) (USFS 2000). The modification has shifted a historical cold water to cool water transition zone upriver several miles. In 1992 the seven-day moving average of daily maximum temperatures recorded on Grouse Creek was 65.3°F (ODEQ data).

Most of the QHA-based comments dealing with high stream temperatures are related to the condition of riparian vegetation (Table 74).

Table 74. QHA-generated comments about high stream temperatures.

Subwatershed/Reach	HUC	Comment
Big Sheep Creek (RM 25)/tributary	07P	High temperature rating reflects riparian condition
Big Sheep Creek (RM 25)/main.1	07P	High temperature rating reflects riparian condition
Big Sheep Creek (RM 25)/main.2	07P	High temperature rating reflects riparian condition
Lower Grouse Creek/main.1	09D	High temperature rating reflects riparian condition
Lower Grouse Creek/main.2	09D	High temperature rating reflects riparian condition
Lower Grouse Creek/Road Creek	09D	High temperature rating reflects riparian condition
Upper Grouse Creek	09F	Grazing has degraded riparian condition and contributed to temperature problems in the upper end of Grouse Creek (plateau area primarily)
Summit Creek/main.1	09H	High temperature rating reflects riparian condition
Summit Creek/main.1	09H	High temperature rating reflects riparian condition

High Temperature—Characterization of Historical Conditions

Historical summer stream temperature data for the Imnaha are limited. It is reasonable to assume that during presettlement conditions (pre-1850s) summer stream temperatures weren't as high as current due to the higher degree of shading provided through the historically denser riparian canopy, and the higher volume of cool water which is currently intercepted by the Wallowa Valley Improvement Canal. Because the canal has been in operation prior to the collection of water quality data, the degree to which it has modified downstream temperatures is unknown.

Characterization of Restoration Needs

Restoration needs that address high stream temperatures are provided in the Limiting Factors Section of this document. Prior to initiation of any restoration efforts, there should be consultation with local biologists to determine the degree to which temperatures are above their natural potential.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, multiple enhancement/restoration efforts specifically designed to decrease summer stream temperatures in the Imnaha subbasin. If the efforts that are designed to mitigate for high temperature effects caused by land use activities were to terminate, while land use practices continued, there would likely be a decline in the amount and availability of spawning and rearing habitat. This reduction would assumedly force focal salmonids into marginal habitat, which would do little to further population restoration goals. The specific degree to which a cessation of projects designed to decrease stream temperatures would affect anadromous salmonid populations in the future is unknown.

Pollutants—Characterization of Current Conditions

Excluding thermal modification and temperature as pollutants, currently none of the Imnaha subwatersheds are on Oregon's §303(d) list for chemical contamination or nutrients, and based on analyses conducted by the USFS, all three watersheds (Big Sheep Creek, upper Imnaha River, and lower Imnaha River) have been classified as "functioning appropriately" for this indicator.

Despite the lack of listing, localized problems with chemical and organic pollutants have been reported in some portions of the subbasin. Septic tanks and feedlots have been cited as potential sources of chemical contaminants to some habitats in the Big Sheep Creek watershed (USFS 1996; Wallowa County and NPT 1999). The Nez Perce Tribe and ODFW (1990) also report that feedlots, located on private lands along Little Sheep Creek and the upper and lower mainstem Imnaha, contribute varying amounts of nutrients to surface water, most notably following localized, high-intensity thunderstorms (B. Smith, ODFW, personal communication, April 12, 2001). The impacts of this pollution on the aquatic environment are, however, considered to be short in duration and scope due to the volume and velocity of flows in the affected areas (B. Smith, ODFW, personal communication, April 12, 2001).

With the exception of the Devils Gulch (HUC 07F) and Lightning Creek (HUC 07G) subwatersheds, all subwatersheds were rated as currently being at least 80% of normative for the

pollutant metric in the QHA modeling process. No pollutant-specific, QHA-generated comments were made.

Pollutants—Characterization of Historical Conditions

Documentation of pollutants historically compromising aquatic habitat conditions in the Imnaha subbasin are not available. Since livestock were historically free-ranging, there was not the current problem of localized impacts from feedlots. Septic tanks, however, have probably always posed somewhat of an organic enrichment problem in the subbasin, as sewer systems have never serviced outlying homesteads. Aquatic pollution prior to settlement of the subbasin was likely never a threat to aquatic habitat conditions, despite the considerable number of livestock (between four and five thousand head in the lowlands) owned by the Nez Perce Tribe.

Characterization of Restoration Needs

Restoration needs that address pollutant problems are provided in the Limiting Factors Section of this document.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there is currently only one Plan specifically designed to deal with nonpoint source pollutants. The Oregon Senate Bill 1010 is designed to reduce water pollution from agricultural sources and protect beneficial uses of watersheds. If these efforts were to terminate, while agriculturally-generated pollution continued, there would likely be a decline in the amount and availability of spawning and rearing habitat. This reduction would assumedly force focal salmonids into marginal habitat, which would do little to further population restoration goals. The specific degree to which a cessation of projects designed to decrease pollution would affect anadromous salmonid populations in the future is unknown.

Obstructions—Characterization of Current Conditions

Irrigation diversions, culverts, and low flow conditions currently represent the primary problems to focal species migration. The USFS (2003d) rated a total of ten subwatersheds as “functioning at risk” due to culverts, and one subwatershed as “functioning at unacceptable risk” due to an irrigation diversion. Comments specific to obstructions that were generated during the QHA modeling process are shown in Table 75.

A diversion ditch for the Wallowa Valley Improvement District canal currently impedes upstream migration of steelhead and bull trout into the upper Little Sheep Creek subwatershed and into creeks such as Big Sheep, McCully, Ferguson, Canal, Redmont, and Salt (USFS 2003d). Irrigation diversions obstructing migration were also identified in lower Camp Creek and in lower Grouse Creek (during low flow periods). Stock ponds in the upper Camp Creek subwatershed and in the Lightning Creek subwatershed were also considered to impede the migration of salmonids into otherwise usable habitat areas (see QHA comments, Table 75). Fish weirs on Little Sheep Creek and the Imnaha River are manmade physical barriers, but because nontarget fish are allowed passage, the facility is not considered a permanent barrier (USFS 2003d).

Culverts on streams within the middle Little Sheep Creek (07H), McCully Creek (07I), Carroll Creek (07Q), Big Sheep Creek (RM 25) (07P), Lick Creek (07Q), Big Sheep (RM 34) (07R), Imnaha River (RM 51) (09J), Gumboot Creek (09K), Imnaha River (RM 55) (09L), and Imnaha River (RM 58) (09M) subwatersheds act as barriers to juveniles only (USFS 2003d). These obstructions are currently considered to represent fish passage barriers at least part of the year and are being evaluated for replacement or removal by the USFS. A culvert on Summit Creek was identified during the QHA modeling process as an obstruction to salmonids, although the specific life history stage impeded was not defined (see QHA comments, Table 75).

Table 75. QHA-generated comments about instream obstructions.

Subwatershed/Reach	HUC	Comment
Lower Camp Creek/main.1	07B	lower end of reach has a diversion, hence the score of 2 in the obstructions cell
Upper Camp Creek/main.2	07C	pond on upper end represents an obstruction; likely to blow out without management action
Summit Creek	07E	culvert limits fish distribution (lower reach)
Lightning Creek	07G	pond limits fish distribution (obstruction)
Lower Grouse Creek/main.1	09D	diversion screen problems in lower end of creek; represents an obstruction during low-flow periods

Obstructions—Characterization of Historical Conditions

Obstructions to focal salmonid species habitat were historically not present in the Imnaha subbasin. The Imnaha falls may have impeded migration during certain times of the year; however, they are not considered to impede year-round movement into headwater habitats. Construction of the Wallowa Valley Improvement District canal in 1877 represented the first known year-round migratory impediment to anadromous and resident species.

Characterization of Restoration Needs

Instream obstruction restoration needs are provided in the Limiting Factors section of this document. All restoration activities should be coordinated with the Wallowa-Whitman National Forest, which is currently in the process of addressing physical passage barriers throughout the subbasin.

Characterization of Future with No New Actions

As shown in the Inventory of Existing Activities volume of the subbasin plan, there are currently, and have been historically, several programs/projects specifically dealing with fish passage issues. If the efforts that are designed to improve habitat connectivity/access were to terminate, the current distribution of resident and anadromous salmonids would remain the same, which for bull trout would mean there would be a continued “high risk of extinction” for the Imnaha subpopulation.

1.2.9 Terrestrial Focal Species Habitat Use and Population Characterization

Detailed information about population status and trend is limited for most of the terrestrial wildlife species in the subbasin, including the focal species (USFS 1995, 1998). Collection of inventory data and the development of a monitoring program for terrestrial species would greatly aid the wildlife managers of the subbasin. Range maps showing the present distribution of select wildlife species in the Columbia Basin have been developed by IBIS, but these maps were unavailable for the terrestrial focal species selected by the Imnaha subbasin terrestrial subcommittee (IBIS 2003). What is known about the populations of terrestrial focal species in the Imnaha subbasin is discussed below; when subbasin-specific data were not available, regional data were used to infer potential trends within the subbasin. As discussed in section 1.2.2.2, terrestrial focal species were selected for the Imnaha subbasin primarily because they were good indicators of broader habitat conditions. Because of this, the following section is organized first by the WHT that the species was selected to represent. The descriptions of terrestrial focal species biology, habitat use, and population trends are intended to be illustrative of the importance of the habitat type for wildlife in the subbasin and the factors that may be influencing the quality of that habitat for the native wildlife of the subbasin.

1.2.9.1 Ponderosa Pine Forest and Woodlands

Flammulated Owl

This Section draws heavily from the species description prepared by Paul Ashley and Stacy Stoval (2004). Please see <http://www.nwcouncil.org/fw/subbasinplanning/> for additional information on flammulated owl biology.

The flammulated owl (*Otus flammeolus*) is a tiny owl with dark brown eyes, dark body, and small ear tufts (USFS 2003c). These owls are one of the most migratory of all North American owls, going south of Mexico during most of the fall and winters. They are found in the Imnaha subbasin from late-spring to early fall to breed. The flammulated owl is a species dependent on large diameter Ponderosa pine forests (Hillis *et al.* 2001). The mature and older forest stands that are used as breeding habitat by the flammulated owl have changed during the past century due to fire management and timber harvest. Concerns that the narrow habitat requirements of the flammulated owl make it susceptible to populations declines led the State of Oregon to designate the flammulated owl a state-sensitive critical species (Marshall *et al.* 1996). Partners of flight uses the flammulated owl as a focal species for the dry forest habitat type (see section 1.2.1).

Flammulated owls are entirely insectivores; nocturnal moths are especially important during spring and early summer (Reynolds and Linkhart 1987). As summer progresses and other prey become available, lepidopteran larvae, grasshoppers, spiders, crickets, and beetles are added to the diet (Goggans 1986). The flammulated owl is distinctively nocturnal although it is thought that the majority of foraging is done at dawn and dusk.

Flammulated owl predators include spotted and other larger owls, accipiters, long-tailed weasels (Zeiner *et al.* 1990), felids and bears (McCallum 1994).

Males arrive on the breeding grounds before females. In Oregon, they arrive at the breeding sites in early May and begin nesting in early June (Goggans 1986). They call to establish territories and to attract arriving females. Birds pair with their mates of the previous year, but if one does not return, they often pair with a bird from a neighboring territory. The male shows the female potential sites from which she selects the one that will be used, usually an old pileated woodpecker or northern flicker hole (Ashley and Stoval 2004).

The laying of eggs happens from about mid-April through the beginning of July. Generally 2 - 4 eggs are laid and incubation requires 21 to 24 days, by female and fed by male. The young fledge at 21 -25 days, staying within about 100 yards of the nest and being fed by the adults for the first week. In Oregon, young fledge in July and August (Goggans 1986). The young leave the nest around after about 25 days but stay nearby. In Colorado, owlets dispersed in late August and the adults in early October (Reynolds and Linkhart 1987).

The flammulated owl occurs mostly in mid-level conifer forests that have a significant Ponderosa pine component (McCallum 1994). In the northern Blue Mountains they typically occur at elevations above 700 meters and below 1,400 meters. Flammulated owls habitat in the Imnaha subbasin consists primarily of mature to old, open canopy Ponderosa pine, Douglas-fir, and grand fir (Bull and Anderson 1978; Goggans 1986; Powers *et al.* 1996).

Flammulated owls are obligate secondary cavity nesters (McCallum 1994), requiring large snags in which to roost and nest. The owls nest primarily in cavities excavated by flickers (*Colaptes spp.*), hairy woodpeckers (*Picoides villosus*), pileated woodpeckers (*Dryocopus pileatus*), and sapsuckers (*Sphyrapicus spp.*) (Bull *et al.* 1990; Goggans 1986; McCallum 1994). For 33 nests studied in northeastern Oregon by Bull *et al.* (1990), 67 percent were created by pileated woodpeckers, 27 percent by northern flickers (*Colaptes auratus*), and 6 percent by decay. Flammulated owls used pileated woodpecker cavities significantly more than expected based on availability.

In northeastern Oregon, Bull and Anderson (1978) found that Ponderosa pine was an overstory species in 73 percent of flammulated owl nest sites. Powers *et al.* (1996) reported that Ponderosa pine was absent from their flammulated owl study site in Idaho and that Douglas-fir and quaking aspen (*Populus tremuloides*) accounted for all nest trees. Flammulated owls will nest only in snags with cavities that are deep enough to hold the birds, and far enough off the ground to be safe from terrestrial predators.

In studies from northeastern Oregon and south central Idaho, nest sites were located 16-52 feet high in dead wood of live trees, or in snags with an average diameter at breast height (DBH) of >20 in. (Goggans 1986; Bull *et al.* 1990; Powers *et al.* 1996). Bull *et al.* (1990) found that stands containing trees greater than 20 in. DBH were used more often than randomly selected stands. Reynolds and Linkhart (1987) suggested that stands with trees >20 in. were preferred because they provided better habitat for foraging due to the open nature of the stands, allowing the birds access to the ground and tree crowns. Some stands containing larger trees also allow more light to the ground that produces ground vegetation, serving as food for insects preyed upon by owls (Bull *et al.* 1990).

Both slope position and slope aspect have been found to be important indicators of flammulated owl nest sites (Goggans 1986, Bull *et al.* 1990). In general, ridges and the upper third of slopes were used more than lower slopes and draws (Bull *et al.* 1990). It has been speculated that ridges and upper slopes may be preferred because they provide gentle slopes, minimizing energy expenditure for carrying prey to nests. Prey may also be more abundant or at least more active on higher slopes because these areas are warmer than lower ones (Bull *et al.* 1990).

Flammulated owls prefer to forage in older stands because the open crowns and park-like spacing characteristic of these stands permits maneuverability during feeding (USFS 1994b). Grasslands in and adjacent to forest stands are thought to be important foraging sites (Goggans 1986). A pair of owls appears to require about 2-10 acres during the breeding season, and substantial patches of brush and understory to help maintain prey bases (Marcot and Hill 1980). Areas with edge habitat and grassy openings up to 5 acres in size are beneficial to flammulated owls (Howle and Ritcey, 1987) for foraging.

Flammulated owls are present throughout the northern Blue Mountains in appropriate habitat types. Their presence has been documented in the subbasin (USFS 1995), but due to their secretive nocturnal nature observations are rare and it is not possible to determine population trends for the species. Population data are also inadequate for trend assessment at the scale of the western United States, but loss and fragmentation of mature forest habitat suggests that populations are declining (USFS 1998; Sauer *et al.* 2003; NatureServe 2003).

Flammulated owls prefer late seral ponderosa pine forests, activities that alter or remove these habitats pose the greatest threat to the species. Several studies have shown a decline in flammulated owl numbers following timber harvesting (Marshall 1957; Howle and Ritcey 1987). Management practices that remove snags reduce the availability of cavities suitable for nesting and are also a threat (Reynolds *et al.* 1989). The suppression of wildfires has allowed many ponderosa pines to proceed to the more shade resistant fir forest types, which is less suitable habitat for these species (Marshall 1957; Reynolds *et al.* 1989; see section 1.5.2)

Aerial spraying of carbaryl insecticides to reduce populations of forest insect pests may affect the abundance of non-target insects important in the early spring diets of flammulated owls (Reynolds *et al.* 1989).

Flammulated owls come late to breeding grounds, and competition for nest sites may be a factor limiting breeding success (McCallum 1994). Saw-whet owls, screech owls, and American kestrels compete for nesting sites, but flammulated owls probably have more severe competition with non-raptors, such as woodpeckers, other passerines, and squirrels for nest cavities (Zeiner *et al.* 1990, McCallum 1994). Birds from the size of bluebirds upward are potential competitors. Owl nests containing bluebird eggs and flicker eggs suggest that flammulated owls evict some potential nest competitors (McCallum 1994). The introduced European starling also uses and competes with flammulated owls for flicker cavities. Encouraging the maintenance and growth of pileated woodpecker and northern flicker populations will help maintain high numbers of cavities, thereby minimizing this competition (Zeiner *et al.* 1990).

White-Headed Woodpecker

This Section draws heavily from the species description prepared by Paul Ashley and Stacy Stoval (2004). Please see <http://www.nwcouncil.org/fw/subbasinplanning/> for additional information on white-headed woodpecker biology.

The White-headed Woodpecker (*Picoides albolarvatus*) is a nonmigratory bird that is a year round resident of lower elevation ponderosa pine habitats in the subbasin. White headed woodpeckers have been designated sensitive by the State of Oregon. They are considered sensitive by Regions 1 and 4 of the Forest service and sensitive by the BLM. Partners in Flight uses the white-headed woodpecker as a focal species for ponderosa pine in the blue mountains (see section 1.2.1). White-headed woodpeckers are particularly vulnerable due to their highly specialized winter diet of ponderosa pine seeds (Ashley and Stoval 2004).

White-headed woodpeckers feed primarily on the seeds of large Ponderosa pines. This makes the white-headed woodpecker quite different from other species of woodpeckers who feed primarily on wood boring insects (Blood 1997; Cannings 1995). White-headed woodpeckers do use secondary food sources including insects, mullein seeds, and suet feeders during the spring and summer (Blood 1997; Joy *et al.* 1995). By late summer, white-headed woodpeckers shift to their exclusive winter diet of ponderosa pine seeds. This dependence is likely the key limiting factor to the white-headed woodpecker's distribution and abundance (Ashley and Stoval 2004).

White-headed woodpeckers are monogamous and may remain associated with their mate throughout the year. They build their nests in old trees, snags or fallen logs but always in dead wood. Every year the pair bond constructs a new nest. This may take three to four weeks. The nests are, on average 3m off the ground. The old nests are used for overnight roosting by the birds (Ashley and Stoval 2004).

The woodpeckers fledge about 3-5 birds every year. During the breeding season (May to July) the male roosts in the cavity with the young until they are fledged. The incubation period usually lasts for 14 days and the young leave the nest after about 26 days. White-headed woodpeckers have one brood per breeding season and there is no replacement brood if the first brood is lost. The woodpeckers are not very territorial except during the breeding season. They are not especially social birds outside of family groups and pair bonds and generally do not have very dense populations (about 1 pair bond per 8 ha) (Ashley and Stoval 2004).

Chipmunks are known to prey on the eggs and nestlings of white-headed woodpeckers. There is also predation by the great horned owl on adult white-headed woodpeckers. However, predation does not appreciably affect the woodpecker population (Ashley and Stoval 2004).

White-headed woodpeckers live in montane, coniferous forests. Studies in Oregon show abundance of the species is positively associated with increasing abundance of large diameter ponderosa pines (Marshall *et al.* 1996) Although most abundant in uncut forest stands it will utilize areas where forested vegetation treatments provide sufficient densities of ponderosa pine. Closed canopy stands with heavy shrub or young conifer regeneration are less likely to support the species than open stands with 50% or less canopy cover (USFS 2003c). Highest abundances of white-headed woodpeckers occur in old-growth stands (Ashley and Stoval 2004).

The bird excavates its nest cavities in moderately decayed wood usually in large diameter snags (USFS 2003c). Generally large ponderosa pine snags consisting of hard outer wood with soft heartwood are preferred by nesting white-headed woodpeckers. In British Columbia 80 percent of reported nests have been in ponderosa pine snags, while the remaining 20 percent have been recorded in Douglas-fir snags. Excavation activities have also been recorded in Trembling Aspen, live Ponderosa pine trees and fence posts (Cannings *et al.* 1987). Breeding territories in Oregon were found to be 104 ha in continuous forest and 321 ha in fragmented forests (Dixon 1995).

Although systematic surveys for this species have not been conducted in the subbasin the species is occasionally observed (USFS 1995; 2003c). Declines in the availability of mature ponderosa pine have resulted in a severe decline in abundance of this species in the Blue Mountains (Csuti *et al.* 2001). Many late/old structure stands of ponderosa pine still exist in the HCNRA and this area may provide source habitats for white-headed woodpeckers colonizing adjacent areas (USFS 2003c).

Nesting and foraging requirements are the two critical habitat attributes limiting the population growth of this species of woodpecker. Both of these limiting factors are very closely linked to the habitat attributes contained within mature open stands of Ponderosa pine. Past land use practices, including logging and fire suppression, have resulted in significant changes to the forest structure within the Ponderosa pine ecosystem (Ashley and Stoval 2004).

1.2.9.2 Eastside and Montane Mixed Conifer Forests

American Marten

The American marten (*Martes americana*) is a medium-sized carnivorous mammal that inhabits boreal forests of North America. In the western U.S., marten ranges include Oregon, Idaho, Washington, Montana, Wyoming, Colorado, Utah, New Mexico, Nevada, and California (Strickland *et al.* 1982). It is globally distributed throughout Canada and Alaska, south through the Rockies, Sierra Nevada, northern Great Lakes Region, and northern New England. Total population size is unknown but probably is at least several hundred thousand. Martin populations are considered secure in Idaho but vulnerable in Oregon (NatureServe 2003). The species was assigned Oregon state sensitive status due to declining habitat quantity and quality due to harvest of mature and old-growth timber (Turley and Holthuijzen 2002).

The American marten breeds in summer the summer and delayed implantation results in an average litter of 3-4 in spring. The young are usually born in a hollow tree, sometimes in rock den. Young are weaned in 6 weeks, and males are sexually mature in 1 year, females in 1-2 years (NatureServe 2003).

The diet of the American marten consists mainly of small mammals, birds, insects, and carrion. When in season berries and other vegetative matter contribute to their diet. American marten forage both on the ground and in trees and are expert at exploiting subnivean prey (voles, red squirrels, etc.) (NatureServe 2003).

American marten prefer structurally complex habitats with multiple canopy layers and abundant down woody debris and under story shrubs (Koehler and Hornocker 1977). They prefer mature

forests with closed canopies but sometimes use openings in forests if there are sufficient downed logs to provide cover. The type of forest is less important to martens than forest structure. In Oregon, populations may be declining due to loss of mature forest habitat. This species is a furbearer in Oregon (Csuti et al. 2001).

In northern California, 74% of 155 daytime resting sites of nine radio-tracked martens were in snags, logs, stumps, and tree canopies. The average size of logs, snags, and stumps used by martens was significantly greater than the average size of those available. Martens commonly use elevated perches from which to pounce on terrestrial prey. Short-rotation timber harvest, clearcutting and single-species replanting, and burning or otherwise removing slash, snags, and downed logs likely are detrimental to marten populations (Verts and Carraway 1998).

Home range size is variable, but usually averages less than 10 sq km, although it may be larger when food sources are scarce (Slough 1989). In the Blue Mountain region American marten inhabit mesic coniferous forests typically above 4,500 ft (BLM 2002). The marten is considered a valuable furbearing species and historic overharvest caused marten population declines in many areas. Today loss of habitat and fragmentation are the primary factors impacting American marten populations (NatureServe 2003).

American martens are known to occur in the subbasin, but little other population information exists (USFS 1998). Recent winter track snow surveys located some marten tracks, with most of them occurring in late or old growth forest habitat (USFS 1998). Two sightings of American marten have been reported to the ONHP one adult was observed in upper Big Sheep in 1988 and a juvenile was observed in upper Little Sheep in 1992 (ONHP 2003). Two museum specimens collected in the Big Sheep Creek drainage are now housed in Oregon State University's fish and wildlife department (Verts and Carraway 1998).

Boreal Owl

The boreal owl (*Aegolius funereus*) breeds in North America from treeline in central Alaska east to Newfoundland; south central Oregon in the Cascade and Blue Mountains, and in the Rocky Mountains south through Washington, Idaho, Montana, Wyoming, and Colorado to northern New Mexico; then east through central Saskatchewan, southern Manitoba, northern Minnesota, southern Quebec and Ontario. Breeds in Eurasia from treeline in northern Scandinavia, Russia, and Siberia, south in the mountains to southern Europe, the western Himalayas, and western China (AOU 1983, Hayward and Hayward 1993). Winters mainly in the breeding range, however it may move south in the eastern U.S. and Europe during eruption years (AOU 1983, Hayward and Hayward 1993) (NatureServe 2003). Oregon is the southern limit for this species on the west coast. Its habitat is isolated to the islands of mature subalpine fir and Engelmann spruce. Its early breeding season is usually associated with deep snow; consequently, there have been very few surveys for this species. Boreal owls were virtually unknown in Oregon prior to 1987. The species is now known to occur on a limited basis in northeastern Oregon and western Idaho, but no population estimates have been made. Obtaining population estimates for this species is complicated by nomadism caused by fluctuating prey density (Hayward and Hayward 1993). Boreal owls are listed as a Sensitive-status undetermined by the State of Oregon (Table 33).

Boreal owls nests in abandoned woodpecker holes or natural cavities in standing snags. Usually in older forests with complex physical structures. Some success has been achieved in getting them to use artificial nest boxes (Harrison 1978). Females typically occupy the nest cavity 1-3 weeks prior to egg laying. In Idaho, nesting was initiated between mid-April and late May. After the female incubates the eggs for between 25-36 days a clutch of 4-6 hatches. The young owls fledge at about 4-5 weeks and are independent after 5-6 weeks. Boreal owls reach sexually mature by 1 year (NatureServe 2003).

Boreal owls hunt from a perch and captures prey on ground (DAI 2004). They eat primarily small mammals, also sometimes birds and insects. They typically forage mostly at night. The best foraging habitat for boreal owls is in spruce/fir stands (DAI 2004).

Large stand replacement fires can destroy the structure of stands that serve as boreal owl habitat. This is thought to be a major adverse impact to the species. Returning to a more natural fire regime through prescribed burning would reduce the threat of large-stand replacement fires to boreal owl habitat in the subbasin (USFS 2003c). Timber harvest may also be a threat to Boreal owls as it affect their habitat by removing nest trees, and forest structure, and can reduce prey populations. However, harvest has been very limited in the subalpine habitats of the HCRNA (USFS 2003c).

Olive-Sided Flycatcher

The olive-sided flycatcher (*Contopus cooperi*) is a rather large (18-20 cm) flycatcher with a large-head, with a proportionately short tail. Plumage is brownish-olive above (brownish on juveniles) with a dull white to yellowish throat, breast, and belly. The streaked or mottled chest patches are darker. The olive-sided flycatcher is migratory and winters in Central and South America. It breeds from Alaska across Canada and south to North Carolina in the East, and the mountains of northern Baja California, Arizona, and New Mexico in the West. It is not found in the great plain and most of the southeastern United States (NatureServe 2003).

North American Breeding Bird Survey (BBS) data indicate declines since 1966 across much of North America; significant overall decline of 68% (3.3%/year) from 1966 to 2000, 49% (3.3%/year) from 1980 to 2000 (Sauer et al. 2001). Declines are relatively similar across range, although they appear to be more severe in the central and eastern regions of the continent (Sauer et al. 2001). Abundance estimates suggest that this bird is thinly distributed throughout its range in the province, although it can reach densities of 100 pairs per sq km in some areas (Cheskey 1987). The olive-sided flycatcher has been designated as an Oregon State sensitive-vulnerable species, and is used by Partners in Flight as a focal species for mesic mixed conifer forest types (see section 1.2.1).

As a neotropical migrant that may spend only three to four months of the year on its North American breeding grounds, the olive-sided flycatcher is at risk from deforestation on its wintering grounds in Central and South America. In California, Marshall (1988) found that olive-sided flycatcher disappeared from breeding ranges on Redwood Mountain California in the 1980s, even though highly suitable habitat remained. Marshall (1988) speculated that the disappearance from suitable, unchanged habitat was caused by the destruction of corresponding forests in Central America, where these birds maintain their winter territories. Olive-sided

flycatchers display strong year-to-year site fidelity on the breeding (Altman 1997) and wintering grounds (Marshall 1988, Altman 1997).

In Oregon the olive-sided flycatchers breeding season commences in May and by October it departs the breeding ground for its migration south. The nest is typical of most passerine birds and is a small cup made of plant material (Csuti et al. 1997). Nests are placed most often in conifers on horizontal limbs from two to 15 m from the ground (Harrison 1979). The clutch of 2-4 eggs is incubated by the female for 16-17 days. The young are independent 2-3 weeks after hatching (Csuti et al. 1997).

Like most flycatchers the olive-sided flycatcher flies out from a perch to catch insects in flight. It eats bees, flying ants, flies, small beetles, mosquitoes, and any other small flying insect that approaches(Csuti et al. 1997). Olive-sided flycatchers have been documented to show a preference for honeybees and other Hymenoptera (Terres 1980).

In the western United States, breeding habitat for the olive-sided flycatcher consists of uneven canopy coniferous forests. Specific cover types that occur in the subbasin and serve as source habitats include Engelmann spruce-subalpine fir, Douglas fir and grand fir (Wisdom et al. 2001). The species requires large blocks of habitat, and at least 20 ha may be necessary to sustain a single territorial pair (Peterson and Fichtel 1992). The olive-sided flycatcher prefers forests with openings containing dead standing trees that overtop the forest below. Such snags are used as perches from which to survey territory and launch insect attacks. Olive-sided flycatchers are often found along the forested edges of beaver (*Castor canadensis*) ponds and rivers, and in areas of burns or blowdown (Cheskey 1987). In winter, olive-sided flycatcher migrants in Costa Rica were found to occur in habitats similar to their breeding habitats broken canopy forests containing tall snags and semi-open areas (Stiles and Skutch 1989).

Some studies in western North America have conclude that the olive-sided flycatcher is more abundant in some types of logged forest (especially those with suitable structural features retained) than it is in unlogged stands (Altman and Sallabanks 2000). However, the continuing increase in availability of logged forest openings is at odds with the documented overall decline in numbers of this species. Perhaps logged forest, although attractive to flycatchers, is an 'ecological trap' (Altman and Sallabanks 2000) and is actually a low quality breeding habitat. This hypothesis is supported by preliminary study in western Oregon, where nest success was substantially higher in postfire habitat than it was in several types of harvested forests (Altman and Sallabanks 2000) (NatureServe 2003).

The presence of the olive sided flycatcher in the subbasin has been documented by the Wallowa-Whitman National Forest (USFS 1995). The species has also been detected on both the Imnaha and Zumwalt breeding bird survey routes in the subbasin (Sauer et al. 2003). However, the data are not long-term or consistent enough to indicate trends.

The primary threat to the olive-sided flycatcher is habitat degradation in both its winter and breeding range. Efforts to reverse the declining population trends of olive-sided flycatchers could selective use of small patch clearcuts or wildfire, beaver restoration or flooding or girdling of trees where there were once historic beaver populations. Snags of varying heights but particularly tall snags should be retained after harvest or fire (Altman 1997). Altered fire regimes

that result in fewer but larger more destructive fires will reduce the amount of edge area between early and late seral forests; these areas are important forage areas for olive sided flycatcher (Wisdom 2001).

Rocky Mountain Elk

Elk (*Cervus elaphus*) require a mosaic of early forage-producing stages and later cover-forming stages of forest development, both in close proximity.

Management of elk in the subbasin is guided by Oregon's Elk Management Plan (ODFW 2003d). The plan was developed through a public review process and identifies acceptable population numbers and management options for each big game management unit.

Big game management units all or partially contained by the Imnaha subbasin include Chesnimnus, Pine Creek, Snake River, and Imnaha. These units are within the Wallowa district. Elk populations in the Wallowa district met or exceeded the management objective of 17,050 for most of the 1980s. Since 1990, elk populations have declined; an estimated elk population of 11,800 was reported for the Wallowa district in 2001 (ODFW unpublished data). Potential factors in this decline include poor calf survival, large predator populations, and the spread of noxious weeds on elk range. In the last three years, the ODFW has spent an estimated \$20,000 on habitat improvements in the lower Imnaha subbasin. These projects were done in collaboration with private landowners and include weed control, seedings, fertilizing, burnings, and water developments (ODFW unpublished data). The majority of the elk range in the subbasin is publicly owned, and damage reports are rare. The number of hunting tags issued in the area has declined by 5,000 tags in recent years, yet elk hunting opportunities remain good (Nowak 2001).

1.2.9.3 Alpine Grassland and Shrublands

Rocky Mountain Goat

The Rocky Mountain goat (*Oreamnos americanus*) is found on ridges and forage in alpine meadows in the subbasin. The species eats sedges, willows, and forbs in warmer months but turns to lichens, moss, and conifer browse in winter. Where available, grass is grazed throughout the year. In the Wallow Mountains, areas intensively used by mountain goats had less timber and more slide rock and cliff rock than surrounding areas did. The goats tended to move to slightly lower elevations in winter (ODFW 2003c).

In the Wallowa Mountains, mountain goats fed along ridgetops in July, in meadows in August and September, and in slide-rock areas in October. In December and January, goats fed along ridges blown free of snow, but during storms, goats were restricted to timber areas, where they fed on conifers and mountain mahogany (Vaughn 1975). With snowmelt and concomitant growth of plants in spring, mountain goats foraged in open areas.

Younger goats face higher mortality than adults. Few predators can catch mountain goats on cliff faces, but elsewhere, they fall prey to mountain lions, bears, coyotes, and bobcats. Golden eagles may eat newborns or knock young off cliffs (Csuti et al. 2001).

The historical distribution of the mountain goat in Oregon is debated. Some documents indicate that the mountain goat is not native to the state of Oregon and that its presence there is a result of introductions (Verts and Carraway 1998, Thomas and O’Neil 2001). However, a review of literature documenting archaeological evidence of the species’ presence, accounts of observations in the journals of Oregon’s early explorers, and early scientific accounts and descriptions of the species led the ODFW to conclude that mountain goats were part of Oregon’s native wild fauna up until or just prior to the time of European settlement (ODFW 2003c). The wildlife managers of the subbasin concur with this conclusion and have decided to treat the mountain goats as extirpated and subsequently reintroduced in this document.

Mountain goats have been released in Oregon on 12 separate occasions. Animals from 8 of these releases could move into the Imnaha subbasin: those released on Hurricane Creek (a tributary to the Wallowa River in the Grande Ronde subbasin, just outside the upper western side of the subbasin); those released at Pine Creek and Summit Pt. (just south of the subbasin divide in the Middle Snake subbasin); and those released at Sluice Creek in the Hells Canyon subbasin. These releases resulted in the reintroduction of 95 sheep (35 males, 60 females) and have formed three herds in the area surrounding the subbasin: the Wallowa Mountain, Elkhorn Mountain, and Hells Canyon herds (Table 76).

Table 76. Rocky Mountain goat introductions in the area surrounding the Imnaha subbasin.

Year	Origin of stock	Male	Female	Total Released	Herd	Release Site
1950	Chopaka Mt., WA	3	2	5	Wallowa Mountains	Joseph Mountain
1983	North Fork Clearwater River, ID	3	3	6	Elkhorn Mountains	Pine Creek
1985	Olympic National Park, WA	2	6	8	Wallowa Mountains	Hurricane Creek
1985	Olympic National Park, WA	4	4	8	Wallowa Mountains	Pine Creek
1986	Misty Fjord, AK	3	5	8	Wallowa Mountains	Hurricane Creek
1986	Misty Fjord, AK	2	5	7	Elkhorn Mountains	Pine Creek
1989	Olympic National Park, WA	8	9	17	Wallowa Mountains	Hurricane Creek
2000	Elkhorn Mountains, OR	3	13	16	Hells Canyon	Sluice Creek
2002	Elkhorn Mountains, OR	7	13	20	Elkhorn Mountains	Summit Point
Total		35	60	95		

The Wallowa Mountain herd was established with five releases (Table 76). The population grew from 5 to 30 animals by 1966. Over the next 20 years, the population remained relatively static until kid recruitment improved following additional releases. The 2002 population estimate for

the Wallowa Mountains was 200 goats. Dispersal into vacant habitat adjacent to core areas is occurring throughout the Wallowa Mountains, and habitat is available to support 600 goats (ODFW 2003c).

The Elkhorn Mountain herd was established from three releases. Kid-to-adult population ratios have been high, and the herd's population has increased rapidly. In 2002, this population was estimated to contain 150 goats. Although the area is capable of supporting an estimated 300 goats, 36 animals have been removed from the herd for transplant to other areas (ODFW 2003c).

Mountain goats transplanted to Hells Canyon in July 2000 are continuing to be monitored. Reproduction has been good, and the 2002 population estimate was 30 animals. Hells Canyon could potentially support a population of 200 goats (ODFW 2003c).

1.2.9.4 Eastside Grasslands

Bighorn Sheep

Bighorn sheep (*Ovis canadensis*) were historically widespread throughout the drier, non-forested regions of western North America. Nowak (1991) estimated that 1.5 to 2 million individual *Ovis Canadensis* may have inhabited North America prior to their decline in the nineteenth century. Bighorns were an important historical resource for Native Americans. Horns and bones were used to make tools and ornaments, hides were used for clothing, and the meat was an important protein source (Valdez and Krausman 1999). Bighorn sheep were especially abundant in the Wallowa Mountains of Oregon (ODFW 2003c).

Overhunting, poor range conditions, and domestic sheep diseases led to the extirpation of bighorn sheep from Oregon in the 1940s (ODFW 2003c). Bighorn populations have increased since the 1900's due to a series of reintroductions, but much of their previous range is still unoccupied (Wisdom et al. 2000). Transplanting is necessary to stimulate new populations in unoccupied habitats because bighorn are extremely loyal to their territories and will not readily move into new ranges (Parker 1985). Between 1979 and 1984, 36 bighorns were released into the lower subbasin; these animals originated from the Salmon River and Jasper National Park bighorn sheep populations (IDFG et al. 1997). The population of the lower Imnaha herd was estimated to be 115 in 1999 (ODFW unpublished data) in 2003 the population of this herd was 165 (ODFW 2003c). The population trend of the lower Imnaha herd is expected to continue increasing (ODFW 2003c).

Bighorn hunting permits are in high demand but their issue is carefully controlled by ODFW. Between 1979 and 1996, 48 bighorn sheep permits were issued for the Imnaha bighorn sheep herd through auction and lottery. These permits resulted in the harvest of resulting in the harvest of 45 bighorns; the Imnaha herd provides more hunting opportunities than neighboring herds (IDFG et al. 1997).

Bighorn sheep habitat consists of steep rocky open terrain with abundant bunchgrasses. Lambing occurs on steep cliffs, which helps the young avoid predation (USFS 1999). The pumpkin creek drainage was highly rated as a potential release site based on the availability of lambing and winter range habitat and a low risk of exposure to domestic sheep populations.

Aggressive non-native plants and other noxious weeds are the primary factor negatively impacting habitat quality in the subbasin. Across their range in Washington, Idaho, and Oregon bighorn habitat has suffered encroachment from yellow-star thistle (*Centaurea solstitialis*), knapweed (*Centaurea* spp.), common crupina (*Crupina vulgaris*), rush skeleton weed (*Chondrilla juncea*), leafy spurge (*Euphorbia esula*), and other plants, which reduce forage quality and vigor. In the Imnaha subbasin, habitat conditions are generally good but the spread of invasive species are threats to the continued quality of Rocky Mountain bighorn sheep range.

Reestablishment of bighorn populations in surrounding areas has been hampered by reoccurring pneumonia die-offs. *Pasteurella haemolytic* and multicida bacteria have been identified as the primary causes of pneumonia in bighorns and are often the result of contact with domestic sheep. Sheep grazing, once prevalent in the Imnaha subbasin, no longer occurs (D. Bryson, Nez Perce Tribe, personal communication, May 2001).

Grasshopper Sparrow

This Section draws heavily from the species description prepared by Paul Ashley and Stacy Stoval (2004). Please see <http://www.nwcouncil.org/fw/subbasinplanning/> for additional information on grasshopper sparrow biology.

The grasshopper sparrow (*Ammodramus savannarum*) is a small migratory bird that breeds throughout most of the lower 48 states, but it is often locally distributed and even uncommon to rare in parts of its range (Vickery 1996). Grasshopper sparrows arrive on the breeding grounds in mid-April and depart for the wintering grounds in mid-September (Vickery 1996). They winter across the southern tier of states, south into Central America.

In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the U.S. since the late 1960s. Based on breeding bird survey data, the grasshopper sparrow has exhibited a declining population trend at the scales of the United States, the western United States, and Oregon between 1966 and 2002. Breeding bird surveys conducted within or near the Imnaha have occasionally documented the species (Sauer et al. 2003). Surveys conducted by The Nature Conservancy on the Zumwalt Prairie in 2001 also documented the occurrence of the species in the subbasin (TNC 2002). It is not possible to determine grasshopper sparrow population trends in the Imnaha subbasin from the data available.

Their diet of the grasshopper sparrow varies by season. In the spring and summer grasshopper sparrows rely on invertebrates for 3/5 of their diet, and seeds for the remainder. In the fall, seeds become a greater component of the diet making up 71% of the total with invertebrates making up the remainder no data was available on the composition of the winter diet. (Martin et al. 1951 in Vickery 1996).

Grasshopper sparrows are monogamous throughout the breeding season and nest in semi-colonial groups of 3-12 pairs (Ehrlich et al. 1988). The female incubates the eggs alone (Ehrlich et al 1988), while the male defends the pair's territory (Smith 1963). The incubation period lasts from 11 to 13 days (Smith 1963, Ehrlich et al 1988, Harrison 1975), with a nestling period of 6 to 9 days after hatching (Harrison 1975, Hill 1976, Kaspari and O'Leary 1988). Hatchlings are blind and covered with grayish-brown down (Smith 1968). After the young hatch, both parents

share the responsibilities of tending the hatchlings (Smith 1963). Brood parasitism by brown-headed cowbirds has been documented but rates are generally low (Vickery 1996).

Throughout most of their range, grasshopper sparrows can produce two broods, one in late May and a second in early July (Smith 1968, Vickery 1996). However, in northern portions of its range like the Imnaha subbasin, one brood is probably most common (Vickery et al. 1992, Wiens 1969).

Predators of the grasshopper sparrow include hawks, Loggerhead Shrikes, mammals and snakes (Vickery 1996). Nest predators cited include: raccoons (*Procyon lotor*), red fox (*Vulpes vulpes*), northern black racers (*Coluber constrictor constrictor*), blue jays (*Cyanocitta cristata*), and common crows (*Corvus brachyrhynchos*) (Johnson and Temple 1990, Wray et. al 1982).

Grasshopper sparrows prefer grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground (Bent 1968, Blankespoor 1980, Vickery 1996). Vickery (1996) states that exposed bare ground is the critical microhabitat type for effective foraging. Other habitat requirements include moderately deep litter and sparse coverage of woody vegetation (Smith 1963; Wiens 1969, 1970; Arnold and Higgins 1986). In east central Oregon grasshopper sparrows occupied relatively undisturbed native bunchgrass communities dominated by *Agropyron spicatum* and/or *Festuca idahoensis* (Holmes and Geupel 1998). Vander Haegen et al. (2000) found no significant relationship with vegetation type (i.e., shrubs, perennial grasses, or annual grasses), but did find one with the percent cover perennial grass. Grasshopper sparrows are area sensitive, preferring large grassland areas over small areas (Herkert 1994a,b, Vickery et al. 1994). Key habitat features of grasshopper sparrow habitat are displayed in Table 30.

Grasshopper sparrows occasionally inhabit cropland, but at lower densities than are found in grassland habitats (Smith 1963, Smith 1968, Ducey and Miller 1980, Basore et al. 1986, Faanes and Lingle 1995). Early season mowing of hayfields causes major nest failures in grassland nesting species. Areas where hayfields are adjacent to bunchgrass grasslands may serve as population sinks for grasshopper sparrows (Wisdom et al 2000).

Table 77. Key habitat relationships required for breeding grasshopper sparrows (Altman and Holmes 2000).

Conservation Focus	Key Habitat Features			
	Vegetative Composition	Vegetation Structure	Landscape/Patch Size	Special Considerations
native bunchgrass cover	native bunchgrasses	bunchgrass cover >15% and >60% total grass cover; bunchgrass >25 cm tall; shrub cover <10%	>40 ha (100 ac)	larger tracts better; exotic grass detrimental; vulnerable in agricultural habitats from mowing, spraying, etc.

Primary threats to the species have been identified as loss, degradation, and incompatible management of grassland habitat (Nature Serve 2003). Maintaining the quality, size and connectivity of the remaining bunchgrass habitat in the subbasin should be a priority for maintaining grasshopper sparrows. See section 1.5.2 for more discussion of the loss and degradation of grassland habitats as a limiting factor to wildlife species and the Imnaha Management plan for strategies for addressing this limiting factor.

1.2.9.5 Wetland and Riparian Areas

Mountain Quail

The mountain quail (*Oreortyx pictus*) is the largest North American quail north of Mexico. Rangewide mountain quail are distributed in five western states including California, Washington, Oregon, Nevada, and Idaho as well as Baja Norte Mexico. They are also found in small disjunct populations as introduced birds on Vancouver, Island, British Columbia and the San Juan Islands of Washington (USFWS 2003d). Mountain quail are found in relatively high numbers throughout suitable habitat in the Coast and Cascade Ranges and the Rouge Umpqua and Willamette valleys of western Oregon. However population numbers in the eastern portion of their range, which includes the Imnaha subbasin have declined dramatically since the 1930s. Due to these declines the eastern population of mountain quail was considered for listing under ESA. On July 2003 the USFWS found that this listing was not warranted in large part due to concerns over the discreteness of the two populations (USFWS 2003d).

Mountain quail habitat in relatively arid areas like the Imnaha subbasin consists of tall dense shrubs close to water, usually in riparian areas (Heekin et al 1993). Mountain quail are usually elevational migrants and winter in coveys below the snow line. In March, pairs start moving to nesting areas, often up in elevation to open forest (Cassirer 1995). Mountain quail nest in a concealed depression on the ground. The female typically lays two clutches of 7-10 eggs, one of which is incubated and raised by the male (Heekin et al 1993). Nest sites in the Imnaha subbasin were most commonly located in Douglas-fir/ common snowberry associations (Crawford and Pope 1999). Nests are usually within 0.5 mile of water. Breeding territories range from 5 to 50 acres. Coveys of 3 to 20 birds form in the fall and break up in the late winter prior to the breeding season (Csuti et al. 2001).

Mountain quail eat primarily plant material throughout the year based at least partially on abundance including perennial seeds, fruits, flowers and leaves annual forbs, legumes and mushrooms. Invertebrate animal matter makes up only 0 to 5 percent of the adult diet but a larger percentage of the juvenile diet (USFWS 2003d). Mountain quail food-producing shrubs found in the subbasin and surrounding area were white alder, serviceberry, hackberry, black hawthorn, smooth sumac, poison ivy, currant, black locust, elderberry, and snowberry. Other shrub species such as chokecherry, ninebark, and syringa have not been identified as food sources but are important components of mountain quail habitat (see summary of food sources contained in Rocklage and Edelmann 2001).

Mountain quail are prey to numerous predators but are especially vulnerable to hawks. Other known predators include great horned owl (*Bubo virginianus*) coyote (*Canis latrans*), bobcat

(*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*) and rattlesnake (*Crotalus sp.*) (USFWS 2003c). Results from predation studies conducted in the subbasin indicate predation rates of more than 60% a year (Pope and Crawford 2002 cited in USFS 2003b).

The species has recently declined in the Blue Mountains area (Csuti et al. 2001) and throughout the Intermountain West (Rocklage and Edelmann 2001). Recent estimates suggest that mountain quail are rare or extirpated in central and southeastern Oregon and present but only in low numbers in northeastern Oregon (Crawford and Pope 1999). Wallowa County is the only county in northeastern Oregon with an open hunting season (ODFW 2003f). Small populations of mountain quail persist in several locations in the subbasin, and a population was recently reintroduced to the Horse Creek drainage where the species had been previously extirpated (Pope and Crawford 1998). The reason for declines in mountain quail populations in the area are not entirely clear, mountain quail have been extirpated from many areas just outside the subbasin where habitat condition remains good (Cassirer 1995; Rocklage and Edelmann 2001).

Yellow Warbler

The yellow warbler (*Dendroica petechia*) is closely associated with various types of riparian vegetation including willows and cottonwoods. It occupies riparian thickets in valleys and follows them upward to mid-elevation mountains. It makes use of willow thickets in mountain meadows and moist quaking aspen groves. The species is susceptible to nest parasitism by brown-headed cowbirds. This susceptibility has caused population declines in some areas (Csuti et al. 2001).

This species was found to have a significant declining population trend based on data from the Central Rocky Mountain Breeding Bird Survey Physiographic Region (Sauer et al. 1999, as cited in Altman 2000) (Figure 61). The yellow warbler has been consistently detected along the Imnaha and Joseph breeding bird survey routes between 1971 and 2002. The Imnaha Route runs from Corral Creek up stream to Adams Creek along the Imnaha River. The Joseph Creek route runs north-south near the town of Joseph, just west of the subbasin. Surveys on these routes show a declining trend in the numbers of yellow warbler detected between 1971 and 2002. The relevance of this observation to population numbers or possible reasons for the decline is not clear (Sauer et al. 2003).

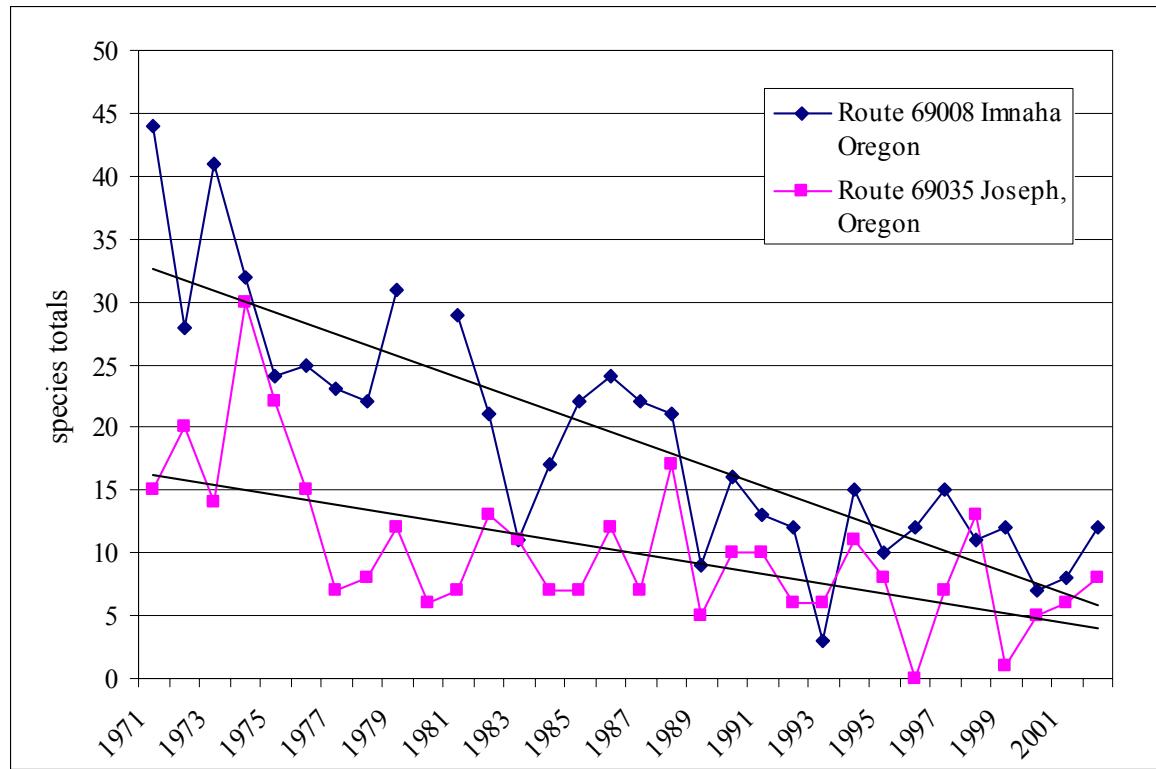


Figure 61. Breeding bird survey counts for the yellow warbler for two routes in or just outside the Imnaha subbasin 1971–2002.

Long-Toed Salamander

The long-toed salamander (*Ambystoma macrodactylum*) is the most common and widespread species of *Ambystoma* in the northwest (Csuti et al. 1997). It is distributed in northern British Columbia south along the coast to central Oregon and inland to the Rocky Mountains of Idaho (Csuti et al. 1997) and western Montana (Petraska 1998 cited in Amphibia Web 2004). It is found more spottily to the south in the Sierra Nevada Mountains of California. An isolated population inhabits Santa Cruz County California (Csuti et al. 1997). The long-toed salamander is dark gray to black with a yellow, tan or olive green dorsal stripe often broken up into blotches (Stebbins 1951). The sides have some white speckling. The ventral side is gray or black (Petraska 1998 cited in AmphibiaWeb 2004).

Both adults and juvenile long-toed salamanders feed primarily on invertebrates. Larvae feed on zooplankton, immature insects, snails, and occasionally other salamander larvae, including conspecifics. Adults eat terrestrial and aquatic invertebrates including: insects, insect larvae, spiders, slugs, earthworms, amphipods, etc. (NatureServe 2003). Predators of larvae probably include aquatic insects and garter snakes; garter snakes and bullfrogs eat adults (Nussbaum et al. 1983).

Long-toed salamander adults are commonly found under bark, rocks or below ground outside of the breeding season. They inhabit a wide variety of terrestrial habitats, including semiarid sagebrush desert, dry woodlands, humid forests, and alpine meadows (Csuti et al. 1997, NatureServe 2003).

Each season adults migrate from non-breeding areas to breeding ponds; the males arrive at the breeding ponds earlier in the season and stay later than females (Beneski et al 1986). Migrations usually occur at night in conjunction with precipitation. At low elevations this migration may be in October or November, but at higher elevations it does not occur until snowmelt in late spring (Petraska 1998 cited in AmphibiaWeb 2004).

Long-toed salamanders breed in temporary or permanent ponds in quiet water at the edge of lakes, ponds streams. In riverine habitats long-toed salamanders tend to use low gradient-moderate gradient pools, in lacustrine habitats they are most commonly found in shallow water habitats and in palustrine habitats they use riparian areas and temporary pools. During the breeding season adults may be found under logs, rocks, and other debris near water (NatureServe 2003).

All but the most extreme upper elevation areas of the subbasin are considered within the range of the long-toed salamander (Csuti et al. 1997). No known surveys for the species have been conducted in the Imnaha subbasin but in the neighboring Snake Hells Canyon Subbasin the species was found to use primarily pools with emergent vegetation and used these structures to attach their eggs. Long-toed salamanders were found to be widespread and abundant in the Craig Mountain Area of the Snake Hells Canyon Subbasin (Llewellyn and Peterson 1998). They were most common in upper elevation pools, particularly those that had been influenced by human activities. This is probably because in that subbasin natural pools tend to be associated with wet meadows or are attached to a relatively high gradient creek system. These habitats did not have the shallow areas and emergent vegetation for egg mass attachment preferred by long-toed salamanders (Llewellyn and Peterson 1998).

Threats to the long-toed salamander are similar to those that threaten amphibian populations worldwide. Eggs exposed to ambient levels of UV-B radiation have been shown to have increased mortality and incidence of deformities than those shielded from UV-B (Blaustein et al 1997). A trematode has been found that disrupts both limb development and regeneration and has been proposed as an explanation of why individuals with supernumerary limbs are found (Sessions and Ruth 1990). Both juvenile and adults are susceptible to environmental contaminants, which may reduce breeding success or cause mortality. Introduction of non-native fish and bull frogs may also threaten this species. Bull frogs have been documented to prey on long-toed salamanders (Nussbaum et al. 1983); In Montana, introduced trout populations clearly excluded salamanders from lakes (Funk and Dunlap 1999). Roads have also been identified as a threat to long-toed salamanders migrating between breeding and non-breeding habitats. High mortality rates of long-toed salamander crossing roads have been documented and salamanders attempting to cross high-speed transportation corridors such as interstate highways were found to almost never successfully transverse the roads and such roads are thought to present functional barriers. No high speed transportation corridors of this type occur within the Imnaha subbasin but roads may be having some impact on the subbasins long-toed salamander populations (NatureServe 2003). The destruction of wetland habitats is probably the greatest threat to long-toed salamanders across their range (AmphibiaWeb 2004); this is likely particularly true in the Imnaha subbasin where the impacts of environmental contaminants, introduced species, and roads remain relatively low (see sections 1.1.1.10 transportation , 1.1.2.3 water resources, 1.1.3.4 invasive plants).

1.2.9.6 Agriculture, Pastures, and Mixed Environ

Mule Deer

Rocky Mountain mule deer (*Odocoileus hemionus*) are native to eastern Oregon. Mule deer occupy a wide range of habitat types; some live in desert shrubs, some in woodlands, and some in conifer forests. Typically, however, mule deer occupy the more open, but more rugged areas (ODFW 2001b). The species is common in the grassland habitats of the subbasin. Shrub species—including antelope bitterbrush (*Purshia tridentata*), rabbitbrush (*Ericameria* and *Chrysothamnus* spp.), juniper, and mountain mahogany (*Cercocarpus* spp.)—provide critical nutrition in the critical winter months.

Fluctuations in mule deer populations appear to be a naturally occurring phenomenon. For example, early explorers of the area reported a scarcity of big game, but 20 years later gold miners found abundant deer herds.

Fluctuations in mule deer populations can be attributed to both natural and human influenced factors. Drought conditions reduce forage and cover values, while severe winter weather conditions can result in large loss of deer. Both conditions can cause poor deer condition and result in lower deer survival. Overgrazing by livestock in the late 1800s and early 1900s resulted in rangelands that were dominated by shrubs and forb species that were more favorable for deer, and populations increased. Increased fire suppression activities by the middle of the twentieth century allowed the encroachment of less nutritious woody vegetation that supports smaller deer populations (ODFW 2001b).

Mule deer in Oregon are managed following Oregon's 2002 *Mule Deer Management Plan*, which represents an update of the 1990 mule deer plan. The plan includes issues and concerns identified in 2002 through input from constituent groups, agency biologists and the public and identifies issues, objectives, and strategies for mule deer management that will be considered in development of the Imnaha subbasin management plan (ODFW 2003e).

Mule deer populations have been generally declining throughout western North America during the last several years. The estimated population of mule deer in Oregon was 260,700 in 1996, which was 18% below the established statewide management objective of 317,400 mule deer. In 2001, this number had grown to 283,000 but still remains below the management objective (ODFW 2001b). Mule deer population estimates for the Wallowa district have been below the ODFW management objective of 26,800 for many years. Mule deer populations in the area have trended upwards for the last five years from a low of 17,400 in 1996 to 20,000 in 2001 (ODFW unpublished data).

The Imnaha subbasin is comprised of part of four ODFW game units: Imnaha, Snake River, Chesnimnus, and Pine Creek. These units were estimated to support a combined total of 3,669 mule deer in 2001. The Imnaha unit covers the largest area in the subbasin and supported an estimated 654 mule deer in 2001 (Table 78) (ODFW 2001b). Management goals in the area are limited by the problem of mule deer foraging on private agricultural lands. Although agricultural lands are very limited in the subbasin, the protection of lands in neighboring subbasin restricts the mule deer population numbers ODFW strives for. The green forage was created in 1983 to assist landowners who are experiencing damage caused by wildlife. The

objective of the green forage program is to alleviate or prevent big game damage on private lands while benefiting wildlife by improving forage quality and quantity on public or private lands (ODFW 2003e).

Table 78. Mule deer herd composition in 2001 for the game units partially contained in the Imnaha subbasin (ODFW 2001b).

Unit	Percent of unit in Imnaha Subbasin	Bucks	Does	Fawns	Total
Imnaha	87	68	383	203	654
Snake River	57	93	704	348	1,145
Chesnimnus	23	64	423	229	716
Pine Creek	10	93	704	348	1,145
Total		318	2,214	1,128	3,660

1.2.9.7 Open Water–Lakes, Rivers, and Streams

Bald Eagle

This Section draws heavily from the species description prepared by Keith Paul (2004). Please see <http://www.nwcouncil.org/fw/subbasinplanning/> for additional information on bald eagle biology.

The bald eagle (*Haliaeetus leucocephalus*) was first protected in the lower 48 states by the Bald Eagle Protection Act of 1940; it was federally listed as endangered in 1967. In 1995, the bald eagle was reclassified as threatened in all of the lower 48 States. No critical habitat has been designated for the bald eagle (USFWS 2003c). In 1963, a National Audubon Society survey reported only 417 active nests in the lower 48 states. In 1994, about 4,450 occupied breeding areas were reported (USFS 2003c). Due to positive trends like this the bald eagle was proposed for delisting on July 6, 1999; a decision on whether to delist the bald eagle is pending (64 FR 36453). The bald eagle was listed as threatened under the Oregon ESA in 1987 (Marshall et al. 1996).

The bald eagle historically ranged throughout North America except extreme northern Alaska and Canada and southern Mexico. Bald eagles can be resident year-round where food is available; otherwise they will migrate or wander to find food. In Oregon, historic bald eagle nests have been documented in 32 of 36 counties. Those counties where historic breeding records did not occur include Sherman, Gilliam, Morrow, and Malheur counties (Isaacs and Anthony 2001). The current range in the lower 48 states has been divided into five recovery areas: Chesapeake Bay, Pacific, Southeastern, Northern States, and Southwestern (USFS 2003c). The Imnaha Subbasin lies within the Pacific recovery area.

A recovery plan for the Pacific population of the bald eagle was completed in 1986. The plan identifies the following de-listing goals which are necessary to obtain a self-sustaining population of bald eagles: 1) a minimum of 800 nesting pairs with an average reproductive rate of one fledged young per pair and an average success rate per occupied site of not less than 65 percent over a five-year period, 2) attainment of breeding population goals should be met in at

least 80 percent of the management zones, 3) wintering populations should be stable or increasing (USFS 2003b).

The Pacific recovery area was divided into zones, and the Imnaha subbasin is part of the Snake River zone. Recovery goals for the Snake River zone are to: 1) locate, monitor, and protect nesting, roosting, and feeding areas, 2) develop nest site plans for nesting and roost areas, 3) monitor productivity, 4) prevent significant habitat disturbance and direct human interference at nest sites and feeding areas, and 5) re-establish six breeding pairs (USFS 2003b).

[Bald eagles consume a variety of prey that varies by location and season. Prey are taken alive, scavenged, and pirated (Frenzel 1985, Watson et al. 1991). Fish were the most frequent prey among 84 species identified at nest sites in south-central Oregon, and a tendency was observed for some individuals or pairs to specialize in certain species (Frenzel 1985). Wintering and migrant eagles in eastern Oregon fed on large mammal carrion, especially road-killed mule deer, domestic cattle that died of natural causes, and stillborn calves, as well as cow afterbirth, waterfowl, ground squirrels, other medium-sized and small rodents, and fish. Proportions varied by month and location. Food habitats are unknown for nesting eagles over much of the state (Isaacs and Anthony 2003a) (Paul 2004)]. Reductions in anadromous fish runs are considered a factor limiting the use of the Imnaha subbasin by bald eagles (USFS 1995; 1998; 2003b).

Bald eagles are most abundant in Oregon in late winter and early spring, because resident breeders (engaged in early nesting activities), winter residents, and spring transients are all present. Nest building and repair occur any time of year, but most often observed from February to June (Isaacs and Anthony unpublished data). Bald eagles are territorial when breeding but gregarious when not (Stalmaster 1987). The size and shape of a defended breeding territory varies widely (1.6 to 13 square miles) depending upon the terrain, vegetation, food availability, and population density of an area (USFS 2003b). Bald eagles exhibit strong nest-site fidelity (Jenkins and Jackman 1993). Both sexes build the nest, incubate eggs, and brood and feed young (Stalmaster 1987). Egg laying (1-4 eggs) occurs mid-February to late April; hatching late March to late May (after about 35 days of incubation); and fledging late June to mid-Aug (Isaacs and Anthony 2003a). After a month of continued partial parental care the young eagles are on their own mortality rates tend to be highest in young eagles and can be caused by disease, food shortages, bad weather, or human interference (USFWS 2003c). During the nest building, egg laying and incubating periods, eagles are extremely sensitive and will abandon a nesting attempt if there are excessive disturbances in the area during this time (USFWS 2003c).

Bald eagles nest in forested areas near the ocean, along rivers, and at estuaries, lakes, and reservoirs (Isaacs and Anthony 2001). Eighty-four percent of Oregon nests were within 1 mi (1.6 km) of water (Anthony and Isaacs 1989). Nest sites in forested areas show a strong preference to multi-layered, mature forest stands. Eagles usually nest in mature conifers with gnarled limbs that provide ideal platforms for nests. Ponderosa pine, Douglas fir, and black cottonwood are preferred nest trees in the Pacific recovery area (USFS 2003b).

Wintering eagles in the Pacific Northwest perch on a variety of substrates; proximity to a food source is probably the most important factor influencing perch selection by bald eagles. Favored perch trees are invariably located near feeding areas, and eagles consistently use preferred branches (Stalmaster 1976). Most tree perches selected by eagles provide a good view of the

surrounding area (Servheen 1975, Stalmaster 1976), and eagles tend to use the highest perch sites available (Stalmaster 1976; USFWS 1986). Dead trees are used by eagles in some areas because they provide unobstructed view and are often taller than surrounding vegetation (Stalmaster 1976). Isolation is also an important feature of bald eagle wintering habitat. In Washington, 98% of wintering bald eagles tolerated human activities at a distance of 300 m (328 yards) (Stalmaster and Newman 1978). However, only 50% of eagles tolerated disturbances of 150 m (164 yards) (USFWS 1986).

Habitat requirements for communal night roosting are different from those for diurnal perching. Communal roosts are invariably near a rich food resource and in forest stands that are uneven-aged and have at least a remnant of the old-growth forest component (Anthony et al. 1982). Close proximity to a feeding area is not the only requirement for night roosting sites, as there are minimum requirements for forest stand structure. In open areas, bald eagles also use cottonwoods and willows for night roosting (Isaacs and Anthony 1983). Most communal winter roosts used by bald eagles offer considerably more protection from the weather than diurnal habitat. Roost tree species and stand characteristics vary considerably throughout the Pacific Northwest (Anthony et al 1982) (USFWS 1986) (Paul 2004)].

Bald eagle use of the Imnaha subbasin is currently and has been historically relatively rare. Suitable habitat for both nesting and wintering bald eagle exists along the larger river systems in the subbasin including the lower Imnaha and Big Sheep Creek (USFS 1995; 1998). Bald eagles are occasionally observed in the subbasin but no nest sites have been documented. Bald eagle nests in closest proximity to the subbasin include two recent active nests located on private land in the Enterprise, Oregon municipal watershed along the Wallowa River and a new nest found in 1999 along the Hells Canyon Reservoir on the Payette National Forest in Idaho). A pair of bald eagles has occupied this nest for the last four years (USFS 2003b).

The status and distribution of bald eagle populations in the decades before World War II are poorly understood. Declines probably began in some populations in the 19th century (USFWS 1986). By 1940, the bald eagle had “become rather an uncommon bird” except along the coast and Columbia River, and in Klamath Co. (Gabrielson and Jewett 1940). Habitat loss (cutting of nest trees) and direct persecution (shooting, trapping, poisoning), probably caused a gradual decline prior to 1940. However, the major factor leading to the decline and subsequent listing of the bald eagle was disrupted reproduction resulting from contamination by organochlorine pesticides, particularly DDT (USFWS 2003c).

Between 1945 and 1974 over 4.5 million acres (1.8 million ha) of National Forest in Oregon were sprayed with DDT an agricultural pesticide, (Henny and Nelson 1981). Undocumented quantities were also applied on private forests and agricultural crops, and for mosquito control around municipalities. In the late 1960s and early 1970s, it was determined that dichlorophenyl-dichloroethylene (DDE), the principal breakdown product of DDT, accumulated in the fatty tissues of adult female eagles. It impaired calcium release necessary for egg-shell formation, thus inducing thin-shelled eggs that are not viable, leading to reproductive failure (USFS 2003b). The deleterious effects of DDT on reproduction (Stalmaster 1987) joined habitat loss and direct persecution as causes of decline through the early 1970's when the population may have reached its historical low. By then, nesting pairs were extirpated in northeastern Oregon (Isaacs and Anthony 2001), where applications of DDT on National Forest land were common and

widespread (Henny and Nelson 1981) (Isaacs and Anthony 2003a). On December 31, 1972, DDT was banned from use in the United States (USFS 2003b).

Loss of habitat, loss of prey and human disturbance are the greatest current threats to bald eagle populations. Actions identified by the Wallowa-Whitman National Forest and currently being implemented in portions of the subbasin that should result in continued improvement in bald eagle habitat include; implementation of management standards for livestock grazing to improve riparian conditions, maintaining snags to provide perches and/or nest trees, restoring fire regimes to maintain large tree species preferred by bald eagles like ponderosa pine and Douglas fir that respond to periodic burns, and continued efforts to protect and restore anadromous fish runs (USFS 2003b). Further development and expansion of these strategies is contained in the Imnaha Subbasin Management Plan.

1.2.10 Environmental Conditions for Focal Species

Characterizing the overall habitat requirements of a wildlife species requires the consideration of three interrelated elements: the cover type (or WHTs), structural conditions, and environmental correlates. These features should be viewed as hierarchical in nature with WHTs occurring at the broadest scale, structural conditions occurring at the stand level and environmental correlates at a site specific or local level (Johnson and O’Neil 2001). This section evaluates the elements of habitat most important to the sensitive species in the subbasin. The technical team felt that while the focal species they selected were good species to use to focus discussions of the issues and habitat concerns of the subbasin a broader group should be used when identifying important habitat elements for management consideration. For this reason wildlife species designated as Federal and State T+E, State sensitive, BLM sensitive, USFS sensitive or Partners in Flight focal species were also included in the following habitat association analysis (see section 1.2.1 for species lists). This group of 69 species will be collectively referred to as ‘concern species’ in the following discussion.

1.2.10.1 *Wildlife Habitat Types*

The WHTs and their general vegetative species composition were introduced in section 1.1.1.9. As described in sections 1.1.1.10 and 1.1.3.3, land use activities and human alterations to ecological processes have altered the distribution, and composition of these WHTs. These changes have influenced the composition and population dynamics of the wildlife communities dependent on the WHTs. Unfortunately, the paucity of historical records and issues of scale make quantifying these changes difficult and estimates of change should be viewed cautiously. The best attempt at quantifying changes in the distribution of WHTs in the subbasin has been conducted by the Northwest Habitat Institute, and their data are presented in Table 79; maps showing historical and current distributions of WHTs visible at the scale of the subbasin are shown in Appendix D. Due to scale differences between the current and historic WHT layers, an analysis of changes in WHT distributions at the 6th field HUC scale was not considered appropriate by the Technical team.

Table 79. Changes in wildlife habitat types (WHTs) distribution in the Imnaha subbasin from historical to current (changes viewed to be most significant to the wildlife of the subbasin based on local knowledge, regional knowledge, and subbasin habitat data in bold).

WHT	Historical WHT Distribution (acres)	Current WHT Distribution (acres)	Change in WHT distribution from current to historical (acres)	Percent (%) change in WHT distribution from historical to current	Change from historical to current in % of subbasin covered by WHT
Montane Mixed Conifer Forest	16,627	52,661	36,034	217	7
Eastside (Interior) Mixed Conifer Forest	96,042	162,903	66,861	70	12
Lodgepole pine forest and woodlands	4,715	0	-4,715	-100	-1
Ponderosa pine forest and woodlands	47,649	25,154	-22,495	-47	-4
Upland Aspen Forest	248	0	-248	-100	0
Subalpine Parklands	30,277	0	-30,277	-100	-6
Alpine Grasslands and Shrublands	9,927	28,365	18,438	186	3
Eastside (Interior) Grasslands	330,562	275,555	-55,007	-17	-10
Shrub-Steppe	6,452	50	-6,402	-99	-1
Agriculture, Pasture, and Mixed Environ	0	1,189	1,189	—	0
Lakes, Rivers, Ponds, and Reservoirs	3,226	82	-3,144	-97	-1
Herbaceous Wetlands	0	16	16	—	0
Montane Coniferous Wetlands	0	420	420	—	0
Eastside (Interior) Riparian Wetlands	248	0	-248	-100	0

The degree of impact changes in the availability of a WHT will have on a particular species depends on the degree of association a species has with the WHT. A species widely known to depend on a habitat for part or all of its life history requirements is considered closely associated with that WHT. A species identified as having a close association with a WHT has an essential need for this habitat for its maintenance and viability. Some species may be closely associated with more than one WHT, during different times of the year or for different activities. Some species are not closely associated with any WHT but are rather generally associated with a number of WHTs. In this case the WHTs play a supportive role in the species maintenance and viability but the species may be more dependent on a particular structural condition (see Section 1.2.10.2) (Johnson and O’Neil 2001).

Habitat types closely associated with the broad wildlife groups of the Imnaha subbasin are displayed in Figure 62 more detailed species specific relationships are contained in Appendix A. Amphibian and reptile species in the subbasin tend to be most commonly closely associated with the wetland and open water WHTs of the subbasin, while close relationships between the subbasins bird and mammal species and their habitat are more evenly distributed among the WHTs. The open water and herbaceous wetland WHTs have the greatest total number of closely associated species (Figure 62). This indicates that alterations in these WHTs are likely to have the most widespread impacts on the ecosystem of the subbasin.

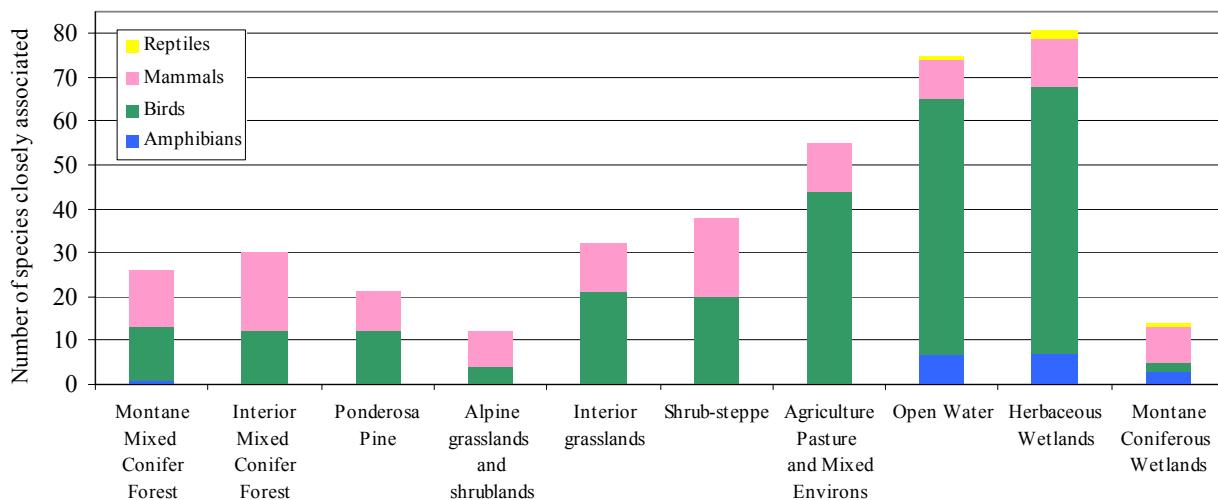


Figure 62. Distribution of close habitat associations among current WHTs in the Imanha subbasin and species groups.

Table 79 indicates that declines in the availability of the lodgepole pine, ponderosa pine, subalpine parklands, shrub-steppe, lakes, rivers and ponds, and riparian wetland WHT have occurred in the subbasin. Some of these changes are likely the result of differences in the spatial scale and mapping techniques at which the historic and current WHT maps were compiled. Discussions with biological resource experts, subbasin specific literature, and the results of regional assessments indicate that the reductions in the extent and quality of riparian wetlands, interior grasslands and ponderosa pine habitats have likely had the most significant impact on the wildlife species of the subbasin. For this reason degradation and reductions in extent of these three habitat types were identified as primary limiting factors to wildlife in the subbasin. See section 1.5.2 for a more detailed discussion of these limiting factors and the Imnaha Subbasin Management Plan for objectives and strategies geared towards reducing the impact of these limiting factors on the wildlife populations of the subbasin.

In contrast, the NHI data indicates that acres of the subbasin covered by montane and eastside conifer forests, alpine grass and shrublands, and montane and herbaceous wetland habitat types have increased between historical and current times. If the availability of habitat were the only factor influencing populations of the wildlife species closely associated with these habitats, their populations could be expected to have increased; however, as illustrated in section 1.2.9, this is not always the case. Many of the species dependent on these WHTs have experienced population declines, which may be partially explained by the influence of structural condition and habitat elements on wildlife habitat (discussed in the following section), as well as out-of subbasin conditions (see section 1.3).

1.2.10.2 Structural Condition

Structural condition is another important feature determining the use of a habitat by a wildlife species. Similarly to WHTs, species widely known to depend on a structural condition for part or all of its life history requirements is considered closely associated with that structural condition. A species identified as having a close association with a structural condition has an

essential need for this habitat for its maintenance and viability. Grassland, forest agricultural and urban habitats all exhibit structural conditions that influence wildlife habitat use. Due to the relatively small amount of the agriculture and urban habitats contained in the subbasin, the relatively small number of closely associated species, and time constraints; wildlife use of different structural conditions in these WHT was not considered.

Forest

Forest structural conditions are based on the following forest stand features: 1) tree size, 2) percent canopy cover (or percent grass/forb cover), and 3) number of canopy layers. Johnson and O’Neil (2001) defined 26 different classes of forest structure conditions based on classifying these forest stand feature using the attributes described in Table 80. Appendix H contains detailed descriptions of the characteristics of the forest structure classes.

Table 80. Attributes used to differentiate forest structure classes (Johnson and O’Neil 2001).

Tree Size (dbh)		Percent Canopy Cover		Number of Canopy Layers	
<i>Shrub/Seedling</i>	<1"	<i>Open</i>	10-39%	<i>Single Story</i>	1 stratum
<i>Sapling/Pole</i>	1-9"	<i>Moderate</i>	40-69%	<i>Multi-story</i>	2 or more strata
<i>Small Tree</i>	10-14"	<i>Closed</i>	70-100%		
<i>Medium Tree</i>	15-19"				
<i>Large Tree</i>	20-29"				
<i>Giant Tree</i>	$\geq 30"$				

Similarly to WHTs, species widely known to depend on a structural condition for part or all of its life history requirements is considered closely associated with that structural condition. A species identified as having a close association with a structural condition has an essential need for this habitat for its maintenance and viability. The degree of association with a structural condition was assessed for the Federal and State Endangered, Threatened, State Sensitive Forest Service Sensitive, Partners in Flight Priority Species and Focal Species (hereafter referred to as concern species). Nineteen of the concern species with habitat in the subbasin are closely associated with a forest structural condition for a life activity (Figure 63). All of these species were closely associated with more than one structural condition. In general the greatest number of species is closely associated with large to giant size class forests or early seral structural conditions, but some concern species were closely associated with all of the structural conditions (Figure 63). This illustrates the importance of maintaining a diversity of structural conditions on the landscape.

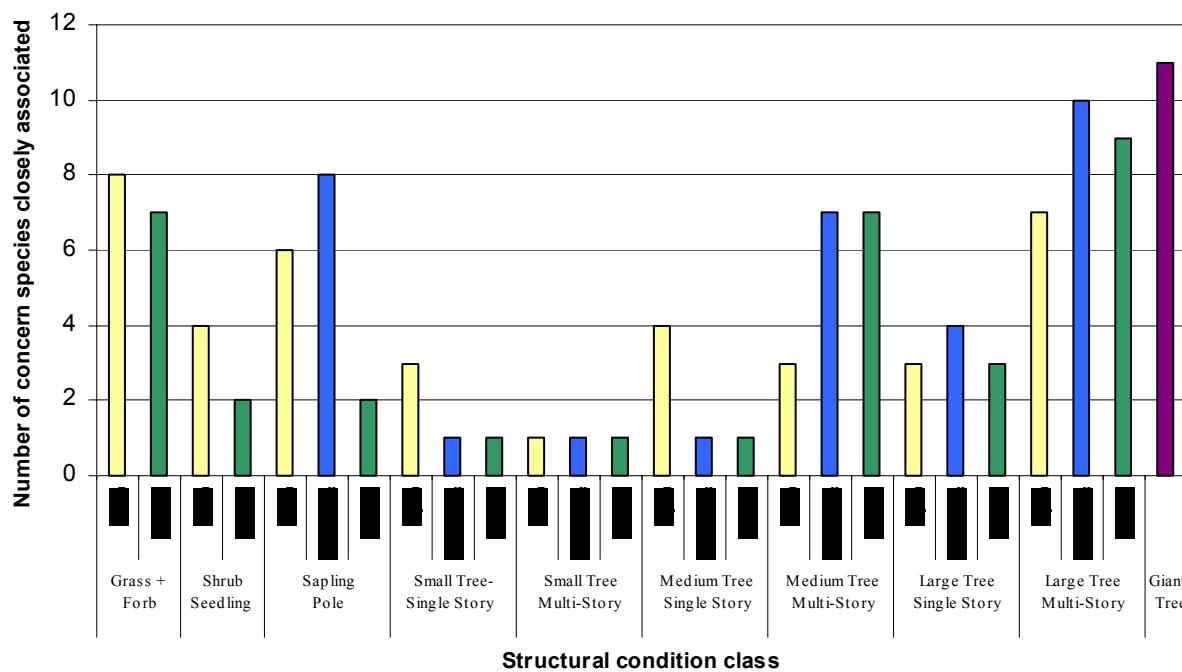


Figure 63. Number of concern species closely associated with forest structural conditions

Comparison of historic and current availability of structural conditions

Historic

Historic range of variability (HRV) is defined as the natural fluctuation of ecological and physical processes and functions that would have occurred in an ecosystem during a specified previous period of time. The Wallowa-Whitman National Forest (USFS) has developed a HRV for the subbasin and surrounding area that identifies a range of forest structural stages that was likely to have occurred prior to the settlement of northeastern Oregon by Euro-Americans (approximately 1850) (USFS 2003a).

Table 81. Historic Range of Variability for Forested Structural Stages by Biophysical Environment, reference point used for analysis by WWNF denoted in parenthesis

	Structural Stage (%)			
	Very early	Early	Mid	Late
Group 1 --- Alpine fir and lodgepole pine cool-cold/moist	1-10 (10)	5-25 (10)	5-70 (45)	5-70 (35)
Group 2 --- Alpine fir and lodgepole pine cold/dry	1-10 (10)	5-25 (10)	5-70 (45)	5-70 (35)
Group 3 --- Alpine fir and lodgepole pine cool/dry	1-10 (10)	5-25 (20)	5-50 (40)	5-60 (30)
Group 4 --- Grand fir cool/dry	1-10 (10)	5-50 (15)	5-50 (50)	5-60 (25)
Group 5 --- Douglas-fir warm/dry	1-15 (10)	5-25 (15)	5-55 (50)	5-55 (25)
Group 6 --- Douglas-fir warm/moist	1-15 (10)	5-25 (15)	10-55 (45)	5-55 (30)
Group 7 --- Ponderosa pine hot/dry	1-15 (10)	5-25 (15)	5-70 (45)	5-70 (30)
Group 8 --- Ponderosa pine hot/moist	1-15 (10)	5-25 (15)	5-70 (40)	5-50 (35)
Average reference point across all biophysical groups	10.0	14.4	45.0	26.9
		29.7		

Current

Current forest structure condition data for the subbasin was derived by performing a GIS overlay of three layers containing information on forest conditions in the subbasin. A subbasin wide layer on tree size has been compiled by the Oregon Natural Heritage Program (ONHP) using data collected from the Wallowa-Whitman National Forest, Oregon GAP, and the Natural Resource Conservation Service. Data on percent canopy cover and the number of canopy layers available through the Wallowa-Whitman National Forest (These data sets are displayed in Figures in Appendix I). In areas where all three data layers overlapped (66 percent of the forested area within the subbasin) it was possible to determine forest structure and assign structural condition classes based on attributes described in Table 80. Available information on current forests structural conditions in the Imnaha subbasin is displayed in Figure 64, and Table 82.

A number of challenges across in assigning structural condition classes that should be considered when evaluating the data. Due to difference in class breaks between the ONHP tree size data and the size classes recommended by Johnson and O’Neil (2001) the shrub/seedling and sapling/pole classes and the small and medium tree classes were combined. In areas classified as grassland in the source data layers, it was difficult to differentiate between areas where grasslands were the climax community and where grasslands were seral to forests. For this reason, the grass/forb structural condition (which is supposed to contain only grassland areas seral to forests) is likely overrepresented by the data. The final issue encountered in assigning structural conditions resulted from differences in classification of tree size data. The tree size data from the ONHP made the break between the seedling/sapling pole and small tree size classes at 9 inches dbh while Johnson and O’Neil recommend the break at 10 inches dbh (Table 80). It was not possible to obtain the raw unclassified data so it was necessary to move the break between the classes to 9 inches dbh.

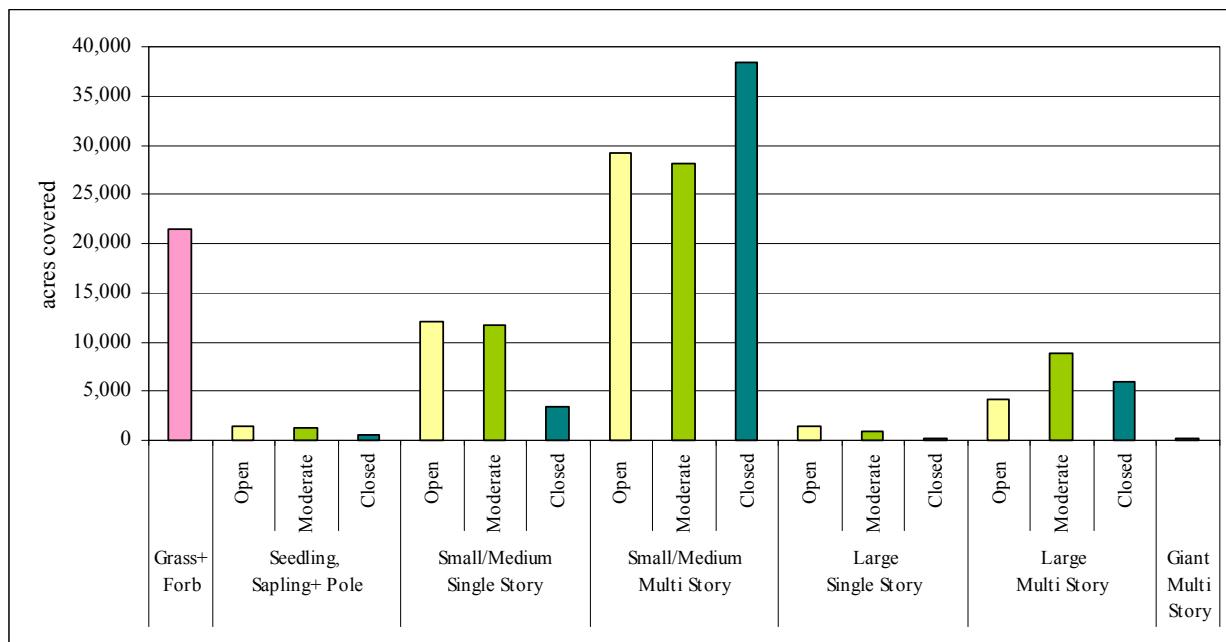


Figure 64. Distribution of current forest structural condition classes in the Imnaha subbasin

Table 82. Acreages and percent of area with data covered by current structural condition classes in the Imnaha subbasin

Structural Condition		Acres Covered	% of area with structural condition data covered
Grass and Forb		21,459	12.69
Seedling, Sapling and Pole	Open	1,403	0.83
	Moderate	1,266	0.75
	Closed	601	0.36
	Total	3,270	1.93
Small/Medium Single Story	Open	12,100	7.16
	Moderate	11,750	6.95
	Closed	3,363	1.99
	Total	27,213	16.09
Small/Medium Multi Story	Open	29,174	17.25
	Moderate	28,197	16.67
	Closed	38,345	22.67
	Total	95,716	56.60
Large Single Story	Open	1,525	0.90
	Moderate	988	0.58
	Closed	106	0.06
	Total	2,618	1.55
Large Multi Story	Open	4,070	2.41
	Moderate	8,801	5.20
	Closed	5,859	3.46
	Total	18,730	11.08

Changes in availability of forest structural conditions

Comparisons of current structural conditions with historical conditions are complicated by difference in the classification systems used in the available data. The USFS developed classes based on structural stages in their development of the HRV for the subbasin. Descriptions of the structural stage classifications used by the USFS and described in the HCNRA-CMP (2003a) indicate that the very early seral stage classification is roughly comparable to the grass/forb and seedling/sapling/pole structural conditions, the early and mid seral stages are roughly comparable to the small and medium tree structural conditions, and the late seral stage is roughly comparable to the large and giant structural conditions. A comparison of historic and current structural conditions in the Imnaha subbasin based on these assumptions is contained in (Table 83).

The structural conditions of the forested communities of the subbasin appear to be within the HRV but small-medium tree forests are near the top of the range of their representation historically while large and giant forests are very low in the range of their representation historically. The data is inconclusive on the seedling, sapling, pole, structural condition (Table 83). As discussed earlier the grass/forb structural condition is probably over-represented in the current data due to the likely inclusion of areas where the climax community is grasslands.

When these areas are included in the analysis the current abundance of very young forests is high in the HRV, when only the seedling sapling pole structural condition is considered the representation of very young forests is very low in the HRV (Table 83). Actual conditions are likely represented by some intermediate between the two states.

Table 83. Comparison of historic structural stages to current structural conditions

Historic			Current		Change	
Historic Structural Stage	HRV ¹	Average reference point ²	Current Structural conditions combined by size class	% of forested area with structure data covered	Current conditions within HRV?	Current conditions above or below historic reference point?
Very Early	1-15	10.0	Grass/forb and seedling sapling pole	14.6	yes	above
			Seedling, sapling, pole only	1.9	yes	below
Early -Mid	10-100	29.7	Small -Medium	73.0	yes	above
Late	5-70	26.9	Large and giant	12.6	yes	below

Changes in the availability of structural conditions in the subbasin have the potential to impact the wildlife species in the subbasin. The greatest number of concern species in the subbasin were closely associated with the large tree-multi storied and giant tree structural conditions (Figure 65). The representation of large trees in the subbasin is on the low end of the HRV. Reductions in the representation of large tree structural conditions in the subbasin are a particular concern because structural conditions are not uniformly distributed across the subbasin. Table 84 shows the distribution of structural conditions by 6th field HUC. Large trees can be seen to be concentrated in a few areas, while they are very rare in most others. Large-single storied stands comprised more than 20 % of the area with data in only one HUC 07N. Large multi-storied stands are better distributed and comprise more than 20% of the area with data in HUCs 07A, 07E, 07K, 07M, 07O, 08F, 09M. Older forests contain numerous Key Environmental Correlates for wildlife, maintaining these elements is a management priority (see Section 1.2.10.3 for details).

Changes in the abundance and distribution of tree age classes in the subbasin are not the only type of structural changes that have occurred in the subbasins forests since historic. As discussed in section 1.1.1.10, fire suppression has resulted in increased forest densities, which have increased the susceptibility of the subbasins forests to insects and disease. Also due to the impacts of fire suppression, wildfire intensities have increased dramatically over historical levels (USFS 1995). A greater extent of the forested areas in the subbasin can be classified as Fuel Models 9 and 10 than were present historically; these areas are characterized by closed timber stands with heavy/dense understories (USFS 1998). Fires burning in Fuel model 9 and 10 tend to be large, intense stand replacing fires, which can have significant negative impacts of both fish and wildlife populations.

Due to the potential for widespread impacts on numerous wildlife species, changes in forest structural conditions and the underlying changes in forest disturbance regimes that caused them were selected as a terrestrial limiting factor by the terrestrial technical team. This issue is discussed further in the terrestrial limiting factors section (1.5.2); strategies for working toward restoring forest structural conditions in the subbasin were developed by the technical team and are presented in the Imnaha Subbasin Management Plan.

Table 84. Distribution of forest structural condition classes by 6th field HUC, Immaha subbasin (see Figure 3 for HUC locations).

6th HUC ¹	Total area of 6th HUC (acres)	% of 6th HUC w/ forest structure data	Grass/Forb	Structural condition class distribution (% of area with forest structure data in 6th HUC)												Giant Tree			
				Seedling/sapling/pole				Small Tree Single Story				Large Tree Single Story				Small/Medium Tree Multi Story			
				Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	
07A	2,900	8.9	0	0	0	0	0	2	0	0	0	0	0	0	0	0	98	0	0
07E	14,891	10.7	1	0	0	0	0	3	0	1	3	0	4	14	23	4	23	25	0
07I	7,288	20.9	18	0	0	0	0	0	6	0	0	0	16	5	53	0	0	0	0
07J	12,438	11.6	0	0	0	3	1	7	1	0	0	0	28	37	17	0	6	0	0
07K	18,800	44.0	2	0	0	0	1	0	0	1	1	0	3	6	9	5	45	27	0
07L	6,339	10.7	58	0	0	0	5	5	0	1	12	0	5	13	0	1	0	0	0
07M	14,301	14.1	11	0	0	0	4	8	0	5	4	0	4	1	0	41	18	3	0
07N	6,669	14.5	36	0	0	0	8	0	0	41	1	0	0	3	0	7	2	1	0
07O	6,979	7.6	0	0	0	0	8	2	0	0	0	0	24	22	19	0	23	1	0
07P	13,585	26.1	5	0	0	0	1	11	0	1	5	0	15	39	12	2	7	1	0
07Q	10,209	38.8	7	5	1	0	10	21	6	0	0	0	9	16	21	0	1	3	0
07R	12,224	32.9	0	12	1	0	1	3	3	0	0	0	25	23	32	0	0	0	0
08A	5,657	5.2	0	0	0	0	0	0	0	0	0	0	10	2	88	0	0	0	0
08B	15,190	14.1	1	0	0	0	3	8	0	0	0	0	27	31	29	1	1	0	0
08C	13,940	8.3	0	0	0	0	4	59	0	0	0	0	16	16	0	0	0	4	0
08D	12,632	0.9	0	0	0	0	19	18	44	0	0	0	2	11	7	0	0	0	0
08E	5,580	22.7	1	0	0	0	0	52	0	0	0	0	2	29	17	0	0	0	0
08F	7,164	33.1	0	0	0	0	2	9	12	0	8	1	1	10	14	19	9	13	0
08G	22,009	59.3	0	1	2	0	4	32	2	1	1	0	12	30	11	1	3	0	0
08H	10,892	7.8	10	0	0	0	8	0	3	0	0	0	48	27	5	0	0	0	0
08I	11,694	44.3	35	0	0	0	6	2	2	0	0	0	42	11	3	0	0	0	0
08J	16,657	56.7	5	0	0	1	14	3	0	0	0	0	39	18	20	0	0	0	0
08K	11,919	19.9	10	4	0	0	57	1	0	0	0	0	13	10	5	0	0	0	0
08L	13,800	75.3	4	0	0	0	10	2	6	0	0	0	21	35	23	0	0	0	0
09A	22,971	57.2	1	0	0	0	22	10	1	0	0	0	20	32	11	1	1	0	0
09B	9,840	56.1	0	0	0	3	1	1	2	0	1	0	40	29	20	0	1	0	0
09C	8,991	21.0	0	0	0	0	3	4	7	0	0	0	12	64	10	0	0	0	0
09D	10,607	6.5	6	0	0	0	7	6	14	0	9	0	20	13	22	0	0	3	0

6th HUC ¹	Total area of 6th HUC (acres)	% of 6th HUC w/ forest structure data	Structural condition class distribution (% of area with forest structure data in 6th HUC)																
			Seedling/sapling/pole			Small Tree Single Story			Large Tree Single Story			Small/Medium Tree Multi Story			Large Tree Multi Story			Giant Tree	
			Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed	Open	Mod.	Closed		
09E	5,694	8.2	27	0	5	0	20	8	0	7	1	0	5	7	5	6	1	7	0
09F	11,522	23.2	14	0	3	1	6	8	0	2	1	0	14	32	11	1	8	0	0
09G	11,962	53.1	26	0	0	0	6	2	8	0	0	0	20	21	17	0	0	0	0
09H	6,287	54.5	28	0	0	0	15	2	0	0	0	0	20	25	9	0	0	0	0
09I	8,169	88.0	52	0	0	0	8	0	0	3	0	0	15	7	6	3	5	0	0
09J	6,382	81.1	25	0	0	0	8	0	0	0	1	0	0	14	20	24	3	2	0
09K	11,983	70.0	19	0	0	0	5	3	0	0	0	0	9	17	30	5	4	6	1
09L	8,925	92.8	32	0	0	0	6	2	0	4	0	1	14	18	9	1	6	7	0
09M	12,567	82.6	24	0	0	0	3	1	0	2	0	0	12	18	12	7	9	11	0
09N	10,687	60.9	5	0	7	0	14	1	3	0	0	0	19	24	24	0	1	1	0
09O	13,625	37.2	13	7	2	0	6	2	1	0	0	0	1	20	48	0	0	0	0
09P	17,773	32.5	8	0	4	1	0	0	0	0	0	0	18	47	17	0	0	0	0

¹ forest structure data was available for <5% of 6th field HUCs 07A, 07B, 07C, 07D, 07E, 07F, 07H, 07G these HUCS are not represented in this table

Grassland

Grassland structure is determined by: 1) shrub height, 2) percent shrub cover (or percent grass/forb cover), and, 3) shrub age class. Johnson and O'Neil (2001) defined 20 different classes of grassland structure conditions based on the attributes described in Table 85. Appendix H contains more detailed descriptions of the characteristics of the grassland structure classes.

Table 85. Attributes used to differentiate grassland structure classes Johnson and O'Neil 2001.

Shrub Height		Percent Shrub Cover		Shrub Age Class	
<i>Low</i>	≤ 1.6 ft	<i>Open</i>	10-69% shrub cover	<i>Seedling/Young</i>	negligible crown decadence
<i>Medium</i>	1.6-6.4 ft	<i>Closed</i>	70-100% shrub cover	<i>Mature</i>	$\leq 25\%$ crown decadence
<i>Tall</i>	6.5-16.5 ft			<i>Old</i>	26-100% crown decadence

Wildlife species can also exhibit close associations with grassland structural conditions. Twelve of the concern species in the subbasin have been demonstrated to have a close-association with a grassland structural condition. Each of these species has a close association with more than one grassland structural condition (see Appendix A). Open grass-forb and young low shrub habitats with closed overstories have the greatest number of closely associated concern species (Figure 65).

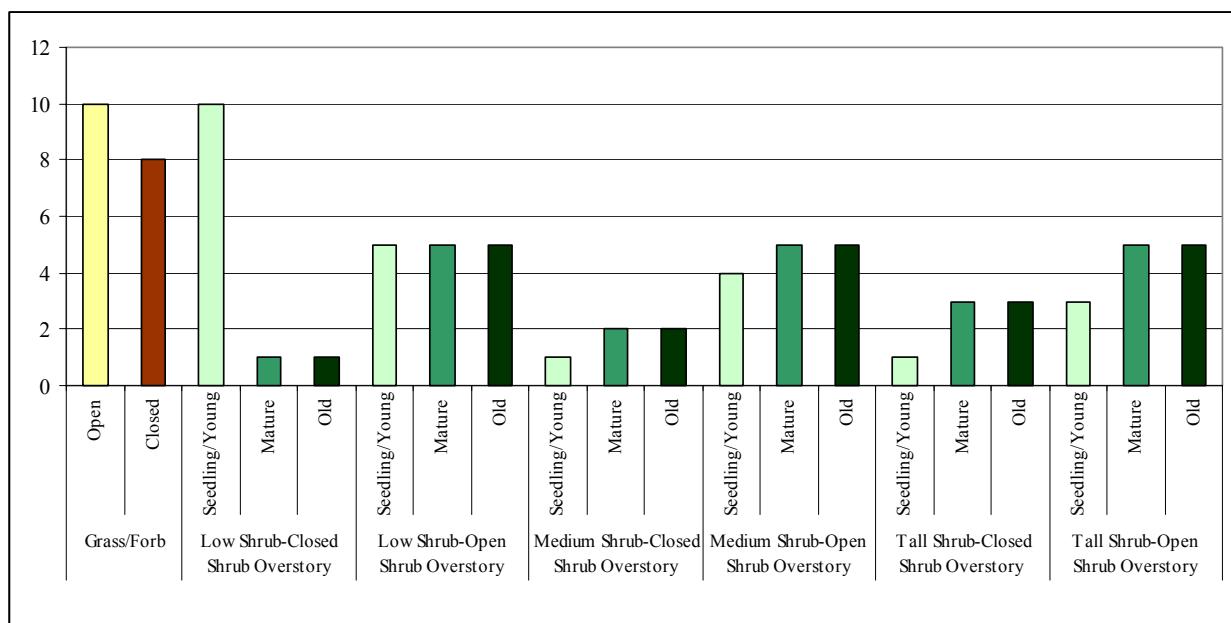


Figure 65. Number of concern species closely associated with grassland structural conditions.

1.2.10.3 Key Environmental Correlates

Key environmental correlates (KECs) (also termed Habitat Elements) are specific substrates, habitat elements, and attributes of species' environments that are not represented by overall (macro) habitats and vegetation structural conditions. Key environmental correlates are the finest scale features that help to define wildlife habitat. KECs recognize and attempt to qualify the high degree of influence either positive or negative the environmental correlates exert of the realized fitness of a species (Johnson and O'Neil 2001). They include natural elements (both environmental and physical), as well as anthropogenic features and their effects, such as roads, buildings, and pollution. Including these fine-scale attributes of an animal's environment when describing its habitat associations expands the concept and definition of a habitat, a term widely used only to characterize the vegetative community or structural condition occupied by a species (Johnson and O'Neil 2001). Failing to address and inventory KECs within these communities and conditions may lead to errors of commission; that is, species may be presumed to occur when in actuality they do not (Johnson and O'Neil 2001). The KECs identified to effect wildlife species across the Columbia Basin by Johnson and O'Neil are described in Appendix J (2001).

All KECs identified to influence habitat use by a focal species are summarized in Appendix K. The technical team reviewed the KECs identified to influence the wildlife species of the subbasin. Based on their understanding of the factors most influencing wildlife populations in the subbasin they identified roads and noxious weeds as limiting factors. These limiting factors are discussed in greater detail in section 1.5.2. The technical team identified strategies for reducing the negative impacts of these KECs on the wildlife populations of the subbasin in the Imnaha Subbasin Management Plan.

1.3 Out-of-Subbasin factors

Both aquatic and terrestrial species in the subbasin are affected by habitat conditions and features that occur outside of the subbasin. The species most impacted by these out-of-subbasin factors are species with large home ranges and species that migrate out of the subbasin to complete one or more lifestages.

1.3.1 Aquatic

Appendix N provides a regional overview of out-of-subbasin factors impacting anadromous fish in various areas throughout the Columbia Basin, including areas above Lower Granite Dam (which includes the Imnaha subbasin). Information presented here will focus on impacts to Snake River stocks and, when possible, those populations or stocks specific to the Imnaha subbasin. As mentioned earlier, Appendix G includes broader scale information.

1.3.1.1 Limiting Factors Outside Subbasin

It is generally accepted that hydropower development on the lower Snake River and Columbia River is the primary cause of decline and continued suppression of Snake

River salmon and steelhead (CBFWA 1991; NPPC 1992; NMFS 1995, 1997; NRC 1995; IDFG 1998; Williams et al. 1998). However, less agreement exists about whether the hydropower system is the primary factor limiting recovery (Marmorek et al. 1998). Other out-of-basin factors contributing to anadromous decline in the Imnaha include habitat losses, predation, fishing pressures, and hatcheries, most of which are influenced to some degree by the Columbia River hydropower system.

1.3.1.2 Estuary

Habitat losses in estuarine environments have also resulted from hydropower system operations. Storage in the upper Columbia and Snake rivers has altered the hydrograph. This alteration has resulted in a reduction in average sediment supply to the estuary, an increase in the residence time of water in the estuary and corresponding decrease in salinity, an increase in detritus and nutrient residence, and a decrease in vertical mixing (Sherwood, as cited in NRC 1996). These changes have converted the estuary to a less energetic system with high organic sedimentation rates. The changes have caused an overall loss of estuarine habitat used for rearing and has contributed to the dramatic decline in salmon populations.

1.3.1.3 Nearshore

El Niño events, combined with other climatic and oceanic phenomenon, have caused a shift in ocean conditions over the past two decades; impacting Columbia Basin salmon returns (NMFS 2000a). Based on the cyclic nature of the oceanic and climatic regimes, conditions are likely going to become more favorable for fish in the next decade (NMFS 2000a).

1.3.1.4 Marine

Patterns of Pacific Decadal Oscillation and salmon production would indicate that poor ocean conditions existed for Columbia River salmon after the late 1970s (Hare et al. 1999). However, the natural fluctuations of ocean productivity affecting all Columbia River stocks, in combination with mortality as a result of the hydropower system, appear to have caused the severe declines in productivity and survival rates for the Snake River stocks. Recent improvements in ocean conditions, however, appear to have had beneficial effects to survival rates, and are attributed partially to the increasing trend in chinook returns (DeHart et al. 2003).

1.3.1.5 Mainstem Habitat

The diversity of mainstem Snake and Columbia river salmonid habitat has been greatly diminished by the hydropower system. High-head dams in the Snake River upstream of the Imnaha have isolated populations and eliminated spawning and rearing habitat. The once lotic nature of the Snake and Columbia rivers has been all but compromised, altering flooding and draining patterns and isolating other habitat types.

Predation of salmonid smolts by various species also represents a potential limiting factor to survival, particularly within reservoirs. Shively et al. (1996) found that pikeminnow

predation would be minimized when water velocity was greater than 1 meter per second and water depth exceeded 10 meters, suggesting that predation by pikeminnow is not a significant threat to outmigrating salmon within the Snake Hells Canyon subbasin itself due to the riverine nature of the reach. Predation by pikeminnow is, however, substantial throughout all or portions of the downstream migration corridor. Northern pikeminnow, a native predator, has become well adapted to the habitat created by river impoundment and has been shown to have substantial predatory impacts on migrating salmonids (Beamesderfer and Rieman 1991, Petersen 1994, Collins et al. 1995).

Other key piscivorous fish species, which may pose a potential limiting factor to anadromous salmonids in the migratory corridor, include walleye, channel catfish, Pacific lamprey, yellow perch, largemouth bass, northern pike, and bull trout (NMFS 2000b; Nelle 1999). Although not necessarily associated with the Snake Hells Canyon reach, these species have been found to consume considerable numbers of outmigrating subyearling chinook and steelhead and are most closely associated with areas upstream and downstream of impoundments. Avian predator populations are also blamed for salmonid predation. These include the Caspian tern, double-crested cormorant, and three species of gulls (NMFS 2000b). Marine mammals, specifically members of the order pinnepedia, represent additional threats to chinook and steelhead (NMFS 200b).

1.3.1.6 Hydropower

Development and operation of the Federal Columbia River Power System, which for the Imnaha includes four dams on the lower Columbia River and four on the lower Snake River, inflicts the largest human-caused toll on Columbia Basin salmon, killing 20 to 40% of the adults and about 80% of young fish (NRC 1995). This limiting factor keeps yearly effective population size low and increases genetic and demographic risk of localized extinction.

History of the Federal Columbia River Power System

The presence of dams on the Columbia and Snake Rivers began with the congressional authorization for the construction of Grand Coulee and Bonneville dams in the early 1930s. This construction initiated the “taming of the Columbia,” a period during which the eight dams currently impeding Imnaha salmon and steelhead were erected. The Bonneville Dam project began in 1933 as an emergency public works project designed to provide jobs and stimulate the Depression economy (Blumm and Bodi, as cited in Cone and Ridlington 1999). Although hydropower production was one of the benefits that Congress sought from the projects, the dams’ primary purpose was navigation (in the case of Bonneville) and flood control, downstream flow regulation, and irrigation (in the case of Grand Coulee) (Blumm and Bodi, as cited in Cone and Ridlington 1999). As Bonneville Dam neared completion, the 1937 Bonneville Project Act was initiated, which provided a vehicle for marketing surplus power. The act produced the Bonneville Power Administration (BPA), which was authorized by Congress to market power from the projects and construct transmission lines to serve the rural Pacific Northwest (Blumm and Bodi, as cited in Cone and Ridlington 1999).

A 1937 report studying the potential effects of Columbia River dam construction on anadromous fish acknowledged the multitude of problems that salmon would inevitably face, including bypass problems for juvenile fish, unscreened irrigation diversions, unsophisticated hatchery technology, and mixed-stock ocean harvests (Blumm and Bodi, as cited in Cone and Ridlington 1999). The report prompted enactment of the Mitchell Act in 1938, which authorized spending for additional scientific studies and funding of measures to preserve and protect Columbia Basin salmon, including hatcheries, fish ladders, irrigation screens, and habitat protection and restoration projects.

A U.S. Army Corps of Engineers report describing development of the lower Snake River for hydropower and navigation was completed in 1938. The report shifted federal emphasis from the mid-Columbia to the lower Snake, and from power to navigation benefits. The report discussed the benefits of making Lewiston, a town over 400 miles inland from the Pacific Ocean, a deepwater port. Although Congress was slow to adopt the plan due to World War II, it eventually passed an omnibus Rivers and Harbors Act in 1945 and adopted U.S. Army Corps of Engineers recommendations for lower Snake River development, anticipating the benefits the construction would have on employment of returning soldiers and post-war economic stabilization (Blumm and Bodi, as cited in Cone and Ridlington 1999).

Authorization for the construction of McNary Dam was also granted in 1945, with the express statute that the project protect salmon migration, promising anadromous fish “free access to their spawning grounds” (Blumm and Bodi, as cited in Cone and Ridlington 1999). Dam operations did not, however, ascribe to the statute, and instead assumed that dam-related salmon losses could be offset through reliance on hatcheries (Blumm and Bodi, as cited in Cone and Ridlington 1999). Congressional authorization for the construction of The Dalles and John Day dams was given in 1948 following disastrous flooding in the spring of the same year. That same year Congress directed the U.S. Army Corps of Engineers to review its plan for the Columbia Basin, which yielded a report that relied heavily upon flood control as a rationale for the projects it recommended.

Construction was completed on John Day, Lower Monumental, and Little Goose in 1968, 1969, and 1970, respectively. Upon their completion, all Columbia and Snake River dams were equipped with fishways that permitted adult passage (NRC 1995). Downstream-migrant facilities were also constructed (or recently reconstructed) on all eight dams. The construction timing of the Columbia and Snake River dams impacting Imnaha salmon and steelhead are shown in Table 86.

The “taming” of the Columbia and Snake rivers ended in the 1970s, as potential sites and public support for new dam construction had been exhausted (NRC 1995). The effects of the dams on anadromous fish loss proved significant. Imnaha chinook production, based on annual redd counts, was severely reduced following the construction of The Dalles Dam in 1957 (D. Bryson, NPT, personal communication, 2001). Redd counts declined even further following construction of Lower Monumental and Lower Granite dams. A recent evaluation of 25 years of juvenile survival statistics found that an estimated 13 to

14% of emigrating smolts are lost annually at each lower Snake and Columbia river dam (Bickford and Skalski, as cited in Ashe 2000).

Table 86. Chronology of the eight U.S. Army Corps of Engineers dams that currently impede migration of Imnaha anadromous salmonids.

Dam	River	Year Constructed
Bonneville	Columbia	1938
McNary	Columbia	1953
The Dalles	Columbia	1957
Ice Harbor	Snake	1961
John Day	Columbia	1968
Lower Monumental	Snake	1969
Little Goose	Snake	1970
Lower Granite	Snake	1975

Effects of the Federal Columbia River Power System

The Columbia Basin hydropower system may kill or harm migrating fish by through any of the following actions:

- Creating deadly high water temperatures in the slackwater reservoirs
- Creating conditions that increase predation on young salmon by other fish and birds
- Reducing river flows needed to help young salmon reach the sea
- Forcing some young fish into deadly turbines
- Forcing many young fish into stressful collection systems and then into barges and trucks
- Blocking upstream migrations of adult fish
- Covering spawning habitat with silt and deep water

When encountering dams, salmon and steelhead may be delayed at ladders on their upstream migration or in the pools on their downriver migration. The delays may cause reduced fitness or mortality. After reaching the actual structure, juveniles pass or attempt to pass in one of four ways: by falling over the dam as a result of water purposefully spilled from the top; swimming through a looped fish bypass tube that brings the salmon down near the bottom of the dam first, then up near the surface to a collection channel, then down again and finally out the bottom on the other side of the dam; traveling in a barge; or navigating a turbine. All passage attempts generally come at a biological price (NRC 1995). When spilled over the top of the dam, juvenile fish may be killed or injured by the fall, by gas supersaturation, or by opportunistic predators awaiting the disoriented

fish. Juvenile fish bypass and collection facilities also exact tolls on migrating salmonids. The juveniles may come into contact with various surfaces of the facility, causing impingement, bruising, descaling, and stress (Chapman, as cited in NRC 1995). Stress accompanies the bypass process, and when fish are delivered directly to the river, may cause disorientation and subsequent predation. Predators also key in on the comparatively high densities of fish located at bypass outfall areas (NRC 1995). Turbine mortality was higher prior to the retrofitting of many dams with bypass collection facilities but continues to represent a lethal toll.

When anadromous fish out-migrate from the hydropower system but fail to return to their natal habitat as adults, they are said to have experienced delayed mortality. The loss can be attributed to a number of factors, including ocean conditions, harvest, stock viability, habitat conditions, predation, and the hydropower system. A recent study contends that much of the delayed mortality experienced by Snake River anadromous salmonids is related to their hydropower system experience (Budy et al. 2001). The study established that direct mortality from hydropower eliminates 25 to 73% of juveniles and adults, after which Snake River fish may experience 37 to 68% “additional mortality” or delayed mortality (Budy et al. 2001). The study offers direct evidence relating direct mortality to hydropower based on PIT-tagged fish. The PIT data show that, while direct mortality is lower for salmon transported via barge than for fish that navigate the dams, delayed mortality is higher for fish transported via barge (Budy et al. 2001). The authors attribute this result to the stress experienced in the hydropower system and collection channels. The PIT data reflect even higher delayed mortality in fish that pass through one or more dams and are then collected and transported from a lower dam.

Currently, the estimated direct survival of Snake River spring/summer chinook smolts through the hydropower system is between 40 and 60%, compared with an estimated survival rate during the 1970s of 5 to 40%. These improvements have occurred as a result of changes in the operation and configuration of the FCRPS, which include increased spill, barging, increased flow, changes in the operation of turbines, and new extended-length screens at McNary, Little Goose, and Lower Granite dams (NMFS 2000a).

In 1996, the Comparative Survival Study (CSS) was initiated to estimate survival rates over different life stages for spring/summer chinook (DeHart et al. 2003). The overall goal of the CSS is to monitor and evaluate the impacts of mitigation measures and actions (e.g., flow augmentation, spill, and transportation) instituted under the NMFS biological opinion to recover listed stocks. Major objectives of the study include (1) development of a long-term index of transport smolt-to-adult returns (SAR) to in-river SAR for Snake River hatchery and wild spring/summer chinook smolts measured at Lower Granite Dam (LGR); (2) develop a long-term index of survival rates from release of smolts at Snake River hatcheries to return of adults to the hatcheries; (3) compute and compare the overall SARs for selected upriver and downriver spring/summer and summer chinook hatchery and wild stocks; and (4) begin a time series of SARs for use in hypothesis testing and in the regional long-term monitoring and evaluation program. The primary focus in DeHart et al. (2003) is for wild and hatchery spring/summer chinook that outmigrated in 1997 to 2000 and returned in 2003.

Findings from DeHart et al. (2003) include:

- The SARs of transported and in-river migrants are well below the 2-6% SARs needed to recover Snake River spring/summer chinook. Despite overall low SAR levels, SARs for chinook from the Imnaha hatchery have increased annually reaching levels over 2% in most study categories in 1999 and 2000. In most cases, Imnaha hatchery smolts that were transported had higher SARs than their in-river counterparts
- There were little or no transport benefits for wild Snake River chinook in most years (1994-2000)
- Delayed hydrosystem mortality was evident for transported Snake River hatchery chinook smolts, which died at a greater rate after release than hatchery smolts that migrated through the hydrosystem in 1997-2000
- Delayed hydrosystem mortality was evident for transported Snake River wild chinook smolts, which died at a greater rate after release than wild smolts that migrated through the hydrosystem in 1994-2000

Adult escapement of anadromous species remains low even given significant hatchery production/supplementation efforts. Low adult abundance has resulted in stocking at variable rates between years, depending on the availability of brood fish (Walters et al. 2001). Smolt-to-adult return rates (SAR), from smolts at the uppermost dam to adults returning to the Columbia River mouth, averaged 5.2% in the 1960s before hydropower system completion and only 1.2% from 1977 to 1994 (Petrosky et al. 2001) (Figure 66). This rate is below the 2 to 6% needed for recovery (Marmorek et al. 1998).

In contrast to the decline in SAR, numbers of smolts per spawner from Snake River tributaries did not decrease during this period, averaging 62 smolts per spawner before hydropower system completion and 100 smolts per spawner afterward (Petrosky et al. 2001) (Figure 66) In this summary, both spawner escapement and smolt yield are measured at the uppermost mainstem dam (currently Lower Granite). The increase in smolts per spawner was due to a reduction in density-dependent mortality as spawner abundance declined. Accounting for density dependence, a modest decrease occurred in smolts per spawner from Snake River tributaries over this period but not of a magnitude to explain the severe decline in life-cycle survival (Petrosky et al. 2001).

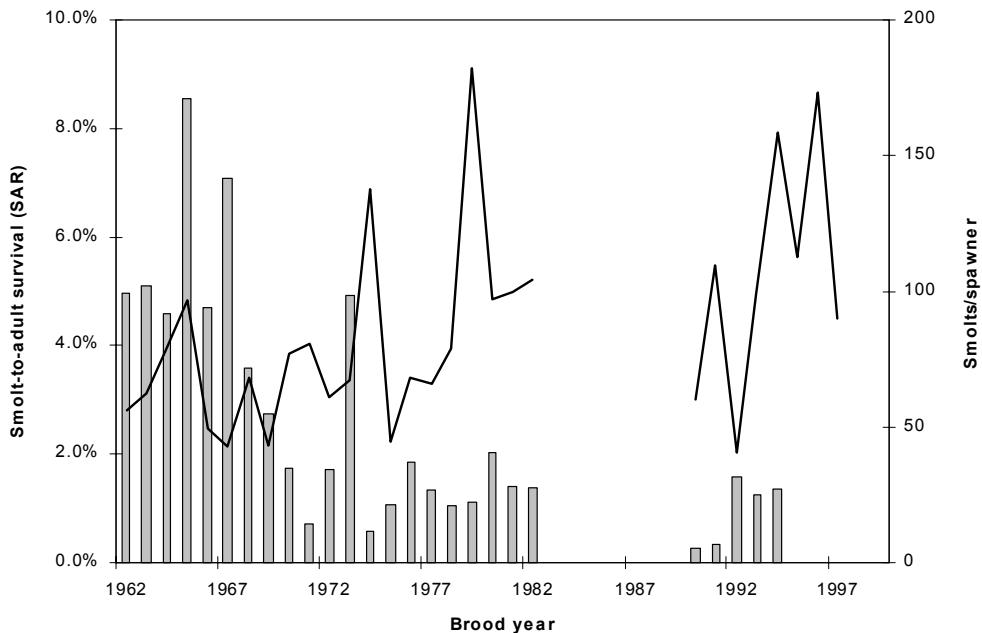


Figure 66. Smolt-to-adult survival rates (SAR; bars) and smolts/spawner (solid line) for wild Snake River spring/summer chinook. The SAR describes survival during mainstem downstream migration to adult returns, whereas the number of smolts per spawner describes freshwater productivity in upstream freshwater spawning and rearing areas (from Petrosky et al. 2001).

The SAR and smolt per spawner observations (Figure 66) indicate that the overall survival decline is consistent primarily with hydropower system impacts and poorer ocean (out-of-subbasin factors), rather than large-scale impacts within the subbasins between the 1960s and present (Schaller et al. 1999, Petrosky et al. 2001). Because the smolt/spawner data represent aggregate populations from a mix of habitat qualities throughout the Snake River basin and are from a period after development, they do not imply that there is no room for survival improvement within the Salmon, Clearwater, Grande Ronde, and Imnaha subbasins. However, because of limiting factors outside the subbasin and critically reduced life-cycle survival for populations even in pristine watersheds, it is unlikely that potential survival improvements within the Snake River subbasins alone can increase survival to a level that ensures recovery of anadromous fish populations.

1.3.1.7 Out-of-Subbasin Harvest

Mixed stock commercial fisheries (both tribal and nontribal) have taken a large toll on anadromous runs. Fishing pressures, combined with dam mortality, have substantially contributed to coho extinctions in the Snake River system and have significantly contributed to the imperiled status of chinook and sockeye in the Snake River system.

NMFS (2000a) estimates that approximately 9% of the spring/summer chinook run is subjected to total in-river (tribal, commercial, sport) harvest. Due to migration patterns of these stocks in conjunction with fishing seasons, ocean harvest is nearly nonexistent. The TAC (1997, as cited in Ashe 2000) concluded that the ocean fishing rate for upriver spring/summer chinook is probably less than 2%, one of the lowest rates of all Columbia River stocks. For Snake River fall chinook, a much more abundant stock, combined ocean and in-river harvest is less than 30% (NMFS 2000a).

Tribal harvesters, those guaranteed by treaty to fish, have reduced annual harvest to a fraction of historical levels but continue to fish commercially for various species. There were treaty and nontreaty commercial seasons for spring/summer chinook in 2001–2003.

1.3.1.8 Hatcheries

There has been considerable concern that hatchery-reared salmon and steelhead have reduced the prevalence of wild anadromous salmonids through competitive interaction, genetic introgression, and disease transmission (Ashe et al. 2000). The fact that more than 70% of Oregon's salmon start life in a fish hatchery (<http://www.oregonvos.net/salmon>) lends credence to this concern. Also, the mixed stock fishery that has been created through the introduction of hatchery fish has resulted in increased harvest rates of wild/natural fish.

The role of salmon hatcheries has shifted several times over the years between a remedy for lost fish habitat to a method of helping boost wild salmon stock. In 1938, Congress passed the Mitchell Act to provide federal money for aggressive construction of hatcheries as a way of replacing the thousands of acres of salmon spawning grounds blocked or flooded behind dams (Cone and Ridlington 1999). Subsequently, more than 80 hatcheries were built in the Columbia Basin.

Early hatchery management often involved little more than transporting the biggest, most desirable species of salmon from one river to another. Little was understood then about the unique genetic makeup of each salmon stock and their innate ability to return to their natal streams.

Between the mid-1950s and early 1970s, scientists became increasingly concerned with the effects hatchery fish were having on wild fish. They contended that the mass production of hatchery salmon was harming the remaining wild salmon runs and endangering the future welfare of salmon populations. Studies determined that hatchery fish had lower survival rates in the ocean than wild fish, and offspring from hatchery fish had lower genetic fitness than wild fish. And because hatchery salmon do not return to upriver spawning grounds, the nutrients released from decomposing carcasses is lost.

In the last ten years, some changes have occurred with respect to reform of hatchery management and artificial production; however, many hatcheries continue to operate under a “numbers game” driven by large production goals for hatchery programs to provide fish for harvest and sale (B. Smith, ODFW, personal communication, April 2003). Hatchery Genetic Management Plans, or HGMPs have been conducted by

NMFS for the Columbia Basin (including the Imnaha) in an attempt to improve return rates and reduce competitive interactions with natural populations (NMFS 1999; Ashe et al. 2000). The plans outline restoration strategies using appropriate stocks, release strategies, rearing densities and release locations. ODFW believes further assessment and adaptation of hatchery production numbers relative to natural population needs would be beneficial (B. Smith, ODFW, personal communication, April 2003).

1.3.2 Terrestrial

Many of the wildlife species of the Imnaha subbasin spend a portion of their life cycle outside the Imnaha subbasin boundaries. This can complicate and potentially reduce the effectiveness of wildlife management actions in the subbasin. Depending on the extent, location, and timing of seasonal movements, out of subbasin effects may range from limited to substantial.

Migratory birds are the species that travel the greatest distance outside of the subbasin. Three of the focal species in the subbasin are neotropical migrants that breed in the subbasin and winter in Mexico or Central America. Flammulated owls are the most migratory of all North American owls, going south of Mexico during most of the fall and winters. Grasshopper sparrows winter in the southern United States, south into Central America (Vickery 1996). The olive-sided flycatcher is migratory and winters in Central and South America (Csuti et al. 1997). Environmental toxins, and habitat degradation in these species winter habitats could have negative impacts on populations of the species in the Imnaha subbasin. Marshall (1988) speculated that the disappearance of the olive-sided flycatcher from suitable, unchanged habitat in California was caused by the destruction of habitat in Central America, where this population maintained their winter territories. Birds migrating to Mexico and Central and South America, where environmental regulations are not as strong as in the U.S., continue to be exposed to relatively high levels of organochlorines. This group of chemicals includes DDT, the pesticide that caused egg shell thinning, reproductive failure and dramatic declines in bald eagle populations in the 1940s. DDT was banned in this country in 1972 but is still used in many other parts of the world (DeWeese et al. 1986).

Many other species in the subbasin make movements of smaller distance out of the subbasin. Large game species including the bighorn sheep, mountain goat, elk, and mule deer focal species may migrate into and out of the subbasin. This commonly results in crossing wildlife management units and potentially state boundaries and can complicate the setting of appropriate hunting seasons and harvest limits. Game species may experience greater hunting pressure when they move out of the subbasin into the more populated surrounding areas. Other potential out of subbasin impacts to game species include increased contact between bighorn sheep and domestic sheep and increased potential for disease transmission.

Species may migrate out of the subbasin in search of habitat and forage, finding high quality habitat may allow for increased populations in the subbasin, while use of unsuitable habitats may result in reduced populations. The neighboring Snake Hells Canyon subbasin has been recognized as having some of the most crucial big game

winter habitat in the region. It is thought that these winter range areas may help support deer and elk populations throughout the region including those in the Imnaha subbasin (Christensen 2001). Use of habitat outside the subbasin may also have negative impacts on the game species in the subbasin. Agricultural areas are very limited in the subbasin but elk and particularly mule deer may migrate outside of the subbasin and forage on private agricultural lands. This results in reduced social carrying capacity and results in public pressure to reduce population management objectives. The relatively high quality grassland habitats of the subbasin provide suitable breeding habitats for grasshopper sparrow. But grasshopper sparrows are also documented to use agricultural areas and hayfields, these areas are not as suitable for breeding grasshopper sparrows and may serve as population sinks (Wisdom et al 2000).

Species with very large home ranges that occur in low densities may migrate into and out of the subbasin in search of prey and mates. Fisher, marten, and particularly lynx and wolverine are species with large home range sizes that may inhabit the Imnaha subbasin. Maintaining and enhancing the integrity of movement corridors for these species may prove critical to maintaining genetic diversity and healthy populations of these species. For instance, mapping of documented wolverine sightings conducted by Edelmann and Copeland (1999) suggests that a narrow corridor in the Seven Devils mountain area of the Snake Hells Canyon Subbasin may provide the only suitable habitat linking wolverine subpopulations in Idaho and Oregon. Reductions of dispersal rates through the corridor may impact the regional viability of wolverine by reducing genetic interchange and lowering the likelihood that all suitable habitat patches are continuously inhabited (Edelmann and Copeland 1999).

1.4 Environment–Population Relationships

Up until this point, this document have focused largely on how changes to terrestrial and aquatic habitats in the subbasin have likely influenced fish and wildlife populations. However, environmental conditions, including habitat and resources available for other species, are influenced by the ecological roles of organisms. Fish and wildlife species perform ecological roles within their environment, and these roles can influence and alter the biotic and abiotic environments they inhabit. These interactions are termed key ecological functions (KEFs).

1.4.1 Aquatic

The literature review regarding the relationships between salmonid populations and their environment is lengthy. Discussions specific to Imnaha focal species and aquatic habitat are provided in section 1.2.5. Discussions about limiting factors specific to life stages of focal species found in the Imnaha subbasin are provided in section 1.5.

Discussions of relationships between spring/summer chinook and their environment may be found in Thompson (1960), the Nez Perce Tribe (1990), Jonasson (1994), Ashe (1995), Carmichael (1995), Mobrand (1995), Sankovich (1995), Myers (1998), Ashe (2000), Cleary (2000), Wallowa-Whitman National Forest (2003), and Cleary et al. (2003).

In-depth discussions of relationships between steelhead and their environment may be found in Thompson (1960), Gaumer (1968), the Nez Perce Tribe (1990), Jonasson (1994), Ashe (1995), Busby (1996), Mundy (1998), USFS (1998), Cleary (2000), Wallowa-Whitman National Forest (2003), and Cleary et al. (2003).

Discussions regarding relationships between fall chinook and their environment are provided in Thompson (1960), the Nez Perce Tribe (1990), Mason (1993), Myers (1998), Garcia (1999, 2000), Connor (2002), and Wallowa-Whitman National Forest (2003).

Discussions focusing on relationships between bull trout and their environment are available in Hemmingsen (1996), Wallowa-Whitman National Forest (1996, 2003), Buchanan (1997), USFS (2001), and USFWS (2002b).

There are limited amounts of information regarding species–environment relationships for lamprey; however, some background discussion may be found in Gaumer (1968), Close (1995) and Kostow (2003).

1.4.2 Terrestrial

Eighty-seven different KEFs preformed by terrestrial species have been identified (Johnson and O’Neil 2001). The 87 KEFs fall within the eight broad classes of functions listed below, more detailed definitions of the 87 KEFs are contained in Appendix M.

- 1) Trophic relationships
- 2) Aids in physical transfer of substances for nutrient cycling
- 3) Organismal relationships
- 4) Carrier, transmitter, or reservoir of vertebrate diseases
- 5) Soil relationships
- 6) Wood structure relationships
- 7) Water relationships
- 8) Vegetation structure and composition relationships

KEFs are hierarchical in nature and so a species that performs the KEF of consuming terrestrial vertebrates also provides the invertebrate eater, secondary consumer, and heterotrophic consumer KEFs. To help illustrate this concept the trophic relationship ecological functions preformed by the American avocet are displayed in Table 87.

Table 87 Trophic relationship KEF preformed by the American avocet (*Recurvirostra americana*)

KEF Code	KEF Description
1	Trophic relationships
1.1	heterotrophic consumer
1.1.2	secondary consumer (primary predator or primary carnivore)
1.1.2.1	invertebrate eater
1.1.2.1.1	terrestrial invertebrates

KEF Code	KEF Description
1.1.2.1.2	aquatic macroinvertebrates
1.1.2.2	vertebrate eater (consumer or predator of herbivorous vertebrates)
1.2	prey relationships
1.2.1	prey for secondary or tertiary consumer (primary or secondary predator)

Most KEFs are preformed by a variety of different species in the subbasin. KEFs preformed by a greater number of species are described as having a higher level of functional redundancy. If one species that performs a KEF with a high level of functional redundancy is extirpated from the ecosystem, the impacts are less severe than if a species that is one of a few or the only species that performs that KEF is extirpated (Johnson and O'Neil 2001). Critical functional link species are the only species that perform a specific ecological function in a community. Their removal would signal loss of that function in the community. Thus, these species are critical to maintaining the full functionality of a system (IBIS 2003). Thirty-two species have been identified as critical functional link species in the Blue Mountain Ecoprovince. Examples of the critical functions contributed by critical functional link species in the subbasin include the physical fragmentation of standing wood by the black bear in herbaceous wetland and alpine grassland habitats, the impoundment of water behind diversions or dams by the American beaver in numerous habitat types, and the creation of roosting, denning, or nesting opportunities by the red squirrel in various forest habitats (see Appendix M a complete list of critical functional link species and their critical functions).

1.4.3 Key Relationships between fish and wildlife

As described in section 1.4.1 aquatic species and particularly salmonids provide a variety of KEFs in the subbasin and across the Columbia Basin and form an important link between marine, freshwater aquatic and terrestrial environments. Anadromous salmon help to maintain ecosystem productivity and may be regarded as a keystone species. Salmon runs input organic matter and nutrients to the trophic system through multiple levels and pathways including direct consumption, excretion, decomposition, and primary production. Direct consumption occurs in the form of predation, parasitism, or scavenging of the live spawner, carcass, egg, or fry life stages. Carcass decomposition and the particulate and dissolved organic matter released by spawning fish deliver nutrients to primary producers (Cederholm et al. 2000). Relationships between wildlife species and salmon vary in terms of their strength; the categories that have been developed to characterize these relationships and are briefly described below see (Cederholm et al. 2000 and Johnson and O'Neil 2001 for more details):

- Strong-consistent relationship-Salmon play or historically played an important role in this species distribution viability, abundance and or population/status. The ecology of this wildlife species is supported by salmon, especially at particular lifestages or during specific seasons.
- Recurrent relationship- The relationship between salmon and this species is characterized as routine, albeit occasional, and often in localized areas (thus affecting only a small portion of this species population).

- Indirect relationship- Salmon play an important routine, but indirect link to this species. The relationship could be viewed as one of a secondary consumer of salmon; for example salmon support other wildlife that are prey of this species.
- Rare relationship- Salmon play a very minor role in the diet of these species often amounting to less than 1 percent of the diet.

Salmon fishes (including their eggs) are a major source of high-energy food that allows for successful reproduction and enhanced survival of many wildlife species. Sixty-seven birds, twenty-three mammals, three reptiles and one amphibian species thought to inhabit the Blue Mountain Province consume salmon during one or more of salmon's lifestages (IBIS 2003). Twenty-five of the ninety-four total species in the province with a relationship to salmon are concern or focal species, these species and their relationship to salmon are displayed in Table 88. The reductions in the salmon runs of the subbasin described in sections 1.2.3-1.2.5, have reduced nutrient inputs into the ecosystem and probably the suitability of the subbasin for many of the wildlife species that consume salmon. For this reason, reductions in anadromous fish populations and the KEFs they provide, were identified as a limiting factor to wildlife (see section 1.5.2 for details ad the Imnaha Subbasin Management Plan for strategies aimed at reducing the impact of this limiting factor on the subbasins wildlife populations.

Table 88. Concern or focal species of the Imnaha subbasin that consume salmon during one or more salmonid lifestages (IBIS 2003).

Common Name	Scientific Name	Relationship
American marten	<i>Martes americana</i>	Rare
Bald eagle	<i>Haliaeetus leucocephalus</i>	Strong-consistent, indirect
Bank swallow	<i>Riparia riparia</i>	Indirect
Barrow's goldeneye	<i>Bucephala islandica</i>	Recurrent, Rare
Gray wolf	<i>Canis lupus</i>	Recurrent
Harlequin duck	<i>Histrionicus histrionicus</i>	Strong-consistent, indirect
Horned grebe	<i>Podiceps auritus</i>	Rare
Peregrine falcon	<i>Falco peregrinus</i>	Indirect
Red-necked grebe	<i>Podiceps grisegena</i>	Rare
Willow flycatcher	<i>Empidonax traillii</i>	Indirect
Wolverine	<i>Gulo gulo</i>	Rare

1.5 Identification and Analysis of Limiting Factors and Conditions

Descriptions of how natural resources in the Imnaha subbasin have changed from historical to current are provided throughout various portions of the assessment. A chronology of the influence of human occupation and land use activities (historical through current) on terrestrial and aquatic resources is provided at the subbasin level in section 1.1.1.10, including the effects of population growth (p. 36), grazing (p. 38), transportation (p. 42), timber harvest (p. 46), agriculture (p. 51), water development (p. 52), and mining (p. 57). Discussions of how water quality (temperature) has been

altered in various subwatersheds are provided in section 1.1.2.3 (p. 65). We examine the influence of natural and anthropogenic disturbance on ecologic processes in section 1.1.3 (p. 79) by focusing on climate, hydrology, erosion, fire, and pathogens. Out-of-subbasin conditions and limiting factors are provided in section 1.3 (p. 259).

Although the previous discussions/characterizations provide insight relative to changes in aquatic and terrestrial resources, they are relatively global in their treatment of the issues. The following sections are therefore devoted to the specific definition of key limiting factors to focal fish and wildlife populations.

1.5.1 Local Factors Limiting Aquatic Focal Species

As discussed previously, declines in relative abundance of the five aquatic focal species (see section 1.2) are associated with changes (i.e., from historical to current) in habitat quantity and quality, both within and outside of the subbasin. Natural and anthropogenic disturbance pressures have caused changes to habitat-forming ecological processes (see section 1.1.3), which have directly and/or indirectly acted to modify habitat conditions.

Within the Imnaha subbasin, high summer water temperatures, insufficient water quantity, areas of inadequate riparian vegetation, low pool quality and frequency, inadequate amounts of LWD, habitat alteration, and excessive sedimentation due to roads are commonly cited as the primary in-basin factors limiting Imnaha fish production, distribution, and population stability (Mason et al. 1993, Huntington 1994, USFS 1994a, Mobrand and Lestelle 1997, Ashe et al. 2000, USFS 2003d). However, factors limiting local fish production or survival may differ from those defined across broader scales, and will vary by species and location.

1.5.1.1 Local Limiting Factors—Spring/summer Chinook

Primary factors limiting spring/summer chinook production in the Imnaha include high stream temperatures, low flows during late season migration, excessive fine sediment, poor riparian condition, low habitat diversity, and low/limited adult escapement or low population size. Areas where these problems are most significant include the lower and upper reaches of the mainstem Big Sheep Creek (RM 0–RM 17, RM 25–RM 34) and the lower half of the mainstem Imnaha River (RM 16). Low/limited adult escapement or low population size is a subbasin-wide limiting factor. A textual discussion of limiting factors specific to life stage is provided below.

Migration—Adult and Juvenile

Wallowa County and Nez Perce Tribe (1993) and Huntington (1994) identified high stream temperatures in the lower Imnaha to be a potential concern for the success and timing of upstream migrating adult chinook salmon. Mobrand and Lestelle (1997) also noted temperature increases from historical levels in the lower river corridor (below Freezeout Creek, RM 29.4) yet did not specifically identify the change as a factor limiting productivity. The patient-template analysis of the mainstem suggests that the relative productivity (survival) of Imnaha chinook salmon has been reduced due to losses in key life history stages, including pre-spawning adults (Mobrand and Lestelle 1997).

Pre-spawning life history stages have been compromised in the middle to lower reaches of the river by losses in habitat diversity and streambed instability (Mobrand and Lestelle 1997). Upon review of the available information, Ashe (et al. 2000) proposes that while high stream temperatures may stress the fish, migration will not be prohibited and rates early season migration as excellent and late season migration conditions to be fair to good.

Wallowa County and the Nez Perce Tribe (1993), Huntington (1994), and Mobrand and Lestelle (1997) identify summer temperatures, flows and sediment loads as potential problems for spring/summer chinook migration into Big Sheep Creek. Upon review of the available information, Ashe (et al. 2000) rates early season migration conditions as “excellent” and late season migration conditions as “fair to poor” (based on temperatures and possible flow concerns).

The emigration of chinook smolts from the Imnaha subbasin does not appear to be limiting the productivity of the population as a whole (Ashe et al. 2000). This is especially true during the early part of the migration between March and April. Smolts that outmigrate later than April are more likely to encounter elevated temperatures, such as in the lower Imnaha and in lower Big Sheep Creek, which may delay or postpone emigration (Gaumer 1968). Ashe (et al. 2000) summarizes smolt outmigration conditions to be excellent in the early part of the migration and good in the latter part of the migration for both the mainstem and Big Sheep Creek.

Spawning and Incubation

In their patient-template analysis, Mobrand and Lestelle (1997) found that the quantity of key chinook habitat has declined in certain portions of the subbasin, and specifically that insufficient substrate size in the middle portions and upper reaches of the Imnaha (up to RM 67) was the primary factor limiting chinook spawning and egg incubation success. Losses of appropriate sized substrate have resulted from upstream channel simplification and bank armoring caused by “stream cleaning” and land use activities (Ashe et al. 2000).

Recent improvements, such as livestock exclosures and woody debris reintroduction by the USFS, have improved gravel accrual rates in the mainstem Imnaha River (Ashe et al. 2000). By the mid-1990s, reaches of the Imnaha upstream of the national forest boundary were considered to have sufficient amounts of woody material, and had gravel bars beginning to form behind logjams. Spawning and incubation conditions were considered to be good to excellent in the upper Imnaha (Ashe et al. 2000).

Spring/summer chinook spawning and incubation life history phases are limited in the upper half of Big Sheep Creek (Mobrand and Lestelle 1997). Although the quantity of spawning and incubation habitat in Big Sheep Creek is comparatively small, losses over time have been substantial (Mobrand and Lestelle 1997). Factors contributing to these declines include changes in water temperature regimes, channel stability, habitat diversity, and, to a lesser extent, flow regimes and sediment load (Mobrand and Lestelle 1997). The USFS (1998b) found that stream temperatures were slightly below environmental potential (at risk) throughout much of the Big Sheep Creek drainage, although the analysis was focusing on summer steelhead. High water temperatures and

low water levels prevent Little Sheep Creek from being suitable chinook spawning habitat (NMFS 2001). Ashe (et al. 2000) summarizes chinook spawning and rearing conditions in the Big Sheep Creek watershed as “fair to excellent in the upper watershed above Coyote Creek (RM 20.4) and fair to poor below Coyote Creek”.

Growth and Feeding

Spring/summer chinook fry colonization and summer rearing life history stages have been reduced from historical levels in the middle to lower reaches of the Imnaha (Mobrand and Lestelle 1997). Habitat conditions that support these particular stages have been compromised by increased water temperatures, small losses in habitat diversity, and increased channel instability (Mobrand and Lestelle 1997). Ashe (et al. 2000) does not consider these losses to significantly threaten chinook production, however, and rates colonization and summer rearing in the Imnaha as “good to excellent”.

In Big Sheep Creek, fry colonization and summer rearing life history stages have been reduced through losses of habitat diversity, elevated temperatures, predators, competitors, flows and sediment loads in the lower 35 stream miles (Mobrand and Lestelle 1997). Colonization and summer rearing life history stages in Little Sheep Creek are not identified as limited since chinook production in the drainage has likely never been significant in relation to the rest of the subbasin (Mobrand and Lestelle 1997). Ashe (et al. 2000) rates colonization and summer rearing conditions as “good to excellent above Coyote Creek (RM 20.4) and fair to poor below Coyote Creek”.

Overwintering survival in the upper Imnaha may be reduced due to anchor ice formation or ice floes (NPPC 1990, Ashe et al. 2000). Ashe (et al. 2000) defines fall redistribution and overwintering life history phases of chinook salmon to range from good to excellent in the lower Imnaha, and fair to good in the upper Imnaha, based on temperatures.

Fall redistribution and overwintering life history stages of chinook may be limited in the lower portion of Big Sheep Creek due to land use activities and the presence of a channel-confining road (Big Sheep Creek Road) (Gaumer 1968). Conditions for fall redistribution and overwintering of spring/summer chinook are considered to be fair to excellent from the 3900 Road bridge to the mouth (Ashe et al. 2000).

1.5.1.2 Local Limiting Factors—Fall Chinook

Primary factors limiting fall chinook production in the Imnaha include fine sediment, low flow, and poor habitat diversity. Because fall chinook are present only in the mainstem below the town of Imnaha, the factors limiting them are focused exclusively in this area.

Migration—Adult and Juvenile

Immigration of adult fall chinook into the Imnaha subbasin occurs during a time of the year when water temperatures are dropping and base flows are increasing (October through the end of November). It is therefore reasonable to assume that flows and temperatures do not represent a limiting factor to this life history stage.

Outmigration of subyearlings from the Imnaha subbasin is also coincident with a period of favorable flow and reduced stream temperatures (end of May through the first half of July), and is therefore not likely to be limited by in-subbasin factors. Factors limiting downstream migration of Imnaha fall chinook are more commonly associated with riverine conditions in the mainstem Snake River.

Reservoir heating of water in upriver pools during summer months and its subsequent release out of Hells Canyon Dam likely contribute to documented higher water temperatures above the confluence of the Salmon River (Rondorf and Tiffan 1996). These temperatures may exacerbate fall chinook immigration and spawning delays, while accelerating egg incubation and juvenile emigration (Rondorf and Tiffan 1996). Consequently, the fish from the Snake Hells Canyon subbasin arrive at Lower Granite Dam, on average, up to four weeks later than they did before development of the Hells Canyon Complex and the U.S. Army Corps of Engineers' four lower Snake River projects (NMFS 2000a). Johnson and Stangl (BLM 2000a) found that fall chinook fry emerging later than mid-May may not be large enough to begin their downstream migration as age 0 fish. Delays in chinook outmigration may also occur due to slack-water impoundments (i.e., upper pool of Lower Granite Dam). Combined, the delays place juvenile migrants in reservoirs during periods when water temperatures approach chinook salmon's thermal tolerance (NMFS 2000a).

Studies examining smoltification timing suggest that the protracted emigration exhibited by Snake Hells Canyon subbasin fall chinook may confer a survival disadvantage to downstream migration life history phases (Rondorf and Tiffan 1997). Gill ATPase followed a trend of increasing activity until late June, then a decline throughout the remainder of the summer (Rondorf and Tiffan 1997). Similarly, subyearling chinook exhibited the most net downstream movement at velocities of 6 to 18 inches per second early in the season, and less movement as the season progressed. This delay often places late arriving fall chinook in unsuitable reservoir environments, and may increase their susceptibility to predation.

Spawning and Incubation

Limiting factors to fall chinook spawning in the Imnaha are not well documented. It is possible that fine sediment may be limiting substrate availability and may partially be responsible for the change in the reported distribution of fish; however, specific habitat limitations from fines is currently unknown. The fact that fall chinook inhabit depositional reaches in the Imnaha requires restoration efforts to be directed to upriver or upland sources rather than in the specific reaches used by the fish.

Because of their ESA listing, little applied research has been conducted regarding the incubation life history stage of fall chinook in the Imnaha subbasin. Methods used to define habitat and water quality criteria relative to incubation life history stages generally require unnecessary and unacceptable levels of direct "take" (in the form of mortality) and are prohibited under the ESA. It is therefore reasonable to use surrogate measures such as laboratory experiments or sedimentation indices to define criteria for incubation life history stages of fall chinook. Empirical data suggest that fine sediments (<6.4 mm) that comprise 20 to 25% of the redd substrate will have a deleterious effect on incubation

success (Eaton and Bennett 1996), including a reduction in the porosity of the redd. The less porous redd will consequently have a reduced intragravel water velocity which will in turn affect oxygen delivery to developing embryos and removal of metabolic wastes. Eaton and Bennett (1996) found that Snake River fall chinook survival to emergence (STE) was not significantly impaired by low water velocity, and that successful STE occurred when velocities were at least 0.3 centimeters per second. Early or premature emergence has been documented when oxygen concentrations within the redd are unsuitable (Alderice et al. 1958) or when water temperatures become warm.

In their biological assessment, the USFS defines fine sediment in the lower Imnaha to be “functioning at risk”. Whether the concentrations are at a level (i.e., comprising 20–25% of the redd) that is detrimental to fall chinook incubation success is unknown.

Some have suggested that excessively low winter temperatures may limit embryonic development of Imnaha fall chinook and consequently reduce production (Mundy and Witty 1998), although supporting data are limited. Mundy and Witty (1998) also contend that fall chinook embryos may be limited by severe and massive ice floes common to the Imnaha, which could potentially disrupt redds and dislodge eggs.

Growth and Feeding

Since the majority of fall chinook growth and feeding occurs out of the Imnaha subbasin, in-basin factors limiting this particular life stage are negligible. Mundy and Witty (1998) suggest that juvenile fish may be swept out of the system during unnaturally elevated spring streamflows; however, this theory is also speculative and currently unfounded.

1.5.1.3 Local Limiting Factors—Steelhead

Primary factors limiting summer steelhead in the Imnaha River include high stream temperatures, poor riparian condition, high flows, excessive fine sediment, low flows and low/limited adult escapement or low population size. These problems are most significant in the Big Sheep Creek watershed. Low/limited adult escapement or low population size represent a subbasin-wide limiting factor. A textual discussion of limiting factors specific to life stage is provided below.

Migration—Adult and Juvenile

Migration of adult steelhead into the subbasin and to their spawning grounds does not appear to be significantly limited by the habitat attributes defined in the QHA modeling process. High stream temperatures, a factor that may modify spawn timing, may be a problem during some years, but do not appear directly attributable to population declines. Riparian condition, high flows, and sediment are all rated “low” (based on QHA ratings) relative to the importance they have on migration life history stages. Low flows are rated high in terms of their influence on migration, and may limit adults access to certain spawning habitats. The USFS (1998b) suggests that low flows may limit rearing and spawning in Big Sheep Creek; however, due to their spawn timing (April through mid-June) it is likely that flows would be sufficient for steelhead spawning success during most years.

Since juvenile steelhead outmigration timing (early April through mid-June) generally coincides with periods of high flow and reduced temperatures, smolt migration life history stages are for the most part not limiting population persistence.

Spawning and Incubation

In the Big Sheep Creek watershed, steelhead spawning and incubation life history stages are most susceptible to excessively high flows, and fine sediment.

Modification of upland vegetation through the Canal Fire (1989), Twin Lake Fire (1994), timber harvest, windstorms, and insect outbreaks have changed runoff characteristics in portions of the drainage, based on flow characteristics of the gaging station at the town of Imnaha (USFS 1998b). High flows, combined snow avalanches and debris flows, occur frequently in the geomorphologically young Big Sheep and Little Sheep Creek systems (USFS 1995), and may be responsible for causing changes to spawning substrate availability and/or disrupt or dislodge steelhead incubating in redds.

Changes to upland vegetation have also accelerated sheet and rill erosion in five subwatersheds within the Big Sheep Creek drainage, and has caused gully erosion to increase in three subwatersheds (USFS 1998b). The increases in fine sediment may be compromising the integrity of steelhead redds and/or emergence success of steelhead fry. Management activities have also introduced sediment into the channel systems. Overall, sediment availability and transport is above environmental potential in these subwatersheds and has been classified as “functioning at risk”.

Sediment availability and rerouting has been altered by private land influences on Big Sheep Creek (RM 31.9), and lower and middle Little Sheep Creek (predominately livestock grazing, rural home sites, and pasture creation) (USFS 2003d). Although increased sediment deposition in low-gradient reaches has been noted, the removal of the hydropower facility on Little Sheep Creek in 1997 is suspected to flush a proportionate amount of stored sediment during spring runoff (USFS 1998b, NMFS 2001).

Water temperatures, turbidity/sediment, substrate and peak/base flows are considered to be either at risk or not properly functioning within portions of Little Sheep Creek (NMFS 2001), and may limit steelhead spawning and incubation life history stages. Areas with sufficient amounts of temperature-ameliorating vegetation are present in some portions of Little Sheep Creek, but are limited in others, mainly due to the presence of the adjacent highway and livestock encroachment on the riparian area.

Steelhead spawning and incubation life history phases below Nine Points Creek on the mainstem Imnaha may be limited by unstable cobble and gravel bars, which resulted from excessively high amounts of bedload movement caused by storm events in 1992 and 1997 (USFS 1998a). Some perennial headwater streams that feed the upper Imnaha may not be suitable for steelhead spawning and incubation due to high amounts of fine sediment produced through various land management activities and natural erosion patterns (USFS 1998a); however, the majority of these streams are in a condition suitable to support spawning and rearing life history stages. The primary factors considered to affect steelhead spawning and rearing habitat are the livestock allotments and roads in

mid-elevation areas on the Forest (B. Knox, ODFW, personal communication, May 2001).

Growth and Feeding

The majority of the fry colonization and early rearing of summer steelhead occurs in the tributaries to the Imnaha, and not the mainstem. The condition of tributary habitat is sufficient in most cases to support early life history forms of steelhead. High stream temperatures do occur in some areas, albeit for a short period of time during a given day, and do not preclude rearing of summer steelhead. The periodic warming does, however, contribute to cumulative impacts to downstream reaches.

Cultivation, farming, and pasturing have reduced the riparian component, specifically the cottonwood communities, resulting in an “at risk” rating (USFS 1998a). The lack of woody material input to the stream channel in these areas has simplified the system both hydrologically and biologically. In an effort to address large organic debris (LOD) deficiencies, the Wallowa-Whitman National Forest has completed bioengineering work along 3 stream miles, where woody material was anchored to the streambank (i.e., hard structures), and has completed work along 13 stream miles, in which woody material was merely reintroduced to the channel (i.e., soft structures) (J. Platz, Wallowa-Whitman National Forest, personal communication, May 2001).

Because steelhead fry colonization and summer rearing life history stages are largely reliant upon diverse, sufficiently deep, cool and productive habitat types (Bjornn and Reiser 1991), the lack of these elements in the lower portions of the Big and Little Sheep Creek drainages may pose a limiting factor to production. The USFS (1998b) defines large woody material throughout lower Big Sheep Creek and lower and middle Little Sheep Creek to be below natural potential (“at risk”) based on PACFISH guidelines and NMFS habitat matrices. A combination of natural landscape characteristics and riparian habitat modification has contributed to the rating. Similarly, pool quality and frequency were rated as “at risk” and did not meet PACFISH guidelines or NMFS criteria for anadromous habitat; the ratings, however, excluded pocket pools, which often comprised up to 30% of the channel (USFS 1998b). Nevertheless, pool frequency, pool quality, large organic matter, streamflow and stream temperatures, are generally least favorable for summer steelhead colonization and summer rearing life history stages in the lower-elevation reaches of the Big Sheep Creek drainage.

The primary constraints to fall redistribution and overwintering life history stages of steelhead in the mainstem Imnaha are related to habitat availability and flow. Similar to summer rearing life history phases, overwintering juvenile steelhead require relatively complex habitat types, like those often provided by in-channel organic debris (Bjornn and Reiser 1991). In select areas where riparian reserves have been altered, such as along private lands bordering some of the lower mainstem reaches or along channels modified through riprapped banks, dredging, and elimination of off-channel refugia (USFS 1998a), the diversity of overwintering habitat has been reduced or eliminated, and hence has constrained the potential productivity of these life history phases. The elimination of riparian reserves and their inherent insulation capacity combined with wintertime base

flows may also restrict overwintering success, since stream temperatures may become low enough to freeze and/or for anchor ice to form.

Adult and juvenile steelhead that utilize Big and Little Sheep Creek during winter months—December through February—are subject to a reduction in available habitat due to anchor ice buildup and ice floes (USFS 1998b). Icing conditions in the smaller perennial tributaries are prevalent throughout the watershed because of low flow conditions.

1.5.1.4 Local Limiting Factors—Bull Trout

High temperatures, low flow, fine sediment, obstructions, and high flows are identified as key habitat attributes that have been impacted and are subsequently limiting bull trout populations throughout the subbasin. Agriculture, forest management practices, and livestock grazing are considered to be primary factors acting to modify habitat conditions (USFWS 2002b).

Migration—Adult and Juvenile

The fluvial and resident forms of bull trout that reside in the Imnaha rely on an unobstructed path both to and from spawning, rearing, and overwintering areas. Seasonal migration barriers, including periods of reduced water quality (i.e., high summer stream temperatures), insufficient flows and/or degraded habitat pose a potential threat to bull trout connectivity between neighboring subpopulations in the Imnaha River and Sheep Creek (USFS 2000).

The construction and operation of irrigation diversions in the Big Sheep Creek watershed has contributed to the decline of bull trout populations by restricting passage, reducing streamflow, and causing increases in summer water temperatures. The diversions that exist in association with the Wallowa Valley Improvement Canal have created physical barriers to migrating bull trout in Big Sheep, Little Sheep, and McCully Creeks. For example, the diversion at McCully Creek has effectively isolated bull trout since the 1880s (Buchanan et al. 1997). The loss of connectivity prevents genetic interchange and refounding potential between bull trout populations above and below the diversions, and because the diversions aren't screened, some bull trout have become entrapped in the canal causing high mortality in some cases (USFWS 2002b).

Irrigation diversions also act to remove potential Big Sheep Creek streamflow into the canal, which carries the water out of the Imnaha subbasin and into the Grande Ronde subbasin (Wallowa Valley). The loss of streamflow during naturally low flow periods contributes to the already high stream temperatures that have been exacerbated by the loss of vegetation through the Canal Fire (1989), Twin Lake Fire (1994), timber harvest, windstorms, and insect outbreaks. Similarly, the low flows that result from irrigation withdrawals can prevent bull trout, which are preparing to spawn, from accessing spawning grounds, and in some cases can strand migrants (USFWS 2002b).

Spawning and Incubation

Spawning and incubation habitat in Big Sheep Creek has been impacted from the Wallowa Valley Improvement Canal, sediment caused by land use activities and vegetation losses, livestock grazing, and nonpoint pollution. A relationship between habitat impacts and the spawning/incubation success of bull trout has not, however, been established (Buchanan et al. 1997).

A primary limitation to bull trout spawning and incubation life history stages in the Big Sheep Creek watershed is a reduction in streamflow caused by irrigation withdrawals. The loss of streamflow during naturally low flow periods contributes to elevated water temperatures that can delay spawning. A delay in spawning may result in late emergence of fry from the gravel, which would result in the juvenile being smaller than fish that had emerged earlier, which may ultimately confer a survival disadvantage during later life history stages (i.e., the smaller fish would be more susceptible to predation and may not successfully overwinter).

Livestock use affects habitat between Owl Creek and Lick Creek (Big Sheep Creek watershed) and in the lower several kilometers of Lick Creek. Overutilization of streamside vegetation contributes to high stream temperatures and sedimentation problems in these and other portions of the subbasin. Similar to other salmonid species, excessive fine sediments in bull trout redds reduce incubation and emergence success. Significant livestock grazing (as well as some feedlot development) also exists in the lower portion of Little Sheep Creek and may cause direct mortality of eggs or alevin if the redd (spawning bed) is trampled during watering or crossing (USFWS 2002b).

Growth and Feeding

Juvenile life history stages of bull trout that utilize the mainstem Imnaha (most known summer rearing and holding areas in the Imnaha River are on National Forest or wilderness lands above Summit Creek) are limited by high stream temperatures, fine sediment, channel instability, and streamflow extremes (excessively high and low spring and summer flows, respectively). Juveniles occurring in Big Sheep Creek (the majority of summer rearing appears to occur above RM 31 near Owl Creek [Buchanan et al. 1997]) are mainly limited by high stream temperatures and streamflow extremes. Juveniles occurring in Little Sheep Creek (the majority of summer rearing appears to occur above the canal diversion at approximately RM 25.5 (Buchanan et al. 1997)) are limited by high stream temperatures, fine sediment, and obstructions. Primary limiting factors to juvenile bull trout occurring in McCully Creek (summer rearing occurs throughout the creek, particularly in National Forest and Wilderness areas (Buchanan et al. 1997) include fine sediment and obstructions.

Because juvenile bull trout rearing habitat in the mainstem Imnaha is primarily associated with areas not influenced by private land ownership, activities, and processes on USFS-managed lands can be attributed to habitat losses. Forest management practices and livestock grazing in the mainstem (above Summit Creek) have acted cumulatively with the inherently unstable granitic geology in this area to contribute excessive fine sediment to the stream channel. Because of the reduced size and competence of the river to

transport sediment, portions of the channel have attained unsuitable width: depth ratios, which have acted to create a shallow and wide system in places (USFWS 2002b). Stream channels with this morphology will typically exhibit higher stream temperatures than a narrower and deeper channel, which may force bull trout to seek out cool water refugia, thereby limiting potential feeding efficiency and growth.

Similar to the mainstem Imnaha, most juvenile rearing in Big Sheep Creek occurs in a portion of the watershed that is managed by the Wallowa Whitman National Forest, and is therefore less subjected to the effects associated with private land ownership.

Streamflow extremes and high temperatures are most commonly associated with changes in upland and riparian vegetation, which in this portion of the watershed, have occurred from natural and anthropogenic influences. Agricultural clearing (for example, Big Sheep Creek between the forest boundary and Coyote Creek), loss of woody debris from campground development (for example, Lick Creek), and harvest-related wildfire have decreased the function of the existing riparian vegetation in many areas (USFWS 2002b).

In Little Sheep Creek, bull trout feeding and growth are directly and indirectly affected by agricultural practices (i.e., irrigation withdrawals) and livestock grazing. Diversion of streamflows for irrigation purposes have contributed to high stream temperatures and directly influence foraging opportunities by preventing access to potentially usable habitats and/or by stranding juvenile fish in dry channel beds (USFWS 2002b). Indirect effects of irrigation withdrawals in Little Sheep Creek include those associated with reductions in water quality. When irrigation water is returned to streams and rivers, it carries sediment and nonpoint pollution from agricultural chemicals which may degrade water quality (USFWS 2002b). Specific concerns include, but are not limited to, much of the Little Sheep Creek watershed, which has water withdrawals that reduce summer and fall flows in the upper reaches of the system (USFS 2001).

Barriers resulting from irrigation diversions are largely responsible for limiting bull trout growth and feeding in McCully Creek. As mentioned previously, the McCully Creek subpopulation of bull trout has been effectively isolated from the rest of the subbasin since the late 1880s. This isolation limits potential feeding and growth opportunities by restricting bull trout to rely exclusively upon available resources within the subwatershed or within the canal itself. And while fish may occasionally “spill” downstream, fish cannot pass upstream of the diversion (USFWS 2002b). Fish movement down the canal is probably limited, at least seasonally, by poor water quality conditions and warm water temperatures that would force fish back into McCully Creek (USFWS 2002b).

1.5.1.5 QHA-Based Limiting Factors Analysis

Qualitative Habitat Assessment (QHA; Mobrand Biometrics 2003b) was used to evaluate habitat conditions within and between sixth field HUCs for spring chinook, fall chinook, steelhead, and bull trout in the Imnaha subbasin. Analyses were run based on the habitat occupied⁷ for each species (Table 89; Figure 67).

⁷ Habitat occupation included consideration of four life history stages, as defined by Mobrand Biometrics (2003b). These were spawning and incubation, summer rearing, winter rearing, and migration.

Raw data used in, and outputs from the QHA model are included in Appendix O. Information included in this section is not a direct reflection of those results. Adjustment was made to QHA restoration scores/ranks to account for relevant factors not considered within the QHA model itself (e.g. amount of available habitat and current management). No adjustment was made to original QHA protection scores/ranks.

To account for the differing amount of habitat between HUCs (*e.g.*, total stream miles in a sixth field HUC used by a given species), QHA restoration scores were standardized based on the average usable length of stream in the subbasin (Table 89). The estimated length utilized within each individual HUC was divided by the subbasin average; the result was then multiplied by the original QHA restoration score for that reach. The streams were re-ranked according to the resultant scores.

Table 89. Average stream miles per sixth field HUC occupied by spring chinook, fall chinook, steelhead, and bull trout in the Imnaha subbasin. Averages were used to standardize restoration scores derived from QHA modeling efforts.

Species	Total # of HUCs Occupied	Average Miles Occupied per HUC	Range (Miles)		Standard Deviation
			Minimum	Maximum	
Spring Chinook	28	5.4	0.8	12.9	3.38
Fall Chinook	4	4.5	1.4	7.2	2.46
Steelhead	46	7.8	2.2	13.5	3.40
Bull Trout	23	8.3	2.4	15.4	3.60

The QHA restoration scores were also adjusted by factoring in the conservation protection status occurring within the immediate floodplain. The aquatics technical team agreed that an effective restoration program should adhere to basic conservation biology concepts, such as building out from areas that are offered some degree of protection. It was assumed that the protection status occurring within a 100-foot buffer zone of the stream channel would most accurately characterize aquatic ecosystem response to management activities. The protection status of the 100-foot buffer zone was derived from land management layers based on GAP designations and included four levels with essentially two degrees of protection; Levels 1 and 2 are lands managed for natural values, whereas Levels 3 and 4 are lands with no special protection. The dominant protection status in the HUC was calculated based on 25% increments (*e.g.*, $\geq 75\%$ of buffer in Levels 1 or 2 received a score of 1; 50-75% of buffer in Levels 1 or 2 received a score of 2; 25-50% in Levels 1 or 2 received a score of 3; $\leq 25\%$ in Levels 1 or 2 received a score of 4). Protection status scores were then used to sort the revised restoration score to arrive at a restoration prioritization schedule (Table 90).

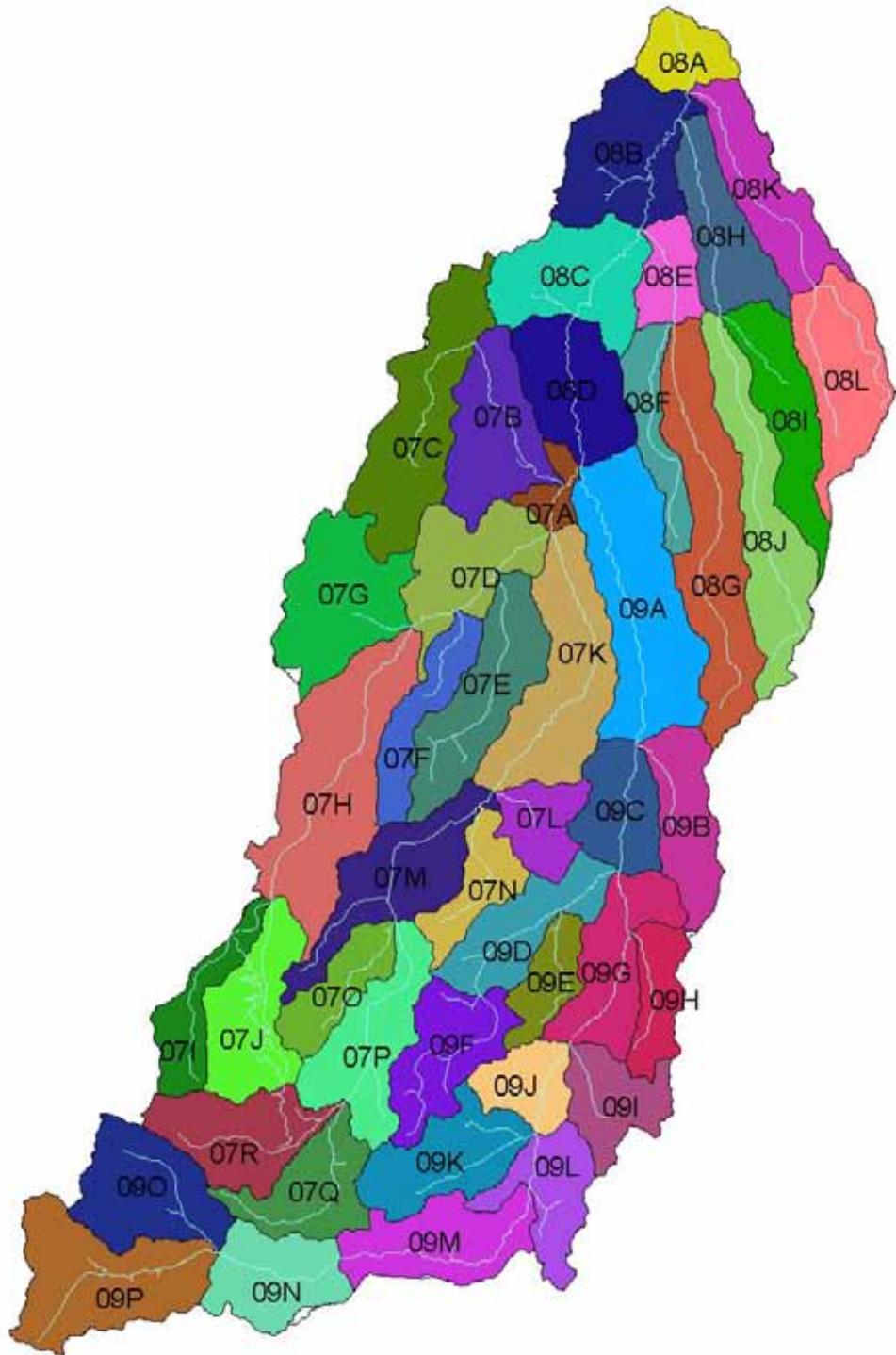


Figure 67. Imnaha subbasin sixth-field HUCs used in the QHA modeling process

Table 90. Conservation protection status of 100-foot buffer zones in each of the 43 sixth field HUCs in the Imnaha subbasin. A score of 1 or 2 ('High') indicates the dominance of conservation-based management, whereas a score of 3 or 4 ('Low') indicates that the buffer zone receives no special protection.

HUC_6	% protected	Buffer Protection Rating	Score
07A	0.0	Low	4.0
07B	86.2	High	1.0
07C	94.5	High	1.0
07D	7.8	Low	4.0
07E	0.0	Low	4.0
07F	61.1	High	2.0
07G	0.0	Low	4.0
07H	0.0	Low	4.0
07I	46.1	Low	3.0
07J	6.9	Low	4.0
07K	0.0	Low	4.0
07L	24.8	Low	4.0
07M	0.0	Low	4.0
07N	19.4	Low	4.0
07O	33.7	Low	3.0
07P	14.4	Low	4.0
07Q	79.2	High	1.0
07R	48.3	Low	3.0
08A	75.7	High	1.0
08B	33.3	Low	3.0
08C	16.1	Low	4.0
08D	0.0	Low	4.0
08E	13.7	Low	4.0
08F	86.3	High	1.0
08G	92.7	High	1.0
08H	17.8	Low	4.0
08I	100.0	High	1.0
08J	100.0	High	1.0
08K	53.3	High	2.0
08L	100.0	High	1.0
09A	10.5	Low	4.0
09B	47.4	Low	3.0
09C	4.2	Low	4.0
09D	8.1	Low	4.0
09E	9.0	Low	4.0
09F	2.0	Low	4.0
09G	5.8	Low	4.0
09H	85.0	High	1.0
09I	96.9	High	1.0
09J	92.6	High	1.0
09K	100.0	High	1.0
09L	100.0	High	1.0
09M	100.0	High	1.0
09N	100.0	High	1.0
09O	100.0	High	1.0
09P	100.0	High	1.0

No adjustment was made to original QHA protection scores/ranks. Protection of both larger and smaller habitat areas used by focal species will be critical to maintaining population/habitat diversity, irregardless of reach length. This concept is consistent with the guiding principles of the accompanying subbasin management plan and with the scientific principles of the Council's Fish and Wildlife Program (NPPC 2000).

Species-specific comparisons of protection versus (adjusted) restoration ranks for each sixth-field HUC are shown in Table 91, Table 94, Table 97, and Table 100. A graphical representation of restoration vs. protection areas for each species follows the respective tables (Figure 68, Figure 69, Figure 70, and Figure 71).

Reaches prioritized for restoration activities are presented in rank order in Table 92, Table 95, Table 98, and Table 101; those prioritized for protection are presented in rank order in Table 93, Table 96, Table 99, and Table 102. In each of these tables, habitat priority factors in need of restoration or protection (respectively) are highlighted using rankings drawn directly from the QHA model outputs⁸ (See Appendix O.

Table 91. Comparative restoration versus protection value for spring chinook sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.

Protection Rank Restoration Rank¹	High	Moderate	Low
High (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Restore 09G Imnaha River 6 07M Big Sheep Creek	Priority = Restore 07K Big Sheep Creek 1 07P Big Sheep Creek 3 08K Cow Creek	Priority = Restore 09A Imnaha River 08D Imnaha River 3 (town) 07D Little Sheep Creek 1 08B Imnaha River
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Protect 09M Imnaha River 09J Imnaha River 07R Big Sheep Creek Headwaters 09N Imnaha River 07Q Lick Creek 1	Priority = Protect & Restore 08H Lightning Creek 09C Imnaha River	Priority = Restore 08C Imnaha River 2 07A Big Sheep Creek 08E Horse Creek
Low (Note: Cells in this row have streams listed in order of Protection Rank)	Priority = Protect 09P South Fork Imnaha River 1 09L Imnaha River	Priority = Protect 09D Grouse Creek 1 07B Camp Creek 1 08A Imnaha River 09B Freezeout Creek 1 09I Crazymann Creek 1	Priority = Protect 09H Summit Creek 1 07E Bear Gulch

⁸ Within QHA a maximum of eleven ranks are possible within each reach (one for each habitat variable). Due to tie rankings, the number of unique ranks observed in any reach considered in this assessment did not exceed 6. To extract only priority information from the QHA matrix, the following rules were applied in creating Table 2 and Table 3: If 2-3 unique ranks existed for a given reach, the single most important issue is highlighted in summary tables; If 4-6 unique ranks existed for a reach, the two most important issues are highlighted in summary tables. Ranks are taken directly from the QHA model output and are comparable within but not between rows/reaches.

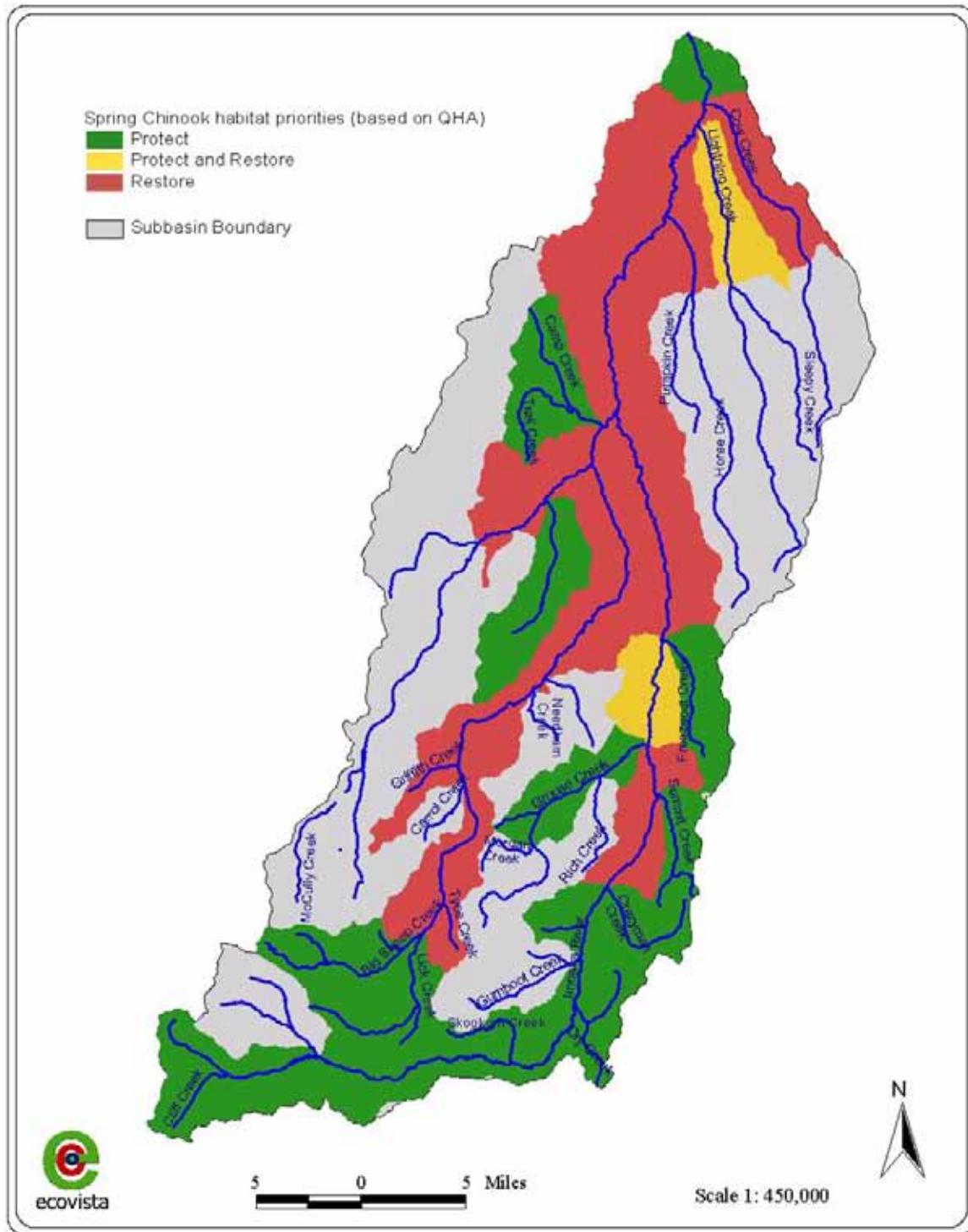


Figure 68. QHA-based restoration and protection areas for spring chinook in the Imnaha subbasin

Table 92. Restoration ranks¹ for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name ²	Length (Miles) ³	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	07K Big Sheep Creek 1	12.9		3				2			1		
2	09A Imnaha River	12.7			3			2			1		
3	09G Imnaha River 6*	8.2			3	2					1		
4	07P Big Sheep Creek 3	8.5	4			3		1			1		
	08D Imnaha River 3 (town)	6.5			3			2			1		
6	07M Big Sheep Creek*	8.2	3				4	1			1		
7	07D Little Sheep Creek 1	4.8			3			2			1		
8	08K Cow Creek	10.3			2		3	3			1		
9	08B Imnaha River	7.2	3			2					1		
10	08C Imnaha River 2	5.4				2		3			1		
11	09J Imnaha River	4.0			3						1		2
12	09M Imnaha River	8.0		3		3		1			1		
	07R Big Sheep Creek Headwaters	3.2				2	3	1					
13	08H Lightning Creek*	8.3			1		2	2			2		
15	07A Big Sheep Creek	3.2				2		3			1		
15	07Q Lick Creek 1	3.4	3	2				1					
17	08E Horse Creek	4.4			4	3		1			1		
17	09N Imnaha River	5.7		3		3		1			1		
19	09C Imnaha River*	5.8			2						1		
20	08A Imnaha River	3.8			2			3			1		
20	09D Grouse Creek 1	1.1	4					1			1		3
22	07B Camp Creek 1	1.7			2	2		1					
23	07E Bear Gulch*	5.4	1		3						1		
23	09H Summit Creek 1*	1.5	3	3	3	3		1			1		
23	09L Imnaha River	2.4		3		3		1			1		
	09P South Fork Imnaha River 1	1.5		3		3		1			1		
27	09I Crazyman Creek 1	1.1						2	2			1	
28	09B Freezeout Creek 1	0.8						2	2			1	

¹/ Uses ‘adjusted’ reach ranks (previously described) to give weight to amount of usable habitat (stream length)

²/ HUCs prioritized as “Protect and Restore” in Table 91 are included in both Table 92 and Table 93 and are marked with an asterisk (*)

³/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which spring chinook use for either spawning/incubation, summer/winter rearing, or migration has been defined (ODFW data)

Table 93. Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Protection Rank	Reach Name ¹											
		Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	
1	09M Imnaha River						3				2	1
1	09P South Fork Imnaha River 1	3	3						2	1		
3	09L Imnaha River						3				1	2
3	09N Imnaha River		1	1		1					1	
5	09J Imnaha River				2						1	3
6	09G Imnaha River 6*		1	1							3	
7	07R Big Sheep Creek Headwaters		1	3							2	
8	07Q Lick Creek 1				2				1	3		
9	07M Big Sheep Creek*			3					1	2		
10	09D Grouse Creek 1	2	2		2	1					2	
11	07P Big Sheep Creek 3						1				3	2
12	07B Camp Creek 1						1				3	2
13	07K Big Sheep Creek 1					3				2	1	
14	08A Imnaha River	3	3							2	1	
15	08H Lightning Creek*						1		1		3	
16	09B Freezeout Creek 1						1				3	2
16	09I Crazyman Creek 1						3				2	1
18	08K Cow Creek						1				3	2
19	09C Imnaha River*						1				3	2
20	07D Little Sheep Creek 1		1	3	1						4	
21	08E Horse Creek		2				1				3	
22	08C Imnaha River 2								3	2	1	
23	08B Imnaha River						1				3	2
24	08D Imnaha River 3 (town)	2		2		1						
25	09H Summit Creek 1*		4	4		1				1		
26	07A Big Sheep Creek		4	4		1				1	3	
27	09A Imnaha River		4	4		1				1	3	
28	07E Bear Gulch*		4	4		1				1	3	

¹/ HUCs prioritized as “Protect and Restore” in Table 91 are included in both Table 92 and Table 93 and are marked with an asterisk (*)

Table 94. Comparative restoration versus protection values for fall chinook sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.

Protection Rank Restoration Rank¹	High	Moderate	Low
High	Priority = Restore 08B Imnaha River	Priority = Restore 08C Imnaha River 2	Priority = Restore
Moderate	Priority = Protect 08A Imnaha River	Priority = Protect & Restore 08C Imnaha River 2	Priority = Restore
Low	Priority = Protect	Priority = Protect	Priority = Protect 08D Imnaha River 3 (town)

Table 95. Restoration ranks¹ for sixth code HUCs and habitat variables within each, for HUCs occupied by fall chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name²	Length (Miles)³	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	08B Imnaha River	7.2			2			1			3		
2	08C Imnaha River 2*	5.4			3	1		2					
3	08A Imnaha River	3.8				1	3	2					
4	08D Imnaha River 3 (town)*	1.4				3	2	1					

¹/ Uses ‘adjusted’ reach ranks (previously described) to give weight to amount of usable habitat (stream length)

²/ HUCs prioritized as “Protect and Restore” in Table 94 are included in both Table 95 and Table 96 and are marked with an asterisk (*)

³/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which fall chinook use for either spawning/incubation, summer/winter rearing, or migration has been defined (ODFW data)

Table 96. Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Protection Rank	Reach Name¹	Riparian Condition					
		Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen
1	08A Imnaha River				3	2	
2	08B Imnaha River				3	2	
3	08C Imnaha River 2*				3	2	
4	08D Imnaha River 3 (town)*				3	2	
							1
							1
							1

¹/ HUCs prioritized as “Protect and Restore” in Table 94 are included in both Table 95 and Table 96 and are marked with and asterisk (*)

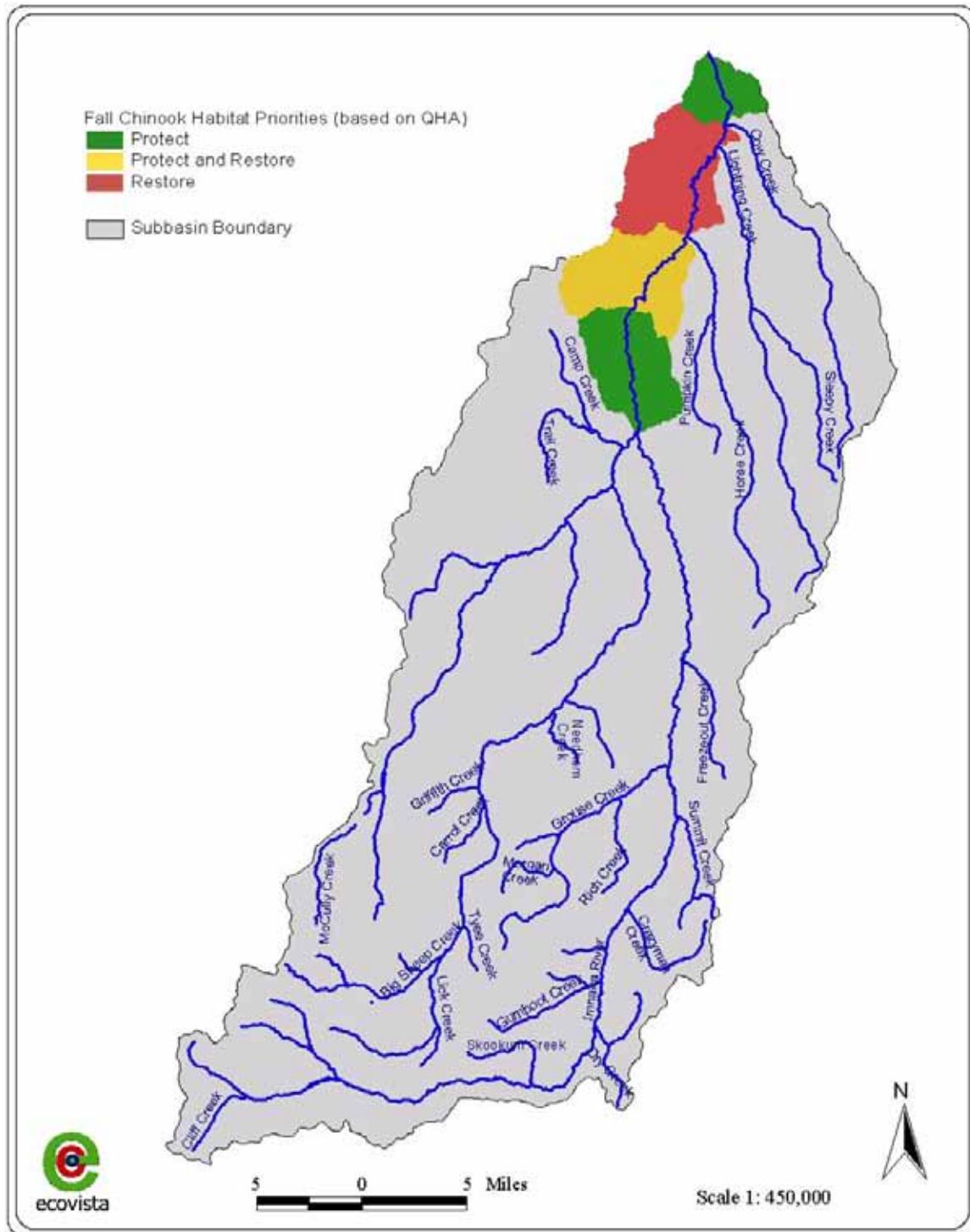


Figure 69. QHA-based restoration and protection areas for fall chinook in the Imnaha subbasin

Table 97. Comparative restoration versus protection value for summer steelhead sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.

<u>Protection Rank Restoration Rank¹</u>	High	Moderate	Low
High (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Restore 07K Big Sheep Creek 1 07M Big Sheep Creek 2 07P Big Sheep Creek 3 09F Grouse Creek Upper 07E Summit Creek (Bear&DowneyGulch) 07D Little Sheep Creek 1 07O Carroll Creek 09K Gumboot Creek 09D Grouse Creek Confluence	Priority = Restore 07H Little Sheep Creek 2 09A Imnaha River 4 08D Imnaha River 3 (Town) 08B Imnaha River 1 07J Little Sheep Creek 3 (Redmont, Ferg., Canal) 07B Lower Camp Creek	
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Protect 08L Cow Creek - Upper 08F Pumpkin Creek 08G Horse Creek Upper 08J Lightning Creek - Upper 08K Cow Creek Confluence 08H Lightning Creek Confluence 09J Imnaha River 7	Priority = Protect & Restore 09G Imnaha River 6 09H Summit Creek 07Q Lick Creek 07N Marr Creek 08E Horse Creek Confluence 09E Rich Creek/Shadow Canyon 07G Lightning Creek	Priority = Restore 08C Imnaha River 2 07C Upper Camp Creek
Low (Note: Cells in this row have streams listed in order of Protection Rank)	Priority = Protect 09L Imnaha River 8 09M Imnaha River 9 09N Imnaha River 09B Freezeout Creek 09I Crazyman Creek 09C Imnaha River 5 07F Devils Gulch 07L Squaw Creek	Priority = Protect	Priority = Protect 08A Imnaha River Confluence 08I Sleepy Creek 07I McCully Creek 07R Big/Little Sheep Headwaters 07A Big Sheep Creek Mouth 09O North Fork Imnaha River 09P South Fork Imnaha River

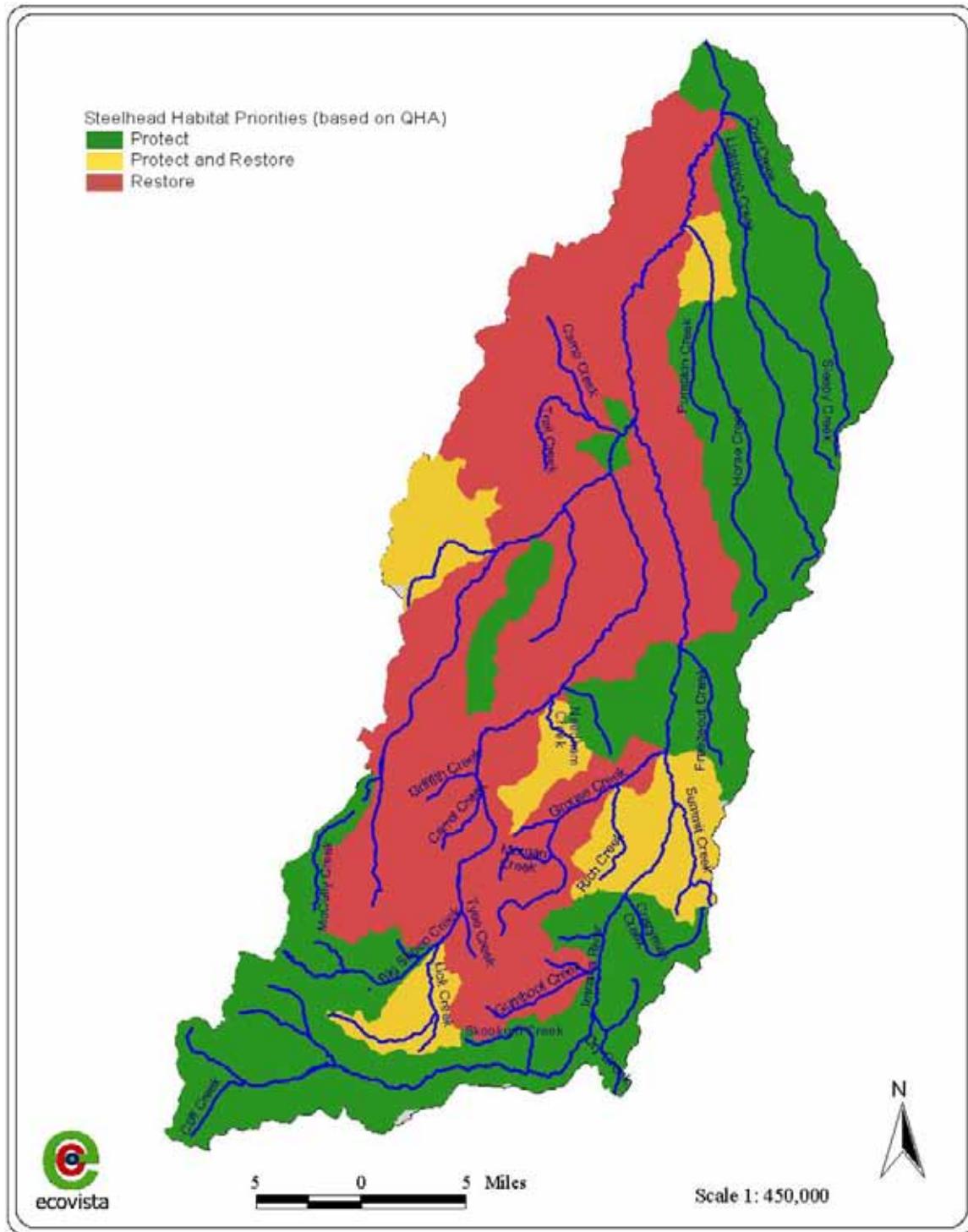


Figure 70. QHA-based restoration and protection areas for summer steelhead in the Imnaha subbasin

Table 98. Restoration ranks¹ for sixth code HUCs and habitat variables within each, for HUCs occupied by summer steelhead within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name ²	Length (Miles) ³	Riparian Condition		Channel Stability	Fine Sediment	High Flow		Low Flow		Oxygen		Low Temperature		High Temperature		Pollutants	Obstructions
			Channel Form	3														
1	07H Little Sheep Creek 2	13.5			2				3						1			
2	09A Imnaha River 4	12.7			2				3						1			
3	07K Big Sheep Creek 1	12.9		3	3				2						1			
4	07M Big Sheep Creek 2	10.9	3							2					1			
5	07P Big Sheep Creek 3	13.1				3			2						1			
6	09F Grouse Creek Upper	13.2	3	1		2												
	07E Summit Creek (Bear&DowneyGulch)	6.0	3			2									1			
7	08D Imnaha River 3 (Town)	8.7			2				3						1			
9	07D Little Sheep Creek 1	8.2			2				3						1			
9	08B Imnaha River 1	7.2			3	2									1			
11	07O Carroll Creek	11.1				1			3						2			
11	09K Gumboot Creek	11.7				3			2						1			
13	09D Grouse Creek Confluence	9.3	2				3								1			
	07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	6.2				1			3							2		
14	07B Lower Camp Creek	6.1		2		3									1			
16	08L Cow Creek Upper	9.7		1											3	2		
17	08F Pumpkin Creek	12.0				2									1	3		
17	09G Imnaha River 6*	13.3			3	2									1			
17	09H Summit Creek*	7.7		3	3				2						1			
20	08G Horse Creek Upper	8.2				1									3	2		
20	08J Lightning Creek Upper	5.3				1									3	2		
20	08K Cow Creek Confluence	11.0			2		3								1			
23	07Q Lick Creek*	8.3	3	2					1									
23	08C Imnaha River 2	6.1			3	2									1			
25	07N Marr Creek*	12.0							3	2					1			
26	07C Upper Camp Creek	10.3			2	3									1			
26	08E Horse Creek Confluence*	3.8				3			2						1			
26	08H Lightning Creek Confluence	3.6			1		2								3			
26	09E Rich Creek/Shadow Canyon*	6.3	2				3								1			
30	07G Lightning Creek*	5.7		2	2										1			
30	09J Imnaha River 7	5.5			2		3								1			
32	09C Imnaha River 5	2.5			2		3								1			
32	09M Imnaha River 9	3.2		3	3				2						1			
34	07A Big Sheep Creek Mouth*	7.3			2				3						1			
35	07F Devils Gulch	4.4				1	3								2			
36	07R Big/Little Sheep Headwaters*	2.8				2	3	1										
37	07L Squaw Creek	3.8						3	2						1			
37	08A Imnaha River Confluence*	4.4			2				3						1			
37	09B Freezeout Creek	8.3							2						1	3		

Restoration Rank	Reach Name ²	Length (Miles) ³	Riparian Condition		Channel Stability		Fine Sediment		Oxygen		Low Temperature		High Temperature		Pollutants		Obstructions	
			Channel Form	Riparian Condition	High Flow	Low Flow	Fine Sediment	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Channel Form	Riparian Condition	High Flow	Low Flow	Fine Sediment	Oxygen
37	09I Crazyman Creek	4.1					2					1	3					
41	09L Imnaha River 8	5.8	3	3				2				1						
41	09N Imnaha River	5.4	3	3				2				1						
43	07I McCully Creek*	4.1					2	1					3					
44	08I Sleepy Creek*	6.0						3				2	1					
45	09O North Fork Imnaha River*	5.8					2	3				1						
45	09P South Fork Imnaha River*	2.1	2									3	1					

¹/ Uses ‘adjusted’ reach ranks (previously described) to give weight to amount of usable habitat (stream length)

²/ HUCs prioritized as “Protect and Restore” in Table 97 are included in both Table 98 and Table 99 and are marked with an asterisk (*)

³/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which steelhead use for either spawning/incubation, summer/winter rearing, or migration (ODFW data)

Table 99. Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by summer steelhead within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Protection Rank	Reach Name ¹	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	09L Imnaha River 8						3			2	1	
1	09M Imnaha River 9						3			2	1	
1	09N Imnaha River						3			2	1	
4	08G Horse Creek Upper						3			2	1	
4	08J Lightning Creek Upper						3			2	1	
6	08L Cow Creek Upper						3			2	1	
7	08H Lightning Creek Confluence						3			2	1	
8	09B Freezeout Creek	3	3				2				1	
8	09I Crazyman Creek	3	3				2				1	
10	08F Pumpkin Creek	3	3				2				1	
11	08K Cow Creek Confluence	3					2				1	
11	09J Imnaha River 7	3					2				1	
13	09C Imnaha River 5	3					2				1	
14	07F Devils Gulch						2			3	1	
15	07L Squaw Creek	2	2								1	
15	07N Marr Creek*	2	2								1	
17	09E Rich Creek/Shadow Canyon*	2	2								1	
18	09G Imnaha River 6*	3					2				1	
19	09D Grouse Creek Confluence	2	2								1	
	07E Summit Creek											
20	(Bear&DowneyGulch)	3					2				1	
21	09F Grouse Creek Upper		3							2	1	
22	07M Big Sheep Creek 2	2		3							1	
23	08E Horse Creek Confluence*	3	2								1	
24	09K Gumboot Creek	2	2								1	
25	07P Big Sheep Creek 3	2	2								1	
26	07Q Lick Creek*		3							2	1	
27	09H Summit Creek*									3	1	2
28	07K Big Sheep Creek 1				2						1	3
29	07O Carroll Creek		2							3	1	
30	07G Lightning Creek*						2			3	1	
31	07D Little Sheep Creek 1						3				1	2
31	09A Imnaha River 4						3				1	2
33	08A Imnaha River Confluence*	3					2				1	3
34	07H Little Sheep Creek 2	3					2				1	
35	08I Sleepy Creek*						3			2	1	
36	08C Imnaha River 2						2				1	3
37	08B Imnaha River 1	3					2				1	
38	07I McCully Creek*	3	3							2	1	
39	07R Big/Little Sheep Headwaters*			3						2	1	
40	07A Big Sheep Creek Mouth*						3				1	2

Protection Rank	Reach Name¹	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
41	07B Lower Camp Creek					3			2	1		
42	08D Imnaha River 3 (Town)					3				1	2	
43	07C Upper Camp Creek	3				2				1		
44	07J Little Sheep Creek 3 (Redmont, Ferg., Canal)		3						2	1		
45	09O North Fork Imnaha River*					3			2	1		
46	09P South Fork Imnaha River*		2						2	1		

¹/ HUCs prioritized as “Protect and Restore” in Table 97 are included in both Table 98 and Table 99 and are marked with an asterisk (*)

Table 100. Comparative restoration versus protection value for bull trout sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity

Protection Rank Restoration Rank¹	High	Moderate	Low
High (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Restore 07R Big Sheep Creek 4 (headwaters) 09M Imnaha River 9	Priority = Restore	Priority = Restore 07H Little Sheep Creek
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	Priority = Protect 07J Little Sheep Creek Headwaters 07I McCully Creek 07P Big Sheep Creek 3 07Q Lick Creek 09J Imnaha River 7	Priority = Protect & Restore 09G Imnaha River 6 09A Imnaha River 4	Priority = Restore 07K Big Sheep Creek 1 08B Imnaha River 1 07D Little Sheep Creek 1 07M Big Sheep Creek 2 08C Imnaha River 2
Low (Note: Cells in this row have streams listed in order of Protection Rank)	Priority = Protect 09N Imnaha River 09P South Fork Imnaha River 09O North Fork Imnaha River 09L Imnaha River 8	Priority = Protect 09C Imnaha River 5 08A Imnaha River Confluence	Priority = Protect 08D Imnaha River 3 07A Big Sheep Creek

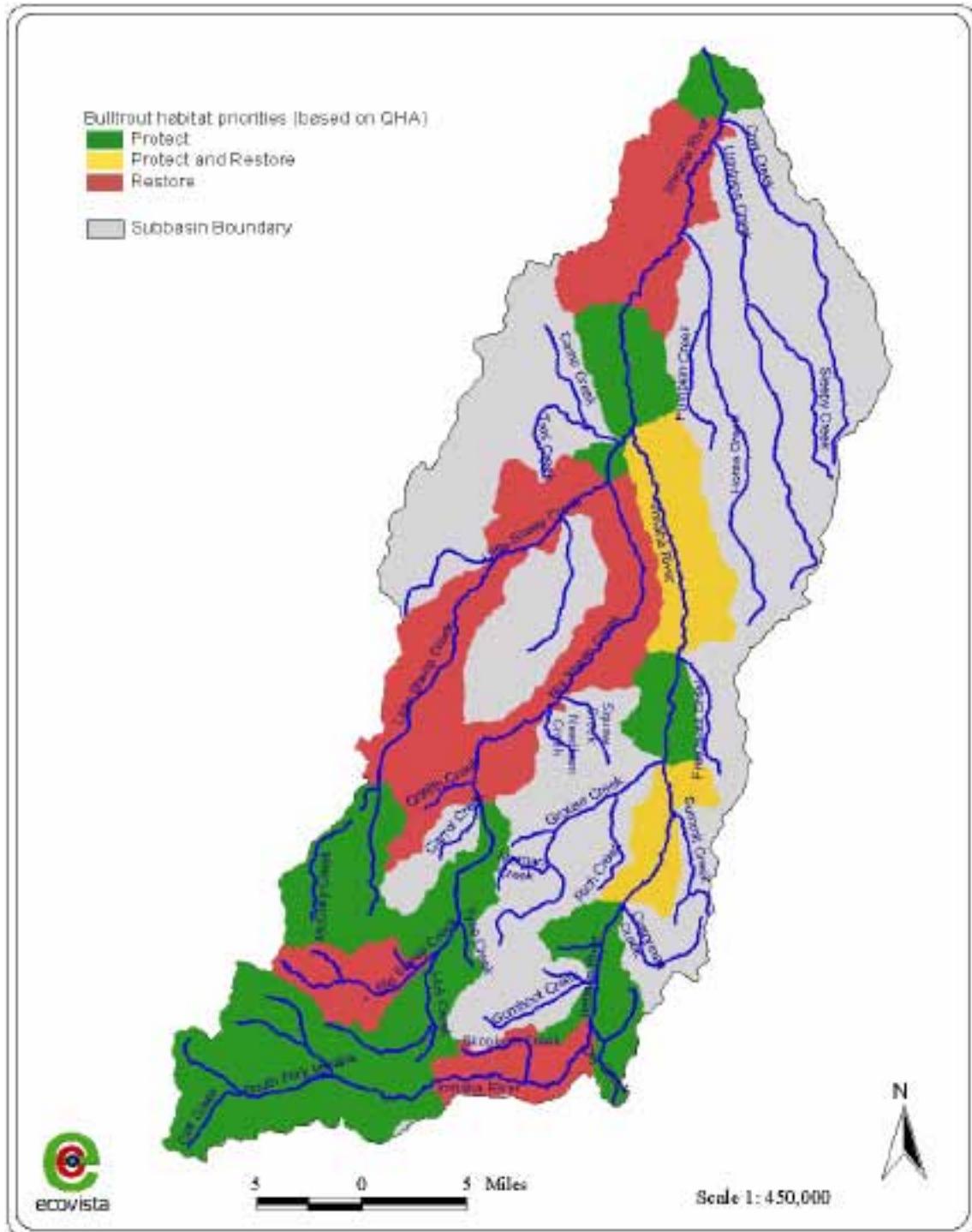


Figure 71. QHA-based restoration and protection areas for bull trout in the Imnaha subbasin

Table 101. Restoration ranks¹ for sixth code HUCs and habitat variables within each, for HUCs occupied by bull trout within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name ²	Length (Miles) ³											
			Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	07R Big Sheep Creek 4 (headwaters)*	12.60	2					3					1
2	07J Little Sheep Creek Headwaters	15.42			4		2			2			1
3	07I McCully Creek	10.14			3						2	1	
4	07P Big Sheep Creek 3	8.50	2	3							1		
5	07Q Lick Creek	9.41	1				2	3				3	
6	07H Little Sheep Creek	13.35						2		2	1	4	
7	09M Imnaha River 9*	10.45		3	5	3	5	1		1		5	
7	07K Big Sheep Creek 1	12.92	4					2		1	2		
7	09G Imnaha River 6*	8.21			3	2				1			
10	09J Imnaha River 7	3.95				1				2		3	
11	07D Little Sheep Creek 1	7.17	4					2		1	2		
11	08B Imnaha River 1	7.22						2		1			
11	09A Imnaha River 4*	12.65			2					1			
14	07M Big Sheep Creek 2	8.15	3							2	1		
14	08C Imnaha River 2	5.43						2		1			
14	08D Imnaha River 3*	6.52						2		1			
17	07A Big Sheep Creek*	3.19						2		1	2		
17	08A Imnaha River Confluence*	3.79				2	2	2		1	2	2	
17	09C Imnaha River 5	5.77			2					1	2	2	
17	09L Imnaha River 8	2.36						2		1			
17	09P South Fork Imnaha River	10.63				1							
22	09N Imnaha River	5.71				1							
22	09O North Fork Imnaha River	6.80				1							

¹/ Uses ‘adjusted’ reach ranks (previously described) to give weight to amount of usable habitat (stream length)

²/ HUCs prioritized as “Protect and Restore” in Table 100 are included in both Table 101 and Table 102 and are marked with an asterisk (*)

³/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which bull trout use for either spawning/incubation, summer/winter rearing, or migration (ODFW data)

Table 102. Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by bull trout within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Protection Rank	Reach Name ¹	Riparian Condition									
		Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	09N Imnaha River	4				1			1	1	
1	09P South Fork Imnaha River	4				1			1	1	
3	09O North Fork Imnaha River	4	4	4	1				1	1	4
4	09M Imnaha River 9*					2			2	1	
	07R Big Sheep Creek 4 (headwaters)*						3		2	1	
6	09L Imnaha River 8			3		2			1		
7	09J Imnaha River 7		3			1			1		
8	07Q Lick Creek		1	1		5			1	1	
9	07I McCully Creek		3			2			1		
10	07P Big Sheep Creek 3		3	3		2				1	
11	07J Little Sheep Creek Headwaters	2				3		3			
12	09G Imnaha River 6*		4		4	1				1	3
13	09C Imnaha River 5	4	4		4	1			1	1	
14	09A Imnaha River 4*	4	4		4	1			1	1	
15	08A Imnaha River Confluence*	4	4			1			1	1	
16	07M Big Sheep Creek 2					1			3	3	1
17	08C Imnaha River 2					3			1	1	
18	08D Imnaha River 3*					3			1	1	
19	08B Imnaha River 1					3			1	1	
20	07K Big Sheep Creek 1					2			2	1	
21	07D Little Sheep Creek 1					2			2	1	
22	07A Big Sheep Creek*					2			2	1	
23	07H Little Sheep Creek					2			3	1	

¹/ HUCs prioritized as “Protect and Restore” in Table 100 are included in both Table 101 and Table 102 and are marked with an asterisk (*)

1.5.2 Local Factors Limiting Terrestrial Species

The primary limiting factors for wildlife in the Imnaha subbasin were selected based on a comparison of threats identified for focal and concern species, with changes in habitat conditions identified at the scale of the WHT, structural condition and KEC (see section.) or KEF (see section 1.4). Seven factors emerged as being the most limiting to the terrestrial communities and their dependent wildlife species in the subbasin. Not surprisingly, these factors are similar to those identified in the broader-scale assessments conducted during the Interior Columbia Ecosystem Management Project (Quigley and Arbelbide 1997, Wisdom 2000). The local limiting factors identify the habitat features in the subbasin that appear to have been most altered between historical and current times.

Addressing these habit level limiting factors will provide the greatest benefit to the greatest number of species and the limiting factors were used as the starting point for the development of the objectives and strategies section of the Imnaha Subbasin Management Plan. There is a level of overlap between the limiting factors that is inherent to both this ecosystem level approach and the way the limiting factor were selected, for example, it was determined in section 1.2.10 that the loss and degradation of the grassland habitats in the subbasin was a primary limiting factor to the wildlife species that depend on these habitats. At the finer scale of the KEC it was determined that noxious weeds and invasive plant species were also primary limiting factor to the wildlife species of the subbasin. The impacts of noxious weed and invasive plant infestation have been most profound in the grassland habitats of the Imnaha subbasin and have been among the primary mechanism for their degradation. The selection of both of these factors as limiting factors will result in some duplication in the development of objectives and strategies in the Management Plan but also provided an opportunity for the technical team to look at the issue from different perspectives and at different scales resulting in a more comprehensive plan for addressing these problems.

Loss of Ponderosa Pine Communities

Data from the Northwest Habitat Institute indicate that the distribution of the Ponderosa Pine WHT has declined by 47% in the Imnaha subbasin between historical and current. Similar results have been documented by Quigley and Arbelbide (1997) and Wisdom (2000) at the scale of the Columbia Basin. Fire suppression and selective timber harvest are the practices most responsible for losses of ponderosa pine habitat both at the scale of the Imnaha subbasin and the Columbia Basin. Fire suppression has allowed more shade tolerant species to establish and overtop ponderosa pine in many areas of the subbasin. Selective timber harvest has targeted commercially valuable large ponderosa pines, reducing both the extent of the WHT and the amount of large structure ponderosa pines, which are particularly valuable to wildlife.

Reductions in the abundance of mature ponderosa pine have likely impacted populations of ponderosa pine dependent wildlife species in the subbasin. Ponderosa pine habitats are important to a variety of wildlife in a variety of ways. Bald eagles are often observed perched in mature ponderosa pine trees (Cassirer 1995). White-headed woodpeckers are completely

dependant on the seeds of the Ponderosa pine for winter feeding and show a preference for these habitat types for nesting and foraging during other seasons of the year. Flammulated owl habitat includes open stands of fire-climax ponderosa pine or Douglas-fir forests (See Section 1.2.9.1 for details). Twenty-one of the subbasin's wildlife species (12 birds and 9 mammals) are closely associated with ponderosa pine habitat types (see section 1.2.10.1 and Appendix A for details. Five of the species closely associated with ponderosa pine habitats in the subbasin are concern or focal species (Table 103).

Table 103. Concern and focal species of the Imnaha subbasin closely associated with ponderosa pine habitats (Johnson and O'Neil 2001).

Common Name	Scientific Name
Flammulated owl	<i>Otus flammeeolus</i>
Great gray owl	<i>Strix nebulosa</i>
Northern goshawk	<i>Accipiter gentilis</i>
Pygmy nuthatch	<i>Sitta pygmaea</i>
White-headed woodpecker	<i>Picoides albolarvatus</i>

Protecting areas of existing mature ponderosa pine and facilitating the development of additional areas of ponderosa pine habitat is an important issue for the ponderosa pine dependent wildlife in the subbasin. Strategies for maintaining existing and developing additional mature ponderosa pine habitat were developed by the terrestrial subcommittee of the Imnaha subbasin technical team and are outlined in the *Imnaha Subbasin Management Plan* (Objective 15). Table 104 shows the current distribution of all ponderosa pines and large and giant size ponderosa pines by subwatershed. Areas containing significant amounts of large ponderosa pines should be considered for protection, while areas with ponderosa pines not in mature size classes should be considered for silvicultural treatments that will preserve the ponderosa pine component and help move it into late seral stages. The data represented in Table 104 is relatively coarse scale continuing inventory will need to be a component of efforts to protect and restore ponderosa pine habitats in the subbasin.

Table 104. Distribution of the ponderosa pine WHT in the Imnaha subbasin by subwatershed.

Subwatershed ¹	Current Ponderosa Pine WHT (acres) (Based on NHI Current WHT Distributions)	Percentage (%) of Watershed Ponderosa Pine	Large or Giant (>21 inches dbf) Ponderosa Pine (acres) (Based on ONHP Size Class Data)	Percentage (%) of Ponderosa Pine WHT Large or Giant Size Class
07A	80.8	2.8	25.2	31.2
07B	1343.9	10.2	0.7	0.0
07C	571.1	3.0	0.0	0.0
07D	1099.0	8.9	201.4	18.3
07E	1087.2	7.3	244.2	22.5
07F	321.4	4.1	12.0	3.7
07G	32.7	0.2	0.0	0.0
07H	545.9	2.2	0.0	0.0
07I	419.4	5.8	0.0	0.0
07J	60.1	0.5	0.0	0.0
07K	1110.0	5.9	214.8	19.4

Subwatershed ¹	Current Ponderosa Pine WHT (acres) (Based on NHI Current WHT Distributions)	Percentage (%) of Watershed Ponderosa Pine	Large or Giant (>21 inches dbf) Ponderosa Pine (acres) (Based on ONHP Size Class Data)	Percentage (%) of Ponderosa Pine WHT Large or Giant Size Class
07L	117.3	1.9	45.9	39.1
07M	377.9	2.6	168.2	44.5
07N	228.8	3.4	148.8	65.0
07O	154.5	2.2	41.7	27.0
07P	237.3	1.7	57.9	24.4
08A	230.5	4.1	0.0	0.0
08B	2100.6	13.8	28.5	1.4
08C	1081.0	7.8	0.2	0.0
08D	839.2	6.6	0.0	0.0
08E	728.7	13.1	0.0	0.0
08F	602.2	8.4	81.8	13.6
08G	2235.1	10.2	15.2	0.7
08H	1614.3	14.8	0.0	0.0
08I	958.7	8.2	0.0	0.0
08J	1027.0	6.2	0.0	0.0
08K	1516.8	12.7	0.0	0.0
08L	354.4	2.6	0.0	0.0
09A	1166.8	5.1	15.8	1.4
09B	230.7	2.3	0.0	0.0
09C	972.5	10.8	5.3	0.5
09D	197.5	1.9	11.8	6.0
09E	31.4	0.6	10.9	34.7
09G	739.1	6.2	0.0	0.0
09H	215.6	3.4	0.0	0.0
09I	5.3	0.1	0.0	0.0
09J	99.9	1.6	0.0	0.0
09K	7.3	0.1	0.0	0.0
09L	67.0	0.8	16.5	24.6
09M	287.2	2.3	148.4	51.7

¹ Subwatersheds 07Q, 07R, 09F, 09N, 09O, and 09P contain no ponderosa pine WHT.

Degradation of Grassland Habitats

Grassland ecosystems have suffered the greatest losses of any habitats in the Columbia Plateau (Kagan et al.1999). The fescue-bunchgrass cover type, which dominates the subbasins grasslands has declined by two thirds from historic levels across the Columbia Basin (Quigley and Arbelbide 1997). Relative to many other parts of the Columbia Basin, the grassland habitats of the Imnaha subbasin are in good condition. Most are in mid-late seral stages and dominated by native vegetation; however, there are areas where historical overgrazing has damaged the subbasin's grasslands and allowed annual grasses and noxious weeds to establish.

Native grasslands of the region evolved without the heavy grazing pressures that occurred on the Great Plains (Mancuso and Moseley 1994). Heavy grazing in the late 1800s and early 1900s led

to alterations in the community structure and aided in colonization by exotic annual grasses and noxious weeds (USFS 1999). Biological soil crusts are an important component of grassland habitats. Crusts reduce wind and water erosion by increasing soil stability, retaining moisture, and increase soil fertility through the addition of carbon, organic matter and soil micronutrients. Biological soil crusts develop slowly and are fragile in some areas crusts in the subbasin have been damaged through grazing, off-road vehicle use, invasion by exotic annual grasses, and fire (USFS 2003a).

Natural succession processes and changes in management have resulted recent upward trends in the condition of grassland habitats in much of the subbasin (USFS 2003a). However, some areas are still degraded. The lower canyon benches dominated by sand dropseed and/or red threeawn tend to exhibit the worst condition of any grassland community in the subbasin (USFS 1995, 1998). Reduced grassland habitat quality has reducing the subbasins ability to support grassland dependent wildlife species.

The most recent analysis of grassland condition in the subbasin has been conducted by the Forest Service for HCRNA grasslands in support of their HCRNA CMP (USFS 2003a). The Forest Service evaluates grassland seral stages to assess the current departure of a specific site from the Potential Natural Condition (PNC) for that site. A seral stage determination is an evaluation of the successional status of the plant community occurring on a site compared with the PNC that would occur on that site if succession progressed absent of outside influences. PNC is based on an evaluation of site characteristics including geology, soils, aspect, climate, elevation, etc., compared to similar site characteristics from areas evaluated and estimated by plant ecologists to be at or near their biotic potential. The types of vegetation associated with each seral class are described below; historically the grasslands in the HCNRA were dominated by mid to late seral-stage vegetation (USFS 2003a).

- Late- the natural/native species community perennial bunchgrasses dominate, with bare ground subordinate to other surface features (rock, gravel, microbiotic crusts, litter).
- Mid – native perennial forbs and grasses co-dominate with the potential natural community perennial bunchgrasses. Bare ground is subordinate or equivalent to other surface features.
- Early – native perennial forbs and other native grasses dominate over the potential natural community perennial bunchgrasses. Bare ground is equivalent to or more extensive than other surface features.
- Very early (Disclimax) – potential natural community perennial bunchgrasses are present on less than 5 percent of the stand. Bare ground is more extensive than other surface features.

Current information about the condition of HCNRA grasslands is limited and based on current and historic inventories (USFS 2003a). The USFS recently compared the existing grassland inventory information to the PNV to determine the ecological condition of grasslands on the HCNRA. Generally, satisfactory condition rangeland is in a mid-seral stage or later with a stable or improving condition trend. Two techniques were used to assess the condition of grasslands in the HCRNA. The first technique evaluated the ecological status and condition of permanent monitoring points on suitable or capable grazing lands. This technique identified that 76 percent of the sites were in satisfactory condition. The second technique analyzed ecological condition

inventories on eight allotments, which included one vacant allotment selected to represent the diversity of conditions throughout the HCNRA. Analysis of capable and suitable acres on these allotments indicates 97 percent of the grazing allotments on the HCNRA are in satisfactory condition. Both analysis excluded areas such as historic homesteads, benches (plowed and farmed), and some of the flatter bottomlands and ridges where livestock were historically concentrated and where site potentials have been permanently altered; these areas contain the majority of early and very-early seral grasslands in the HCRNA (USFS 2003a). Alternative E-modified the selected alternative in the HCNRA CMP focuses grassland restoration efforts in the HCRNA on deep soil benches in early seral condition.

The loss and degradation of grassland habitats in the subbasin has the potential to impact the numerous wildlife species that depend on these habitats. Species that are closely associated with the eastside grassland WHT would be expected to be the most impacted but the numerous other species that use grassland habitats could also be affected. Strategies for the improvement of grassland habitat condition and protection of existing high quality grassland areas were developed by the terrestrial subcommittee of the Imnaha subbasin technical team (Objectives 14A and 14B management plan).

Degradation of Riparian Habitats

Riparian habitats are immensely valuable to both fish and wildlife populations in the subbasin. More of the subbasins wildlife species are more closely associated with wetland and riparian WHTs than with any other WHT (Appendix A). Eighty-one species in the subbasin are closely associated with herbaceous wetlands, while 14 are closely associated with coniferous wetlands. Many other species use riparian and wetland habitat occasionally or as travel corridors. Riparian habitats in the Imnaha subbasin have been altered through various human activities, including livestock grazing, timber harvest, and road construction. Alterations in vegetative structure and disturbance regimes have contributed to increased intensity fire, flood and insects outbreaks, which have also reduced riparian quality. The Imnaha subbasin Multi-species Biological Assessment identified 17 subwatershed in the subbasin where riparian conditions are functioning at risk (7A,7D,7E,7H,7J,7K,7M,7O,7P,7Q, 8D, 9A,9D,9E,9F,9H,9K; see Figure 3 for locations). Riparian areas in the remaining twenty-nine subwatersheds are thought to be functioning appropriately.

Subwatersheds with riparian areas that are functioning at risk are concentrated in the Big and Little Sheep Drainages. In lower portions of this drainage riparian species, such as cottonwood and ponderosa pine, by grazing, cultivation, homesteading/clearing, and road construction (USFS 2000). In the upper watershed, insect infestations and the Canal Creek Fire of 1989 have reduced effective stream shade-providing riparian vegetation. Engelmann spruce is sparse in the Big Sheep Creek riparian zones, as they have suffered 50 to 100% mortality due to insect infestations. Consequently, much of the overstory in the primary riparian zone is missing or dead and where Engelmann spruce mortality has been high, a grass/forb community dominates the primary riparian zone (USFS 2001).

Conditions in the riparian zones of much of the subbasin have shown improvements due to protection and restoration resulting from the 1992 listing of salmon as a threatened species (USFS 1999). Strategies for further improvement of the condition of riparian and wetland

habitats in the subbasin and the preservation of high-quality areas were developed by the technical team in objective 16A and 16B of the *Imnaha Subbasin Management Plan*. Strategies developed to improve the next limiting factor ‘changes in disturbance regime and vegetative structure’ will help to protect riparian areas from catastrophic fires.

Changes in disturbance regime and vegetative structure

Fire suppression has resulted in increased accumulation of fuels, higher tree densities, and the accumulation of duff. These conditions create a situation in which even light severity fires can be damaging due to the concentrated heating of the tree bole. The accumulation of ground fuels along with denser, multi storied stand conditions have created “fuel ladders” that carry fire into the tree canopy, resulting in high intensity crown fires. Unlike the moderate severity fires that burned historically, many wildfires now have the potential to impact soil productivity and increase erosion through the consumption of organic matter and high temperature that may result. The net result is wildfires that are more severe and more difficult to control (BLM 2002). Over the past 100-plus years, the percentage of higher burn intensities in Blue Mountain forests has increased beyond historic conditions (Johnson 1998). Focal species threatened by large stand-replacing fires include the boreal owl, olive-sided flycatcher and American marten (USFS 2003b).

Fire suppression has resulted in a shift to more shade tolerant tree species and contributed to the development of dense, multi-layered stands. Forests with these conditions are more susceptible to insects and disease than forests developed in more natural disturbance regimes (USFS 1998).

These changes in forest vegetative conditions are illustrated by the increase of fuel model 9 or 10 in the subbasin (See section 1.1.3.2 and 1.1.3.3 for details). Fires burning in fuel models 9 and 10 can have much higher intensities, are more difficult to suppress, and have longer and more severe ecological impacts than other fires. Large fires result in a more homogenous distribution of structural conditions and can reduce the diversity of species an area can support. Returning to a more natural fire regime through prescribed burning would reduce the threat of large-stand replacement fires and promote large diameter trees and snags. Table 105 shows the percentage of the fuel model data in the subwatershed that is fuel model data 9 or 10. Subwatersheds comprised of large areas of fuel model 9 and 10, may need to be considered for vegetative treatment and prescribed burning to reduce fuel loads and protect habitat for wildlife and fish. Because some forests naturally exhibit fuel model 9 and 10 characteristics, making these decisions will require on the ground surveys to determine where conditions pose the greatest risk of catastrophic fire. During technical team meetings two areas of great concern were identified the Lick Creek (O7Q) and Gumboot (09K) subwatersheds.

Altered disturbance regimes have changed the abundance and distribution of forest structural conditions in the subbasin from what was historically present (see sections 1.1.3.3 and 1.2.10 for details). Many areas of the subbasin are under represented for mature forest habitat types when compared with the historical range of variability (See section 1.2.10 for details). Mature forests and the key environmental correlate (snags, downed wood etc.) they usually contain are very important to numerous wildlife species, including the American marten, boreal owl, and olive-sided flycatcher focal species. Deficits in the late and old structural stages in the subbasin are most pronounced where timber harvest, uncharacteristic fire and insect infestations have

occurred (USFS 2003). As shown in section 1.2.10 , large-single storied stands comprised more than 20 % of the area with data in only one HUC 07N. Large multi-storied stands are better distributed and comprise more than 20% of the area with data in HUCs 07A, 07E, 07K, 07M, 07O, 08F, 09M. Strategies for restoring more natural disturbance regimes and forest structural conditions to the subbasin and protecting existing large structural condition forests were developed by the technical team in objective 18A of the *Imnaha Subbasin Management Plan*.

Table 105. Subwatersheds with a high concentration of fuel models 9 and 10.

Subwatershed¹	Percentage (%) of subwatershed with fuel model data in fuel model 9 or 10
07A	0.0
07E	0.0
07I	36.7
07J	35.1
07K	4.7
07L	31.4
07N	34.8
07O	37.6
07P	35.6
07Q	47.7
07R	27.4
08A	0.0
08B	0.9
08C	0.0
08E	0.0
08F	22.1
08G	35.0
08H	6.3
08I	33.7
08J	24.7
08K	10.9
08L	31.7
09A	9.5
09B	33.4
09C	73.9
09D	51.4
09E	51.5
09F	57.0
09G	35.5
09H	31.8
09I	18.8
09J	19.3
09K	28.8
09L	12.8
09M	40.6

Subwatershed¹	Percentage (%) of subwatershed with fuel model data in fuel model 9 or 10
09N	27.3
09O	39.2
09P	52.3

¹Subwatersheds with fuel model data for less than 50% of the subwatershed were removed from the analysis (07B, 07C, 07D, 07F, 07G, 07H, 07M).

Roads and Habitat Fragmentation

Even though road densities in the subbasin are relatively low, the transportation system of the Imnaha subbasin is a limiting factor to wildlife populations in some areas of the subbasin.

More than 65 species of terrestrial vertebrates in the interior Columbia River basin have been identified as being negatively affected by road-associated factors (Wisdom et al. 2000). Road-associated factors can negatively affect habitats and populations of terrestrial vertebrates both directly and indirectly. Wisdom et al. (2000) identified 13 factors consistently associated with roads in a manner deleterious to terrestrial vertebrates (Table 106). The Wallowa-Whitman National Forest uses the following classes to quantify in general terms the impact of roads on wildlife sensitive to open roads: low impacts can be expected in areas with a density less than 1.0 mi./sq. mi, a moderate impact at densities between 1.0-2.5 mi./sq. mi., and a high impact when densities are greater than 2.5 mi./sq. mi. of open road (USFS 2003a). The Imnaha Subbasin Multi-Species BA considered both the density and location of roads when considering the potential impacts of roads on listed aquatic species. These ratings may also be useful for getting a general idea of the potential impacts of roads on terrestrial, particularly riparian dependent, species and are displayed in Table 106.

Table 106. Road-associated factors with deleterious impacts on wildlife (Wisdom et al. 2000).

Road-Associated Factor	Effect of Factor in Relation to Roads
Snag reduction	Reduction in density of snags due to their removal near roads, as facilitated by road access
Down log reduction	Reduction in density of large logs due to their removal near roads, as facilitated by road access
Habitat loss and fragmentation	Loss and resulting fragmentation of habitat due to establishment and maintenance of road and road right-of-way
Negative edge effects	Specific case of fragmentation for species that respond negatively to openings or linear edges created by roads
Overhunting	Nonsustainable or nondesired legal harvest by hunting as facilitated by road access
Overtrapping	Nonsustainable or nondesired legal harvest by trapping as facilitated by road access
Poaching	Increased illegal take (shooting or trapping) of animals as facilitated by road access

Collection	Collection of live animals for human uses (e.g., amphibians and reptiles collected for use as pets) as facilitated by the physical characteristics of roads or by road access
Harassment or disturbance at specific use sites	Direct interference of life functions at specific use sites due to human or motorized activities, as facilitated by road access (e.g., increased disturbance of nest sites, breeding leks or communal roost sites)
Collisions	Death or injury resulting from a motorized vehicle running over or hitting an animal on the road
Movement barrier	Preclusion of dispersal, migration or other movements as posed by a road itself or by human activities on or near a road or road network
Displacement or avoidance	Spatial shifts in populations or individual animals away from a road or road network in relation to human activities on or near a road or road network
Chronic negative interaction with humans	Increased mortality of animals due to increased contact with humans, as facilitated by road access

Table 107. Road density by subwatershed and multi-species matrix ratings (USFS 2003d).

Subwatershed ¹	Subwatershed Area (mi ²)	Road Length (mi)	Road Density (mi/mi ²)	Multi-species Matrix rating for Road Density and Drainage Network ²
07A	4.5	3.3	0.7	Functioning at Risk
07B	20.6	24.7	1.2	not rated
07C	29.6	47.0	1.6	not rated
07D	19.4	19.9	1.0	Functioning at Unacceptable Risk
07E	23.3	24.1	1.0	Functioning at Risk
07F	12.2	13.6	1.1	not rated
07G	24.1	50.6	2.1	not rated
07H	38.0	59.4	1.6	Functioning at Risk
07I	11.4	10.7	0.9	Functioning Appropriately
07J	19.4	66.1	3.4	Functioning at Unacceptable Risk
07K	29.4	19.5	0.7	Functioning Appropriately
07L	9.9	24.5	2.5	Functioning at Unacceptable Risk
07M	22.4	50.4	2.3	Functioning at Risk
07N	10.4	18.7	1.8	Functioning Appropriately
07O	10.9	57.3	5.2	Functioning at Unacceptable Risk
07P	21.2	80.1	3.8	Functioning at Unacceptable Risk
07Q	16.0	53.9	3.4	Functioning at Unacceptable Risk
07R	19.1	21.4	1.1	Functioning at Risk
08A	8.8	8.5	1.0	Functioning Appropriately
08B	23.7	29.4	1.2	Functioning at Risk
08C	21.8	19.9	0.9	Functioning Appropriately
08D	19.7	13.2	0.7	Functioning Appropriately
08E	8.7	7.4	0.8	Functioning Appropriately

Subwatershed¹	Subwatershed Area (mi²)	Road Length (mi)	Road Density (mi/mi²)	Multi-species Matrix rating for Road Density and Drainage Network²
08F	11.2	9.6	0.9	Functioning Appropriately
08G	34.4	17.6	0.5	Functioning Appropriately
08H	17.0	8.9	0.5	Functioning Appropriately
08I	18.3	2.0	0.1	not rated
08J	26.0	8.5	0.3	Functioning Appropriately
08K	18.6	9.6	0.5	Functioning Appropriately
08L	21.6	6.8	0.3	Functioning Appropriately
09A	35.9	41.7	1.2	Functioning Appropriately
09B	15.4	6.7	0.4	Functioning Appropriately
09C	14.1	11.0	0.8	Functioning Appropriately
09D	16.6	37.5	2.3	Functioning at Risk
09E	8.9	39.0	4.4	Functioning at Unacceptable Risk
09F	18.0	93.3	5.2	Functioning at Unacceptable Risk
09G	18.7	32.2	1.7	Functioning at Risk
09H	9.8	22.8	2.3	Functioning at Risk
09I	12.8	47.0	3.7	Functioning at Unacceptable Risk
09J	10.0	25.7	2.6	Functioning at Unacceptable Risk
09K	18.7	75.0	4.0	Functioning at Unacceptable Risk
09L	13.9	61.2	4.4	Functioning at Unacceptable Risk
09M	19.6	55.7	2.8	Functioning at Unacceptable Risk
09N	16.7	2.7	0.2	Functioning Appropriately
09O	21.3	0.0	0.0	Functioning Appropriately
09P	27.8	0.0	0.0	Functioning Appropriately

1 Subwatersheds of greatest concern in bold

2 Considers both road density and location and rates risk to various aquatic species. When ratings were different for the aquatic species the rating indicating the greater impact was used.

The WWNF through the CMP decision (2003a) plans to reduce open road density below 1.5 miles per square mile in the majority of sub-watersheds in the subbasin within the next 5 years. Objectives and strategies for further reducing road impacts and expanding road reduction efforts to private lands were developed by the Imnaha subbasin technical team and are presented in the Imnaha Subbasin Management Plan objective 19A.

Noxious weeds and other invasive plants

The introduction of nonnative plants to the Imnaha subbasin has reduced its ability to support native wildlife and plant species. Introduced plants in the subbasin often outcompete native plant species and alter ecological processes, thereby reducing habitat suitability (Quigley and Arbelbide 1997). Many invasive are not palatable to either livestock or wildlife, nor do they provide suitable habitat for wildlife species. For example, purple loosestrife is not readily eaten, nor does it provide nesting habitat. However, it replaces aquatic species that do provide quality habitat (USFS 2003a).

Weed problems in the subbasin are less severe than in many areas of the Columbia Basin but are most severe in the grassland habitats. The naturally open structure of the subbasin's grassland vegetation, its soils, and climate have predisposed it to invasion by weeds, especially by species of Mediterranean origin (USFS 2003a).

Noxious weed surveys conducted by the Wallowa-Whitman National Forest have documented the presence of 14 noxious weed species in the subbasin (see section 1.1.3.4 for details). Of these bugloss and Canada thistle cover the greatest number of acres. Additional survey effort is needed to document the extent of currently established noxious weed populations and to swiftly identify and treat new invasions in the subbasin.

Preventing the spread and establishment of noxious weeds and invasive plants in the subbasin is a high priority for the subbasins management agencies. Numerous federal, state, county, tribal and private organizations are working together in the area to coordinate weed education, prevention and control efforts including biological control insects and herbicide applications. Noxious weed control and eradication efforts are resource intensive, in order to most effectively employ these resources a prioritization of efforts is necessary. Wallowa County maintains a list of noxious weed priorities in the county, the 'A list' identifies the highest priority weed species for control or irradication in the county.

Highest	4 = Invasibility high, presence confirmed/probable, threat high, eradication/containment possible, and biocontrol not effective 3 = Invasibility high, presence at least probable, threat high, containment may not be possible, and/or biocontrol possible 2 = Invasibility and/or threat medium, containment impossible, or biocontrol effective
Low	1 = Invasibility and/or threat low, containment impossible, or biocontrol effective

Table 108. Wallowa County "A" List Noxious Weed Species

Wallowa County "A" List Noxious Weed Species		East Canyons	Zumwalt
Common Name	Scientific Name		
Common Bugloss*	<i>Anchusa officianalis</i>	4	3
Common Crupina	<i>Crupina vulgaris</i>	3	3
Dalmatian Toadflax*	<i>Linaria dalmatica</i>	4	3
Diffuse Knapweed	<i>Centaurea diffusa</i>	3	2
Japanese Knotweed	<i>Polygonum cuspidatum</i>	3	2
Jointed Goatgrass*	<i>Aegilops cylindrica</i>	3	3
Leafy Spurge	<i>Euphorbia esula</i>	4	4
Meadow Hawkweed*	<i>Hieraceum pratense</i>	4	4
Meadow Knapweed*	<i>Centaurea pratensis</i>	3	4
Mediterranean Sage*	<i>Salvia aethiopsis</i>	3	3
Medusahead rye*	<i>Taeniatherum caput-medusae</i>	3	4
Musk Thistle*	<i>Carduus nutans</i>	2	4
Perennial Pepperweed*	<i>Lepidium latifolium</i>	4	4

Wallowa County "A" List Noxious Weed Species			
Purple Loosestrife*	<i>Lythrum salicaria</i>	3	3
Rush Skeletonweed*	<i>Chondrilla juncea</i>	4	4
Russian Knapweed	<i>Centaurea repens</i>	4	3
Scotch Thistle	<i>Onopordum acanthium</i>	3	3
Spotted Knapweed	<i>Centaurea maculosa</i>	4	4
Sulfur Cinquefoil	<i>Potentilla recta</i>	4	4
Tansy Ragwort*	<i>Senecio jacobaea</i>	4	3
Whitetop*	<i>Cardaria draba</i>	4	4
Yellow Starthistle	<i>Centaurea solstitialis</i>	3	4
Blooddrop/Pheasant Eye		?	4
Orange Hawkweed	<i>Hieracium aurantiacum</i>	4	3
Poison Hemlock	<i>Conium maculatum</i>	4	3
False Hoary Alyssum		?	?
Yellow Toadflax*	<i>Linaria Vulgaris</i>	3	3

Table 109. Wallowa County "B" List Noxious Weed Species

Wallowa County "B" List Noxious Weed Species		East Canyons	Zumwalt
Common Name	Scientific Name		
Canada Thistle	<i>Cirsium arvense</i>	2	2
Chicory	<i>Cichorium intybus</i>	3	2
Common Burdock	<i>Arctium minus</i>	2	2
Common Teasle	<i>Dipsacus fullonum</i>	2	2
Field Bindweed	<i>Convovulvis arvensis</i>	3	3
Hounds Tongue	<i>Cynoglossum officinale</i>	3	2
Kochia	<i>Kochia scoparia</i>	2	2
Mullen	<i>Verbascum thapsis</i>	2	2
Myrtle Spurge	<i>Euphorbia sp.</i>	4	3
Oxeye Daisy	<i>Chrysanthemum leucanthemum</i>	3	3
Puncture vine	<i>Tribulus terrestris</i>	3	2
Reed Canary Grass	<i>Phalaris arundinacea</i>	2	2
St. Johnswort	<i>Hypericum perforatum</i>	1	2
Western Waterhemlock	<i>Cicuta douglasii</i>	3	3
Ventenata	<i>Ventenata dubia</i>	3	3
Tall Buttercup	<i>Rununculas acris</i>	3	3
Bur Buttercup	<i>Rununculas testiculatum</i>	2	3

Table 110. Wallowa County Watch List Noxious Weed Species

Wallowa County Watch List Noxious Weed Species		East Canyons	Zumwalt
Common Name	Scientific Name		
Black Henbane	Hyoscyamus niger	1	1
Bouncing Bette	Saponaria officinalis	3	1
Buffalo Bur	Solanum rostratum	1	1
Common Cockle Bur	Xanthium strumarium	1	1
Dyers Woad	Isatis Tinctoria	2	2
Foxtail	Hordeum leporinum	2	2
Lambsquarter	Chenopodium berlandieri	2	2
Marsh Elder	Iva xanthofolia	2	2
Russian Thistle	Salsola iberica	3	3
Clary Sage	Salvia Pratensis	?	?
Salt Cedar	Tamarix ramosissima	2	2
Himalayan Blackberry	Rubus concolor	3	2
Russian Olive	Elaeagnus angustifloia	?	?

Strategies for preventing the establishment of new invasive species and reducing the rate of spread or eliminating established invaders were developed by the Imnaha subbasin technical team (objective 17A of the management plan). The introduction and spread of invasive species is tied to other activities in the subbasin including road construction and use, livestock grazing, fire, timber harvest and other soil disturbing activities. Strategies developed by the technical team to address these issues and included in the *Imnaha Subbasin Management Plan* will also help to reduce the impact of introduced plant species on the subbasin.

Loss of Marine-Derived Nutrients

The concept of Key Ecological Functions (KEFs) refers to the main ecological roles of a species or group of species that influence diversity, productivity or sustainability of ecosystems (see section 1.4.3 for details). Salmonids provide a variety of KEFs in the subbasin and across the Columbia Basin and form an important link between marine, freshwater aquatic and terrestrial environments. Anadromous salmon help to maintain ecosystem productivity and may be regarded as a keystone species. Salmon runs input organic matter and nutrients to the trophic system through multiple levels and pathways including direct consumption, excretion, decomposition, and primary production. Direct consumption occurs in the form of predation, parasitism, or scavenging of the live spawner, carcass, egg, or fry life stages. Carcass decomposition and the particulate and dissolved organic matter released by spawning fish deliver nutrients to primary producers (Cederholm et al. 2000). Relationships between wildlife species and salmon vary in terms of their strength; the categories that have been developed to characterize these relationships and are briefly described below see (Cederholm et al. 2000 and Johnson and O’Neil 2001 for more details):

- Strong-consistent relationship-Salmon play or historically played an important role in this species distribution viability, abundance and or population/status. The ecology of this wildlife species is supported by salmon, especially at particular lifestages or during specific seasons.
- Recurrent relationship- The relationship between salmon and this species is characterized as routine, albeit occasional, and often in localized areas (thus affecting only a small portion of this species population).
- Indirect relationship- Salmon play an important routine, but indirect link to this species. The relationship could be viewed as one of a secondary consumer of salmon; for example salmon support other wildlife that are prey of this species.
- Rare relationship- Salmon play a very minor role in the diet of these species often amounting to less than 1 percent of the diet.

Salmon fishes (including their eggs) are a major source of high-energy food that allows for successful reproduction and enhanced survival of many wildlife species. Sixty-seven birds, twenty-three mammals, three reptiles and one amphibian species thought to inhabit the Blue Mountain Province consume salmon during one or more of salmon's lifestages (IBIS 2003). Twenty-five of the ninety-four total species in the province with a relationship to salmon are concern or focal species, these species and their relationship to salmon are displayed in Table 88; species with more than one type of relationship consume salmon during multiple salmon lifestages. The reductions in the salmon runs of the subbasin described in section 1.2.3-1.2.5, have reduced nutrient inputs into the ecosystem and probably the suitability of the subbasin for many of the wildlife species that consume salmon. Strategies for restoring salmon runs and salmon habitat in the subbasin were developed by the aquatic subcommittee in objectives 1A-12A in the *Imnaha Subbasin Management Plan*. Strategies for reducing the impact of nutrient losses to the subbasin were developed by the terrestrial subcommittee in objective 20A in the management.

1.6 References

- Altman, B. 1997. Olive-sided Flycatcher in western North America: Status review. Prepared for U.S. Fish and Wildlife Service, Oregon State Office, Portland. 59 pp.
- Altman, B. and A. Holmes. 2000. Conservation strategy for landbirds in the Columbia Plateau of eastern Oregon and Washington. Final Report Version 1.0. Oregon-Washington Partners in Flight, Boring, Oregon, USA.
- Altman, B. and R. Sallabanks. 2000. Olive-sided Flycatcher. The Birds of North America. Vol. 13, No. 502: American Ornithologists' Union. The Academy of Natural Sciences of Philadelphia.
- American Ornithologists' Union (AOU), Committee on Classification and Nomenclature. 1983. Check-list of North American Birds. Sixth Edition. American Ornithologists' Union, Allen Press, Inc., Lawrence, Kansas.
- American Ornithologists' Union (AOU), Committee on Classification and Nomenclature. 1983. Check-list of North American Birds. Sixth Edition. American Ornithologists' Union, Allen Press, Inc., Lawrence, Kansas.
- AmphibiaWeb: Information on amphibian biology and conservation. [web application]. 2004. Berkeley, California: AmphibiaWeb. Available: <http://amphibiaweb.org/>. (Accessed: 2004).
- Anthony, R. G., and F. B. Isaacs. 1989. Characteristics of Bald Eagle nest sites in Oregon. Journal of Wildlife Management 53: 148-159.
- Anthony, R. G., R. L. Knight, G. T. Allen, B. R. McClelland, and J. I. Hodges. 1982. Habitat use by nesting and roosting bald eagles in the Pacific Northwest. Trans. N. Am. Wildlife Nat. Res. Conference 47: 332-342.
- Arnold, T. W., and K. F. Higgins. 1986. Effects of shrub coverages on birds of North Dakota mixed-grass prairies. Canadian Field-Naturalist 100:10-14.
- Arnsberg, B.D., W.P. Connor, E. Connor, M.J. Pishl, and M.A. Whitman. 1992. Mainstem Clearwater River study: assessment for salmonid spawning, incubation, and rearing. Final Report. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Project No. 88-15.
- Ashe, B. L., A. C. Miller, P. A. Kucera, and M. L. Blenden. 1995. Spring outmigration of wild and hatchery chinook salmon and steelhead smolts from the Imnaha River, March 1 - June 15, 1994. FPC Technical Report. NPT DFRM Lapwai, Idaho
- Ashe, B.; Concannon, K.; Johnson, D. B.; Zollman, R. L.; Bryson, D. and Alley, G. (2000). *Northeast Oregon Hatchery Project (NEOH) Spring Chinook Master Plan*. Nez Perce Tribe.

Ashley, P. and Stoval S. 2004. Southeast Washington Ecoregional Assessment. Prepared for the Northwest Power and Conservation Council.

Bartlett, G. (1992). From the Wallowas. Pika Press: Eugene, OR.

Basore, N. S., L. B. Best, and J. B. Wooley. 1986. Bird nesting in Iowa no-tillage and tilled cropland. *Journal of Wildlife Management* **50**:19-28.

Beamesderfer, R. C., and B. E. Rieman. 1991. Abundance and Distribution of Northern Squawfish, Walleyes, and Smallmouth Bass in John Day Reservoir, Columbia River. *Transactions of the American Fisheries Society* **120**:439–447.

Beamesderfer, R.C.P., H.A. Schaller, M.P. Zimmerman, C.E. Petrosky, O.P. Lngness and L. LaVoy. (1996). *Spawner-Recruit Data for Spring and Summer Chinook Salmon Populations in Idaho, Oregon, and Washington*. Chapter in D.R. Marmorek, editor. Plan for Analyzing and testing hypotheses (PATH) final report for fiscal year 1998. ESSA Technologies Ltd., Vancouver, B.C.

Bent, A. C. 1968. Life histories of north American cardinals, grosbeaks, buntings, towhees, finches, sparrows and allies. Dover Publications, Inc., New York, New York.

Berryman, A. A., X. Chen, and J. Firehammer. Snake River Steelhead: An endangered fishery threatened by dynamic instability?

Best, L. B., H. Campa, III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, Jr., and S. R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: a regional approach. *Wildlife Society Bulletin* **25**:864-877.

Bjornn, T. C. and Reiser, D. W. (1991). Habitat Requirements of Salmonids in Streams. In: Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. M. R. Meehan, Ed. Bethesda, MD: American Fisheries Society Special Publications, pp. 83-138

Beneski, J. T. Jr., Zalisko, E. J., and J. H. Larsen 1986. Demography and migratory patterns of the eastern long-toed salamander *Ambystoma macrodactylum columbianum*. *Copeia*, 1986, 398-408.

Blankenship, H. Lee and Glen W. Mendel. 1997. Upstream Passage, spawning, and stock identification of fall chinook in the Snake River, 1992 and 1993. Washington Department of Fish and Wildlife. Final Report to BPA. Project Number 92-046. Contract Number DE-B179-92BP60415.

Blankespoor, G. W. 1980. Prairie restoration: effects on nongame birds. *Journal of Wildlife Management* **44**:667-672.

Blaustein, A. R., Kiesecker, J. M., Chivers, D. P., and Anthony, R. G. 1997. Ambient UV-B radiation causes deformities in amphibian embryos. *Proceedings of the National Academy of Sciences of the United States of America*, 94(25), 13735-13737.

Blenden, M.L., R.S. Osborne, and P.A. Kucura. 1996. Spring outmigration of wild and hatchery chinook salmon and steelhead trout smolts from the Imnaha River, Oregon, February 6 - June 20, 1995. Bonneville Power Administration Technical Report. Contract DE- FC79-88BP38906. Project 87-127. NPT DFRM. Lapwai, ID.

Blenden, M.L., S.J. Rocklage, and P.A. Kucura. 1997. Spring outmigration of wild and hatchery chinook salmon and steelhead trout smolts from the Imnaha River, Oregon, February 23 - June 24, 1996. Bonneville Power Adiminstation Technical Report. Contract DE-FC79-88FC38906. Project 87-127. NPT DFRM. Lapwai, ID.

Blenden, M.L., P.A. Kucera, and E.R. Veach. 1998. Spring emigration of natural and hatchery chinook salmon and steelhead smolts from the Imnaha River, Oregon, February 25 - June 27, 1997. Bonneville Power Administration Technical Report. Contract DE-FC79-88BP38906. Project 87-127. NPT DFRM. Lapwai, ID.

Blenden, M.L. and P.A. Kucera. 2002. Salmonid densities in selected streams in the Clearwater River, Grande Ronde River, and Salmon River subbasins: 1992 to 2000. Bliss, T. M. (2001). Water rights for the portion of McCully Creek diverted into the Wallowa subbasin. January draft. Wallowa-Whitman National Forest

Blood D.A. 1997. White-headed Woodpecker. Wildlife at Risk in British Columbia, Brochure. Province of British Columbia, Ministry of Environment, Lands and Parks.

Bryce, S. A. and A. J. Woods (2000). Level III and IV Ecoregion Descriptions for Oregon - Metadata. Draft 8, 11/29/00.

Buchanan, D. V.; Hanson, M. L. and Hooton, R. M. (1997). Status of Oregon's Bull Trout: Distribution, Life History, Limiting Factors, Management Considerations, and Status. Portland: Oregon Department of Fish and Wildlife

Budy, P., Thiede, G.P., Bouwes, N., Petrosky, C.E., Schaller, H. (2001). Evidence Linking Delayed Mortality of Snake River Salmon to Their Ealier Hydroystem Experience. North American Journal of Fisheries Management. Vol. 22, No. 1, pp. 35-51.

Bull, E. L., and R. G. Anderson. 1978. Notes on flammulated owls in northeastern Oregon. Murrelet 59:26-28

Bull, E. L., A. L. Wright, and M. G. Henjum. 1990. Nesting habitat of flammulated owls in Oregon. J. Raptor Res. 24:52-55.

Bureau of Land Management (BLM). 1993. Biological Evaluation, ESA Section 7 Consultation of Lands Within the Imnaha Hydrologic Unit. Baker Resource Area, Vale District, Oregon.

Bureau of Land Management (BLM). 2000. Snake River Subbasin: Biological Assessment of Ongoing and Proposed Bureau of Land Management Activities on Sockeye Salmon, Fall Chinook Salmon, Spring/Summer Chinook Salmon, Steelhead Trout, Bull Trout, and BLM Sensitive Species. U.S. Department of the Interior, BLM, Cottonwood, ID.

Bureau of Land Management (BLM). 2002. Lower Snake River Ecosystem Analysis at the Watershed Scale. U.S. Department of the Interior, BLM, Cottonwood Field Office, Cottonwood, ID.

Burner, 1951. Characteristics of spawning nests of Columbia River salmon. USDI Fish and Wildlife Service. Fisheries Bulletin 61 Volume 52. Washington, D.C.

Busby, P. J.; Wainwright, T. C.; Bryant, G. J.; Lierheimer, L. J.; Waples, R. S.; Waknitz, F. W. and Lagomarsino, I. V. (1996). *Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California*. Seattle: National Marine Fisheries Service.

Cannings, R. J.. 1995. Status of the White-headed Woodpecker in British Columbia. Wildlife Branch, Ministry of Environment, Lands and Parks, Victoria, BC. Wildlife Bulletin No. B-80. 8pp.

Carmichael, R.W., and R.T. Boyce. 1986. U.S. v. Oregon. Imnaha spring chinook production report. Oregon Department of Fish and Wildlife.

Carmichael, R.W., B.A. Miller and R.T. Messmer (1989). Summer steelhead creel surveys in the Grande Ronde, Wallowa and Imnaha Rivers for the 1987-88 run year. Oregon Department of Fish and Wildlife, Fish Research Project AFFI-LSR-89-02, 1989 Annual Progress Report, Portland.

Carmichael, R.W., B.A. Miller and R.T. Messmer (1991). Summer steelhead creel surveys in the Grande Ronde, Wallowa and Imnaha Rivers for the 1989-90 run year. Oregon Department of Fish and Wildlife, Fish Research Project AFFI-LSR-89-02, 1991 Annual Progress Report, Portland.

Carmichael, R. W., T. A. Whitesel, and B. C. Jonasson. 1995. Evaluation of the success of supplementing Imnaha River steelhead with hatchery reared smolts: Phase one. Bonneville Power Administration, Portland, OR.

Carmichael, R.W., S.J. Parker, and T.A. Whitsel. 1998. Status review of the Chinook salmon hatchery program in the Imnaha River basin, Oregon. In Lower Snake River Compensation Plan Status Review Symposium, February 1998. USFWS LSRCP, Boise, Idaho.

Carrey, J., Conley, C., and A. Barton. 1979. *Snake River in Hells Canyon*. Backeddy Books, Cambridge, Idaho.

Cassirer, E. F. 1995. Wildlife Inventory, Craig Mountain Mitigation Area, Idaho. Idaho Department of Fish and Game, Nongame and Endangered Wildlife Program, Lewiston.

Cederholm, C. J., D. H. Johnson, R. E. Bilby, L. G. Dominguez, A. M. Garrett, W. H. Graeber, E. L. Greda, M. D. Kunze, B. G. Marcot, J. F. Palmisano. 2000. Pacific Salmon and Wildlife-Ecological Contexts, Relationships, and Implications for Management. Washington Department of Fish and Wildlife, Olympia.

- Chalfant, S.A. 1974. *Aboriginal territory of the Nez Perce Indians*. In: Nez Perce Indians, 25-246. New York: Garland Publishing, Inc.
- Chamberlin, T. W.; Harr, R. D. and Everest, F. H. (1991). Timber Harvesting, Silviculture, and Watershed Processes. In: Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W. R. Meehan, Ed. Bethesda, MD: U. S. Forest Service, pp. 181-205.
- Chapman, W. M. (1940). Report of a Field Trip to the Snake River Drainage in Idaho and Eastern Oregon, 1940. Childs, A. B. (1997). Wildlife Mitigation Plan for the John Day and McNary Dams, Columbia River Basin. Confederated Tribes of the Umatilla Indian Reservation. Prepared for the Bonneville Power Administration.
- Chapman, D. W., and Witty, K.L. (1993). Habitats of weak salmon stocks of the Snake River Basin and feasible recovery measures. U. S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. 136 pp.
- Cheskey, T. 1987. Olive-sided flycatcher. Pages 250-251 in M. D. Cadman, P. F. J. Eagles, and F. M. Helleiner, editors. *Atlas of the breeding birds of Ontario*. Fed. Ontario Nat., University of Waterloo Press, Waterloo, Ontario.
- Chilcote, M., C. Dale, K. Kostow, H. Schaller, and H. Weeks. 1992. Wild fish management policy. Oregon Dep. Fish Wildlife, Biennial Progress Report, 31 p. (Available Oregon Department of Fish and Wildlife, P.O. Box 59, Portland, OR 97201.)
- Cleary, P.J., M.L. Blendon, and P.A. Kucera. 2000. Emigration of natural and hatchery chinook and steelhead smolts from the Imnaha River, Oregon, October 14, 1997 to June 16, 1998. Bonneville Power Administration Technical Report. Contract #97AM30423.
- Cleary, P.J., M.L. Blendon, and P.A. Kucera. 2002. Emigration of natural and hatchery chinook and steelhead smolts from the Imnaha River, Oregon, October 19, 1998 to June 24, 1999. Bonneville Power Administration Technical Report. Contract #97AM30423.
- Cleary, P.J., M.L Blendon, and K. Gillogly. 2003. Emigration of natural and hatchery chinook and steelhead smolts from the Imnaha River, Oregon, October 20, 1999 to June 15, 2000. Bonneville Power Administration Technical Report. Contract #97AM30423.
- Cleary, P.J., P.A. Kucera, M.L. Blendon, N. Espinosa and C. M. Albee. 2003. Emigration of natural and hatchery chinook salmon and steelhead smolts from the Imnaha River, Oregon, October 17, 2000 to June 12, 2002. Bonneville Power Administration Technical Report. Contract 00003087 and 00004004.
- Cleary, P.J., M.L. Blendon, and P.A. Kucera. In prep. Emigration of natural and hatchery chinook and steelhead smolts from the Imnaha River, Oregon, October 1, 2002 to June 25, 2003. Bonneville Power Administration Technical Report. Contract #97AM30423.
- Close, D.A. 2000. Pacific Lamprey Research and Restoration Project. Annual Report 1998. DOE-BPA Project No 94-026 Contract No 00000248.

Collins, K., R. E. Beaty, and B. R. Crain. 1995. Changes in Catch Rate and Diet of Northern Squawfish Associated with the Release of Hatchery-Reared Juvenile Salmonids in a Columbia Reservoir. North American Journal of Fisheries Management **15**:346–357.

Columbia Basin Fish and Wildlife Authority. (1991). *Integrated System Plan for Salmon and Steelhead Production in the Columbia River Basin*. Funded by the Northwest Power Planning Council.

Columbia Basin Fish and Wildlife Authority (CBFWA) (1999). FY 2000 Draft Annual Implementation Work Plan. Submitted to the Northwest Power Planning Council.
<http://www.cbfwf.org/products.htm>

Connor, W. P., H. L. Burge, R. Waitt, and T. C. Bjornn. 2002. Juvenile Life History of Wild Fall Chinook Salmon in the Snake and Clearwater Rivers. North American Journal of Fisheries Management **22**:703–712.

Cone, J. and Ridlington, S. (1999). The Northwest Salmon Crisis; A Documentary History. Oregon State University Press, Corvallis, OR

Connor, W. P., H.L. Burge, and W.H. Miller (1993). Rearing and emigration of naturally produced Snake River fall chinook salmon juveniles. U. S. Fish and Wildlife Service.

Crawford, J. and M. Pope 1999. Game Bird Research Program Oregon State University Mountain Quail Research: Annual Report 1999 Oregon State University Corvallis, OR.

Csuti, B., J. A. Kimerling, T. A. O’Neil, M. M. Shaughnessy, E. P. Gaines, and M. M. P. Huso. 1997. *Atlas of Oregon Wildlife: Distribution, Habitat, and Natural History*. Oregon State University Press, Corvallis, OR.

Csuti, B., T. A. O’Neil, M. M. Shaughnessy, E. P. G. and, and J. C. Hak. 2001. *Atlas of Oregon Wildlife: Distribution, Habitat, and Natural History*, 2nd edition. Oregon State University Press, Corvallis, OR.

Curet, T. 1994. Habitat use, food habits, and the influence of predation on subyearling chinook salmon in Lower Granite and Little Goose reservoirs. Master’s thesis. University of Idaho, Moscow.

DeHart, M., T. Berggren, H. Franzoni, L. Basham, P. Wilson, H. Schaller, C. Petrosky, E. Weber, R. Boyce and N. Bouwes. 2003. Comparative Survival Study (CSS) of PIT Tagged Spring/Summer Chinook - 2002 Annual Report, Migration Years 1997 – 2000, Mark/Recapture Activities and Bootstrap Analysis. Prepared by the Fish Passage Center and Comparative Survival Study Oversight Committee for the Bonneville Power Administration.

DeWeese, L. R., L. C. McEwen, G. L. Hensler, and B. E. Petersen. 1986. Organochlorine contaminants in Passeriformes and other avian prey of the Peregrine Falcon in the Western United States. Environmental Toxicology and Chemistry **5**:675-693.

Digital Atlas of Idaho (DAI) 2004. Idaho's Natural History Online-Biology
<http://imnh.isu.edu/digitalatlas/index.htm> Accessed April 2004.

Dixon, R.D. 1995. Ecology of White-headed Woodpeckers in the Central Oregon Cascades. Masters Thesis, Univ. of Idaho, Moscow, ID. In Garrett, K. L., M.G. Raphael and R.D. Dixon. 1996. White-headed Woodpecker (*Picoides albolarvatus*). In The Birds of North America No. 252 (A. Poole and F. Gill, eds.) The Birds of North America Inc., Philadelphia, PA.

Ducey, J., and L. Miller. 1980. Birds of an agricultural community. Nebraska Bird Review **48**:58-68.

Duncan, D. and Cawthon, G. (1994). *Draft Grande Ronde Model Watershed Program Operations- Action Plan*. La Grande, OR

Edelmann, F., and J. Copeland. 1999 Wolverine Survey in the Seven Devils Mountains of Hells Canyon. Technical Report E. 3.2-29. Idaho Power Company.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The Birder's Handbook. Simon and Schuster, New York. 785pp.

Faanes, C. A., and G. R. Lingle. 1995. Breeding birds of the Platte River Valley of Nebraska. Jamestown, ND: Northern Prairie Wildlife Research Center home page.
<http://www.npwrc.usgs.gov/resource/distr/birds/platte.htm> (Version 16JUL97).

Flesher, M. W.; Buckman, M. A.; Carmichael, R. W.; Messmer, R. T. and Whitesel, T. A. (1993). *Summer Steelhead Creel Surveys on the Grande Ronde, Wallowa, and Imnaha Rivers for the 1992-93 Run Year*. Portland: Oregon Department of Fish and Wildlife.

Flesher, M. W., et al. (1994). Summer Steelhead Creel Surveys on the Grande Ronde, Wallowa, and Imnaha Rivers for the 1993-94 Run Year. Portland: Oregon Department of Fish and Wildlife.

Flesher, M. W. et al. (1995). Summer Steelhead Creel Surveys on the Grande Ronde, Wallowa, and Imnaha Rivers for the 1994-95 Run Year. Portland: Oregon Department of Fish and Wildlife.

Flesher, M. W. et al. (1996). Summer Steelhead Creel Surveys on the Grande Ronde, Wallowa, and Imnaha Rivers for the 1995-96 Run Year. Portland: Oregon Department of Fish and Wildlife.

Flesher, M. W. et al. (1997). Summer Steelhead Creel Surveys on the Grande Ronde, Wallowa, and Imnaha Rivers for the 1996-97 Run Year. Portland: Oregon Department of Fish and Wildlife.

Flesher, M. W. et al. (1999). Summer Steelhead Creel Surveys on the Grande Ronde, Wallowa, and Imnaha Rivers for the 1997-98 Run Year. Portland: Oregon Department of Fish and Wildlife.

- Frenzel, R. W. 1985. Environmental contaminants and ecology of Bald Eagles in southcentral Oregon. Ph.D. dissertation, Oregon State University, Corvallis.
- Funk, W. C., and W. W. Dunlap. 1999. Colonization of high-elevation lakes by long-toed salamanders (*AMBYSTOMA MACRODACTYLUM*) after the extinction of introduced trout populations. Canadian Journal of Zoology 77:1759-1767.
- Gabrielson, I. N., and S. G. Jewett. 1940. Birds of Oregon. Oregon State College, Corvallis. (Reprinted in 1970 as Birds of the Pacific Northwest by Dover Publishing, New York).
- Garcia, A. P. (2000). Spawning Distribution of Fall Chinook Salmon in the Snake River. U. S. Fish and Wildlife Service.
- Gaumer, T. F. (1968). *Behavior of Juvenile Anadromous Salmonids in the Imnaha River, September 1964 – June 1967*. Fish Commission of Oregon; Nez Perce Tribe.
- Goggans, R. 1986. Habitat use by flammulated owls in northeastern Oregon. Thesis, Oregon State University, Corvallis, Oregon, USA.
- Groves, P. A. 2001. The Timing and Distribution of Fall Chinook Salmon Spawning Downstream of the Hells Canyon Complex. Chapter 1 in P. Groves, editor. Evaluation of Anadromous Fish Potential within the Mainstem Snake River, Downstream of the Hells Canyon Complex of Reservoirs. Technical Report E.3.1-3. Idaho Power Company
- Groves, P. A., and J. A. Chandler. 1999. Spawning Habitat Used by Fall Chinook Salmon in the Snake River. North American Journal of Fisheries Management 19:912–922
- Groves, P. A. and J. A. Chandler. 2001. Physical Habitat and Water Quality Criteria for Chinook Salmon Associated with the Hells Canyon Complex. Chapter 2 in P. Groves, editor. Evaluation of Anadromous Fish Potential within the Mainstem Snake River, Downstream of the Hells Canyon Complex of Reservoirs. Technical Report E.3.1-3. Idaho Power Company
- Haines, F. (1955). The Nez Perce Tribesmen of the Columbia Plateau. University of Oklahoma Press: Norman.
- Hare, S. R., N. J. Mantua, and R. C. Francis. 1999. Inverse Production Regimes: Alaska and West Coast Pacific Salmon. Fisheries 24:6–14.
- Harrison, C. 1978. A Field Guide to the Nests, Eggs and Nestlings of North American Birds. Collins, Cleveland, Ohio.
- Harrison, H. H. 1979. A field guide to western birds' nests. Houghton Mifflin Company, Boston. 279 pp.
- Hayward, G.D. and P.H. Hayward. 1993. The Boreal Owl. In The Birds of North America, No. 63 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC. The American Ornithologist's Union.

- Heekin, P.E.; Reese, K.P.; and Zager, P. 1993. Movements, habitat use, and population characteristics of Mountain quail in west-central Idaho. Annual Report. University of Idaho. Moscow, ID.
- Henny, C. J., and M. W. Nelson. 1981. Decline and present status of Peregrine Falcons in Oregon. *Murrelet* 62: 43-53.
- Herkert, J. R. 1994a. The effects of habitat fragmentation on midwestern grassland bird communities. *J. Ecol. Appl.* 4:461-471.
- Herkert, J. R. 1994b. Breeding bird communities of midwestern prairie fragments: the effects of prescribed burning and habitat-area. *Nat. Areas J.* 14:128-135.
- Hesse, J.A., N. Espinosa, M. Blendon, and R. Sharma. In prep. Tributary-specific adult steelhead abundance: Imnaha River Subbasin, Oregon 2000 - 2003. Nez Perce Tribe Department of Fisheries Resources Management. Lower Snake River Compensation Plan Technical Report 2004-?. Lapwai, Idaho.
- Hill, R. A. 1976. Host-parasite relationships of the Brown-headed Cowbird in a prairie habitat of west-central Kansas. *Wilson Bull.* 88:555-565.
- Hillis, M., V. Wright, and A. Jacobs. 2001. U.S. Forest Service region one flammulated owl assessment.
- Holmes, A.L. and G.R. Geupel. 1998. Avian population studies at Naval Weapons System Training Facility Boardman, Oregon. Unpubl. rept. submitted to the Dept. of Navy and Oreg. Dept. Fish and Wildl. Point Reyes Bird Observatory, Stinson Beach, CA.
- Howle, R. R., and R. Ritcey. 1987. Distribution, habitat selection, and densities of flammulated owls in British Columbia. Pages 249-254 in R. W. Nero, R. J. Clark, R. J. Knapton, and R. H. Hamre, editors. *Biology and conservation of northern forest owls*. USDA Forest Service General Technical Report RM-142.
- Hunter, M. 2003. Oregon's Important Bird Areas-Wallowa Mountains. Available <http://www.oregoniba.org/wallowamtns.htm>
- Huntington, C. W. 1994. *Stream and Riparian Conditions in the Grande Ronde Basin, 1993*. Canby, OR: Clearwater BioStudies, Inc.
- Hyun, S., and Talbot, A. 2004. Status of Snake River spring/summer chinook salmon and steelhead by an integrated risk metric. Columbia River Inter-Tribal Fish Commision report for Bonneville Power Administration. 41 pp.
- IBIS. 2003. Interactive Biodiversity Information System. <<http://ibis.nwhi.org>>. Northwest Habitat Institute, Corvallis, OR.
- Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife, U.S. Forest Service, Bureau of Land

- Management, and Foundation of North American Wild Sheep. 1997. Restoration of the Bighorn Sheep to Hells Canyon—The Hells Canyon Initiative. Technical Bulletin No. 97-14.
- Idaho Department of Fish and Game. (1998). Idaho's Anadromous Fish Stocks: Their Status and Recovery Options. Report to the Director. May 1, 1998. Idaho Department of Fish and Game. IDFG 98-13.
- Interior Columbia Basin Ecosystem Management Project (ICBEMP). 1997. Response on Centers of Endemism, Rarity, and Biodiversity and Hotspots by the Terrestrial Ecology Assessment Staff. Available at <http://www.icbemp.gov/spatial/metadata/aux_pdf/hotspots.pdf>.
- Interior Columbia Basin Ecosystem Management Project (ICBEMP). 1997b. *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins: Vol. II.* Portland: U. S. Department of Agriculture, Forest Service.
- Interior Columbia Basin Ecosystem Management Project (ICBEMP). 2002. Spatial Data. Available at www.ICBEMP.gov
- Isaacs, F. B., and R. G. Anthony. 1983. Ecology of wintering bald eagles in the Harney Basin, Oregon, 1982-1983. Report for U.S. Dept. of Interior, Bureau of Land Management, Burns, OR. Unpublished Manuscript 21 pp.
- Isaacs, F. B., and R. G. Anthony. 2001. Bald Eagle nest locations and history of use in Oregon and the Washington portion of the Columbia River Recovery Zone, 1972 through 2001. Unpublished report, Oregon Cooperative Fish and Wildlife Resources Unit, Oregon State University, Corvallis.
- Isaacs, F. B., and R. G. Anthony. 2003. Bald Eagle. Pp. 140-144 in Birds of Oregon: A General Reference. D.B. Marshall, M.G. Hunter, and A.L. Contreras, Eds. Oregon State University Press, Corvallis, OR.
- Jenkins, J. M., and R. E. Jackman. 1993. Mate and nest site fidelity in a resident population of Bald Eagles. Condor 95: 1053-1056.
- Johnson, C. G. 1994. *Forest Health in the Blue Mountains: A Plant Ecologist's Perspective on Ecosystem Processes and Biological Diversity.* Portland: U. S. Department of Agriculture
- Johnson C. J. 1998. Vegetation response after wildfires in national forests of northeastern Oregon. USDA Forest Service, Pacific Northwest Region, R6-NR-ECOL-TP-06-98, 128 pp. plus appendices.
- Johnson, R. G., and S. A. Temple. 1990. Nest predation and brood parasitism of tallgrass prairie birds. Journal of Wildlife Management 54:106-111
- Johnson, D. H., and T. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis.

Joy. J., R. Driessche and S. McConnell. 1995. 1995 White-headed Woodpecker Population and Habitat Inventory in the South Okanagan. Report For the BC Ministry of Environment, Lands and Parks. 21pp.

Kagan, J. (2001) Ecoregion description memorandum. Oregon Natural Heritage Program. Cited in Watershed Professionals Network, 2001.

Kaspari, M. and H. O'Leary. 1988. Nonparental attendants in a north-temperate migrant. *Auk* **105**:792-793.

Kilpatrick M. 2001 A Pathfinder to Information on The Endangered Species Act of 1973.
<http://www.llrx.com/features/esa.htm> Accessed: September 2003

Kjelstrom, L.C. and R.L. Moffatt (1981). *A Method of Estimating Flood-Frequency Parameters for Streams in Idaho*. Boise: U.S. Geological Survey. Prepared in cooperation with the U.S. Army Corps of Engineers, U.S. Water and Power Resources Service, U.S. Bureau of Land Management, and Idaho Transportation Department.

Kjelstrom, L. C. (1998). *Methods for Estimating Selected Flow-Duration and Flood-Frequency Characteristics at Ungaged Sites in Central Idaho*. Boise: U. S. Geological Survey. Prepared in cooperation with U. S. Bureau of Indian Affairs.

Knapton, R. W. 1979. Birds of the Gainsborough-Lyleton region. Saskatchewan Natural History Society Special Publication 10. 72 p.

Koehler, G. M. & Hornocker, M. G. 1977. Fire effects on marten habitat in the Selway-Bitterroot Wilderness. *J. Wildl. Manage.* **41**:500-505.Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife, Portland

Kostow, K. 2002. Oregon Lampreys: Natural History Status and Problem Analysis. Oregon Department of Fish and Wildlife, Portland.

Kucera, P. 1989. Nez Perce Tribal Review of the Imnaha River Lower Snake River Compensation Plan. Working paper. LSRCP Technical Report AFF1/LSR-89-08. Nez Perce Tribe Fisheries Management, Lapwai, Idaho.

Llewellyn, R.L. and C.R. Peterson 1998. Distribution, Relative Abundance and Habitat Associations of Amphibians and Reptiles on Craig Mountain, Idaho Technical Bulletin No. 98-15 Idaho Bureau of Land Management.

Marmorek, D. R., and C. N. Peters, editors, and 26 coauthors. (1998). Plan for Analyzing and Testing Hypothesis (PATH): Preliminary Decision Analysis Report on Snake River Spring/Summer Chinook. Draft Report. Compiled and edited by ESSA Technologies Ltd., Vancouver, B.C.

Marcot B. G., and R. Hill. 1980. Flammulated owls in northwestern California. *Western Birds* **11**:141-149.

- Marshall, J. T., Jr. 1957. Birds of Pine-Oak Woodland in Southern Arizona and Adjacent Mexico. *Pac. Coast Avifauna*, No. 32. 125pp.
- Marshall, J. T. 1988. Birds lost from a giant sequoia forest during fifty years. *Condor* 90(2):359-372.
- Marshall, D. B., M. W. Chilcote, and H. Weeks. 1996. Species at risk: sensitive, threatened and endangered vertebrates of Oregon, 2nd ed. Oregon Department of Fish and Wildlife, Portland, OR.
- Mason, D.; Taylor, L.; Kriesel, M.; Wenderoth, J. and Sadowski, J. (1993). Biological Evaluation Section 7 Consultation for Bureau of Land Management Lands in Imnaha Hydrologic Unit. Bureau of Land Management
- Martin, A. C., H. S. Zim, and A. L. Nelson. 1951. American wildlife and plants, a guide to wildlife food habits. Dover, NY.
- Mays, D. 1992. Imnaha River Stream Survey Report. Wallowa Mountains Zone, Wallowa-Whitman National Forest, Oregon.
- McCallum, D.A 1994. Review of Technical Knowledge: Flammulated Owls. Pages 14-46 In G.D. Hayward and J. Verner, ed. Flammulated, Boreal and Great Gray Owls in the United States: a Technical Conservation Assessment. For. Ser. Gen. Tech. Rep. GTR-RM-253, Fort Collins, CO.
- McIntosh, B. A.; Sedell, J. R.; Smith, J. E.; Wissmar, R. C.; Clarke, S. E.; Reeves, G. H. and Brown, L. A. (1994). "Historical Changes in Fish Habitat for Select River Basins of Eastern Oregon and Washington." *Northwest Science* 68(Special Issue): 36-53.
- McKelvey, K. S., K. B. Aubry, and Y. K. Ortega. 2000. History and Distribution of Lynx in the Contiguous United States. Chapter 8 in L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, et al., technical editors. *Ecology and Conservation of Lynx in the United States*. University Press of Colorado, Boulder. 480pp.
- McPhail, J. D., and C. B. Murray. 1979. The early life-history and ecology of Dolly Varden (*Salvelinus malma*) in the Upper Arrow Lakes. University of British Columbia, Department of Zoology and Institute of Animal Resources, Vancouver.
- Mundy, P. R. and Witty, K. (1998). *Imnaha Fisheries Management Plan: Documentation for Managing Production and Broodstock of Salmon and Steelhead*. Fisheries and Aquatic Sciences; S. P. Cramer and Associates.
- Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle Washington. NOAA Technical Memorandum NMFS-NWFSC-35.

National Marine Fisheries Service. (1995). Endangered Species Act Section 7 Consultation. Biological Opinion. Reinitiation of Consultation on 1994-1998 operation of the federal Columbia River power system and juvenile transportation program in 1995 and future years. March 2, 1995. National Marine Fisheries Service. Northwest Region.

National Marine Fisheries Service. (1997). In Digital Studios. Salmon Conflict. Position Statements. Response of National Marine Fisheries Service, (R. Jones) to questionnaire for Internet project. CyberLearning Collection. <http://www.cyberlearn.com>. Ron. S. Nolan, Aptos, CA Posted March 22, 1997.

National Marine Fisheries Service (NMFS). 1999. Endangered and threatened species; threatened status for three chinook salmon evolutionarily significant units (ESUs) in Washington and Oregon, and endangered status for one chinook salmon ESU in Washington. Fed. Reg. 64: 14308-14328.

National Marine Fisheries Service (NMFS). 2000a. Biological Opinion on Impacts of Treaty Indian and Non-Indian Year 2000 Winter, Spring, and Summer Fisheries in the Columbia River Basin, on Salmon and Steelhead Listed Under the Endangered Species Act.

National Marine Fisheries Service (NMFS). 2000b. White Paper: Predation on Salmonids Relative to the Federal Columbia River Power System. Seattle, WA. 68pp.

National Marine Fisheries Service (2001). "Endangered Species Act – Section 7 Consultation & Magnuson – Stevens Act Essential Fish Habitat Consultation. Biological Opinion – Little Sheep Creek Bridges, Wallowa County, Oregon". Consultation conducted for the Federal Highway Administration.

National Marine Fisheries Service (NMFS). 2002. Memorandum from Bob Lohn to Frank Cassidy regarding establishment of interim abundance and productivity targets for ESA listed salmon and steelhead in the Interior Columbia Basin. Available online via: <http://www.nwr.noaa.gov/occd/InterimTargets.pdf>

National Research Council (NRC). 1995. Upstream: Salmon and Society in the Pacific Northwest. Prepublication Copy. NRC, National Academy of Sciences. Washington, DC.

Natural Resources Conservation Service (NRCS) 2001. State Soil Geographic (STATSGO) Data Base for the Conterminous United States. <http://soils.usda.gov/>

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>.

Neeley, D., K. Witty, and S. P. Cramer. 1993. Genetic risk assessment of the Imnaha master plan. Prepared for the Nez Perce Tribe. S.P. Cramer and Associates, Gresham, Oregon.

Nelle, R. D. 1999. Smallmouth bass predation on juvenile fall chinook salmon in the Hells Canyon Reach of the Snake River, Idaho. Master's Thesis. University of Idaho, Moscow.

Nelson, W.G., G. Horak, and S. Wilsey. 1978. Instream Flow Strategies for Oregon. U.S. Dept. of the Interior—Fish and Wild Service, Report FWS/OBS-78/43. Washington D.C.

Nez Perce Tribe; Confederated Tribes of the Umatilla Indian Reservation and Oregon Department of Fish and Wildlife (1990). *Imnaha River Subbasin Salmon and Steelhead Production Plan*.

Nez Perce Tribe 2003. Nez Perce History- Frequently asked questions. Available at: <http://www.nezperce.org/History/FrequentlyAskedQ.htm>

Northwest Habitat Institute (NHI). 2003. Website. <<http://www.nwhi.org>>. Northwest Habitat Institute, Corvallis, OR.

Northwest Power and Conservation Council (NPPC). 1990. Presence/absence database from Northwest Power Planning Council's subbasin planning process unpublished, (StreamNet Library).

Northwest Power Planning Council. (1992). Columbia basin fish and wildlife program – strategy for salmon, volumes 1 and 2. Northwest Power Planning Council, Portland, OR

Northwest Power and Conservation Council (NPPC). 2001. Technical Guide for Subbasin Planners. Council Document 2001-20.

Noss, R.F., and A. Cooperrider. 1994. Saving nature's legacy: protecting and restoring biodiversity. Island Press, Washington, D.C.

Nowak, R. M. 1991. Walker's Mammals of the World, vol. 2. Fifth edition. The Johns Hopkins University Press, Baltimore and London.

Nowak, C. 2001. Draft Subbasin Summary for the Grande Ronde River. Prepared for Northwest Power Planning Council.

Nussbaum, R. A., E. D. Brodie, Jr., and R. M. Storm. 1983. Amphibians and Reptiles of the Pacific Northwest. University Press of Idaho. 332 pp.

Oregon Department of Environmental Quality (ODEQ) 2003. Oregon's 2002 303d listed streams-GIS layer

Oregon Department of Fish and Wildlife (ODFW). 2001a. Streamflow Restoration Priorities. Available via; <http://www.dfw.state.or.us/hcd/FlowRestore/index.html>

Oregon Department of Fish and Wildlife (ODFW). 2001b. Oregon Big Game Statistics –Mule Deer Available at: <http://www.dfw.state.or.us>

Oregon Department of Fish and Wildlife (ODFW). 2003a. Endangered Species Fact Sheet—Canada Lynx. <<http://oregonfwo.fws.gov/EndSpp/FactSheets/Mammals/Lynx.dwt>>. Accessed August 2003.

Oregon Department of Fish and Wildlife (ODFW). 2003b. Oregon Department of Fish and Wildlife Sensitive Species. <<http://www.dfw.state.or.us/>> Accessed September 2003.

Oregon Department of Fish and Wildlife (ODFW). 2003c. Oregon's Bighorn Sheep & Rocky Mountain Goat Management Plan. June 10, 2003 Draft

Oregon Department of Fish and Wildlife (ODFW). 2003d. Oregon's Elk Management Plan. Available at: <http://www.dfw.state.or.us> Accessed Oct 2003

Oregon Department of Fish and Wildlife (ODFW). 2003e. Oregon's Deer Management Plan. Available at: <http://www.dfw.state.or.us> Accessed Oct 2003

Oregon Department of Fish and Wildlife (ODFW). 2003f. 2003 Game Bird Seasons Available at: <http://www.dfw.state.or.us> Accessed Oct 2003

Oregon Geospatial Data Clearinghouse (OGDC) 2000 Spatial Data Library
<http://www.gis.state.or.us/data/> Accessed Oct 2003

Oregon Natural Heritage Program (ONHP). 2002. Element Occurrence Records, GIS Database
<http://oregonstate.edu/ornhic/data-request.html>

Oregon Natural Heritage Program (ONHP). 2003. Current vegetation and trees size data, GIS Database <http://oregonstate.edu/ornhic/data-request.html>

Orr, E.L., W.N. Orr. (1996). Geology of Central Idaho. Geology of the Pacific Northwest: 194-217.

Pater et al. (1997) Ecoregions for Western Washington and Oregon. Map product from a USEPA Regional Applied Research Effort.

Parker, T. 1985. Bighorn sheep management plan 1986–1990. Idaho Department of Fish and Game, Boise.

Paul, K. 2004. Bald Eagle. Wildlife species summary prepared for the Northwest Power and Conservation Council. Available at <http://www.nwppc.org/>

Petersen, J. H. 1994. The Importance of Spatial Pattern in Estimating Predation on Juvenile Salmonids in the Columbia River. Transactions of the American Fisheries Society **123**:924–930.

Peterson, J. M. C., and C. Fichtel. 1992. Olive-sided flycatcher, CONTOPUS BOREALIS. Pages 353-367 in K. J. Schneider and D. M. Pence, editors. Migratory nongame birds of management concern in the Northeast. U.S. Fish and Wildlife Service, Newton Corner, Massachusetts. 400 pp.

- Petraska, J. W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C.
- Petrosky, C. E., H. A. Schaller, and P. Budy. 2001. Productivity and Survival Rate Trends in the Freshwater Spawning and Rearing Stage of Snake River Chinook Salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 58:1196–1207.
- Powers, L. R., A. Dale, P. A. Gaede, C. Rodes, L. Nelson, J. J. Dean, and J. D. May. 1996. Nesting and food habits of the flammulated owl (Otus flammeolus) in southcentral Idaho. Journal of Raptor Research 30:15-20.
- Pratt, K. L. 1992. A review of bull trout life history. Pages 5-9 in P. J. Howell and D. V. Buchannan, editors. Proceedings of the Gearhart Mountain Bull trout workshop. Oregon Chapter of American Fisheries Society, Corvallis.
- Ratliff, D. E., and P. J. Howell. 1992. Pages 10-17 in P. J. Howell and D. V. Buchannan, editors. Proceedings of the Gearhart Mountain Bull trout workshop. Oregon Chapter of American Fisheries Society, Corvallis.
- Regional Ecosystem Office 2003. Geospatial Center-Forest Service GIS Data available at www.REO.gov
- Reid E. H., C.G. Johnson, and W. B Hall. 1991. Green fescue grassland: 50 years of secondary succession under sheep grazing. USDA Forest Service R6-F16-SO-0591, 37 pp.
- Reynolds, R. T., and B. D. Linkart. 1987. The Nesting Biology of Flammulated Owls in Colorado. Pages 239-248. In R. W. Nero, R. J. Clark, R. J. Knapton, and R. H. Hamre, eds. Symp. On the Biology and Conservation of Northern Forest Owls. U.S. Dep. Ag., For. Serv., Rocky Mtn For. and Range Exp. Stn., Gen. Tech. Rep. RM-142. 248pp.
- Reynolds, R. T., R. A. Ryder, and B. D. Linkart. 1989. Small Forest Owls. Pages 131-143. In National Wildlife Federation. Proc. Western Raptor Management Symposium and Workshop. Natl. Widl. Fed. Tech. Ser. No. 12. 317pp.
- Rieman, B. E. and McIntryre, J. D. (1993). *Demographic and Habitat Requirements for Conservation of Bull Trout*. Ogden, UT: U. S. Forest Service, Intermountain Research Station.
- Rocklage, A. M., and F. B. Edelmann. 2001. A landscape-level habitat assessment for mountain quail in Hells Canyon. Technical Report E.3.2-6 in License application for the Hells Canyon Complex. Idaho Power Company, Boise, ID, USA.
- Rondorf, W. and W. H. Miller (1993). Identification of the spawning, rearing and migratory requirements of fall chinook salmon in the Columbia River Basin. 1991 Annual Report, prepared for the U. S. Department of Energy, Bonneville Power Administration. Portland, OR 97208-3621.

Rondorf, W. and W. H. Miller (1994). Identification of the spawning, rearing and migratory requirements of fall chinook salmon in the Columbia River Basin. 1992 Annual Report, prepared for the U. S. Department of Energy, Bonneville Power Administration. Portland, OR 97208-3621.

Rondorf, W. and W. H. Miller (1995). Identification of the spawning, rearing and migratory requirements of fall chinook salmon in the Columbia River Basin. 1993 Annual Report, prepared for the U. S. Department of Energy, Bonneville Power Administration. Portland, OR 97208-3621.

Rose, R. K.; Sausen, G. and Martin, K. (1992). *Imnaha River Drainage: Assessment of Ongoing Management Activities*. Wallowa-Whitman National Forest.

Ruediger, Bill, Jim Claar, Steve Gniadek, Bryon Holt, Lyle Lewis, Steve Mighton, Bob Naney, Gary Patton, Tony Rinaldi, Joel Trick, Anne Vandehey, Fred Wahl, Nancy Warren, Dick Wenger, and Al Williamson. 2000. Canada lynx conservation assessment and strategy. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Missoula, MT.

Sauer, J. R., J. E. Hines, and J. Fallon. 2001. The North American Breeding Bird Survey, Results and Analysis 1966 - 2000. Version 2001.2, USGS Patuxent Wildlife Research Center, Laurel, MD. Available at: <http://www.mbr.nbs.gov/bbs/bbs.html>.

Sauer, J. R., J. E. Hines, and J. Fallon. 2003. The North American Breeding Bird Survey, Results and Analysis 1966 - 2002. Version 2003.1, USGS Patuxent Wildlife Research Center, Laurel, MD.

Schaller, H. A., C. E. Petrosky, and O. P. Langness. 1999. Contrasting Patterns of Productivity and Survival Rates for Stream-Type Chinook Salmon (*Oncorhynchus tshawytscha*) Populations of the Snake and Columbia Rivers. Canadian Journal of Fisheries and Aquatic Sciences **56**:1031–1045.

Schwartzberg, M, P.A. Kucera, and M.L. Blenden. 2001 in prep. Migration of juvenile chinook salmon and steelhead in the Imnaha River, Oregon, March 1992 through June 1994. Nez Perce Tribe Department of Fisheries Resources Management. Lapwai, Idaho.

Servheen, C. W. 1975. Ecology of the wintering bald eagles on the Skagit River, Washington. M.S. Thesis. University of Washington, Seattle. 96 pp.

Sessions, S. K., and S. B. Ruth 1990. "Explanation for naturally occurring supernumerary limbs in amphibians." *Journal of Experimental Zoology*, 254(1990), 38-47.

Shively, R. S., T. P. Poe, M. B. Sheer, and R. Peters. 1996. Criteria for Reducing Predation by Northern Squawfish near Juvenile Salmonid Bypass Outfalls at Columbia River Dams. Regulated Rivers: Research and Management **12**:493–500.

- Skolvin, J. M., and J. W. Thomas (1995). Interpreting long-term trends in Blue Mountain ecosystems from repeat photography. Gen. Tech. Rep. PNW-GTR-315. Portland, OR; U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
- Slough, B. G. 1989. Movements and habitat use by transplanted marten in the Yukon Territory. *J. Wildl. Mgmt.* 53:991-997.
- Smith, R. L. 1963. Some ecological notes on the Grasshopper Sparrow. *Wilson Bulletin* 75:159-165.
- Smith, R.L. 1968. Grasshopper sparrow. Pp. 725-745 in *Life Histories Of North American Cardinals, Grosbeaks, Buntings, Towhees, Sparrows, And Allies*, Comp. A.C. Bent et al., Ed. O.L. Austin, Jr. U.S. Natl. Mus. Bull. No. 237, Pt. 2. Washington, D.C.
- Spruell, P. and F. W. Allendorf. (1997). Nuclear DNA analysis of Oregon bull trout. Final Report to Oregon Department of Fish and Wildlife. Division of Biological Sciences, University of Montana, Missoula.
- Spruell, P., A.R. Hemmingsen, P.J. Howell, N. Kanda & F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. *Conservation Genetics*, 4: 17–29
- Stalmaster, M. V. 1976. Winter ecology and effects of human activity on bald eagles in the Nooksack River Valley, Washington. M.S. Thesis. West Washington State College, Bellingham, WA. 100 pp.
- Stalmaster, M. V. 1987. *The Bald Eagle*. Universe Books, New York.
- Stalmaster, M. V. and J. R. Newman. 1978. Behavioral responses of wintering bald eagles to human activity. *Journal of Wildlife Management* 43:506-513.
- Stebbins, R.C. 1951. *Amphibians of Western North America*. University of California Press, Berkeley.
- Stiles, F. G., and A. F. Skutch. 1989. A guide to the birds of Costa Rica. New York: Cornell University Press.
- StreamNet. 2003. StreamNet On-Line: The Northwest Aquatic Information Network. <http://www.streamnet.org>.
- Strickland, M. A., C. W. Douglas, M. Novak, and N. P. Hunzinger. 1982. Marten. Pages 599-612 in Chapman, J. A., and G. A. Feldhamer, eds. *Wild mammals of North America: Biology, management, and economics*. Johns Hopkins University Press. Baltimore, MD.
- Stiles, F. G., and A. F. Skutch. 1989. *A Guide to the Birds of Costa Rica*. Comstock Publ. Associates, Cornell University Press, Ithaca, New York. 511 pp.

Taylor, G. H., and C. Southards (1997). Long Term Climate Trends and Salmon Populations. Accessed January 15, 2002 <http://www.ocs.orst.edu/reports/climate_fish.html>

Technical Recovery Team. (TRT) 2003. Independent Populations of Chinook, Steelhead, and Sockeye for Listed Evolutionarily Significant Units Within the Interior Columbia River Domain. Discussion Draft

Terres, J. K. 1980. The Audubon Society encyclopedia of North American birds. Alfred A. Knopf, New York.

The Nature Conservancy (TNC). 2002. Oregon, places we protect, Zumwalt prairie. Available at: <http://nature.org/wherewework/northamerica/states/oregon/preserves/art6813.html>

The Nature Conservancy (TNC). 2003a. Current ownership GIS layer supplied in support of subbasin planning.

The Nature Conservancy (TNC). 2003b. The Middle Rockies-Blue Mountain Ecoregional Plan.

Thompson, R. N. and Haas, J. B. (1960). Environmental Survey Report Pertaining to Salmon and Steelhead in Certain Rivers of Eastern Oregon and the Willamette River and its Tributaries. Clackamas: Fish Commission of Oregon, Research Division.

Tiffan, K. F., D. W. Rondorf, W. P. Connor, H. L. Burge. 1999. Post-release attributes and survival of hatchery and natural fall chinook salmon in the Snake River. Annual Report 1998. Prepared for Bonneville Power Adminstration, Portland, OR. <<http://www.efw.bpa.gov/cgi-bin/efw/FW/publications.cgi>>. Downloaded May 2001.

Turley, N. J., and A. M. Holthuijzen. 2002. A Description of State and Federal Species of SpecialConcern in Hells Canyon Idaho Power Company Technical Report Appendix E.3.2-38

U. S. Army Corps of Engineers (1975). Special Report, Lower Snake River fish and wildlife compensation plan. Lower Snake River, Washington and Idaho, June, 1975. US Army Engineering District, Walla Walla, Washington. 46pp.

U. S. Army Corps of Engineers (1990). Annual Fish Passage Report. Portland and Walla Walla Districts, Portland.

U. S. Federal Register (2000). Designated Critical Habitat: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho and California. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U. S. Department of Commerce. (Accessed online data 4/6/01 via <http://www.nwr.noaa.gov/1salmon/salmesa/fedreg.htm>

U. S. Fish and Wildlife Service (USFWS). 1986. Recovery Plan for the Pacific Bald Eagle. USFWS, Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS) 2000. Revised recovery Plan for MacFarLane's Four-O'Clock (*Mirabilis macfarlanei*) Region 1 U.S. Fish and Wildlife Service Portland Oregon.

U.S. Fish and Wildlife Service (USFWS) 2002a. Canidate and Listing Priority Assignment Form- *Coccyzus americanus* Yellow-billed cuckoo.

U.S. Fish and Wildlife Service (USFWS) 2002b. Chapter 12, Imnaha-Snake Rivers Recovery Unit, Oregon. 86 p. In: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 2003a. Hells Canyon National Recreation Area Comprehensive Management Plan Multi-Species Biological Assessment, Snake River, Wallowa County, Oregon—Biological Opinion (1-17-03-F-0435).

U.S. Fish and Wildlife Service (USFWS) 2003b. National Wetlands Inventory
<http://www.nwi.fws.gov/> Accessed: November 2003

U. S. Fish and Wildlife Service (USFWS). 2003c. Oregon Fish and Wildlife Office website, Bald Eagle fact sheet: <http://oregonfwo.fws.gov/EndSpp/FactSheets/Birds/BaldEagle.dwt>.

U.S. Fish and Wildlife Service (USFWS) 2003d. Endangered and Threatened Wildlife and Plants: 90-day Finding for a Petition To List the Mountain Quail as Threatened or Endangered. Federal Register **68** (14):3000-3005

U.S. Fish and Wildlife Service (USFWS) 2004. History and Evolution of the Endangered Species Act of 1973 and Its Relationship to CITES. <http://endangered.fws.gov/esasum.html>
<http://endangered.fws.gov/esasum.html>

U. S. Forest Service (USFS). 1993. Imnaha River Wild and Scenic River Management Plan. Wallowa-Whitman National Forest.

U. S. Forest Service (USFS). 1994a. *Sheep Creek Section 7 Watershed: Assessment of Ongoing and Proposed Activities*. Wallowa-Whitman National Forest.

U. S. Forest Service (USFS). 1994b. Neotropical Migratory Bird Reference Book. Neotropical Migratory Bird Reference Book. USDA Depart. Ag. For. Serv. Pacific Southwest Region, San Francisco, CA.

U. S. Forest Service (USFS). 1995. Big Sheep Creek Watershed Analysis. Wallowa-Whitman National Forest

U. S. Forest Service (USFS). 1998a. Steelhead Consultation for Big Sheep Creek Section 7 Watershed: Assessment of Ongoing and Proposed Activities. Wallowa-Whitman National Forest.

U. S. Forest Service (USFS). 1998b. Steelhead Consultation for Imnaha River Section 7 Watershed: Assessment of Ongoing and Proposed Activities. Wallowa-Whitman National Forest.

- U. S. Forest Service (USFS). 1998c. Bull Trout Consultation for Imnaha River Section 7 Watershed (includes Big Sheep Creek and Imnaha River Watersheds): Assessment of Ongoing and Proposed Activities. Wallowa-Whitman National Forest.
- U. S. Forest Service (USFS) 1998d. Upper Imnaha River and Lower Imnaha River Watershed Analysis. Wallowa-Whitman National Forest, Hells Canyon National Recreation Area, Eagle Cap Ranger District, Wallowa Valley Ranger District.
- U. S. Forest Service (USFS). 2000. Bull Trout Consultation for Imnaha River Section 7 Watershed (Includes Big Sheep Creek and Imnaha River Watersheds): Assessment of Ongoing and Proposed Activities. Wallowa-Whitman National Forest.
- U. S. Forest Service (2001). *Imnaha Subbasin Multi-Species Biological Assessment (2000-2001: Assessment of ongoing and proposed activities)*. Wallowa-Whitman National Forest. Eagle Cap Ranger District, Hells Canyon Ranger District, Wallowa Valley Ranger District, Pine Ranger District.
- U.S. Forest Service (USFS). 2003a. Hells Canyon National Recreation Area Comprehensive Management Plan Final Environmental Impact Statement, Volume 1. U.S. Department of Agriculture, USFS, Pacific Northwest Region.
- U.S. Forest Service (USFS). 2003b. Hells Canyon National Recreation Area Comprehensive Management Plan, Biological Assessment. U.S. Department of Agriculture, USFS, Pacific Northwest Region.
- U.S. Forest Service (USFS). 2003c. Hells Canyon National Recreation Area Comprehensive Management Plan, Biological Evaluation. U.S. Department of Agriculture, USFS, Pacific Northwest Region.
- U.S. Forest Service (USFS). 2003d. Imnaha Subbasin Multi-Species Biological Assessment (2003-2005). Wallowa-Whitman National Forest.
- U. S. Geological Survey (USGS). 2002. Digital Elevation Model Available at
<http://or.waterdata.usgs.gov/nwis/sw>
- U. S. Geological Survey (USGS). 2002b. Historical Streamflow Data. Accessed January 5, 2002.
<http://or.waterdata.usgs.gov/nwis/sw>
- Valdez, R., and P. R. Krausman. 1999. Description, distribution, and abundance of mountain sheep in North America. Pages 3-22. In. (R. Valdez and P. R. Krausman, eds.) Mountain sheep of North America. University of Arizona Press, Tucson.
- Vallier, T.L. (1973) (Unpublished map)
- Vallier Tracy L. and Howard C. Brooks 1987. Geology of the Blue Mountains regions of Oregon, Washington and Idaho: The Idaho Batholith and its border zone. U.S.G.S., Professional Paper 1436, 196pp.

- Vander Haegen, W. M., F. C. Dobler, and D. J. Pierce. 2000. Shrubsteppe bird response to habitat and landscape variables in eastern Washington, USA. *Conservation Biology* 14:1145-1160.
- Vaughnan, M. R. 1975. Aspects of mountain goat ecology, Wallowa Mountains, Oregon. M.S. thesis, Oregon State University, Corvallis, 113 pp.
- Verts, B.J. and L.N. Carraway. 1998. Land Mammals of Oregon. University of California Press.
- Vickery, P. D., M. L. Hunter, Jr., and J.V. Wells. 1992. Use of a new reproductive index to evaluate relationship between habitat quality and breeding success. *Auk* 109:697-705.
- Vickery, P. D., M. L. Hunter, Jr., and S. M. Melvin. 1994. Effect of habitat area on the distribution of grassland birds in Maine. *Cons. Biol.* 8:1087-1097.
- Vickery, P. D. 1996. Grasshopper Sparrow (*Ammodramus savannarum*). In *The Birds of North America*, No. 239 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.
- Wallowa County and Nez Perce Tribe (1993; revised in 1999). *Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy*. Nez Perce Tribe, Lapwai, Idaho.
- Wallowa County Chamber of Commerce (2001). "County Businesses" Wallowa County
- Waples, R.S., O.W. Johnson, P.B. Aebersold, C.K. Shiflett, D.M. VanDoornik, D.J. Teel, and A.E. Cook. 1993. A genetic monitoring and evaluation program for supplemented populations of salmon and steelhead in the Snake River basin, Bonneville Power Administration: 159.
- Watershed Professionals Network (WPN). 1999. Oregon Watershed Assessment Manual. Salem, OR: Governor's Watershed Enhancement Board.
- Watershed Professionals Network, L.L.C. (WPN). 2001. Hydrologic Process Identification for Eastern Oregon. Prepared for Oregon Watershed Enhancement Board.
- Watson, J. W., M. G. Garrett, and R. G. Anthony. 1991. Foraging ecology of Bald Eagles in the Columbia River estuary. *Journal of Wildlife Management* 55: 492-499.
- Weis, Paul L., J. L. Gualtieri, and William F. Cannon (1976). U.S. Geological Survey; Ernest T. Tuchek, Arel B. McMahan and Francis E. Federspiel, U.S. Bureau of Mines., Mineral Resources of the Eagle Cap Wilderness and Adjacent Areas, Oregon., Geological Survey Bulletin 1385-E; 100pp.
- Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. *Ornithological Monographs* 8:1-93.
- Williams et al. (1998). Response to the questions of the Implementation Team regarding juvenile salmon transportation in the 1998 season. ISAB Report 98-2. February 27, 1998.

Independent Scientific Advisory Board. Northwest Power Planning Council and National Marine Fisheries Service, Portland, OR

- Wisdom, M. J., R. S. Holthausen, D. C. Lee, B. C. Wales, W. J. Murphy, M. R. Eames, C. D. Hargis, V. A. Saab, T. D. Rich, F. B. Samson, D. A. Newhouse, and N. Warren. 2000. Source Habitats for Terrestrial Vertebrates of Focus in the Interior Columbia Basin: Broad Scale Trends and Management Implications. U.S. Department Agriculture, Forest Service, Pacific Northwest Research Station General Technical Report PNW-GTR-485 Portland, OR.
- Wray, T., II, K. A. Strait, and R. C. Whitmore. 1982. Reproductive success of grassland birds on a reclaimed surface mine in West Virginia. *Auk* **99**:157-164.
- Zeiner, D. C., W. Laudenslayer Jr., K. Mayer, and M. White., eds. 1990. California's Wildlife, Vol. 2, Birds. Calif. Dep. Fish and Game, Sacramento. 732pp.

2 Appendices

Appendix A Wildlife Species and Habitat Use, Immaha Subbasin.

Appendix A Table 1. Wildlife species with potential habitat within the Immaha subbasin and the wildlife habitat types (WHTs) with which they are closely associated (Johnson and O'Neil 2001, IBIS 2003).

Common Name	Species Name	WHT with which Species Is Closely Associated ¹											
		4	5	7	10	15	16	19	21	22	24		
Long-toed salamander	<i>Ambystoma macrodactylum</i>								x	x	x		
Inland tailed frog	<i>Ascaphus montanus</i>	x											
Western toad	<i>Bufo boreas</i>								x	x	x		
Pacific chorus (tree) frog	<i>Pseudacris regilla</i>								x	x	x		
Bullfrog	<i>Rana catesbeiana</i>								x	x	x		
Columbia spotted frog	<i>Rana luteiventris</i>								x	x	x		
Northern leopard frog	<i>Rana pipiens</i>								x	x	x		
Great Basin spadefoot	<i>Scaphiopus intermontanus</i>								x	x	x		
8	Total Amphibians	(number of amphibians closely associated with WHT)											
Cooper's hawk	<i>Accipiter cooperii</i>								7	7	3		
Northern goshawk	<i>Accipiter gentilis</i>		x	x									
Sharp-shinned hawk	<i>Accipiter striatus</i>												
Spotted sandpiper	<i>Actitis macularia</i>												
Western grebe	<i>Aechmophorus occidentalis</i>								x	x			
Northern saw-whet owl	<i>Aegolius acadicus</i>		x	x									
Boreal owl	<i>Aegolius funereus</i>												
White-throated swift	<i>Aeronautes saxatalis</i>												
Red-winged blackbird	<i>Agelaius phoeniceus</i>								x				
Wood duck	<i>Aix sponsa</i>									x			
Chukar	<i>Alectoris chukar</i>								x	x			
Grasshopper sparrow	<i>Ammodramus savannarum</i>								x	x			
Sage sparrow	<i>Amphispiza belli</i>								x	x			
Northern pintail	<i>Anas acuta</i>								x	x			

Common Name	Species Name	WHT with which Species Is Closely Associated ¹									
		4	5	7	10	15	16	19	21	22	24
American wigeon	<i>Anas americana</i>						x		x	x	x
Northern shoveler	<i>Anas clypeata</i>						x	x	x	x	x
Green-winged teal	<i>Anas crecca</i>								x		x
Cinnamon teal	<i>Anas cyanoptera</i>					x		x	x		x
Blue-winged teal	<i>Anas discors</i>					x		x	x		x
Eurasian wigeon	<i>Anas penelope</i>					x		x			
Mallard	<i>Anas platyrhynchos</i>					x		x			x
Gadwall	<i>Anas strepera</i>					x		x	x		x
Greater white-fronted goose	<i>Anser albifrons</i>					x		x	x		x
American pipit	<i>Anthus rubescens</i>				x		x				
Western scrub-jay	<i>Aphelocoma californica</i>										
Golden eagle	<i>Aquila chrysaetos</i>										
Black-chinned hummingbird	<i>Archilochus alexandri</i>										
Great egret	<i>Ardea alba</i>								x	x	
Great blue heron	<i>Ardea herodias</i>					x		x	x		x
Short-eared owl	<i>Asio flammeus</i>					x		x	x		x
Long-eared owl	<i>Asio otus</i>					x		x	x		x
Burrowing owl	<i>Athene cunicularia</i>					x		x			
Lesser scaup	<i>Aythya affinis</i>							x	x		x
Redhead	<i>Aythya americana</i>							x	x		x
Ring-necked duck	<i>Aythya collaris</i>										
Greater scaup	<i>Aythya marila</i>							x			x
Canvasback	<i>Aythya valisineria</i>							x	x		x
Upland sandpiper	<i>Bartramia longicauda</i>					x					
Cedar waxwing	<i>Bombycilla cedrorum</i>										
Bohemian waxwing	<i>Bombycilla garrulus</i>										
Ruffed grouse	<i>Bonasa umbellus</i>										
American bittern	<i>Botaurus lentiginosus</i>							x			x

Common Name	Species Name	WHT with which Species Is Closely Associated ¹											
		4	5	7	10	15	16	19	21	22	24		
Canada goose	<i>Branta canadensis</i>							x	x	x	x		
Great horned owl	<i>Bubo virginianus</i>												
Bufflehead	<i>Bucephala albeola</i>	x						x	x	x			
Common goldeneye	<i>Bucephala clangula</i>							x					
Barrow's goldeneye	<i>Bucephala islandica</i>	x						x					
Red-tailed hawk	<i>Buteo jamaicensis</i>					x	x						
Rough-legged hawk	<i>Buteo lagopus</i>												
Ferruginous hawk	<i>Buteo regalis</i>				x	x							
Swainson's hawk	<i>Buteo swainsoni</i>				x	x	x						
Green heron	<i>Butorides virescens</i>							x					
Sanderling	<i>Calidris alba</i>											x	
Dunlin	<i>Calidris alpina</i>							x	x	x			
Baird's sandpiper	<i>Calidris bairdii</i>										x		
Stilt sandpiper	<i>Calidris himantopus</i>							x					
Western sandpiper	<i>Calidris mauri</i>							x	x				
Pectoral sandpiper	<i>Calidris melanotos</i>									x			
Least sandpiper	<i>Calidris minutilla</i>									x			
Semipalmated sandpiper	<i>Calidris pusilla</i>									x			
California quail	<i>Callipepla californica</i>												
Common redpoll	<i>Carduelis flammea</i>												
Pine siskin	<i>Carduelis pinus</i>												
Lesser goldfinch	<i>Carduelis psaltria</i>												
American goldfinch	<i>Carduelis tristis</i>												
Cassin's finch	<i>Carpodacus cassinii</i>												
House finch	<i>Carpodacus mexicanus</i>									x			
Purple finch	<i>Carpodacus purpureus</i>												
Turkey vulture	<i>Cathartes aura</i>												
Hermit thrush	<i>Catharus guttatus</i>												

Common Name	Species Name	WHT with which Species Is Closely Associated ¹									
		4	5	7	10	15	16	19	21	22	24
Swainson's thrush	<i>Catharus ustulatus</i>										
Canyon wren	<i>Catherpes mexicanus</i>										
Willet	<i>Catoptrophorus semipalmatus</i>					x	x			x	
Greater sage-grouse	<i>Centrocercus urophasianus</i>				x	x					
Brown creeper	<i>Certhia americana</i>			x							
Belted kingfisher	<i>Ceryle alcyon</i>					x					
Vaux's swift	<i>Chaetura vauxi</i>			x							
Semipalmated plover	<i>Charadrius semipalmatus</i>					x					
Killdeer	<i>Charadrius vociferus</i>					x					
Snow goose	<i>Chen Caerulescens</i>					x	x	x			
Ross's goose	<i>Chen rossii</i>					x	x	x			
Black tern	<i>Chlidonias niger</i>							x			
Lark sparrow	<i>Chondestes grammacus</i>					x					
Common nighthawk	<i>Chordeiles minor</i>										
American dipper	<i>Cinclus mexicanus</i>					x					
Northern harrier	<i>Circus cyaneus</i>							x			
Marsh wren	<i>Cistothorus palustris</i>							x			
Evening grosbeak	<i>Coccothraustes vespertinus</i>	x							x		
Northern flicker	<i>Colaptes auratus</i>										
Northern bobwhite	<i>Colinus virginianus</i>					x	x				
Band-tailed pigeon	<i>Patagioenas fasciata</i>										
Rock pigeon	<i>Columba livia</i>							x			
Olive-sided flycatcher	<i>Contopus cooperi</i>	x	x								
Western wood-peewee	<i>Contopus sordidulus</i>										
American crow	<i>Corvus brachyrhynchos</i>							x			
Common raven	<i>Corvus corax</i>										
Steller's jay	<i>Cyanocitta stelleri</i>										
Trumpeter swan	<i>Cygnus buccinator</i>					x	x	x			

Common Name	Species Name	WHT with which Species Is Closely Associated ¹									
		4	5	7	10	15	16	19	21	22	24
Tundra swan	<i>Cygnus columbianus</i>							x	x	x	x
Black swift	<i>Cypseloides niger</i>										
Blue grouse	<i>Dendragapus obscurus</i>		x	x							
Yellow-rumped warbler	<i>Dendroica coronata</i>										
Townsend's warbler	<i>Dendroica townsendi</i>										
Bobolink	<i>Dolichonyx oryzivorus</i>						x				
Pileated woodpecker	<i>Dryocopus pileatus</i>										
Gray catbird	<i>Dumetella carolinensis</i>										
Hammond's flycatcher	<i>Empidonax hammondi</i>										
Least flycatcher	<i>Empidonax minimus</i>										
Dusky flycatcher	<i>Empidonax oberholseri</i>										
Cordilleran flycatcher	<i>Empidonax occidentalis</i>										
Willow flycatcher	<i>Empidonax traillii</i>							x			
Gray flycatcher	<i>Empidonax wrightii</i>										
Horned lark	<i>Eremophila alpestris</i>		x								
Brewer's blackbird	<i>Euphagus cyanocephalus</i>							x			
Spruce grouse	<i>Falcipennis canadensis</i>										
Merlin	<i>Falco columbarius</i>										
Prairie falcon	<i>Falco mexicanus</i>		x	x							
Peregrine falcon	<i>Falco peregrinus</i>										
Gyrfalcon	<i>Falco rusticolus</i>										
American kestrel	<i>Falco sparverius</i>								x	x	
American coot	<i>Fulica americana</i>								x	x	
Common snipe	<i>Gallinago gallinago</i>							x	x	x	
Common loon	<i>Gavia immer</i>								x		
Common yellowthroat	<i>Geothlypis trichas</i>								x		
Northern pygmy-owl	<i>Glaucidium gnoma</i>	x									
Sandhill crane	<i>Grus canadensis</i>						x	x	x	x	

Common Name	Species Name	WHT with which Species Is Closely Associated ¹									
		4	5	7	10	15	16	19	21	22	24
Pinyon jay	<i>Gymnorhinus cyanocephalus</i>										
Bald eagle	<i>Haliaeetus leucocephalus</i>							x			
Black-necked stilt	<i>Himantopus mexicanus</i>							x	x		
Barn swallow	<i>Hirundo rustica</i>							x	x		
Harlequin duck	<i>Histrionicus histrionicus</i>							x			
Yellow-breasted chat	<i>Icteria virens</i>										
Bullock's oriole	<i>Icterus bullockii</i>										
Varied thrush	<i>Ixoreus naevius</i>	x	x								
Dark-eyed junco	<i>Junco hyemalis</i>										
Northern shrike	<i>Lanius excubitor</i>						x	x	x		
Loggerhead shrike	<i>Lanius ludovicianus</i>						x	x	x		
Herring gull	<i>Larus argentatus</i>						x	x	x		x
California gull	<i>Larus californicus</i>									x	
Ring-billed gull	<i>Larus delawarensis</i>								x		
Bonaparte's gull	<i>Larus philadelphicus</i>										
Franklin's gull	<i>Larus pipixcan</i>								x		
Black rosy-finches	<i>Leucosticte atrata</i>					x					
Gray-crowned rosy-finches	<i>Leucosticte tephrocotis</i>				x						
Short-billed dowitcher	<i>Limnodromus griseus</i>								x	x	
Long-billed dowitcher	<i>Limnodromus scolopaceus</i>								x		
Marbled godwit	<i>Limosa fedoa</i>								x		
Hooded merganser	<i>Lophodytes cucullatus</i>								x		
Red crossbill	<i>Loxia curvirostra</i>										
White-winged crossbill	<i>Loxia leucoptera</i>	x									
Lewis's woodpecker	<i>Melanerpes lewis</i>										
Surf scoter	<i>Melanitta perspicillata</i>										
Wild turkey	<i>Meleagris gallopavo</i>										
Swamp sparrow	<i>Melospiza georgiana</i>								x		

Common Name	Species Name	WHT with which Species Is Closely Associated ¹											
		4	5	7	10	15	16	19	21	22	24		
Lincoln's sparrow	<i>Melospiza lincolni</i>											x	
Song sparrow	<i>Melospiza melodia</i>												
Common merganser	<i>Mergus merganser</i>								x				
Northern mockingbird	<i>Mimus polyglottos</i>												
Brown-headed cowbird	<i>Molothrus ater</i>								x				
Townsend's solitaire	<i>Myadestes townsendi</i>												
Ash-throated flycatcher	<i>Myiarchus cinerascens</i>												
Clark's nutcracker	<i>Nucifraga columbiana</i>												
Long-billed curlew	<i>Numenius americanus</i>					x	x	x					
Snowy owl	<i>Nyctea scandiaca</i>												
Black-crowned night-heron	<i>Nycticorax nycticorax</i>					x	x	x					
MacGillivray's warbler	<i>Oporornis tolmiei</i>												
Mountain quail	<i>Oreortyx pictus</i>							x					
Sage thrasher	<i>Oreoscoptes montanus</i>												
Flammulated owl	<i>Onus flammatus</i>	x	x										
Western screech-owl	<i>Otus kennicottii</i>								x	x	x		
Ruddy duck	<i>Oxyura jamaicensis</i>												
Osprey	<i>Pandion haliaetus</i>								x				
House sparrow	<i>Passer domesticus</i>									x			
Savannah sparrow	<i>Passerculus sandwichensis</i>						x	x					
Fox sparrow	<i>Passerella iliaca</i>	x	x	x									
Lazuli bunting	<i>Passerina amoena</i>							x					
American white pelican	<i>Pelecanus erythrorhynchos</i>								x				
Gray partridge	<i>Perdix perdix</i>								x				
Gray jay	<i>Perisoreus canadensis</i>	x											
Cliff swallow	<i>Petrochelidon pyrrhonota</i>								x				
Double-crested cormorant	<i>Phalacrocorax auritus</i>								x				
Common poorwill	<i>Phalaenoptilus nuttallii</i>												

Common Name	Species Name	WHT with which Species Is Closely Associated ¹									
		4	5	7	10	15	16	19	21	22	24
Wilson's phalarope	<i>Phalaropus tricolor</i>								x	x	
Ring-necked pheasant	<i>Phasianus colchicus</i>							x			
Black-headed grosbeak	<i>Pheucticus melanocephalus</i>										
Black-billed magpie	<i>Pica pica</i>						x				
White-headed woodpecker	<i>Picoides albolarvatus</i>					x					
Black-backed woodpecker	<i>Picoides arcticus</i>										
Downy woodpecker	<i>Picoides pubescens</i>										
Three-toed woodpecker	<i>Picoides tridactylus</i>										
Hairy woodpecker	<i>Picoides villosus</i>										
Pine grosbeak	<i>Pinicola enucleator</i>		x								
Green-tailed towhee	<i>Pipilo chlorurus</i>	x	x								
Spotted towhee	<i>Pipilo maculatus</i>										
Western tanager	<i>Piranga ludoviciana</i>	x	x	x							
Snow bunting	<i>Plectrophenax nivalis</i>										
Black-bellied plover	<i>Phalaropus squatarola</i>							x	x		
Horned grebe	<i>Podiceps auritus</i>							x	x		
Red-necked grebe	<i>Podiceps grisegena</i>							x	x		
Eared grebe	<i>Podiceps nigricollis</i>							x	x		
Pied-billed grebe	<i>Podilymbus podiceps</i>							x	x		
Black-capped chickadee	<i>Poecile atricapillus</i>										
Mountain chickadee	<i>Poecile gambeli</i>										
Chestnut-backed chickadee	<i>Poecile rufescens</i>										
Vesper sparrow	<i>Pooecetes gramineus</i>					x	x	x			
Sora	<i>Porzana carolina</i>								x		
Bush tit	<i>Psaltriparus minimus</i>										
Virginia rail	<i>Rallus limicola</i>								x		
American avocet	<i>Recurvirostra americana</i>							x	x		
Ruby-crowned kinglet	<i>Regulus calendula</i>										

Common Name	Species Name	WHT with which Species Is Closely Associated ¹											
		4	5	7	10	15	16	19	21	22	24		
Golden-crowned kinglet	<i>Regulus satrapa</i>	x	x										
Bank swallow	<i>Riparia riparia</i>											x	
Rock wren	<i>Salpinctes obsoletus</i>												
Say's phoebe	<i>Sayornis saya</i>					x	x						
Rufous hummingbird	<i>Selasphorus rufus</i>												
Mountain bluebird	<i>Sialia currucoides</i>												
Western bluebird	<i>Sialia mexicana</i>			x									
Red-breasted nuthatch	<i>Sitta canadensis</i>												
White-breasted nuthatch	<i>Sitta carolinensis</i>		x										
Pygmy nuthatch	<i>Sitta pygmaea</i>		x										
Red-naped sapsucker	<i>Sphyrapicus nuchalis</i>												
Red-breasted sapsucker	<i>Sphyrapicus ruber</i>												
Williamson's sapsucker	<i>Sphyrapicus thyroideus</i>												
American tree sparrow	<i>Spizella arborea</i>												
Brewer's sparrow	<i>Spizella breweri</i>					x							
Clay-colored sparrow	<i>Spizella pallida</i>												
Chipping sparrow	<i>Spizella passerina</i>												
northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>								x	x			
Calliope hummingbird	<i>Stellula calliope</i>												
Caspian tern	<i>Sterna caspia</i>								x	x			
Forster's tern	<i>Sterna forsteri</i>								x	x			
Common tern	<i>Sterna hirundo</i>								x	x			
Great gray owl	<i>Strix nebulosa</i>			x									
Barred owl	<i>Strix varia</i>	x											
Western meadowlark	<i>Sturnella neglecta</i>					x	x	x					
European starling	<i>Sturnus vulgaris</i>								x			x	
Tree swallow	<i>Tachycineta bicolor</i>								x	x			
Violet-green swallow	<i>Tachycineta thalassina</i>												

Common Name	Species Name	WHT with which Species Is Closely Associated ¹									
		4	5	7	10	15	16	19	21	22	24
Bewick's wren	<i>Thryomanes bewickii</i>										
Lesser yellowlegs	<i>Tringa flavipes</i>							x	x		
Greater yellowlegs	<i>Tringa melanoleuca</i>							x	x		
Solitary sandpiper	<i>Tringa solitaria</i>						x				
House wren	<i>Troglodytes aedon</i>										
Winter wren	<i>Troglodytes troglodytes</i>										
American robin	<i>Turdus migratorius</i>										
Sharp-tailed grouse	<i>Tympanuchus phasianellus</i>					x	x				
Eastern kingbird	<i>Tyrannus tyrannus</i>					x					
Western kingbird	<i>Tyrannus verticalis</i>					x					
Barn owl	<i>Tyto alba</i>					x					
Orange-crowned warbler	<i>Vermivora celata</i>										
Nashville warbler	<i>Vermivora ruficapilla</i>										
Cassin's vireo	<i>Vireo cassinii</i>					x					
Warbling vireo	<i>Vireo gilvus</i>										
Wilson's warbler	<i>Wilsonia pusilla</i>										
Yellow-headed blackbird	<i>Xanthocephalus xanthocephalus</i>						x				
Mourning dove	<i>Zenaidura macroura</i>						x				
White-throated sparrow	<i>Zonotrichia albicollis</i>										
Golden-crowned sparrow	<i>Zonotrichia atricapilla</i>					x					
White-crowned sparrow	<i>Zonotrichia leucophrys</i>										
Harris's sparrow	<i>Zonotrichia querula</i>										
260	Total Birds	(number of birds closely associated with WHT)									
Pronghorn	<i>Antilocapra americana</i>				x	x					
Pallid bat	<i>Antrozous pallidus</i>					x	x				
Pygmy rabbit	<i>Brachylagus idahoensis</i>					x	x	x			
Coyote	<i>Canis latrans</i>					x					
Wolf	<i>Canis lupus</i> (suspected)										

Common Name	Species Name	WHT with which Species Is Closely Associated ¹									
		4	5	7	10	15	16	19	21	22	24
American beaver	<i>Castor canadensis</i>								x	x	
Elk	<i>Cervus elaphus</i>										
Southern red-backed vole	<i>Clethrionomys gapperi</i>	x	x							x	
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>								x		
Virginia opossum	<i>Didelphis virginiana</i>							x			
Ord's kangaroo rat	<i>Dipodomys ordii</i>					x					
Big brown bat	<i>Eptesicus fuscus</i>	x	x	x			x			x	
Common porcupine	<i>Erethizon dorsatum</i>	x	x	x							
Northern flying squirrel	<i>Glaucomys sabrinus</i>	x	x								
Silver-haired bat	<i>Lasionycteris noctivagans</i>	x	x								
Hoary bat	<i>Lasiurus cinereus</i>										
Sagebrush vole	<i>Lemmiscus curtatus</i>					x					
Snowshoe hare	<i>Lepus americanus</i>	x	x							x	
Black-tailed jackrabbit	<i>Lepus californicus</i>					x					
White-tailed jackrabbit	<i>Lepus townsendii</i>				x				x	x	
Northern river otter	<i>Lutra canadensis</i>										
Lynx	<i>Lynx canadensis</i>	x									
Bobcat	<i>Lynx rufus</i>										
Yellow-bellied marmot	<i>Marmota flaviventris</i>										
American marten	<i>Martes americana</i>	x	x								
Striped skunk	<i>Mephitis mephitis</i>										
Long-tailed vole	<i>Microtus longicaudus</i>								x	x	
Montane vole	<i>Microtus montanus</i>				x		x		x	x	
Water vole	<i>Microtus richardsoni</i>		x							x	
House mouse	<i>Mus musculus</i>							x			
Ermine	<i>Mustela erminea</i>										
Long-tailed weasel	<i>Mustela frenata</i>										
Mink	<i>Mustela vison</i>							x	x		

Common Name	Species Name	WHT with which Species Is Closely Associated ¹											
		4	5	7	10	15	16	19	21	22	24		
California myotis	<i>Myotis californicus</i>		x										
Western small-footed myotis	<i>Myotis ciliolabrum</i>				x								
Long-eared myotis	<i>Myotis evotis</i>					x	x		x	x	x		
Little brown myotis	<i>Myotis lucifugus</i>												
Fringed myotis	<i>Myotis thysanodes</i>												
Long-legged myotis	<i>Myotis volans</i>	x	x	x									
Yuma myotis	<i>Myotis yumanensis</i>								x	x	x		
Bushy-tailed woodrat	<i>Neotoma cinerea</i>	x	x					x					
American pika	<i>Ochotona princeps</i>			x									
Mule deer	<i>Odocoileus hemionus</i>												
White-tailed deer	<i>Odocoileus virginianus</i>							x					
Muskrat	<i>Ondatra zibethicus</i>									x			
Northern grasshopper mouse	<i>Onychomys leucogaster</i>							x					
Rocky Mountain goat	<i>Oreamnos americanus</i>					x							
Bighorn sheep	<i>Ovis canadensis</i>								x	x	x		
Great Basin pocket mouse	<i>Perognathus parvus</i>						x						
Canyon mouse	<i>Peromyscus crinitus</i>												
Deer mouse	<i>Peromyscus maniculatus</i>	x	x	x	x	x	x	x	x	x	x		
Heather vole	<i>Phenacomys intermedius</i>	x	x	x	x	x	x	x	x	x	x		
Western pipistrelle	<i>Pipistrellus hesperus</i>					x	x	x	x	x	x		
Raccoon	<i>Procyon lotor</i>							x	x	x	x		
Mountain lion	<i>Puma concolor</i>												
Norway rat	<i>Rattus norvegicus</i>												
Western harvest mouse	<i>Reithrodontomys megalotis</i>							x					
Coast mole	<i>Scapanus orarius</i>	x	x										
Eastern fox squirrel	<i>Sciurus niger</i>									x			
Merriam's shrew	<i>Sorex merriami</i>							x					
Water shrew	<i>Sorex palustris</i>	x								x			

Common Name	Species Name	WHT with which Species Is Closely Associated ¹									
		4	5	7	10	15	16	19	21	22	24
Preble's shrew	<i>Sorex preblei</i>										
Vagrant shrew	<i>Sorex vagrans</i>										
Belding's ground squirrel	<i>Spermophilus beldingi</i>				x	x	x	x	x		
Merriam's ground squirrel	<i>Spermophilus canus</i>										
Columbian ground squirrel	<i>Spermophilus columbianus</i>	x	x	x	x	x					
Golden-mantled ground squirrel	<i>Spermophilus lateralis</i>	x	x	x							
Piute ground squirrel	<i>Spermophilus mollis</i>						x				
Western spotted skunk	<i>Spilogale gracilis</i>										
Nuttall's (mountain) cottontail	<i>Sylvilagus nuttallii</i>					x	x				
Yellow-pine chipmunk	<i>Tamias amoenus</i>			x							
Least chipmunk	<i>Tamias minimus</i>					x					
Douglas's squirrel	<i>Tamiasciurus douglasii</i>						x				
Red squirrel	<i>Tamiasciurus hudsonicus</i>	x									
American badger	<i>Taxidea taxus</i>					x	x				
Northern pocket gopher	<i>Thomomys talpoides</i>	x	x	x	x	x	x				
Black bear	<i>Ursus americanus</i>										
Grizzly bear	<i>Ursus arctos</i>										
Red fox	<i>Vulpes vulpes</i>			x							
Western jumping mouse	<i>Zapus princeps</i>			x							
80	Total Mammals	(number of mammals closely associated with WHT)									
	Rubber boa	<i>Charina bottae</i>									
	Painted turtle	<i>Chrysemys picta</i>						x	x		
	Western whiptail	<i>Cnemidophorus tigris</i>									
	Racer	<i>Cohober constrictor</i>									
	Western rattlesnake	<i>Crotalus viridis</i>									
	Western skink	<i>Eumeces skiltonianus</i>									
	Desert horned lizard	<i>Phrynosoma platyrhinos</i>									

Common Name		Species Name	WHT with which Species Is Closely Associated ¹								
			4	5	7	10	15	16	19	21	22
	Gopher snake	<i>Pituophis catenifer</i>									
	Sagebrush lizard	<i>Sceloporus graciosus</i>									
	Western fence lizard	<i>Sceloporus occidentalis</i>									
	Common garter snake	<i>Thamnophis sirtalis</i>								x	x
11	Total Reptiles	(number of mammals closely associated with WHT)							1	2	1
359	Total Wildlife Species	(number of wildlife species closely associated with WHT)	26	30	21	12	32	38	55	75	81
			14								

WHT Key¹

- 4—Montane Mixed Conifer
- 5—Interior Eastside Mixed Conifer
- 7—Ponderosa Pine
- 10—Alpine Grasslands and Shrublands
- 15—Interior Grasslands
- 16—Shrub-steppe
- 191—Agriculture
- 21—Open Water
- 22—Herbaceous Wetlands
- 24—Montane Coniferous Wetlands

Appendix B Information on the grazing allotments of the Imnaha subbasin.

Appendix Table 2. Use intensity, use timing, and features of the grazing allotment of the Imnaha subbasin.

Allotment Name	Number of Pastures	Livestock Kind/Class	Permit Type	Animal Numbers Permitted	Season of Use	Listed Fish Habitat	Acres	Percent Suitable Grazing Lands		
Bear Gulch	5	Cattle, cow/calf	Term grazing	124 pair	4/16–11/10	y	9,550	85		
			Term private land (waived)	19 pair						
Big sheep	4	Cattle, cow/calf	Term grazing	350	4/16–6/30	y	20,762	77		
			Term private land (waived)	300	11/1–12/31					
Blackmore	2	Cattle, cow/calf	Term grazing	100	5/1–6/30		n	46		
			Term private land (waived)	100	11/1–12/31					
Carroll Creek	7	Cattle, cow/calf	Term grazing	64 pair	4/16–5/15 and 11/16–12/15	n	823	46		
			Term private land (waived)	21 pair						
Cayuse	7	Cattle, cow/calf	Term grazing	58 pair	4/25–5/10	y	3,173	54		
			Term grazing with on-off provisions (not waived)	22 pair	6/1–7/31					
Chalk	4	Cattle, cow/calf	Term grazing	140 pair	11/1–12/15		n	66		
			Term private land (waived)	140 pair	4/25–5/10					
			Term grazing	82 pair	6/1–7/31		42,413	65		
			Term private land (waived)	348 pair	11/1–12/15	y				

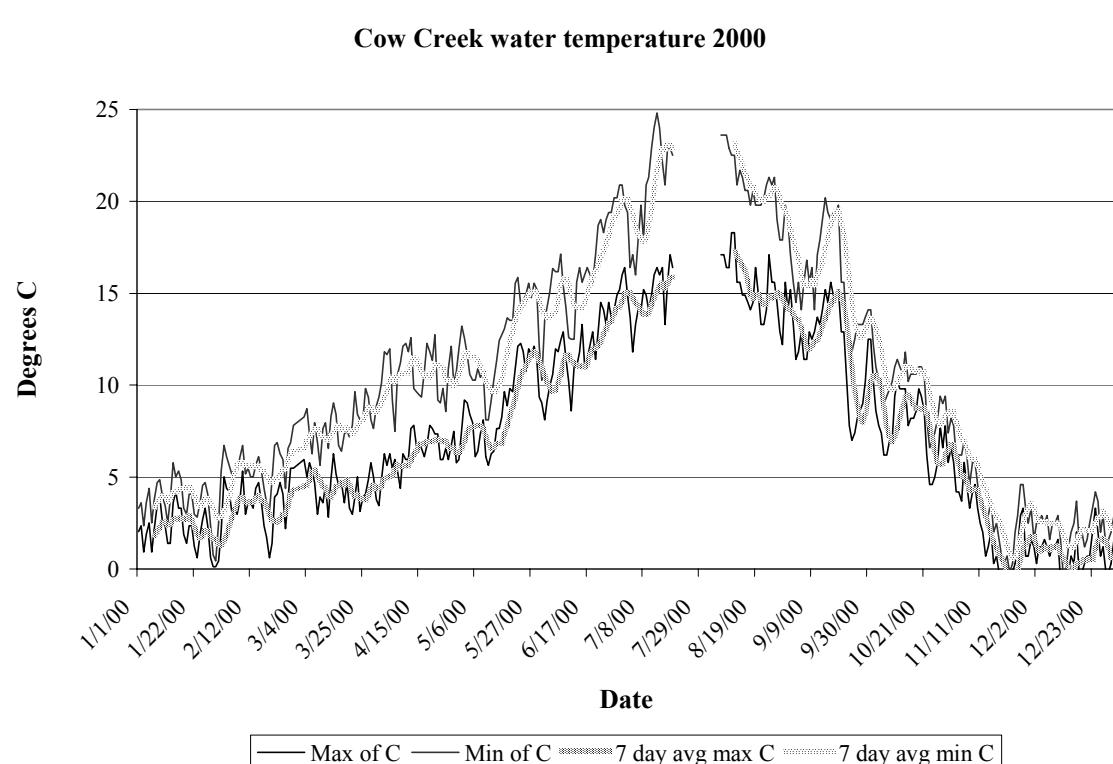
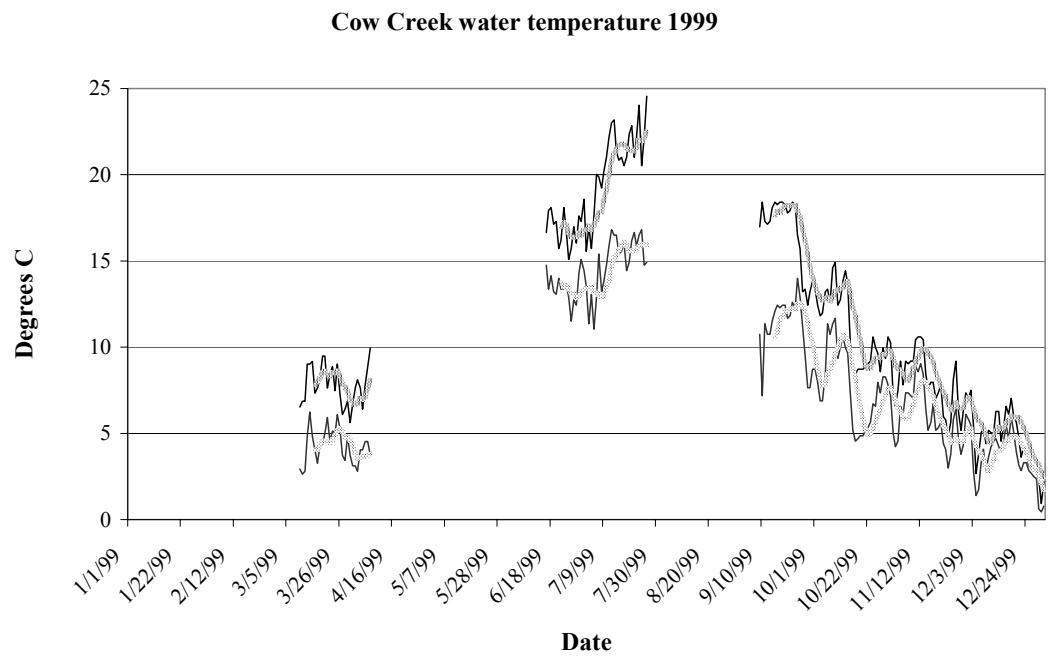
Allotment Name	Number of Pastures	Livestock Kind/Class	Permit Type	Animal Numbers Permitted	Season of Use	Listed Fish Habitat	Acres	Percent Suitable Grazing Lands
College	2	Cattle, cow/calf	Term grazing	30 pair	4/16-5/15 and 11/1-11/30	n	669	38
Cow Creek	6	Cattle, cow/calf	Term grazing	231 pair	11/1-12/31 and 2/1-5/15	y	7,363	66
			Term private land	38 pair	11/1-12/31 and 3/1-5/15			
Divide	6	Cattle, cow/calf	Term grazing	225 pair	6/11-10/21	y	16,717	78
Dodson Hass	23	Cattle, cow/calf	Term grazing	507 pair	11/1-12/31 and 2/1-5/15	y	10,397	98
			Term private land (waived)	158 pair	11/1-12/31 and 3/1-5/15			
Dunlap Thorn	3	Cattle, cow/calf	Term grazing	150 pair	11/11-12/20 and 5/1-5/30	n	2,309	97
			Term private land (waived)	35 pair				
Dunn Creek	1	Cattle, cow/calf	Term grazing	32 pair	11/1-11/30 and 4/16-5/15	n	319	56
Grizzly Ridge	1	Cattle, cow/calf	Term grazing	46 pair	4/16-7/15	n	3,802	100
			Term grazing permit with on-off provisions (not waived)	186				
Grouse-line	7	Cattle, cow/calf	Term grazing	130 pair	4/16-5/15	y	13,815	94
				151 pair	5/16-10/31			
				467 pair	11/1-11/30			
			Term private land (waived)	170 pair	4/16-5/15			
				63 pair	5/16-10/31			
				524 pair	11/1-11/30			
Horse Creek	5	Cattle, cow/calf	Term grazing	192 pair	3/16-6/15	y	8,723	59
				234 pair	10/28-11/30			

Allotment Name	Number of Pastures	Livestock Kind/Class	Permit Type	Animal Numbers Permitted	Season of Use	Listed Fish Habitat	Acres	Percent Suitable Grazing Lands
Keeler	4	Horses	Term grazing	2 head	11/16-4/30	n	310	100
			Term grazing permit with on-off provisions (not waived)	2 head				
Log Creek	6	Cattle, cow/calf	Term grazing	247 pair	Variable Totals 5.3 months within 3/1-1/31	y	10,312	72
Lone Pine	1	Cattle, cow/calf Horses/Mules	Term Private Land (waived)	150 pair	Variable Totals 5.3 months within 3/1-1/31			
			Term Grazing	300 pair	12/1-5/31	n	10,839	73
Mar Flat	16	Cattle, cow/calf Horse/Mule	Term grazing	100 pair	7/1-10/31	y	85,740	48
				1021pair	5/16-10/31			
Middle point	9	Cattle, cow/calf	Term grazing	4 head	6/1-10/31			
				6 head	6/1-10/15			
Mink	1	Cattle, cow/calf	Term grazing	132 pair	4/16-5/31 and 11/16-11/30	y	5,280	67
				16 pair				
Needham	2	Cattle, cow/calf	Private land (waived)	118 pair	4/16-5/31			
			Term grazing	25 pair	6/1-8/30	n	644	47
Rhodes Creek	16	Cattle, cow/calf	Term private land (waived)	25 pair				
			Term grazing	35 pair	5/1-10/31	y	1,634	65

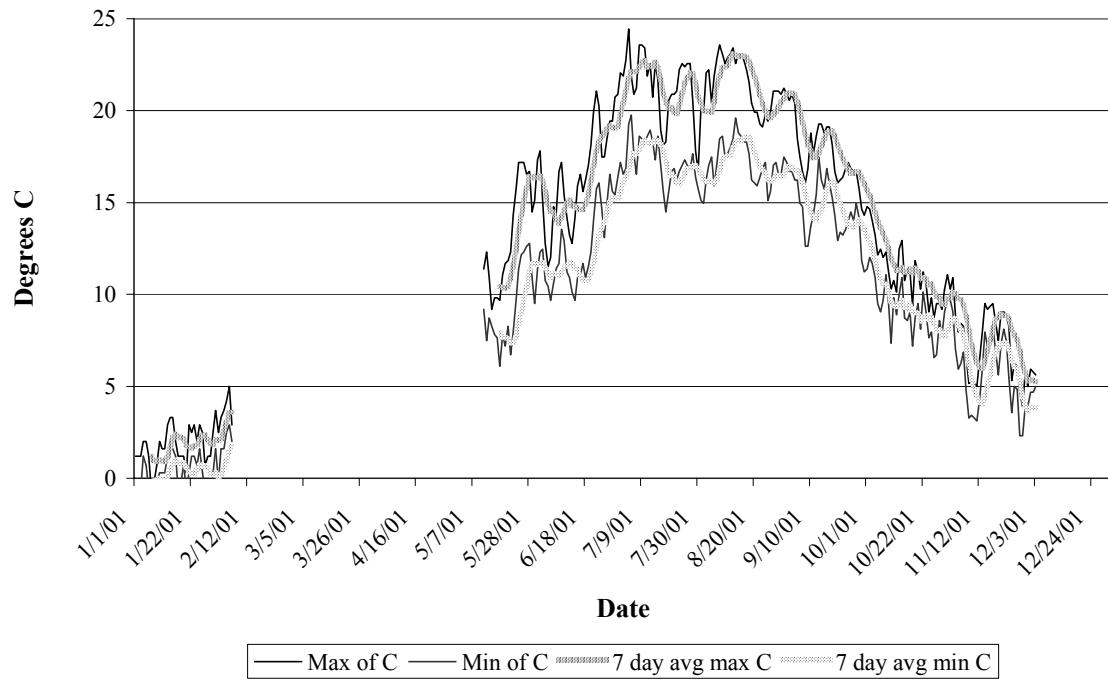
Allotment Name	Number of Pastures	Livestock Kind/Class	Permit Type	Animal Numbers Permitted	Season of Use	Listed Fish Habitat	Acres	Percent Suitable Grazing Lands
				101 pair	4/16-5/15			
Horses/Mules		Term grazing	15 head	11/1-5/15				
Saddle Creek	7	Cattle, cow/calf	Term grazing	100 pair	5/16-10/31	y	18,202	47
Schleur	5	Cattle, cow/calf	Term grazing	100 pair	4/16-5/15 and 11/1-11/30	n	2,851	28
		Private land (not waived)	20 pair					
Snell	2	Cattle, cow/calf	Term grazing	100 pair	4/16-5/15 and 11/1-11/30	n	1,317	43
Toomey	8	Cattle, cow/calf	Term grazing	184 pair	11/1-12/31 and 2/1-5/15	n	5,538	85
		(waived)	Term private land	52	11/1-12/31 and 3/1-5/15			
College	1	Horses & Mules	N/A	5-20 head	5/1-11/30, as needed	n	700	NA
Thorn Creek Horse	2	Horses & Mules	N/A	5-20 head	As needed	n	100	NA
Lick Creek	1	Horses & Mules	N/A	4-10 head	7/16-11/15	n	12	NA
Memaloose	1	Horses & Mules	N/A	5-20 head	6/1-10/31	y	1,080	NA
Lord Flat	1	Horses & Mules	N/A	5-20 head	6/1-10/31	n	1,800	NA

Appendix C Continuous water temperature monitoring data (1999-2003) for select tributaries and mainstem reaches in the Lower Imnaha, Big Sheep Creek, and Upper Imnaha watersheds

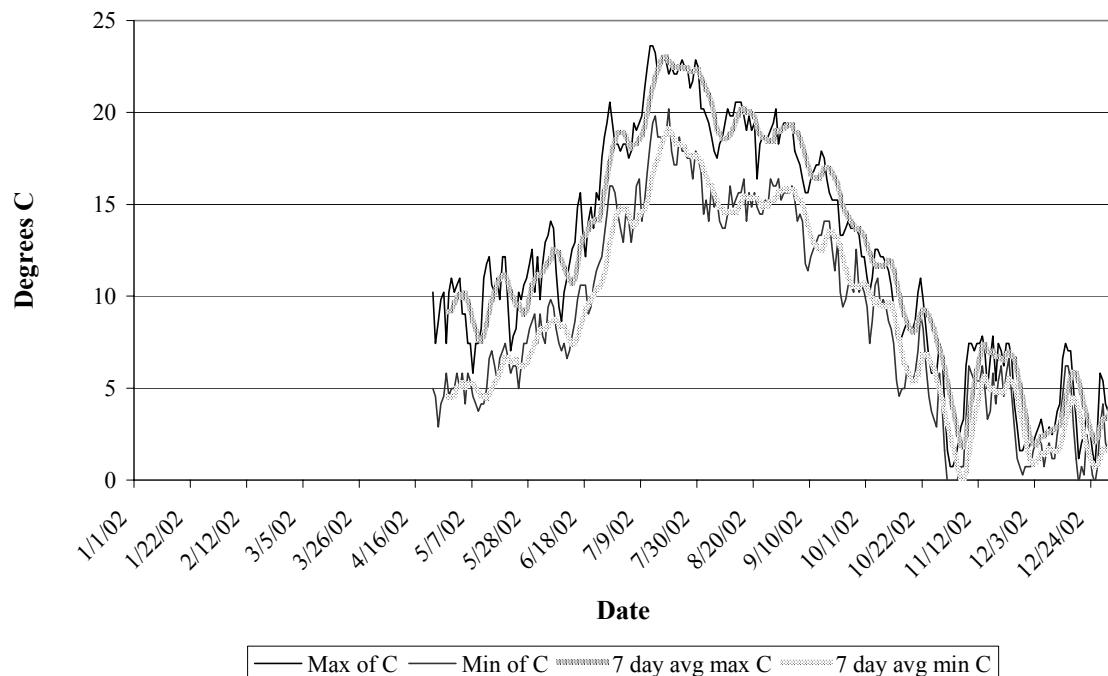
Lower Imnaha Watershed, Water Temperatures:



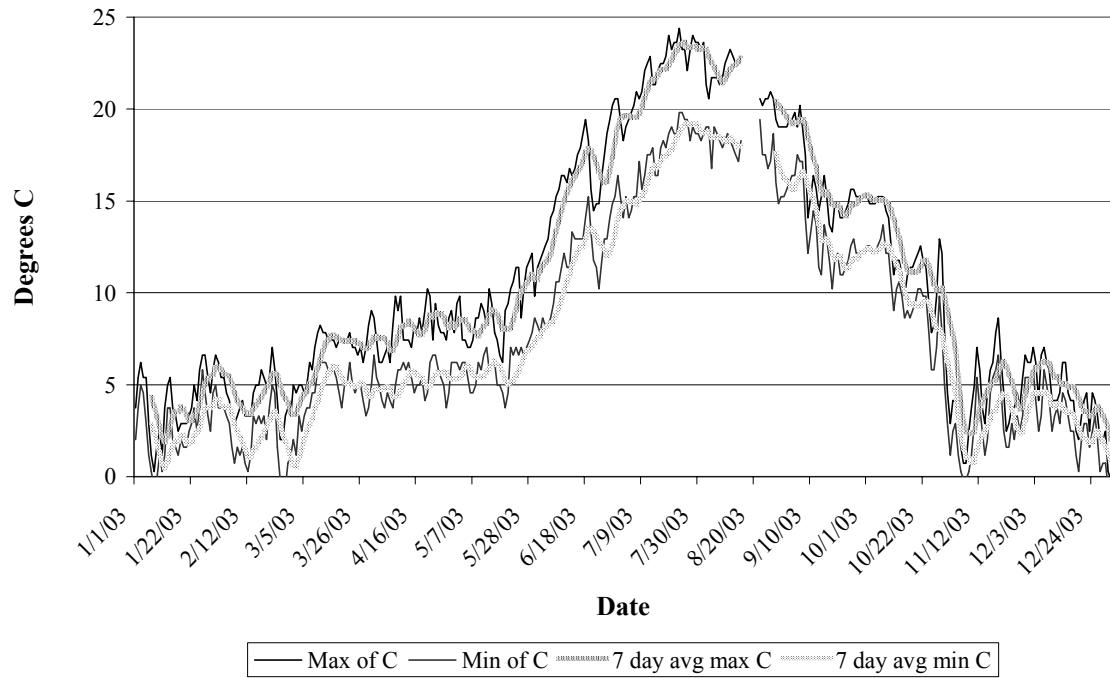
Cow Creek water temperature 2001



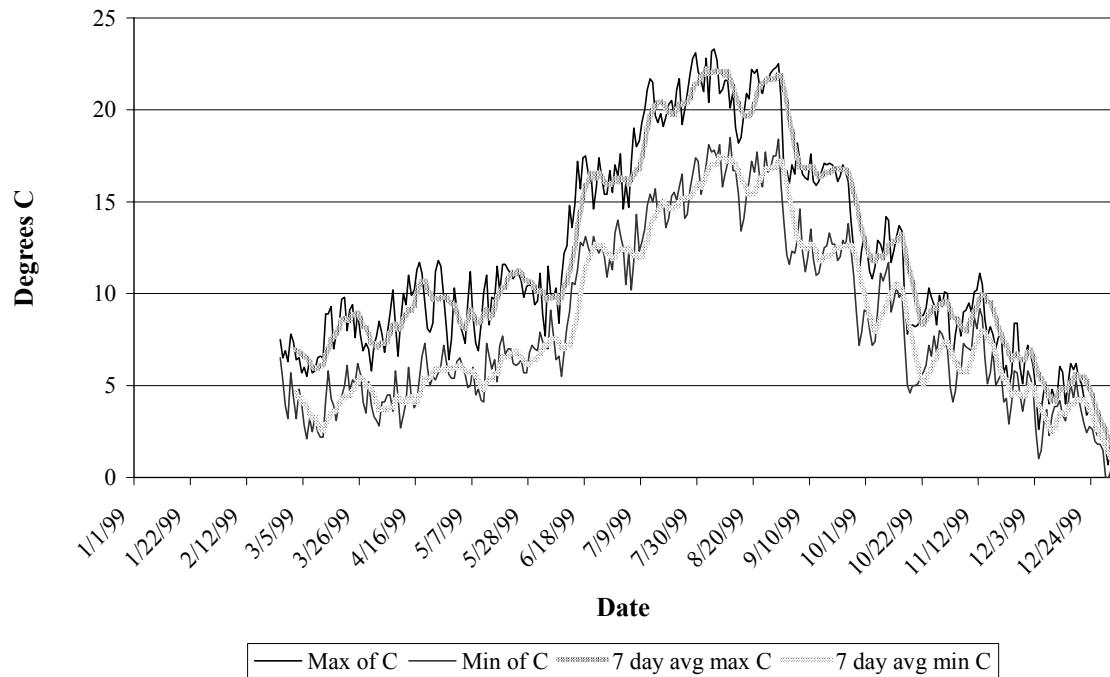
Cow Creek water temperature 2002



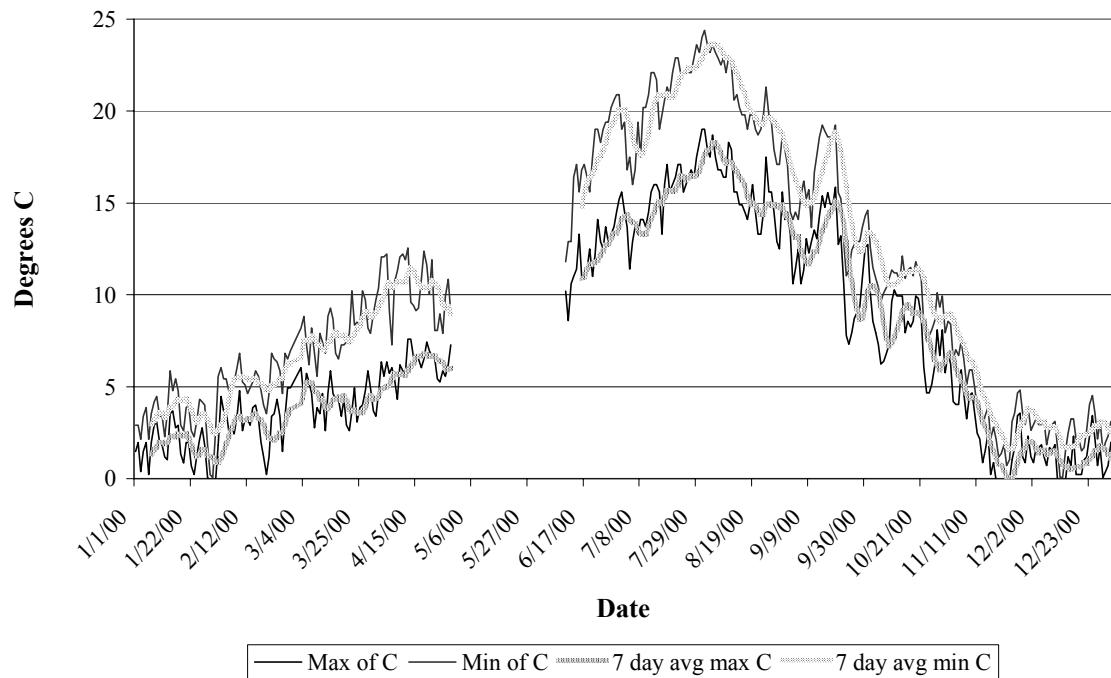
Cow Creek water temperature 2003



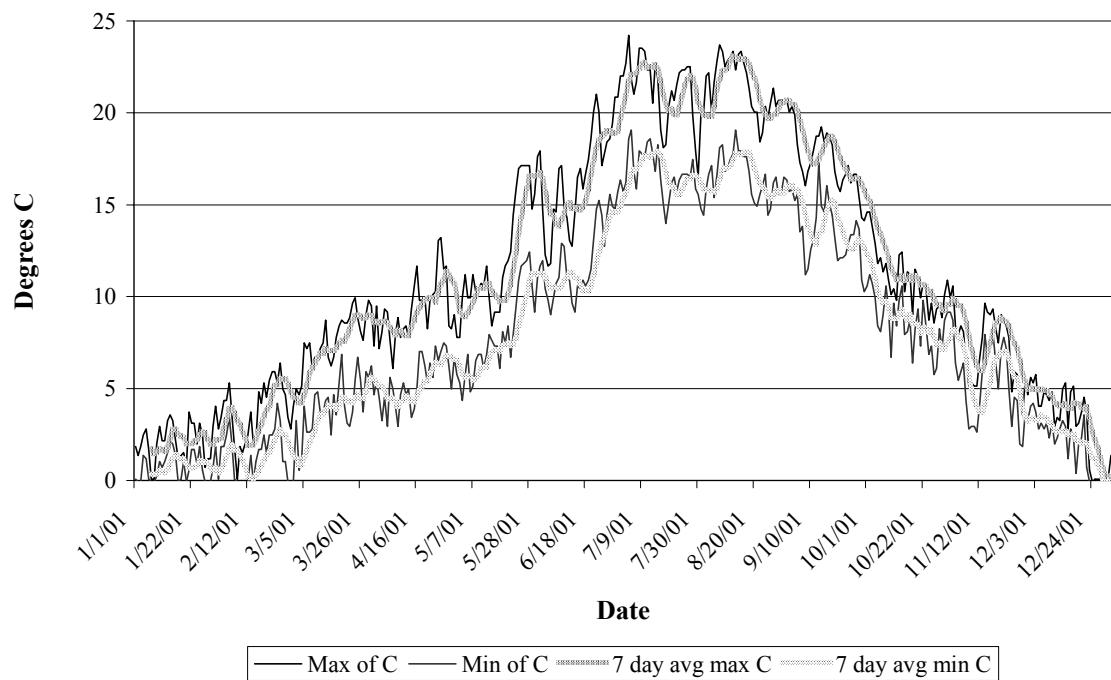
Lightning Creek water temperature 1999



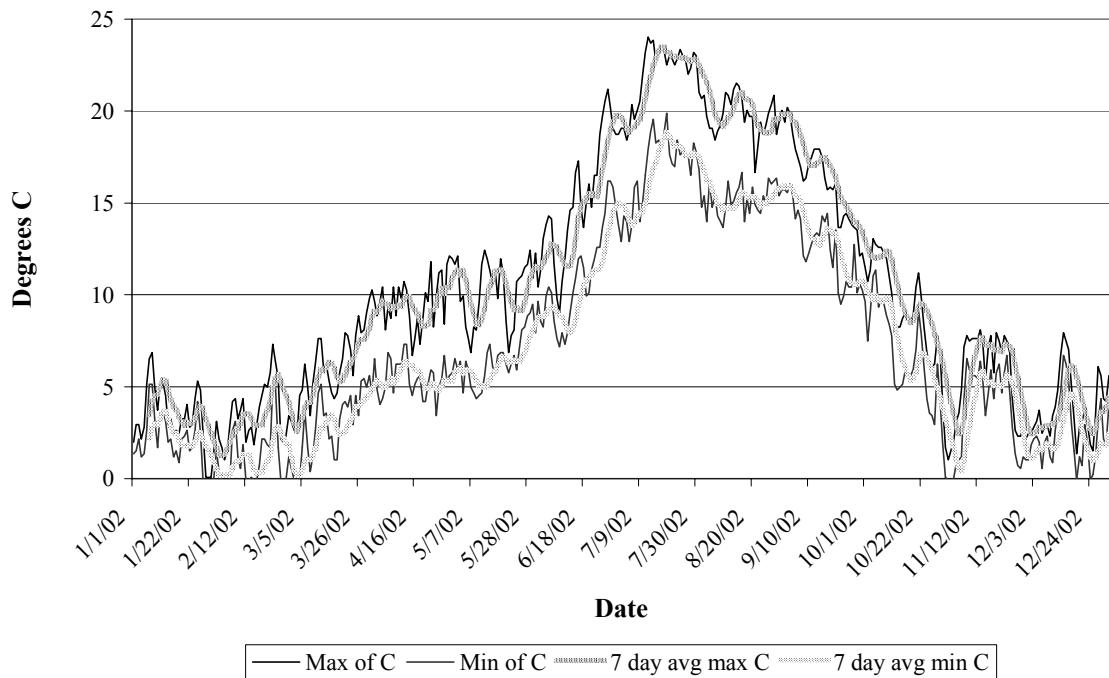
Lightning Creek water temperature 2000



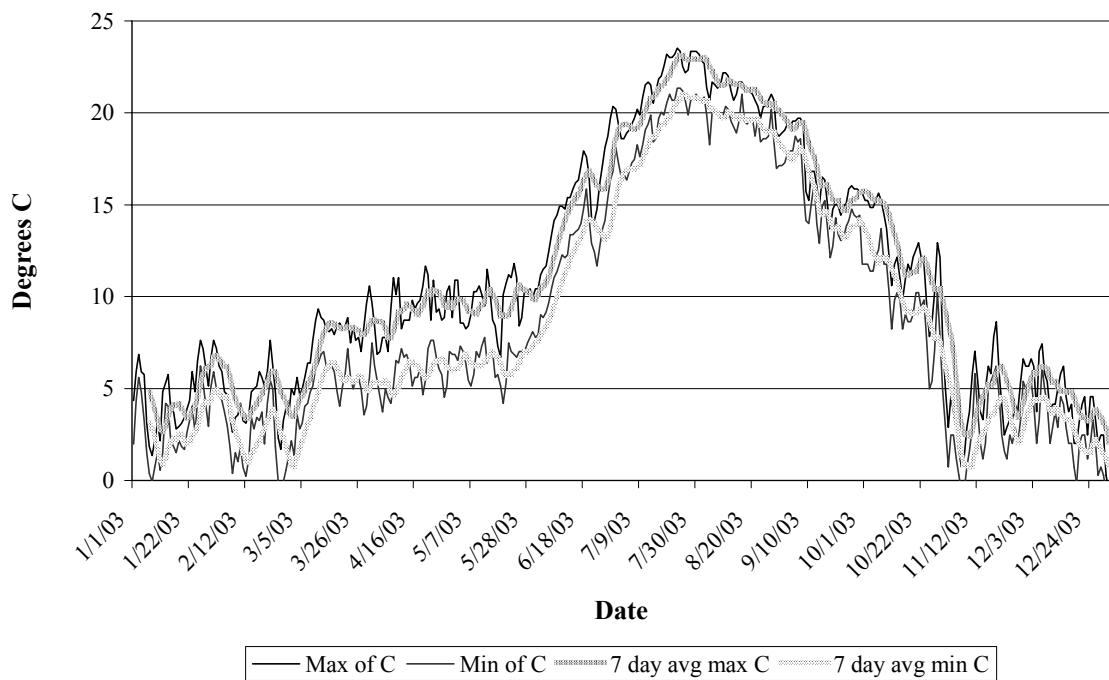
Lightning Creek water temperature 2001



Lightning Creek water temperature 2002

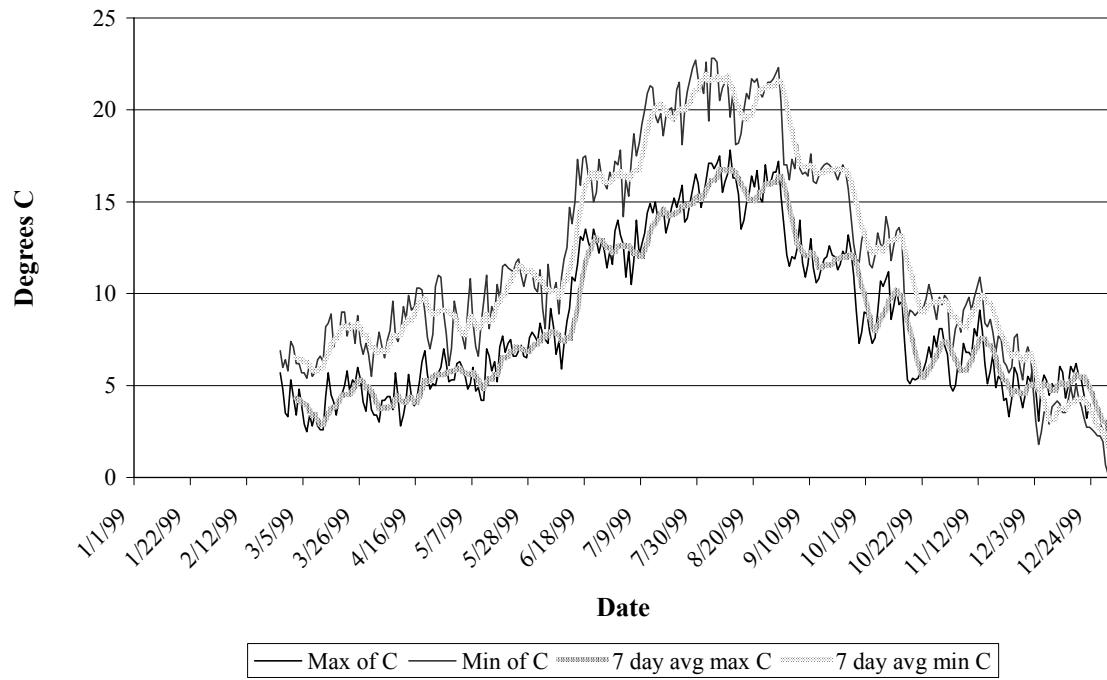


Lightning Creek water temperature 2003

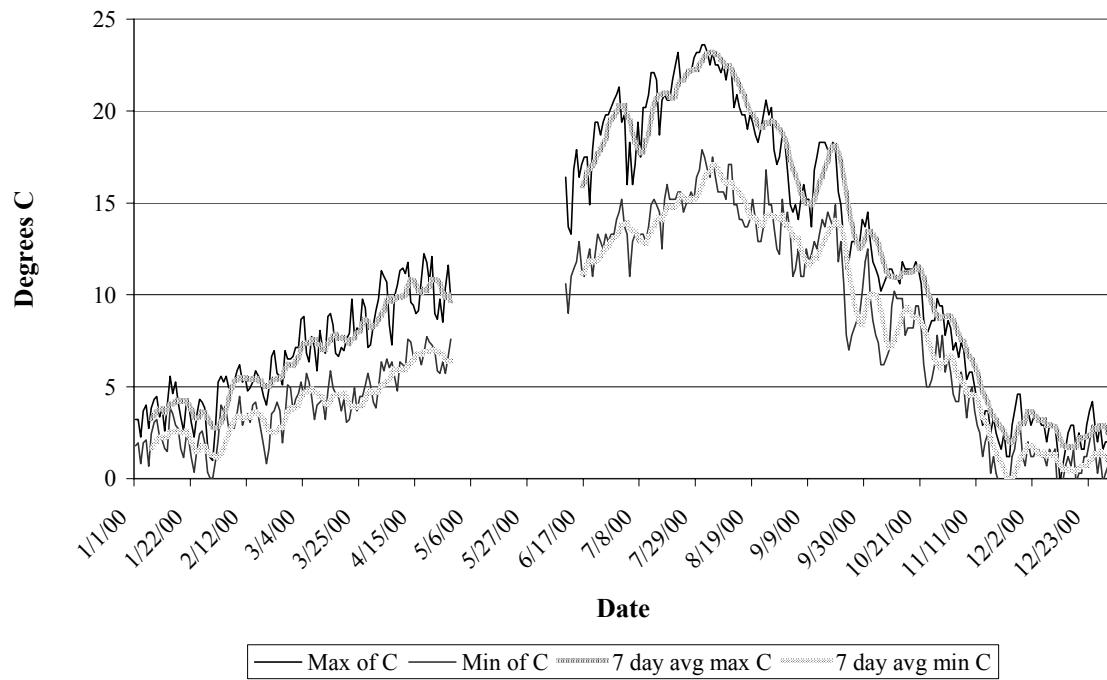


*2003 Lightning Creek temperature recorder was buried by bedload at the end of May and wasn't dug out till September. Maximum and minimum daily temperatures are not as variable as normal.

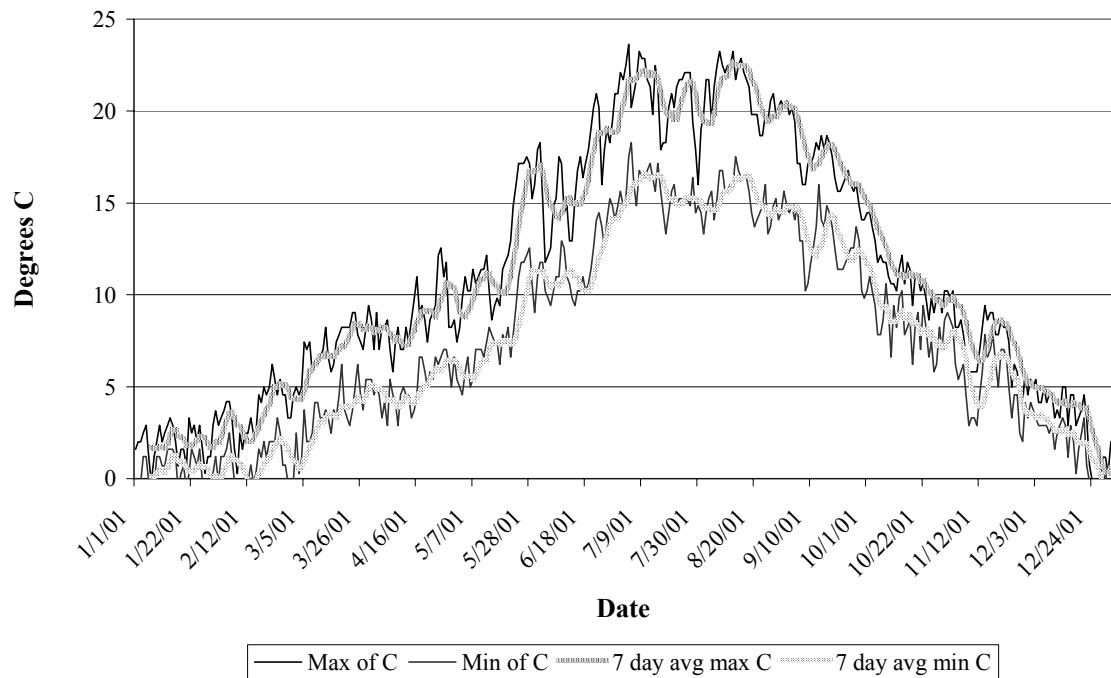
Horse Creek water temperature 1999



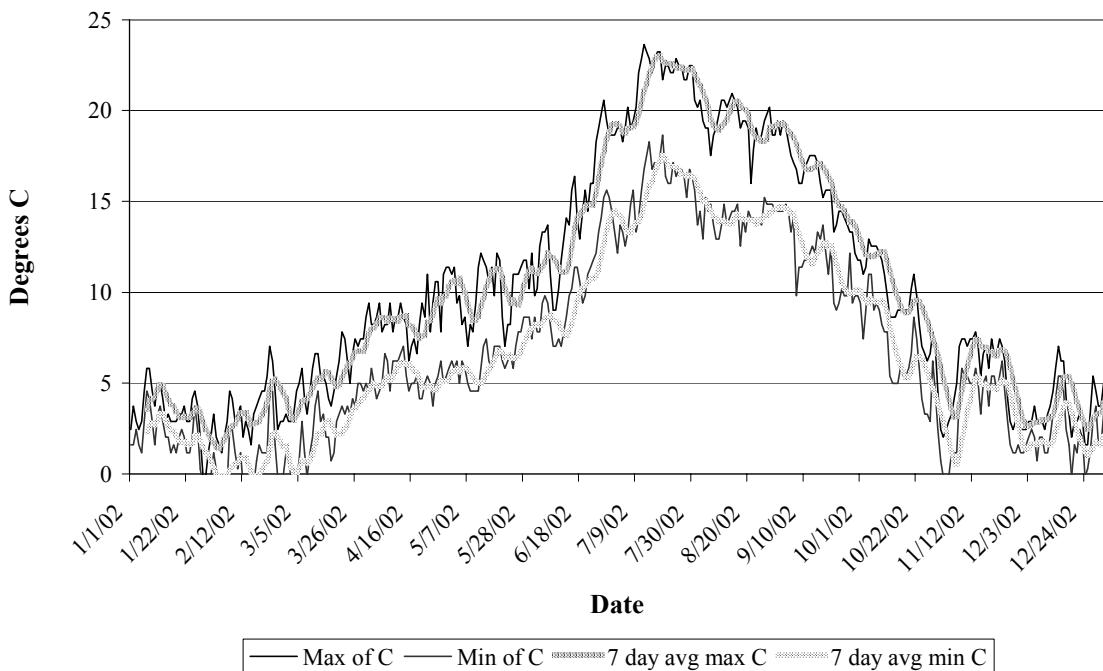
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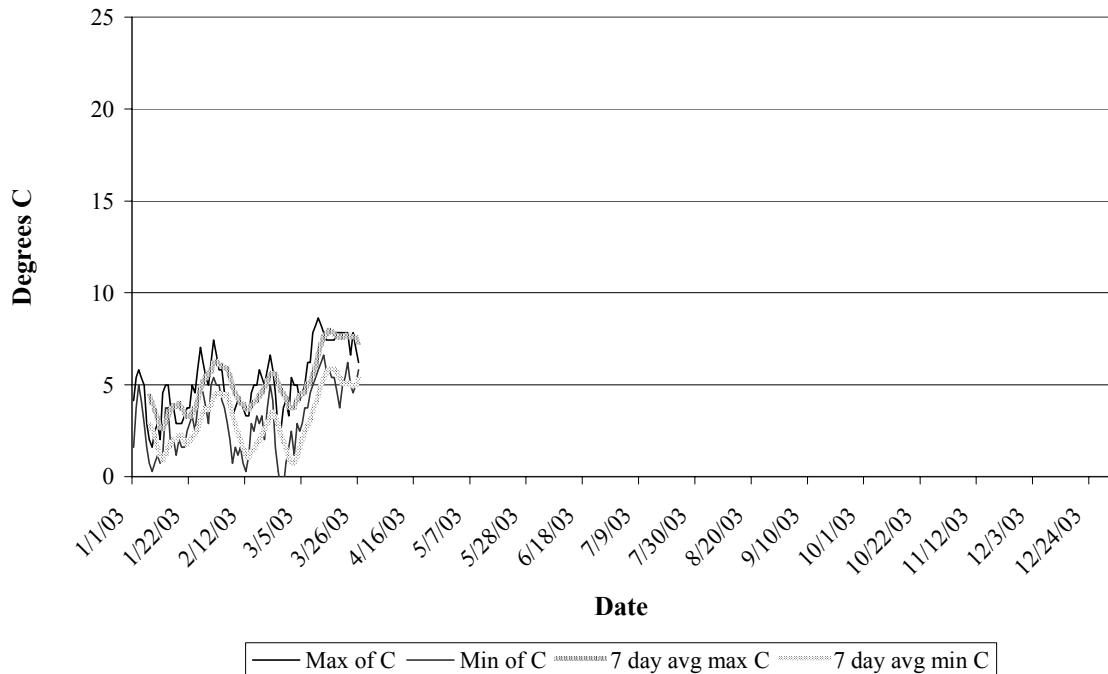
Water temperature Horse Creek 2001



Horse Creek water temperature 2002

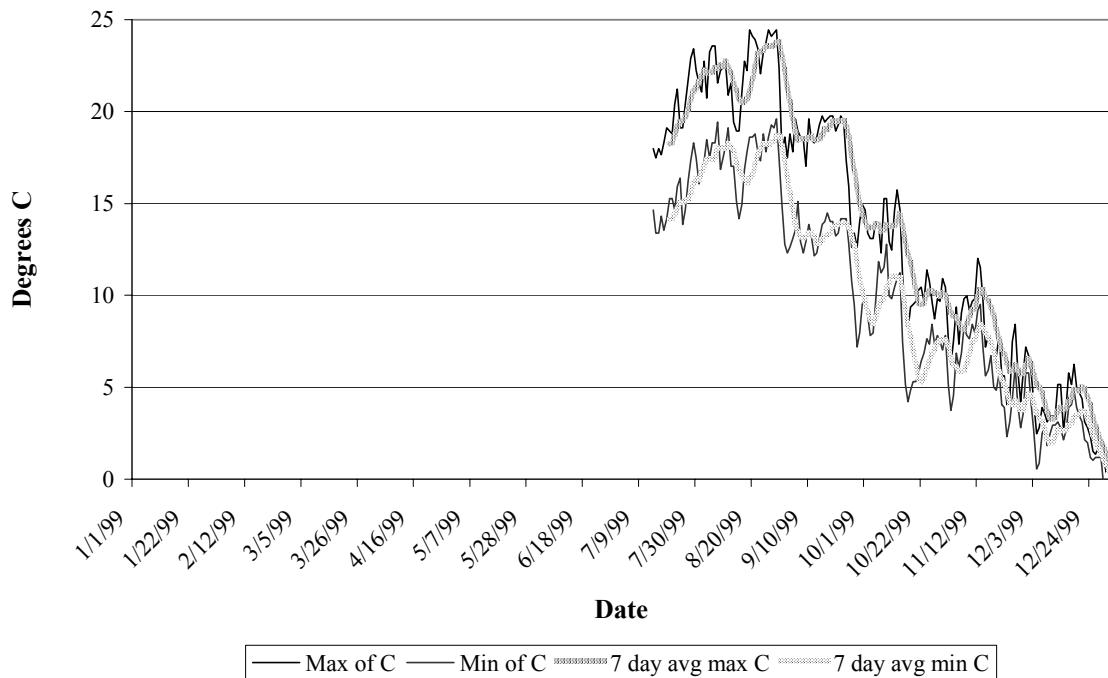


Horse Creek water temperature 2003

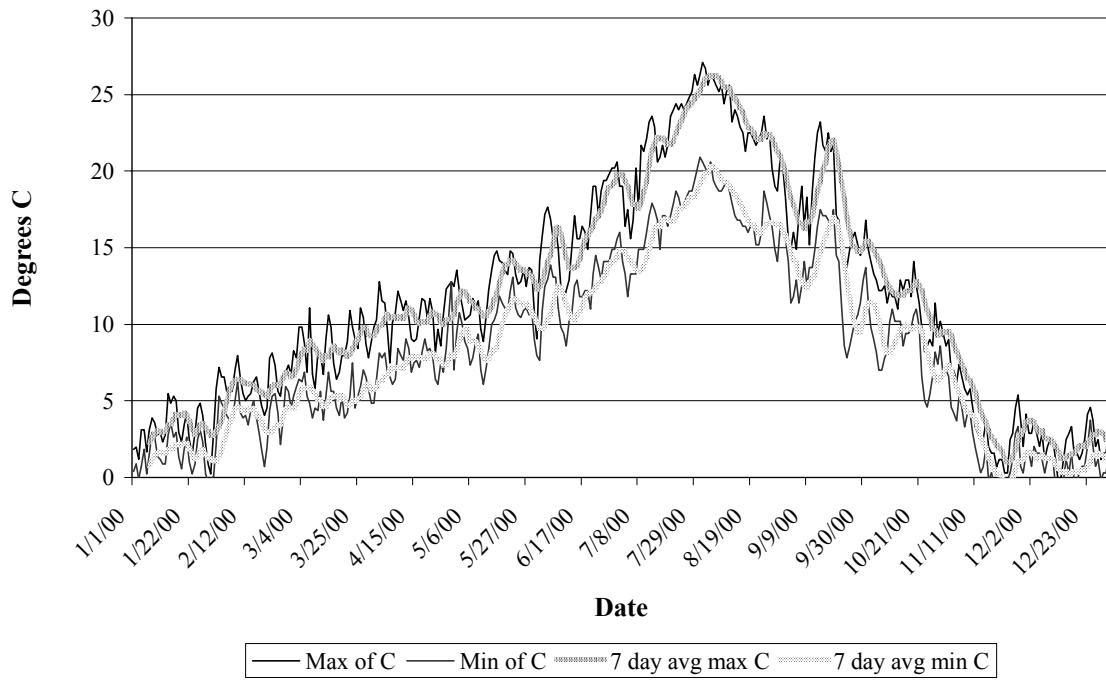


*During 2003, the Nez Perce Tribe was not allowed access to Horse Creek by landowner and had to pull temperature recorder.

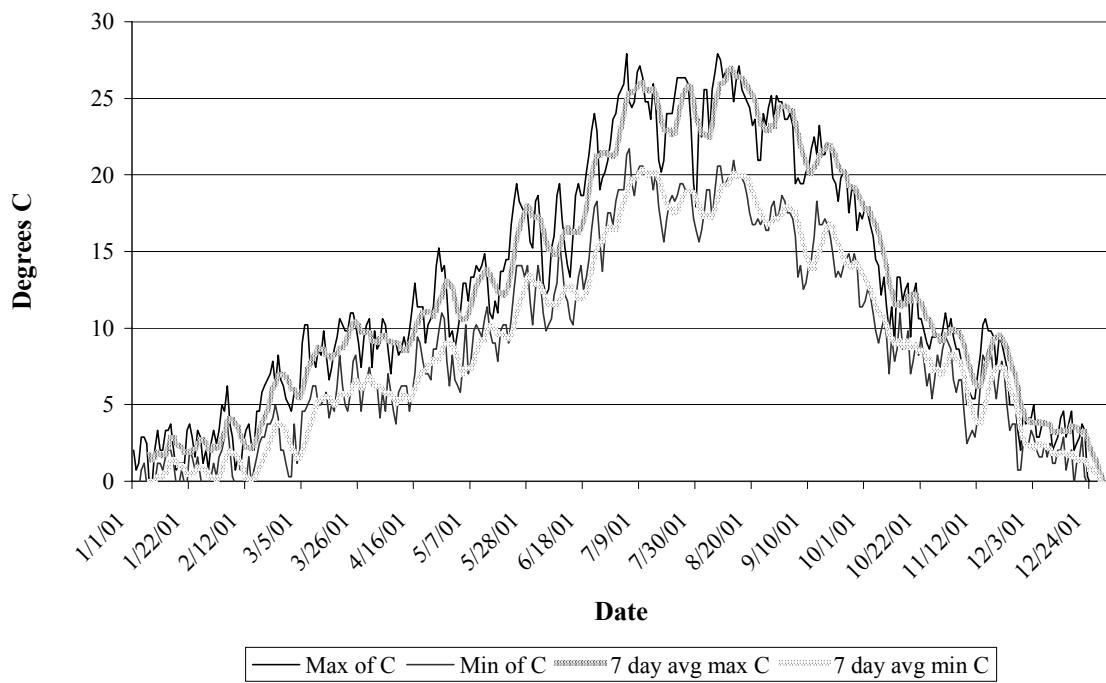
1999 Imnaha River water temperature at rkm 7



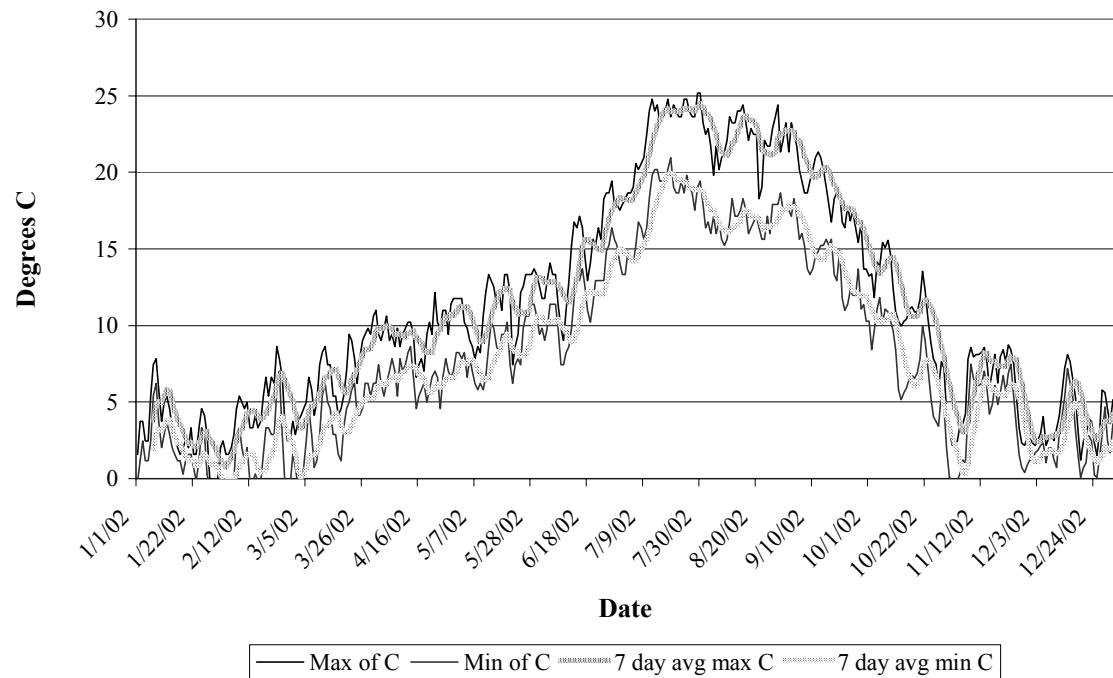
2000 Imnaha River water temperature at rkm 7



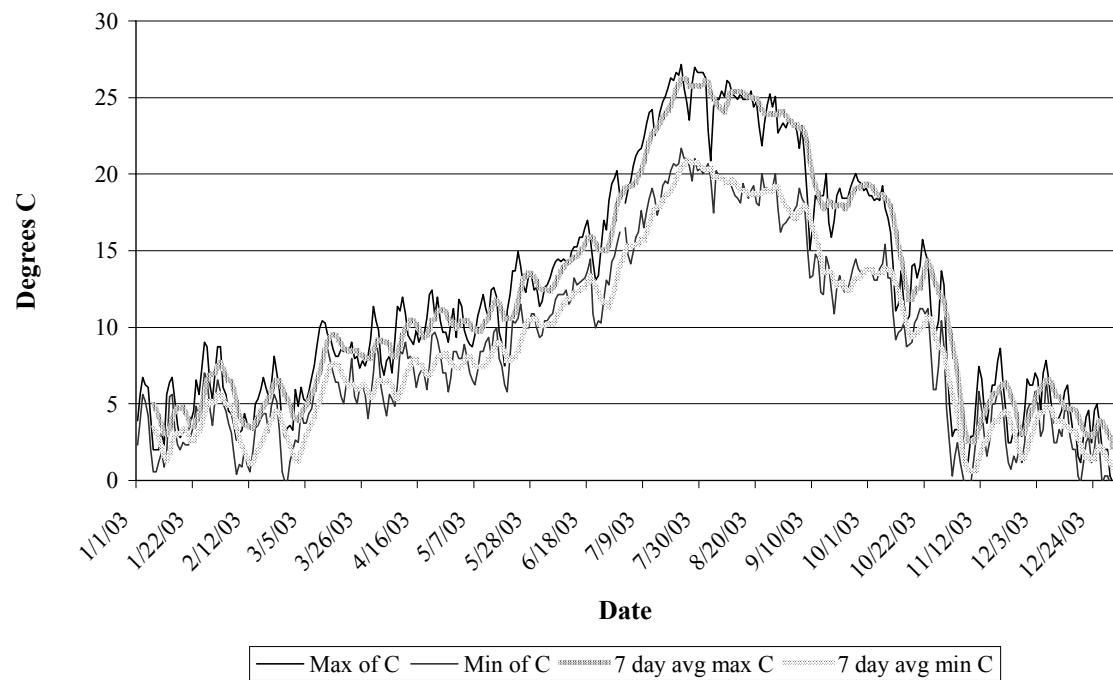
2001 Imnaha River water temperature at rkm 7



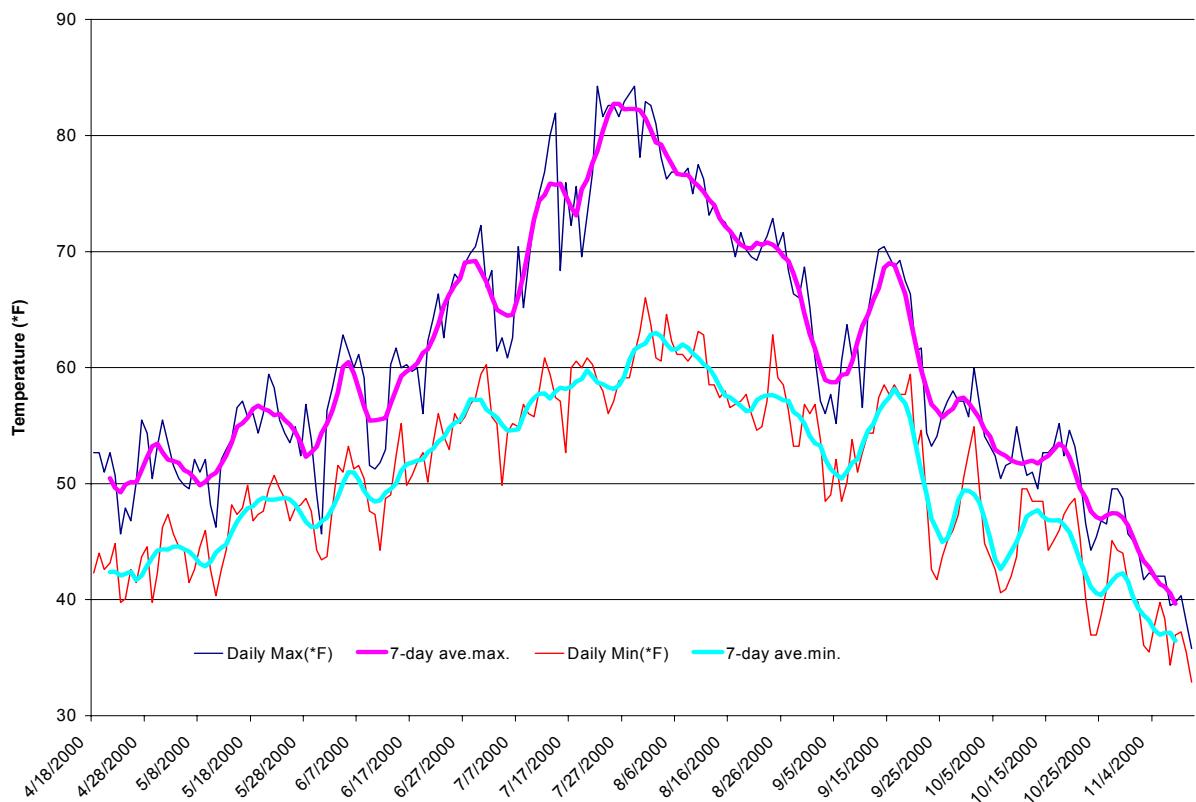
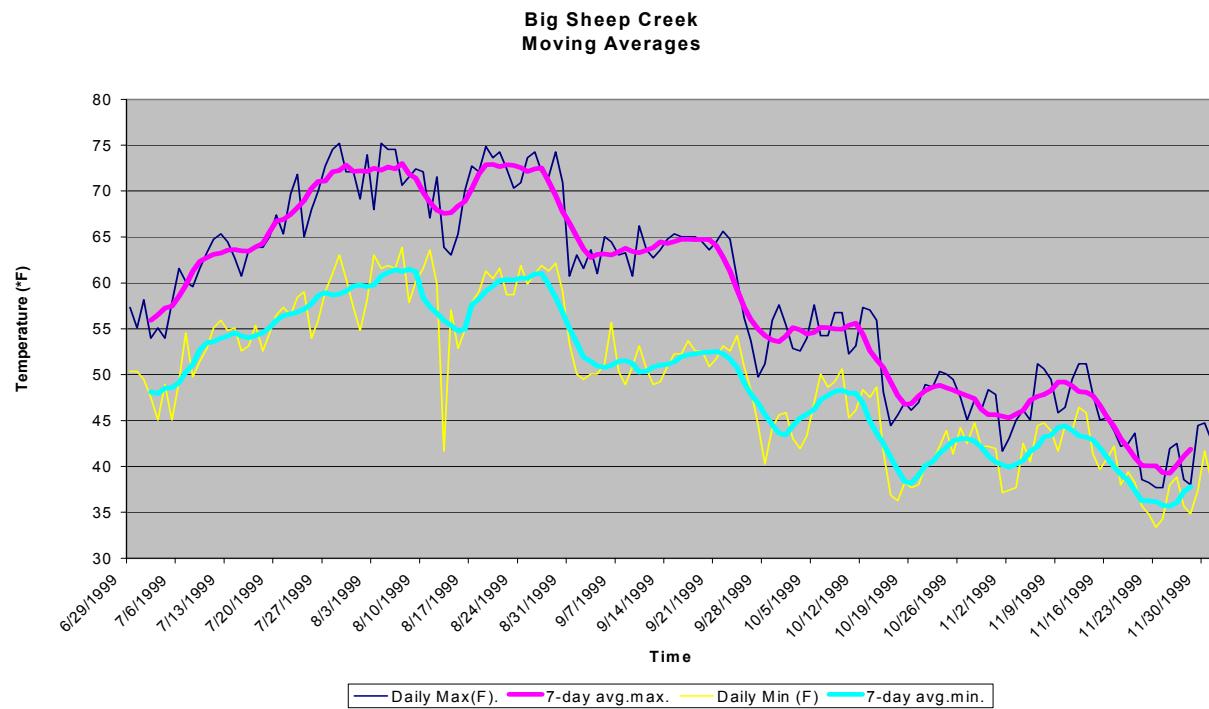
2002 Imanaha River water temperature at rkm 7



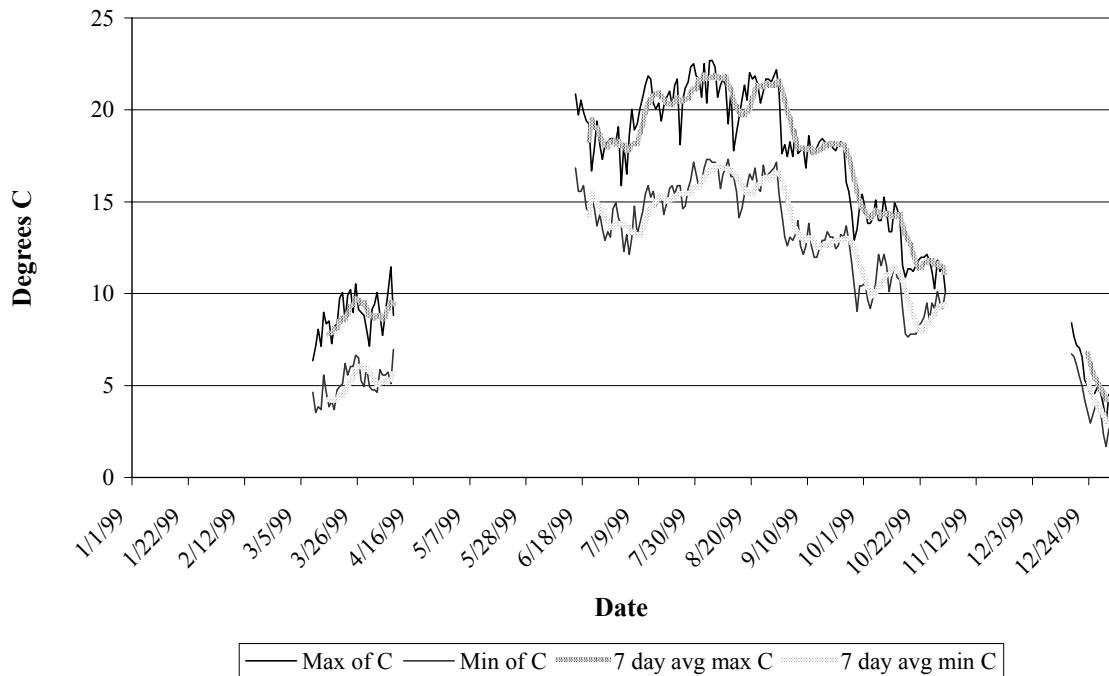
2003 Imnaha River water temperature at rkm 7



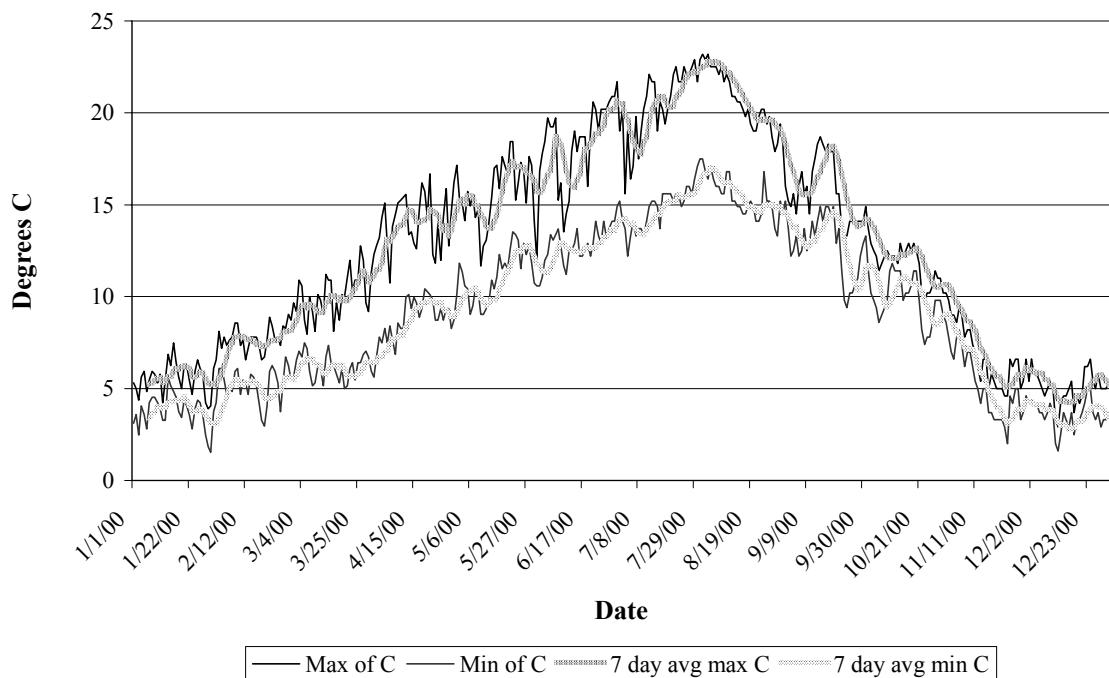
Big Sheep Creek Watershed, Water Temperatures:



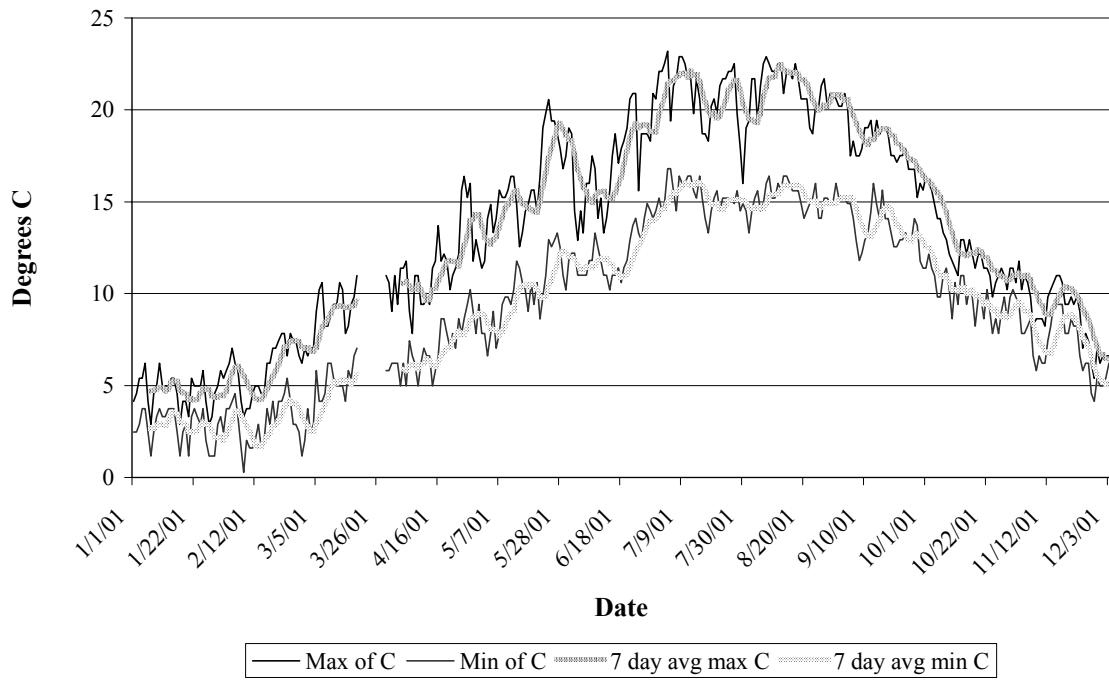
Camp Creek water temperature 1999



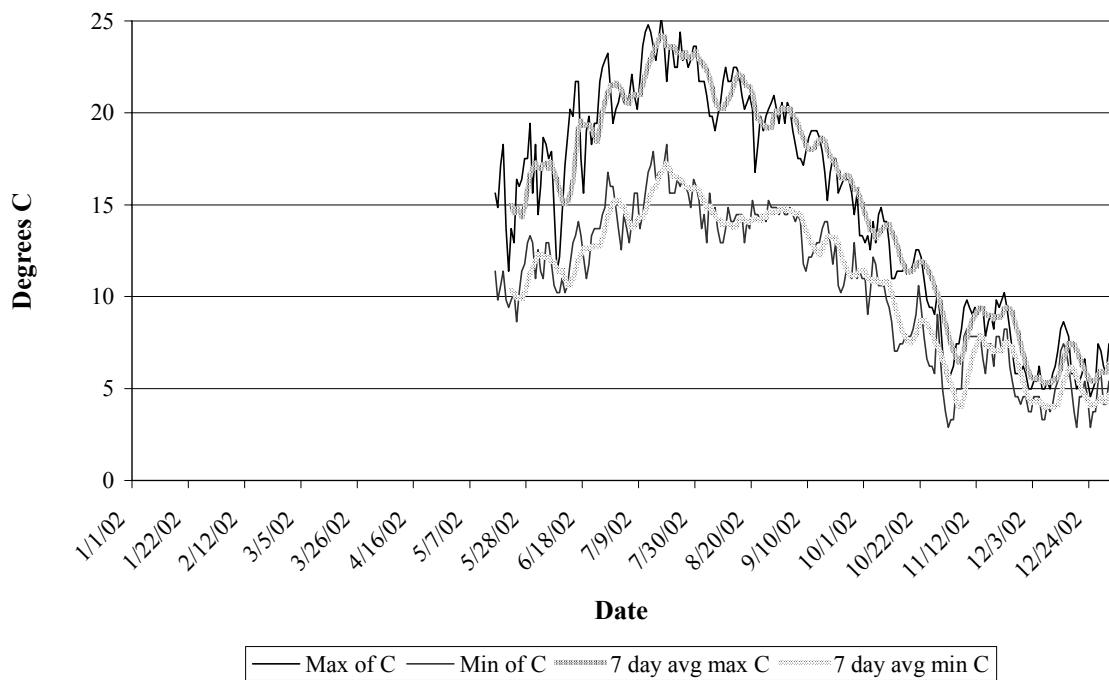
Camp Creek water temperature 2000



Camp Creek water temperature 2001

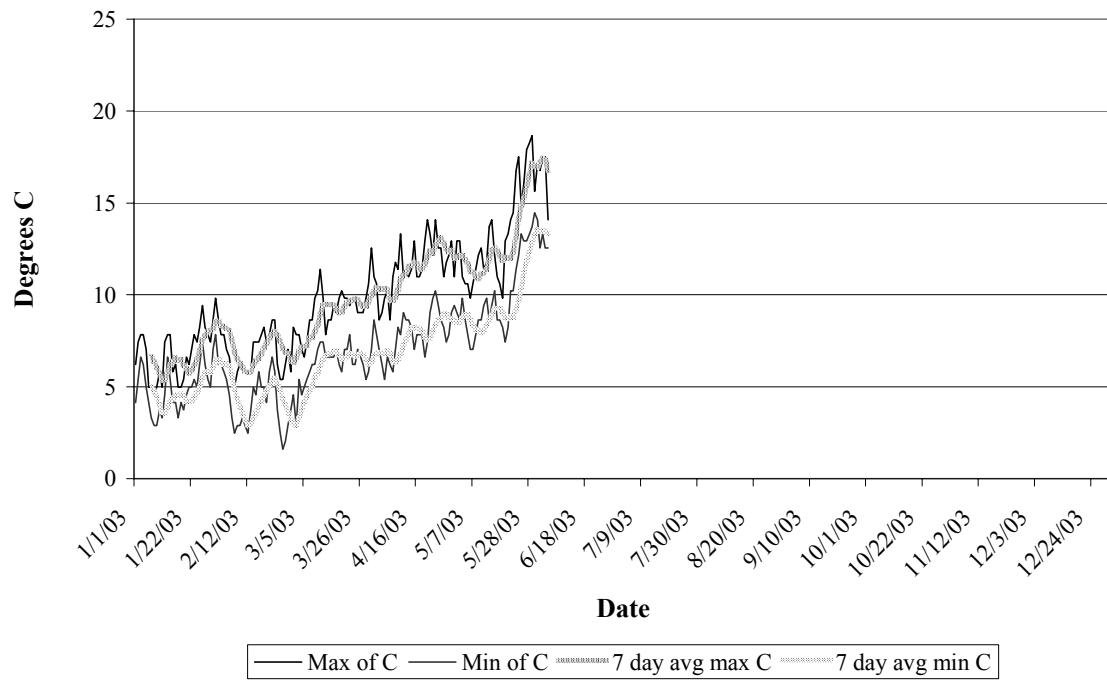


Camp Creek water temperature 2002

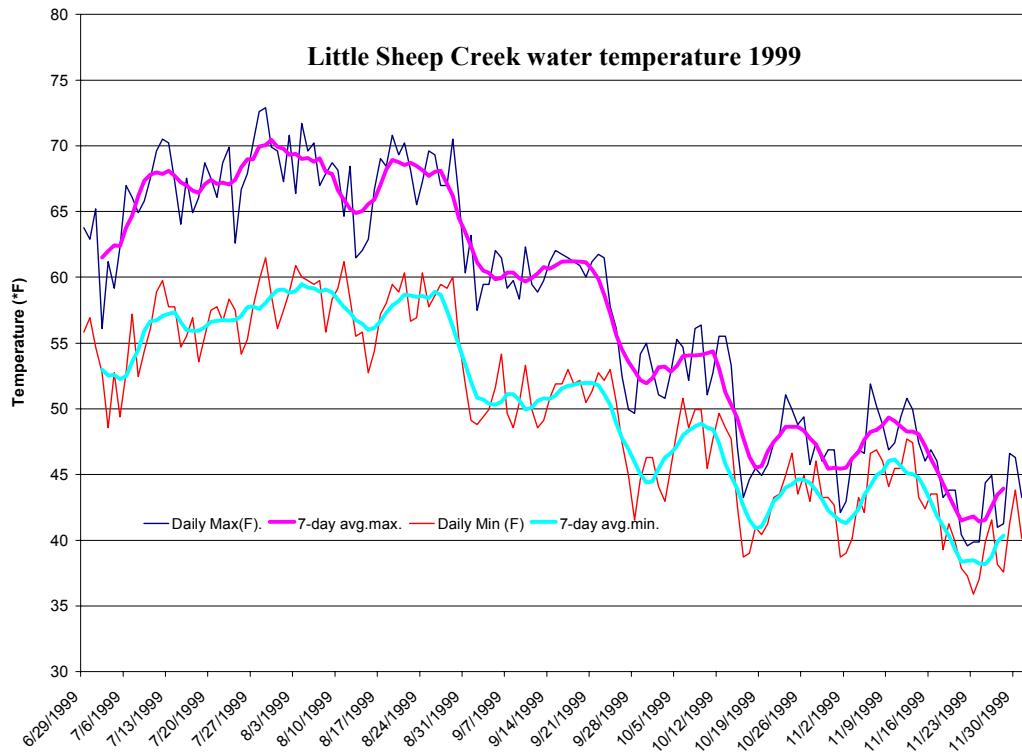


2002 Camp Creek temperature recorder was thrown out of water by some individual in early part of the year.

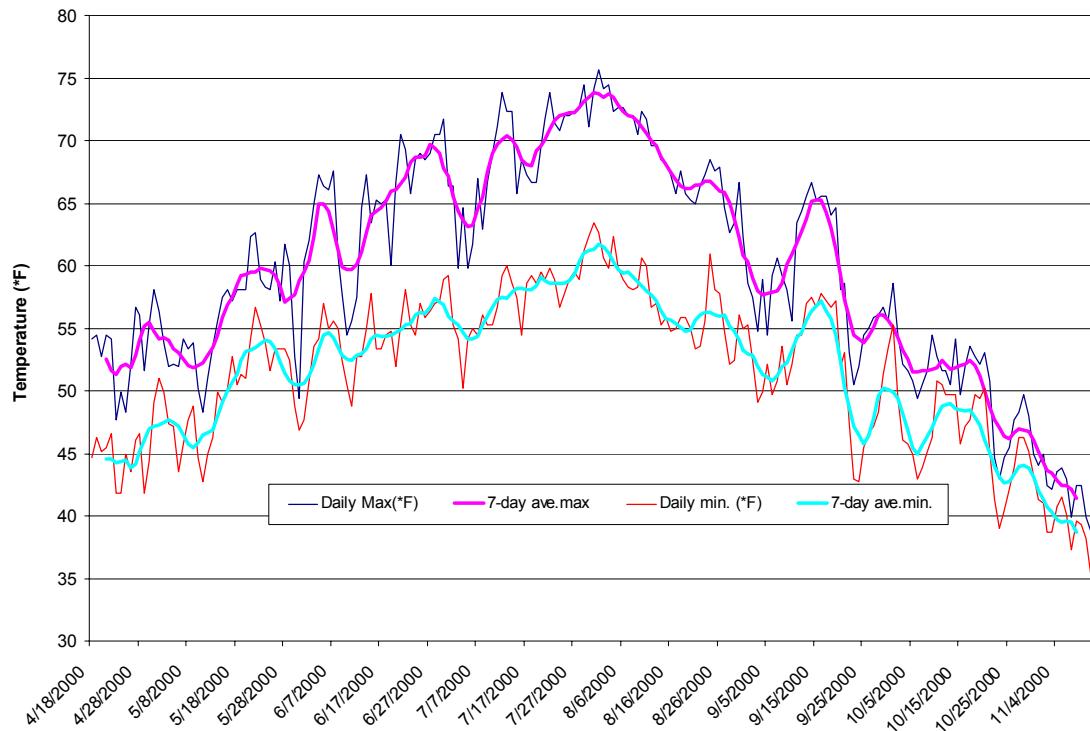
Camp Creek water temperature 2003



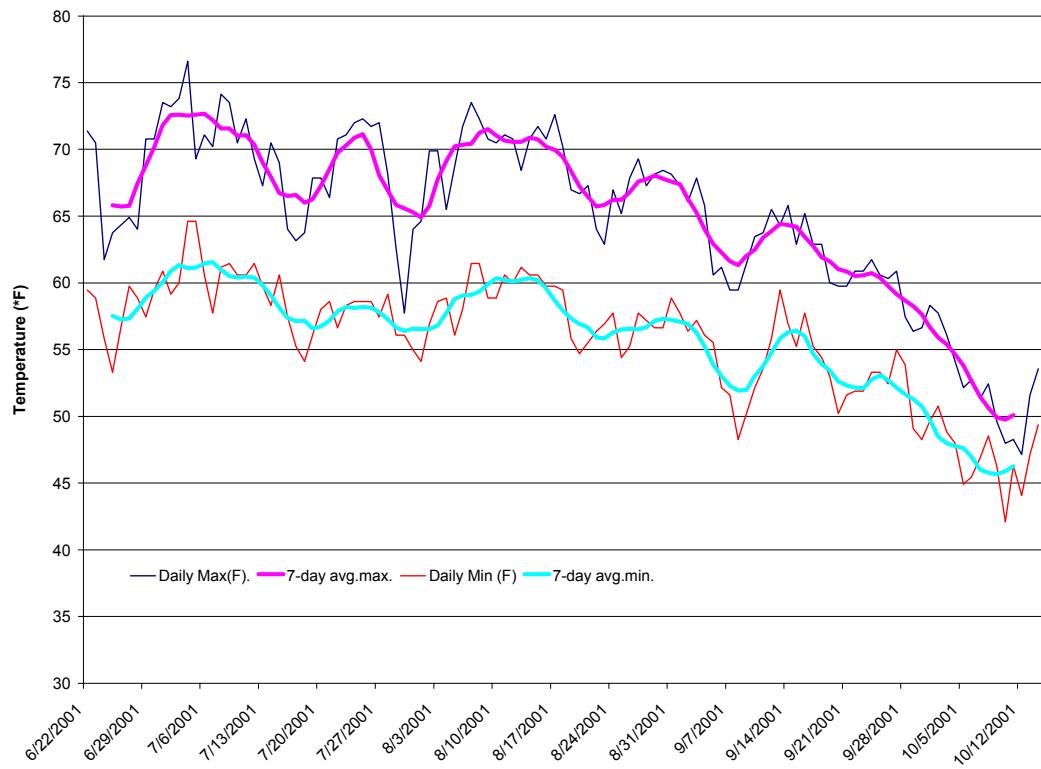
2003 Camp Creek temperature data for last half of year has yet to be downloaded from instrument.



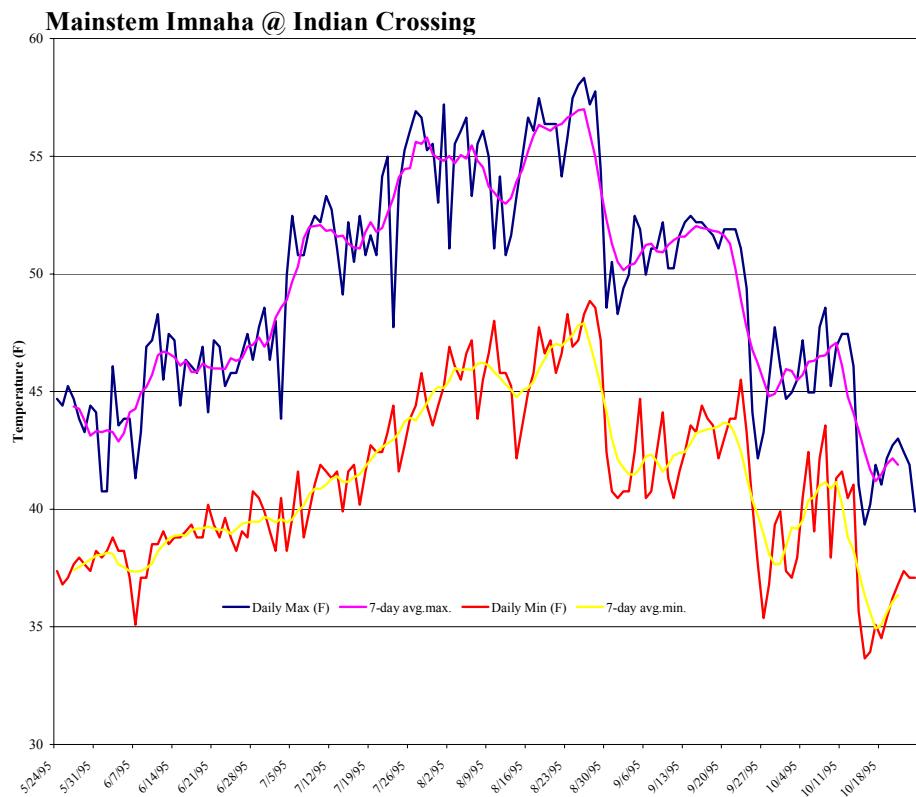
Little Sheep Creek water temperature 2000



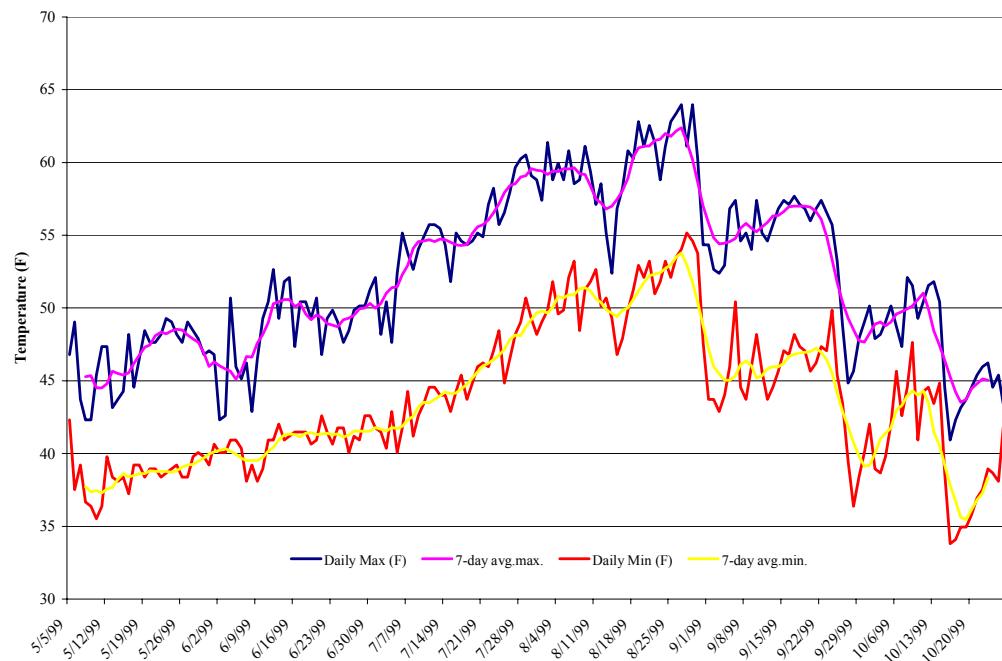
Little Sheep Creek water temperature 2001



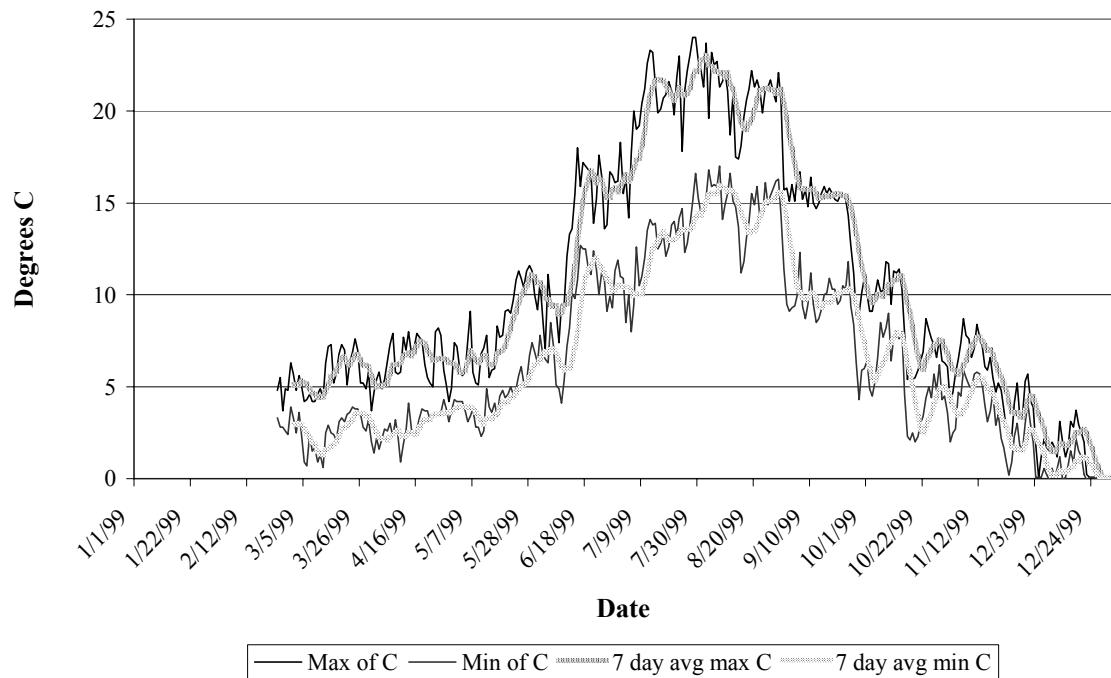
Upper Imnaha Watershed, Water Temperatures:



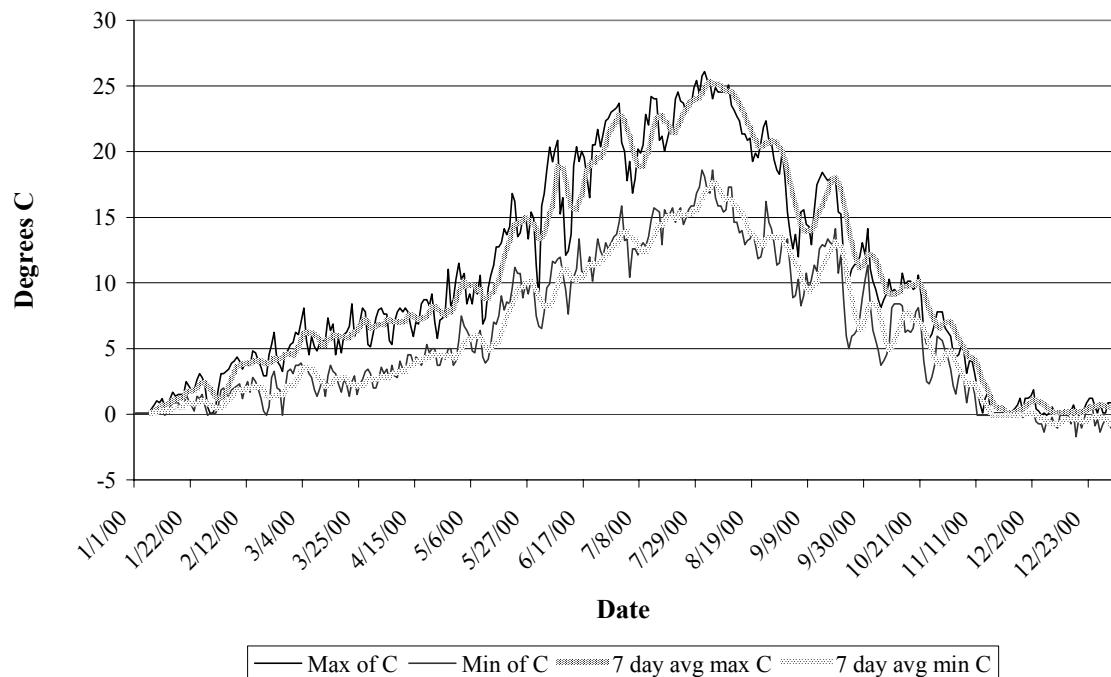
Mainstem Imnaha water temperatures (1999) @ Nine Points Creek



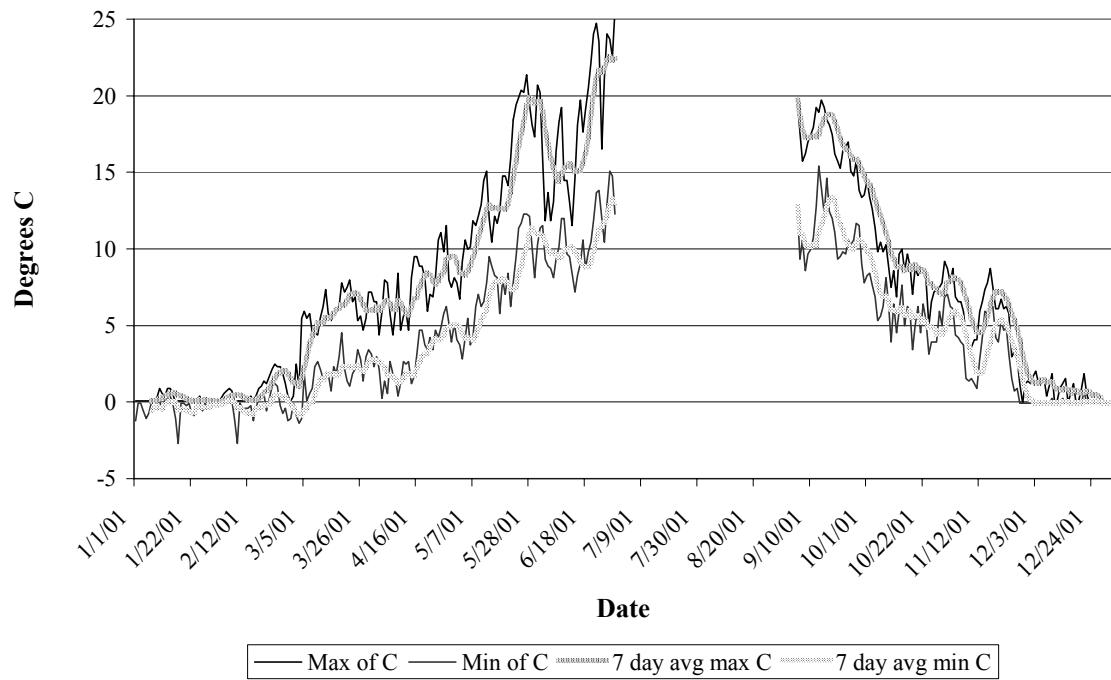
Grouse Creek water temperature 1999



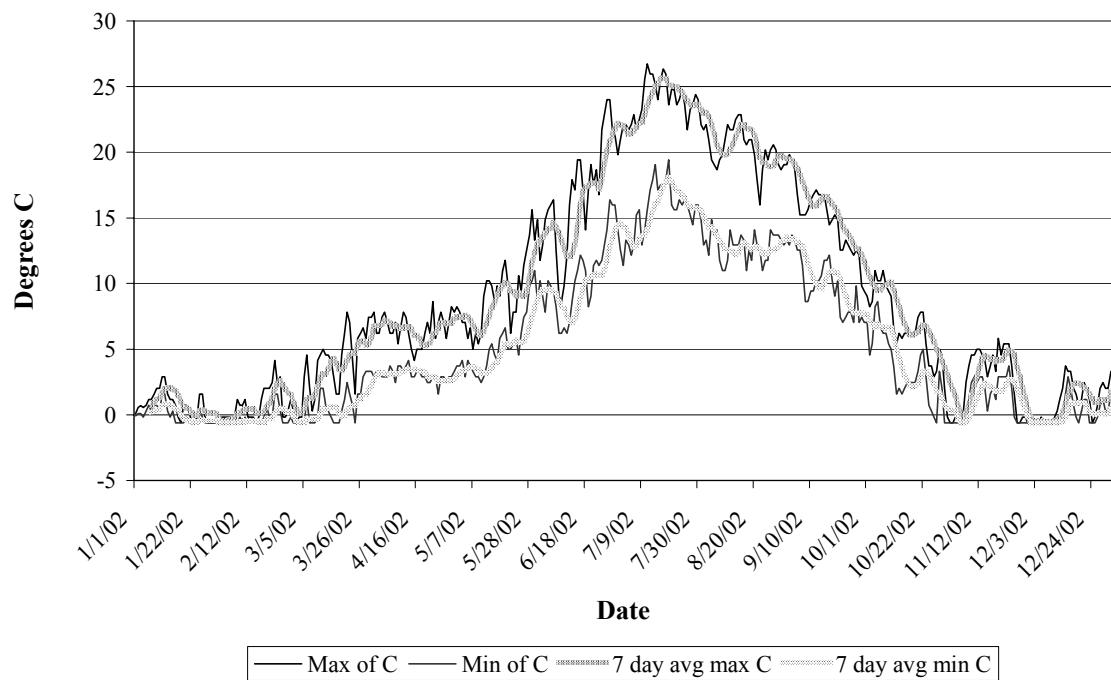
Grouse Creek water temperature 2000



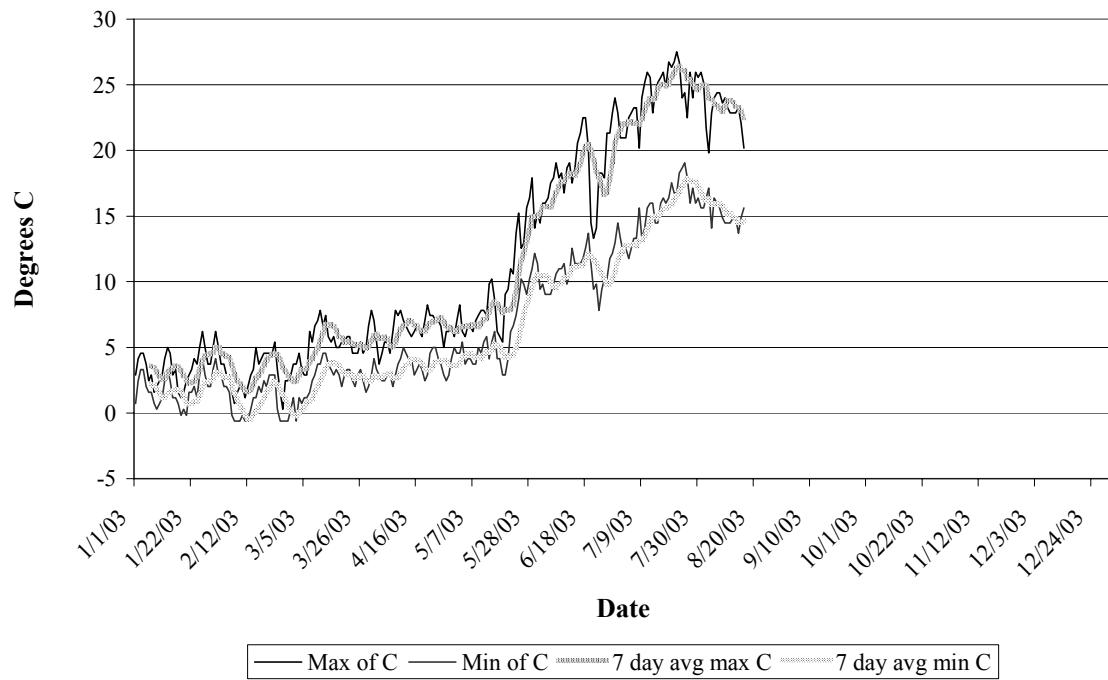
Grouse Creek water temperature 2001



Grouse Creek water temperature 2002

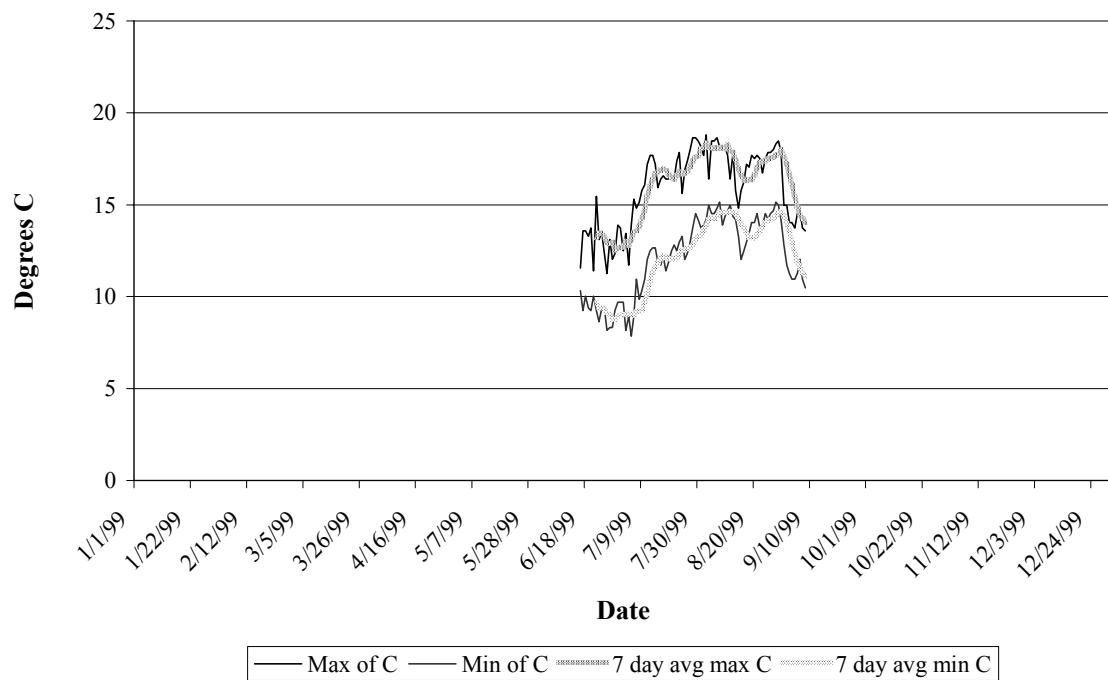


Grouse Creek water temperature 2003

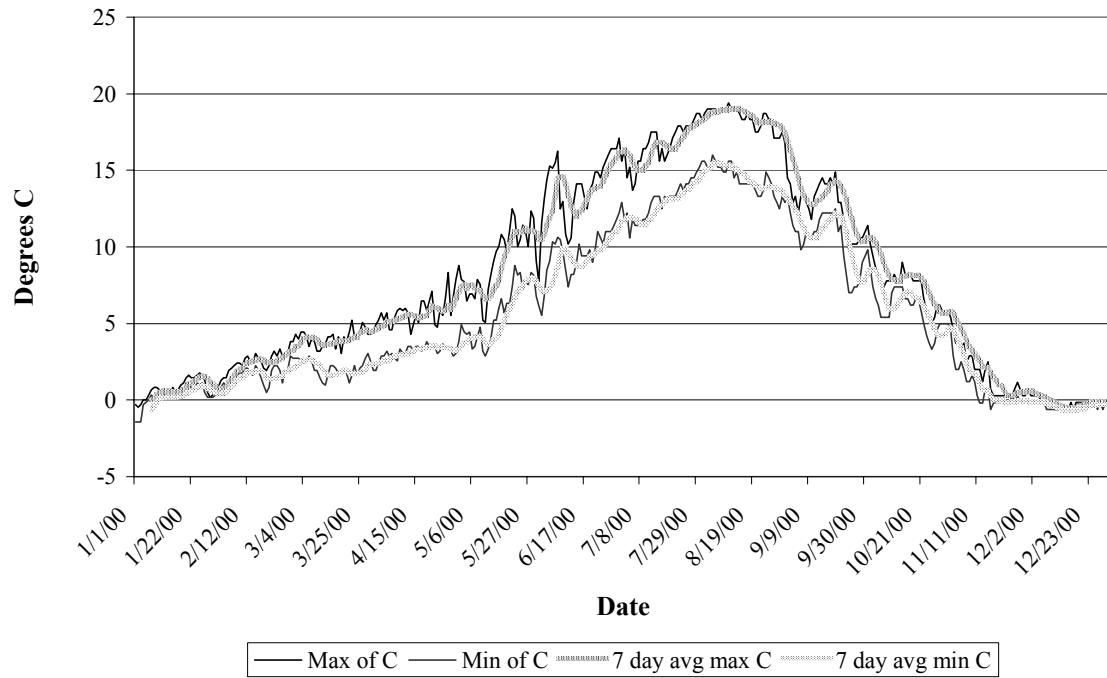


2003 Grouse Creek temperature data for last half of year has yet to be downloaded from instrument.

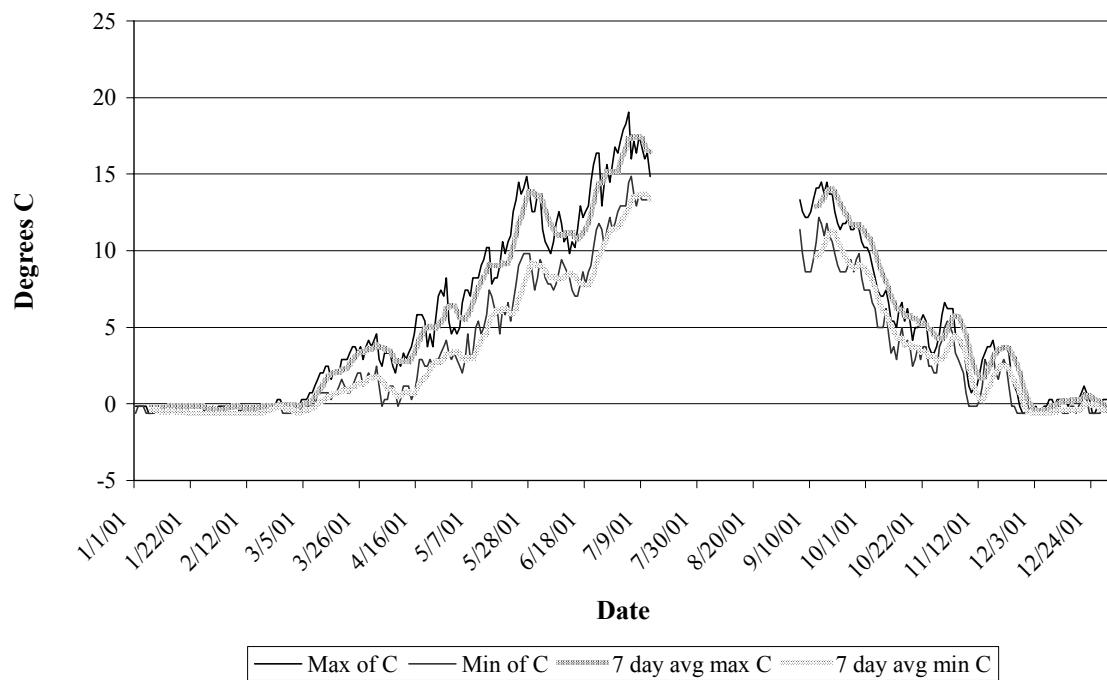
Gumboot Creek water temperature 1999



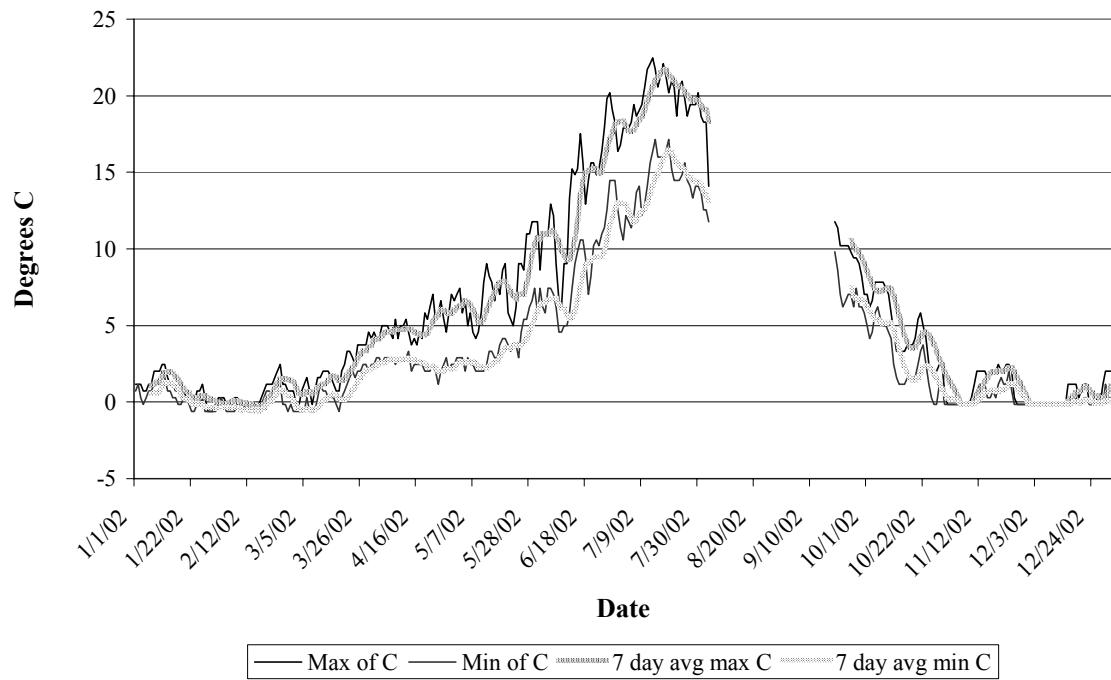
Gumboot Creek water temperature 2000



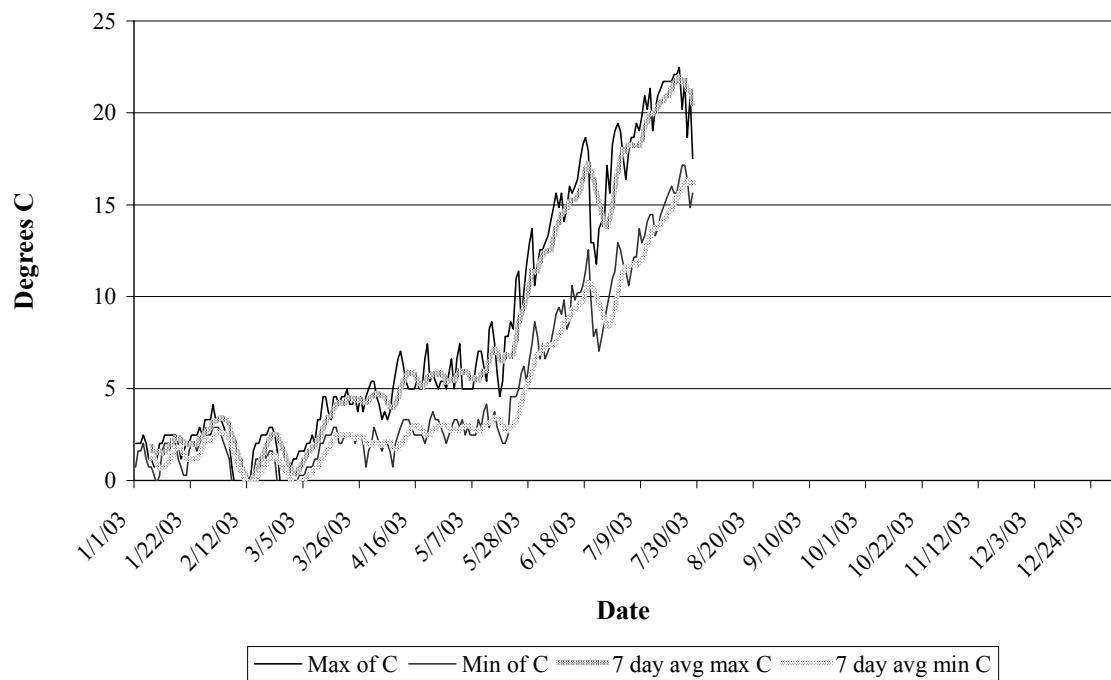
Gumboot Creek water temperature 2001



Gumboot Creek water temperature 2002

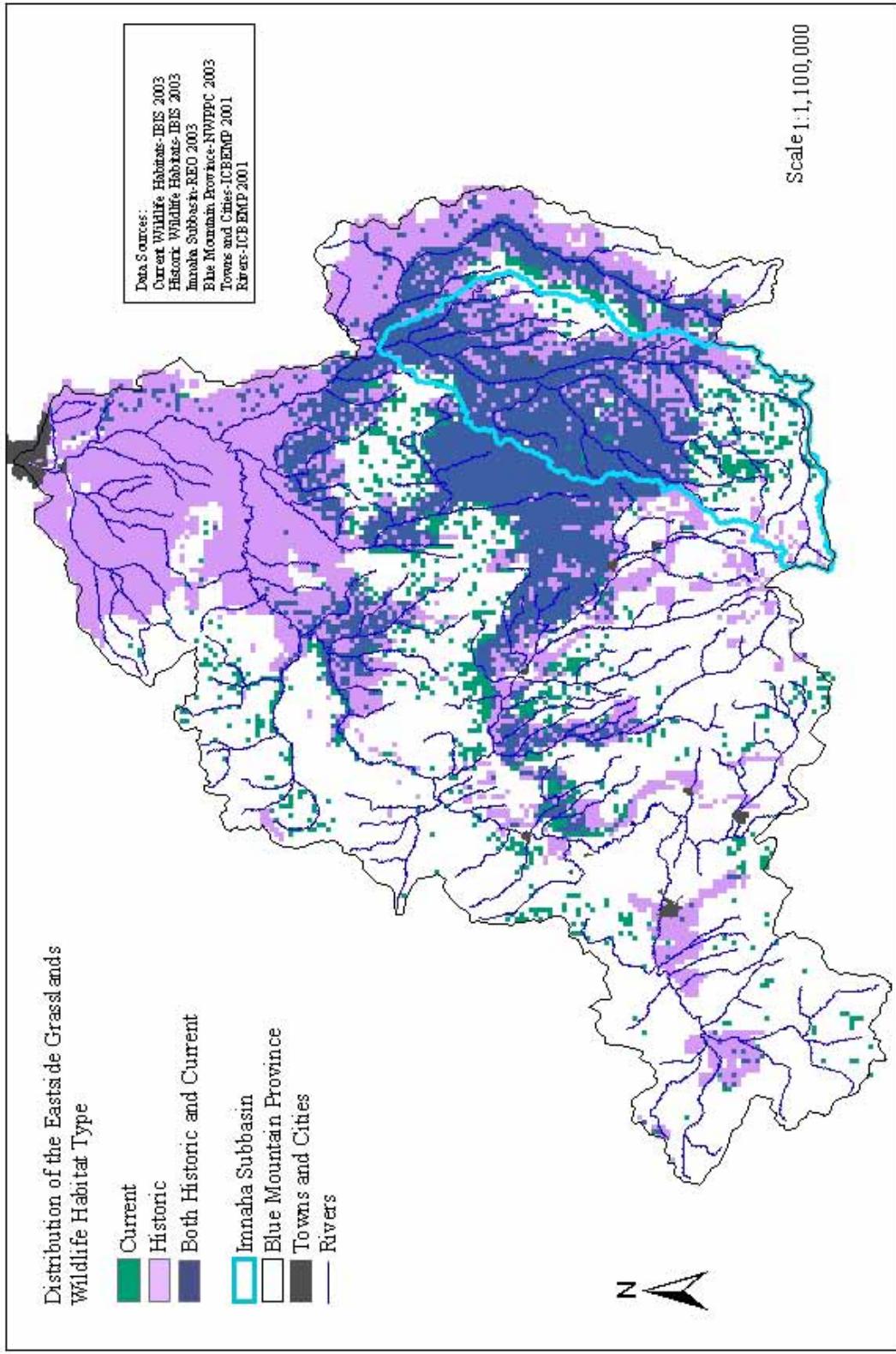


Gumboot Creek water temperature 2003



*2003 Gumboot Creek temperature data for last half of year has yet to be downloaded from instrument.

Appendix D. Comparison of the historical and current distributions for the major wildlife habitat types (WHTs) of the Innaha subbasin and Blue Mountain Ecoprovince.



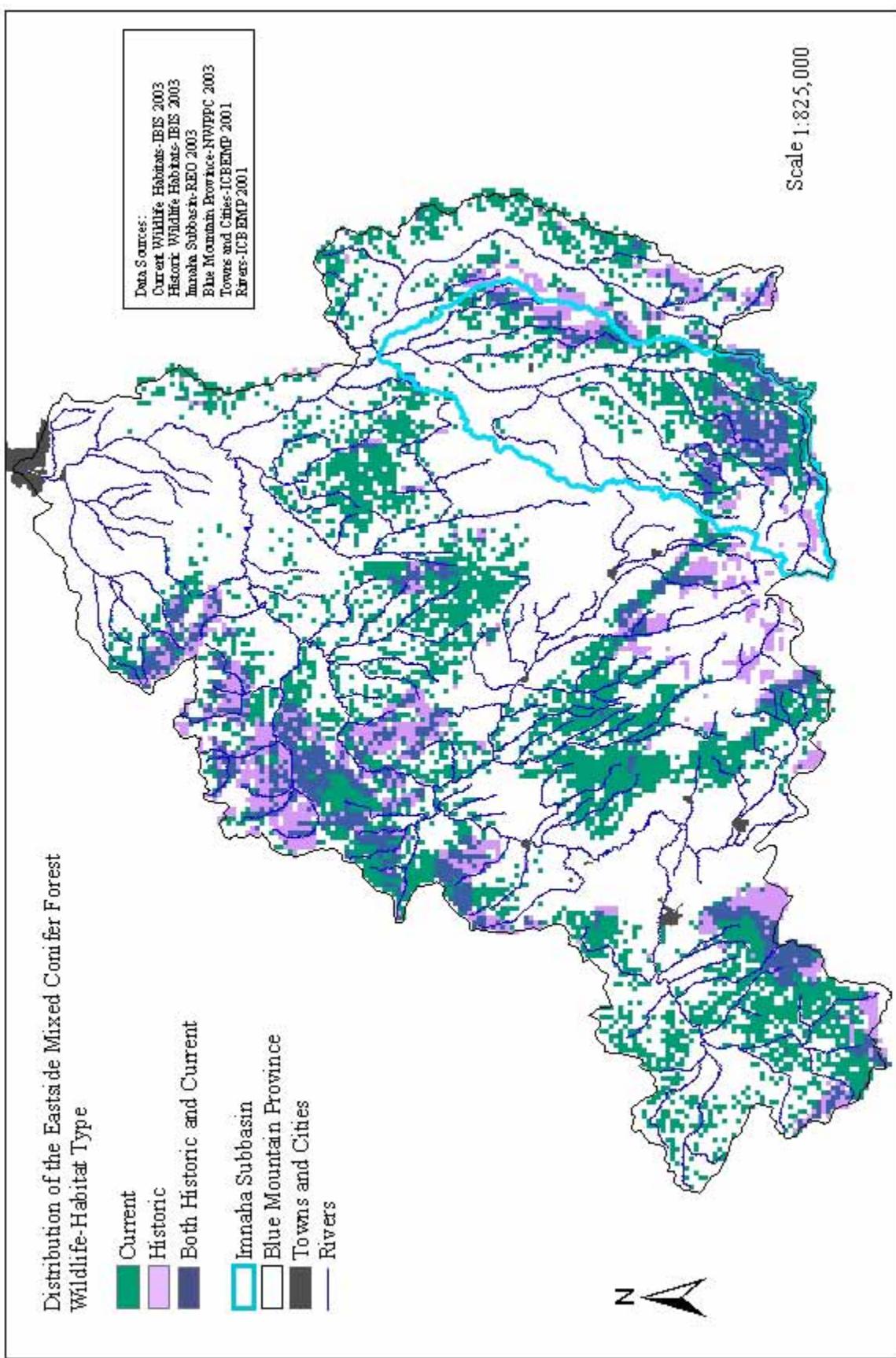
Distribution of the Montane Mixed Conifer Forest
Wildlife-Habitat Type

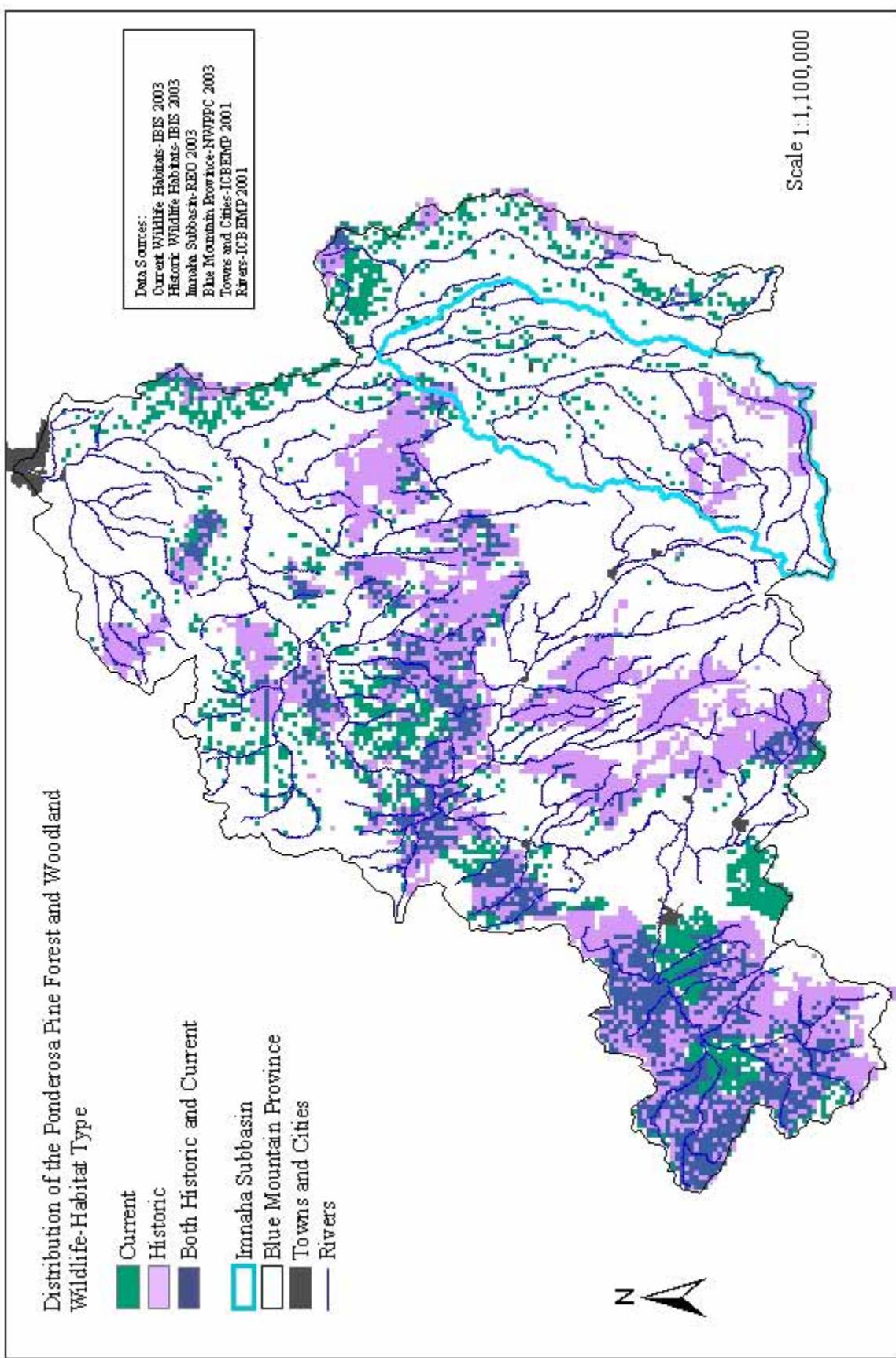
- █ Current
- █ Historic
- █ Both Historic and Current
- █ Imnaha Subbasin
- █ Blue Mountain Province
- █ Towns and Cities
- Rivers

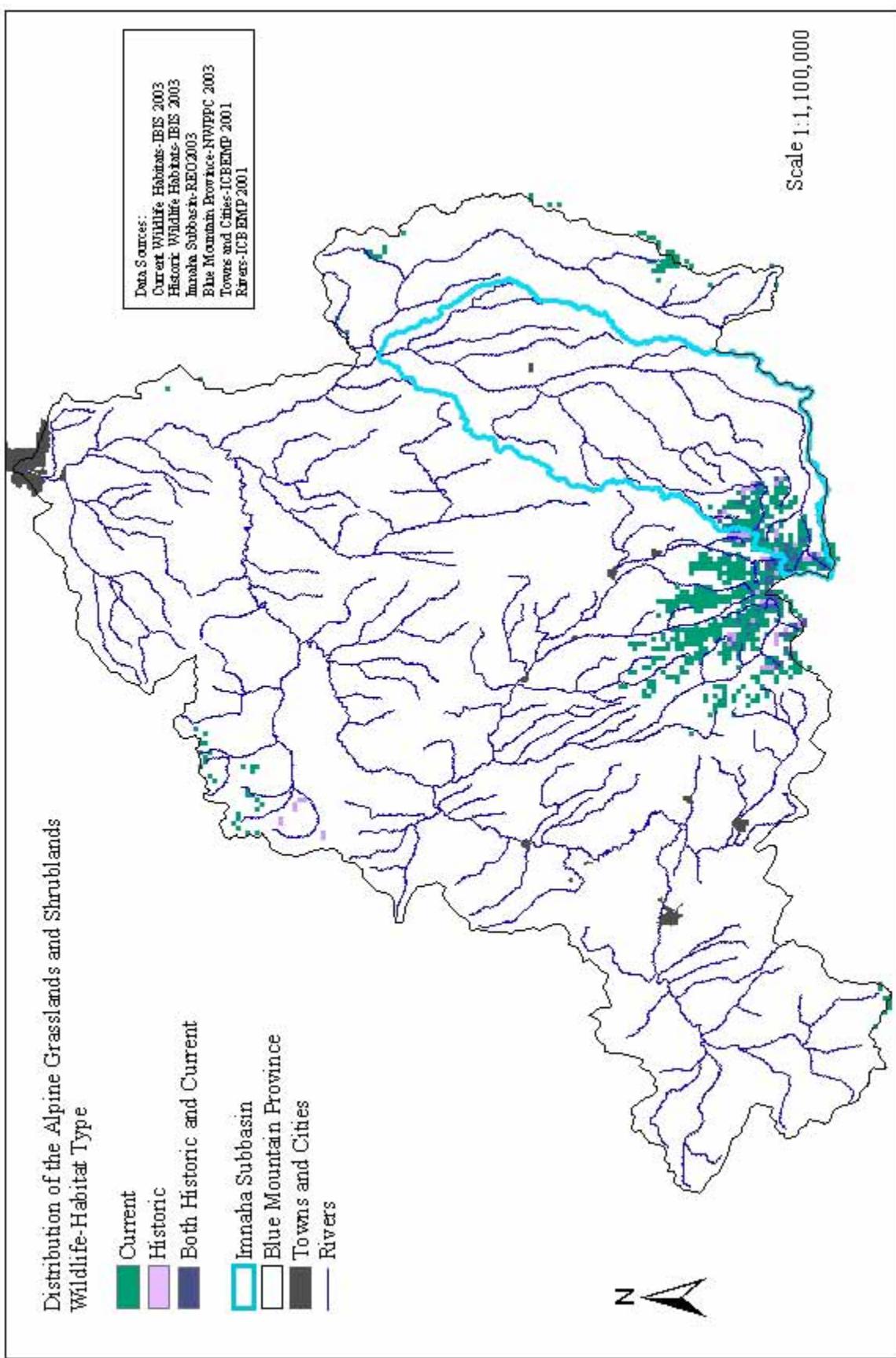
Data Sources:
Current Wildlife Habitats-IBS 2003
Historic Wildlife Habitats-IBS 2003
Imnaha Subbasin-REO 2003
Blue Mountain Province-NWTFPC 2003
Towns and Cities-ICBEMP 2001
Rivers-ICBEMP 2001

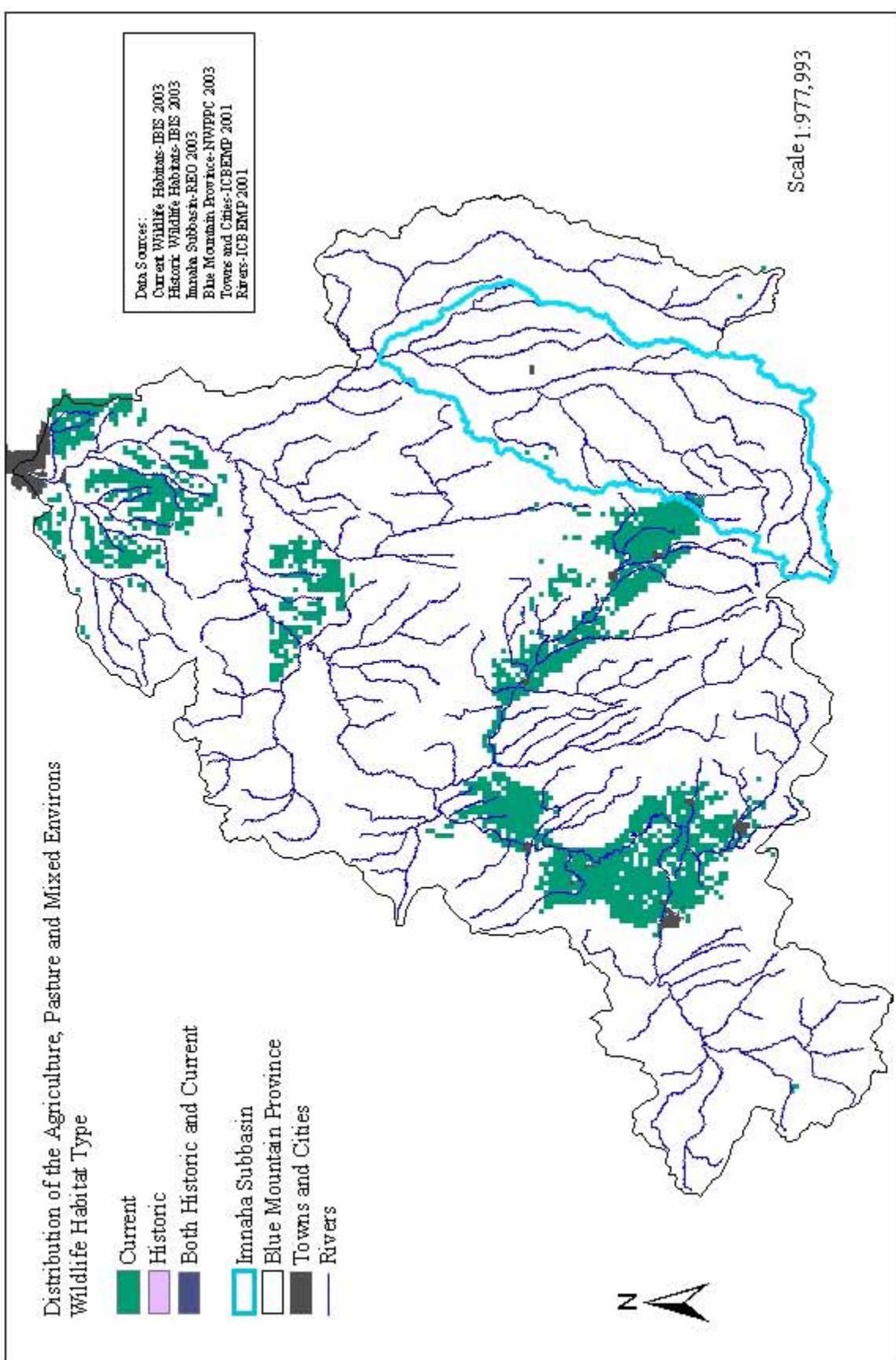
Scale 1:1,100,000











Appendix E. Species that contributed to the selection of portions of the Imnaha subbasin in the conservation Portfolio for the Middle Rockies-Blue Mountain Ecoregion

Appendix Table 3. Species that contributed to the selection of portions of the Imnaha subbasin in the conservation Portfolio for the Middle Rockies-Blue Mountain Ecoregion (TNC 2003).

Common Name	Scientific Name
Fish and Wildlife Species	
Northern goshawk	<i>Accipiter gentilis</i>
White sturgeon	<i>Acipenser transmontanus</i>
Inland tailed frog	<i>Ascaphus montanusi</i>
Grey wolf	<i>Canis lupus</i>
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>
Bobolink	<i>Dolichonyx oryzivorus</i>
American peregrine falcon	<i>Falco peregrinus anatum</i>
Shortface lanx	<i>Fisherola nuttalli</i>
Common loon	<i>Gavia immer</i>
California wolverine	<i>Gulo gulo luscus</i>
Harlequin duck	<i>Histrionicus histrionicus</i>
Wallowa rosy-finches	<i>Leucosticte tephrocotis wallowa</i>
Lynx	<i>Lynx canadensis</i>
Fisher	<i>Martes pennanti</i>
Steelhead	<i>Oncorhynchus mykiss mykiss</i>
Chinook	<i>Oncorhynchus tshawytscha</i>
Mountain quail	<i>Oreortyx pictus</i>
Flammulated owl	<i>Otus flammmeolus</i>
Black-backed woodpecker	<i>Picoides arcticus</i>
Three-toed woodpecker	<i>Picoides tridactylus</i>
Bull trout	<i>Salvelinus confluentus</i>
Pygmy nuthatch	<i>Sitta pygmaea</i>
Siskiyou caddisfly	<i>Tinodes siskiyou</i>
Columbian sharp-tailed grouse	<i>Tympanuchus phasianellus columbianus</i>
Plants	
Wallowa needlegrass	<i>Achnatherum wallowaensis</i>
Swamp onion	<i>Allium madidum</i>
Hells Canyon (eared) rockcress	<i>Arabis hastatula</i>
Wavy (scalloped) moonwort	<i>Botrychium crenulatum</i>
Cusick's camas	<i>Camassia cusickii</i>
Fraterna Indian paintbrush	<i>Castilleja fraterna</i>
Curl-leaf mountain mahogany	<i>Cercocarpus ledifolius</i>
Beaked spikerush	<i>Eleocharis rostellata</i>
Davis' fleabane	<i>Erigeron engelmannii var. davisii</i>
Cliff buckwheat	<i>Eriogonum scopulorum</i>

Common Name	Scientific Name
Hazel's prickly phlox	<i>Leptodactylon pungens</i> ssp. <i>hazeliae</i>
Blue mountain biscuitroot	<i>Lomatium oreganum</i>
Membrane-leaved (thinsepal) monkeyflower	<i>Mimulus hymenophyllum</i>
Stalk-leaved monkeyflower	<i>Mimulus patulus</i>
MacFarlane's four o'clock	<i>Mirabilis macfarlanei</i>
Least (small) phacelia	<i>Phacelia minutissima</i>
Barton's raspberry	<i>Rubus bartonianus</i>
Spalding's silene	<i>Silene spaldingii</i>
Sand dropseed	<i>Sporobolus cryptandrus</i>
Plant Associations and Habitats	
Grand fir	<i>Abies grandis</i>
Grand fir/Idaho goldthread	<i>Abies grandis/Coptis occidentalis</i>
Subalpine fir	<i>Abies lasiocarpa</i>
Subalpine fir/whitebark pine	<i>Abies lasiocarpa/Pinus albicaulis</i>
Netleaf hackberry/bluebunch wheatgrass	<i>Celtis reticulata/Pseudoroegneria spicata</i>
Curl-leaf mountain mahogany/mountain snowberry	<i>Cercocarpus ledifolius/Symphoricarpos oreophilus</i>
Onespike danthonia/Sandberg bluegrass	<i>Danthonia unispicata/Poa secunda</i>
Parsnipflower buckwheat/bluebunch wheatgrass	<i>Eriogonum heracleoides/Pseudoregneria spicata</i>
Western larch	<i>Larix occidentalis</i>
Lodgepole pine	<i>Pinus contorta</i>
Ponderosa Pine Forest and Woodland	<i>Pinus ponderosa</i>
Quaking aspen, black hawthorn, common snowberry	<i>Populus tremuloides/Crataegus douglasii/Symphoricarpos albus</i>
Douglas-fir	<i>Pseudotsuga menziesii</i>
Douglas-fir/brand fir	<i>Pseudotsuga menziesii/Abies grandis</i>
Douglas-fir/lodgepole pine	<i>Pseudotsuga menziesii/Pinus contorta</i>
Western red cedar	<i>Thuja plicata</i>
Alpine	various
Badlands/Breaks	various
Bitterbrush	various
Canyon Grasslands	various
Mesic Upland Shrubs	various
Mixed Mesic Forest	various
Mixed Sagebrush Steppe	various
Native Grass or Forb	various
Subalpine Meadow	various

Appendix F. Federal Species of Concern-Wallowa County

Mammals

Pale western big-eared bat
Pacific big-eared bat
California wolverine
Silver-haired bat
Pacific fisher
Small-footed myotis (bat)
Long-eared myotis (bat)
Fringed myotis (bat)
Long-legged myotis (bat)
Yuma myotis (bat)
California bighorn sheep
Preble's shrew

Corynorhinus (=*Plecotus*) *townsendii pallescens*
Corynorhinus (=*Plecotus*) *townsendii townsendii*
Gulo gulo luteus
Lasionycteris noctivagans
Martes pennanti pacifica
Myotis ciliolabrum
Myotis evotis
Myotis thysanodes
Myotis volans
Myotis yumanensis
Ovis canadensis californiana
Sorex preblei

Birds

Northern goshawk
Western burrowing owl
Ferruginous hawk
Olive-sided flycatcher
Willow flycatcher
Harlequin duck
Yellow-breasted chat
Lewis' woodpecker
Mountain quail
White-headed woodpecker
Columbian sharp-tailed grouse

Accipiter gentilis
Athene cunicularia hypugea
Buteo regalis
Contopus cooperi (=*borealis*)
Empidonax traillii adastus
Histrionicus histrionicus
Icteria virens
Melanerpes lewis
Oreortyx pictus
Picoides albolarvatus
Tympanuchus phasianellus columbianus

Amphibians and Reptiles

Tailed frog

Ascaphus truei

Fish

Pacific lamprey
Interior redband trout

Lampetra tridentata
Oncorhynchus mykiss gibbsi

Invertebrates

Great Columbia River spire snail
Siskiyou caddisfly

Fluminicola columbianus
Tinodes siskiyou

Plants

Wallowa ricegrass
Blue Mountain onion
Hells Canyon rockcress
Upward-lobed moonwort
Crenulate grape fern
Twinspike moonwort
Stalked moonwort
Fraternal paintbrush
Purple alpine paintbrush
Hazel's prickly-phlox
Greenman's desert parsley
Membrane-leaved monkeyflower

Achnatherum wallowaensis
Allium dictuon
Arabis hastatula
Botrychium ascendens
Botrychium crenulatum
Botrychium paradoxum
Botrychium pedunculosum
Castilleja fraterna
Castilleja rubidia
Leptodactylon pungens ssp. *hazeliae*
Lomatium greenmanii
Mimulus hymenophyllum

Appendix G. PACFISH/INNFISH PFC Matrix

Appendix Table 4. Matrix of pathways and indicators (reproduced from (National Marine Fisheries Service 1996)

Pathway/Indicators	Properly Functioning	At Risk	Water Quality	Not Properly Functioning
Temperature (1)	50-57°F (max 7-day average)	57-60°F (max 7-day-spawning) 57-64°F (migration/rearing)	>60°F (max 7-day spawning) >64°F (migration/rearing)	
Sediment/Substrate (1)	Embeddedness <20%. Dominant substrate is gravel or cobble. Gravel/cobble bars stable. Turbidity low.	Embeddedness 20-30%. Gravel and cobble is subdominant. Gravel/cobble bars are in the process of stabilizing. Turbidity moderate.	Embeddedness >30%. Bedrock, sand, silt, or small gravel dominant. Gravel/cobble bars very mobile. Turbidity high.	
Chemical Contamination	Low levels of chemical contamination; no CWA 303(d) designated reaches.	Moderate levels of chemical contamination; one CWA 303(d) designated reach.	High levels of chemical contamination; more than one CWA 303(d) designated reach.	
Physical Barriers	Man-made barriers do not restrict fish passage.	Man-made barriers present restrict fish passage at base/low flows.	Man-made barriers present restrict fish passage at a range of flow conditions.	Man-made barriers present restrict fish passage at a range of flow conditions.
	Habitat Access	Habitat Elements		
Large Woody Material (1) >20 pieces/mi.	Meets standards (left). Adequate sources for LWM recruitment from riparian areas.	Currently meets standards for properly functioning, but lacks potential sources from riparian areas of LWM recruitment to maintain that standard, <i>or</i> Doesn't meet standard, but has recruitment potential.	Does not meet standards for properly functioning and lacks potential LWM recruitment.	Does not meet standards for properly functioning and lacks potential LWM recruitment.
Pool Frequency and Quality (1) Width (ft.) Pools/mi.	Meets pool frequency standards (left) and LWM recruitment standards for properly functioning habitat, or has adequate flow and bedrock to maintain pools. Residual (holding) pool depth greater than 3 meters with good cover and cool water. Minor reduction of pool volume by fine sediment acceptable.	Mets pool frequency standards (left) but LWM recruitment standards inadequate to maintain pools over time. Lacks adequate flow or bedrock to form stable pools. Residual (holding) pool depth less than 3 meters with less than adequate cover/temperature. Moderate reduction in pool volume by fine sediment.	Does not meet pool frequency standards. Does not contain deep pools. Pool volumes are reduced by fine sediment.	Does not meet pool frequency standards. Does not contain deep pools. Pool volumes are reduced by fine sediment.
Off-Channel Habitat	Natural potential <i>or</i> backwaters with cover and low energy off-channel areas	Some backwater and high-energy side channels.	Few or no backwaters; no off-channel ponds.	
Refugia	Habitat refugia exists and are buffered	Habitat refugia exists but are not adequately buffered	Habitat refugia does not exist.	
	Channel Conditions and Dynamics			
Width:Depth ratio (1)	Meet Rosgen's classification system (Rosgen 1996).	Does not meet Rosgen's classification system, but morphology/vegetation components are in place and system is moving towards meeting this classification.	Does not meet Rosgen's classification system and morphology/vegetation components are not in place.	
Streambank Condition (1)	>90% stable.	80-90% stable.	<80% stable.	Severe reduction in hydrologic connectivity. Wetland functions degraded, where channel type allows formation of wetlands.
Floodplain Connectivity	Off-channel areas are hydrologically connected to the main channel. Overbank flows occur and maintain wetland functions, riparian vegetation and succession, where channel type allows.	Reduced linkage of wetland floodplains. Overbank flows are reduced relative to historic frequency as evidenced by moderate degradation of wetland function, where channel type allows formation of wetlands.		

Pathway/Indicators	Properly Functioning	At Risk	Not Properly Functioning
Hydrology			
Changes in Peak/Base Flow	Watershed hydrographs indicated peak flow, base flow, and flow timing characteristics comparable to an undisturbed watershed.	Some evidence of altered peak flow, base flow, and/or flow timing.	Pronounced changes in peak flow, base flow, and/or flow timing.
Increase in Drainage Network	Zero or minimum increase in drainage network density due to roads.	Moderate increases in drainage network density due to roads (5%).	Significant increases in drainage network density due to roads (>20%).
Watershed Conditions			
Road Density and Location	<2 mi/sq.mi.; no valley bottom roads.	2-3 mi/sq.mi.; some valley bottom roads.	>3 mi/sq.mi.; many valley bottom roads.
Disturbance History	<15% ECA with no concentration of disturbance in unstable areas or riparian areas.	<15% ECA with some disturbance in unstable areas or riparian areas.	>15% ECA with disturbance concentrated in unstable areas or riparian areas.
Riparian Reserves	Riparian reserves provide shade, LWM recruitment, habitat protection, and connectivity in all subwatersheds. Riparian plant community has the vigor, health, composition and diversity to support riparian reserve values.	Moderate loss of connectivity or function of riparian reserves. Riparian plant community lacking the vigor, health, composition and/or diversity to support riparian reserve values, but is in an upward trend.	Riparian reserves are fragmented with poor connectivity and little protection of habitats. Riparian plant community lacking the vigor, health, composition and/or diversity to support riparian reserve values, and is in a static or downward trend.

Appendix H. Descriptions of Forest and Grassland Structural Conditions (Johnson and O'Neil 2001).

Table 111. Descriptions of structural conditions in forest habitats

Structural Condition	Description
Grass/Forb– Open	Grass/Forb dominated with <70% coverage by grasses and forbs. Shrubs and small seedlings may be present, but do not dominate stand, (seedlings < 10% canopy cover), and there can be remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover.
Grass/Forb– Closed	Grass/Forb dominated with >70% coverage by grasses and forbs. Shrubs and small seedlings may be present, but do not dominate stand, (seedlings < 10% canopy cover), and there can be remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover.
Shrub/Seedling– Open	Seedlings are large enough to add structure to the stand but are small enough that the structure is similar to shrubs and may have remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover. There is <70% cover of shrubs or seedlings. Tree size has <1" dbh, and there is only a single canopy stratum.
Shrub/Seedling– Closed	Seedlings are large enough to add structure to the stand but are small enough that the structure is similar to shrubs. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is >70% cover of shrubs or seedlings. Tree size has <1" dbh, and there is only a single canopy stratum.
Sapling/Pole– Open	The canopy is open enough that understory vegetation may be abundant. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of sapling and pole-sized trees. Tree size is 1"-9" dbh, and there is a single canopy stratum.
Sapling/Pole– Moderate	Understory development is hampered by available light and moisture. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of sapling and pole-sized trees. Tree size is 1"-9" dbh, and there is a single canopy stratum.
Sapling/Pole– Closed	The understory is depauperate or absent. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is > 70% cover of sapling and pole-sized trees. Tree size is 1"-9" dbh and there is a single canopy stratum.
Small Tree– Single Story– Open	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of small trees, with <10% cover of other tree sizes. Tree size is 10-14" dbh, and there is a single canopy stratum.
Small Tree– Single Story– Moderate	Some grass/forb or shrub understory may be present. Remnant trees (green trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of small trees with <10% cover of other sized trees. Tree size is 10-14" dbh, and there is a single canopy stratum.
Small Tree– Single Story– Closed	Grass/Forb or shrub understory minor or absent. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is > 70% cover of small trees, with <10% cover of other sized trees. Tree size is 10-14" dbh, and there is a single canopy stratum.

Structural Condition	Description
Medium Tree-Single Story-Open	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of medium trees, with <10% cover of other sized trees. Tree size is 15-19" dbh, and there is a single canopy stratum.
Medium Tree-Single Story-Moderate	Grass/Forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of medium trees with <10% cover of other sized trees. Tree size is 15-19" dbh, and there is a single canopy stratum.
Medium Tree-Single Story-Closed	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is >70% cover of medium trees with <10% cover of other sized trees. Tree size is 15-19" dbh, and there is a single canopy stratum.
Large Tree-Single Story-Open	Grasses, shrubs, and/or seedlings may occur in the understory. There is 10-39% cover of large and/or giant size trees with <10% cover of other sized trees. Tree size is 20"-29" dbh, and there is a single canopy stratum.
Large Tree-Single Story-Moderate	Some grass/forb or shrub understory may be present. There is 40-69% cover of large and/or giant trees with <10% cover of other sized trees. Tree size is 20"-29" dbh, and there is a single canopy stratum.
Large Tree-Single Story-Closed	Grasses, shrubs, and/or seedlings may occur in the understory. There is >70% cover of large and/or giant trees with <10% cover of other sized trees. Tree size is 20"-29" dbh, and there is a single canopy stratum.
Small Tree-Multistory-Moderate	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 10-39% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10"-14" dbh, and there are two or more canopy strata.
Small Tree-Multistory-Moderate	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 40-69% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10"-14" dbh, and there are two or more canopy strata.
Small Tree-Multistory-Closed	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory extremely limited or absent. There is >70% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10-14" dbh, and there are two or more canopy strata.

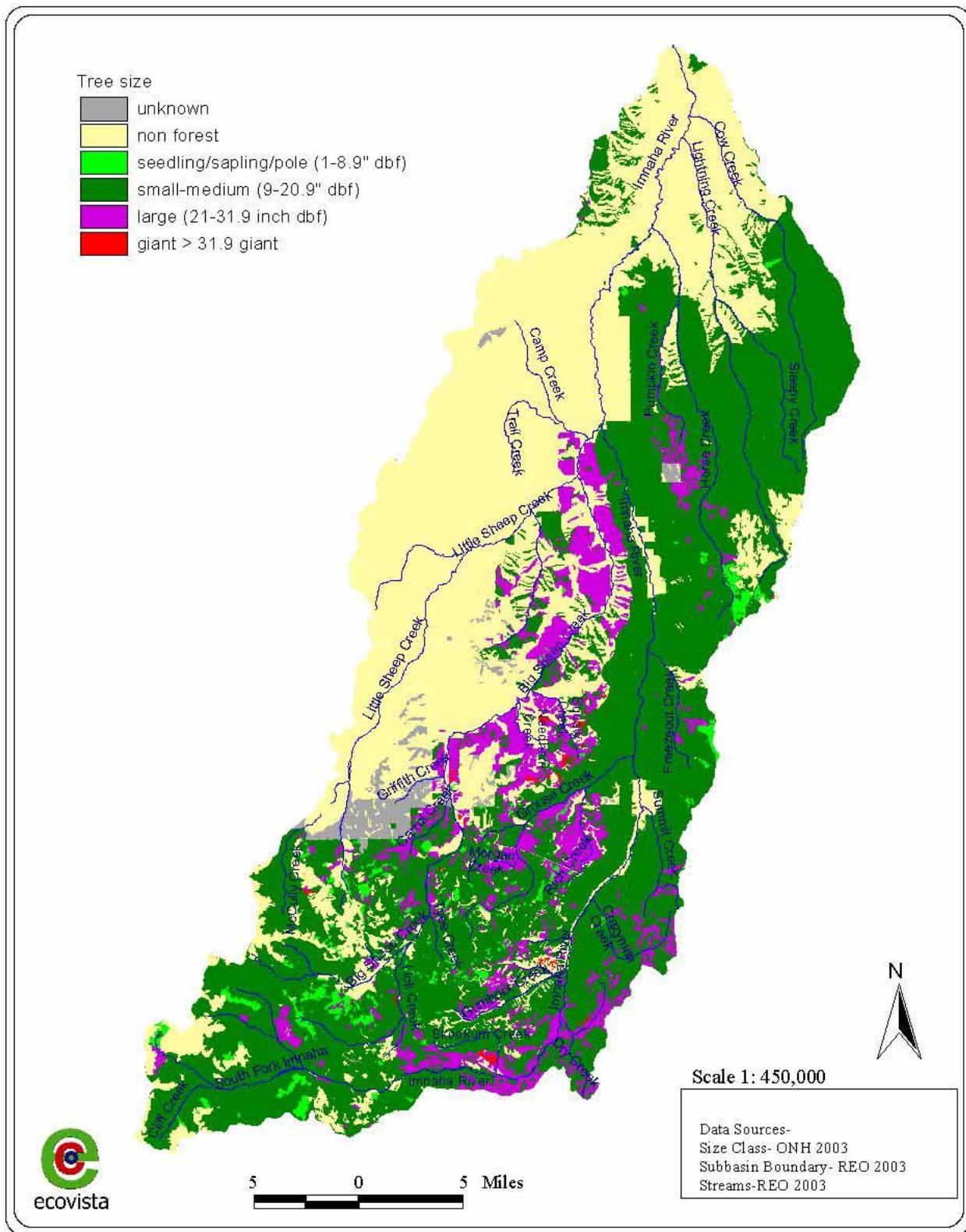
Structural Condition	Description
Medium Tree - Multistory- Open	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 10-39% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15"-19" dbh, and there are two or more canopy strata.
Medium Tree- Multistory- Moderate	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 40-69% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15"-19" dbh, and there are two or more canopy strata.
Medium Tree- Multistory- Closed	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb understory may be present, but is probably limited. There is >70% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15"- 19" dbh, and there are two or more canopy strata.
Large Tree- Multistory- Open	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands >40% cover of giant trees are classified in the “Giant, multistoried” stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is 10-39% total canopy cover, with at least 10% or more canopy cover from large and/or giant trees and another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20"-29" dbh, and there are two or more canopy strata.
Large Tree- Multistory- Moderate	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands >40% cover of giant trees are classified in the “Giant, multistoried” stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is 40-69% total canopy cover, at least 10% or more canopy cover from large trees with another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20"-29" dbh, and there are two or more canopy strata.
Large Tree- Multistory- Closed	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands >40% cover of giant trees are classified in the “Giant, multistoried” stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is >70% total canopy cover, at least 10% or more canopy cover from large trees with another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20"-29" dbh, and there are two or more canopy strata.
Giant Tree- Multistory	These stands have an overstory of giant sized trees with one or more distinct canopy layers of smaller trees. Stands with <40% canopy cover are classified in the “large tree–multistory–open”, stage. There is >40% canopy cover. Tree size is > 30" dbh, and there are two or more canopy strata.

Table 112. Descriptions of structural conditions in grassland habitats

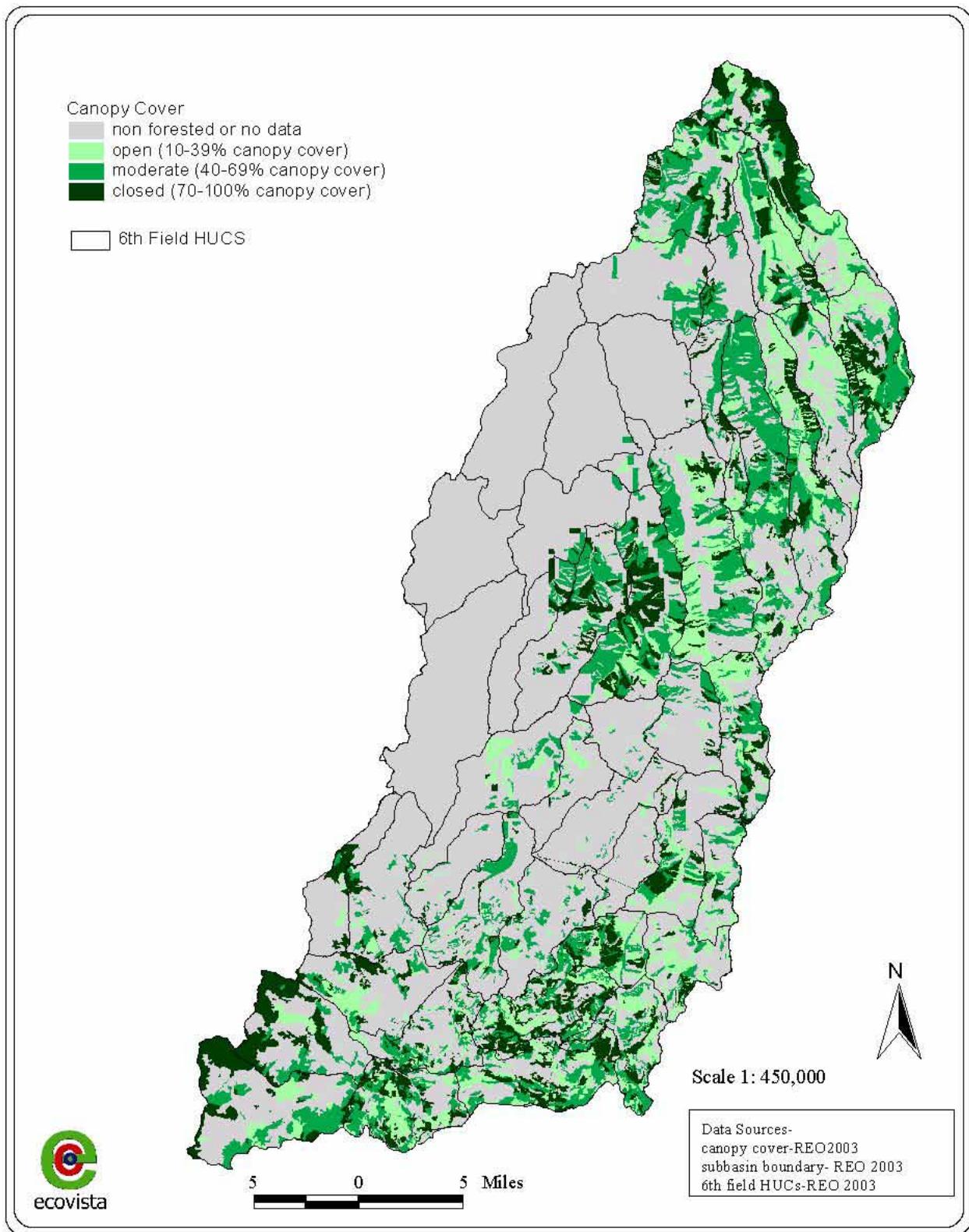
Structural Condition	Description
Grass/Forb - Open	Grasslands that have <10% shrub cover and < 10% tree canopy cover. Grasses and forbs cover less than 70% of the ground, and bare ground is evident.
Grass/Forb- Closed	Grasslands that have <10% shrub cover and <10% tree canopy cover. Grasses and forbs cover >70% of the ground.
Low shrub- Open Shrub Overstory- Seedling/Young	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Low shrub- Open Shrub Overstory- Mature	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is <25%.
Low shrub- Open Shrub Overstory- Old	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is >25%.
Low shrub- Closed Shrub Overstory- Seedling/Young	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Low shrub- Closed Shrub Overstory- Mature	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover < 10%. Crown decadence is <25%.
Low shrub- Closed Shrub Overstory- Old	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover. Crown decadence is >25%.
Medium shrub- Open Shrub Overstory- Seedling/Young	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Medium shrub- Open Shrub Overstory- Mature	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is <25%.

Structural Condition	Description
Medium shrub–Open Shrub Overstory–Old	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is >25%.
Medium shrub–Closed Shrub Overstory–Seedling/Young	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have <10% tree canopy cover. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Medium shrub–Closed Shrub Overstory–Mature	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have <10% tree canopy cover. Crown decadence is <25%.
Medium shrub–Closed Shrub Overstory–Old	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have <10% tree canopy cover. Crown decadence is >25%.
Tall shrub–Open Shrub Overstory–Seedling/Young	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70%, and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Tall shrub–Open Shrub Overstory–Mature	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is <25%.
Tall shrub–Open Shrub Overstory–Old	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70%, and may have tree canopy cover <10%. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is >25%.
Tall shrub–Closed Shrub Overstory–Seedling/Young	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >70%, and may have tree canopy cover <10%. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Tall shrub–Closed Shrub Overstory–Mature	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >70%, and may have tree canopy cover <10%. Crown decadence is <25%.
Tall shrub–Closed Shrub Overstory–Old	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >70%, and may have tree canopy cover >25%.

Appendix I. GIS layers used in determining forest structural condition

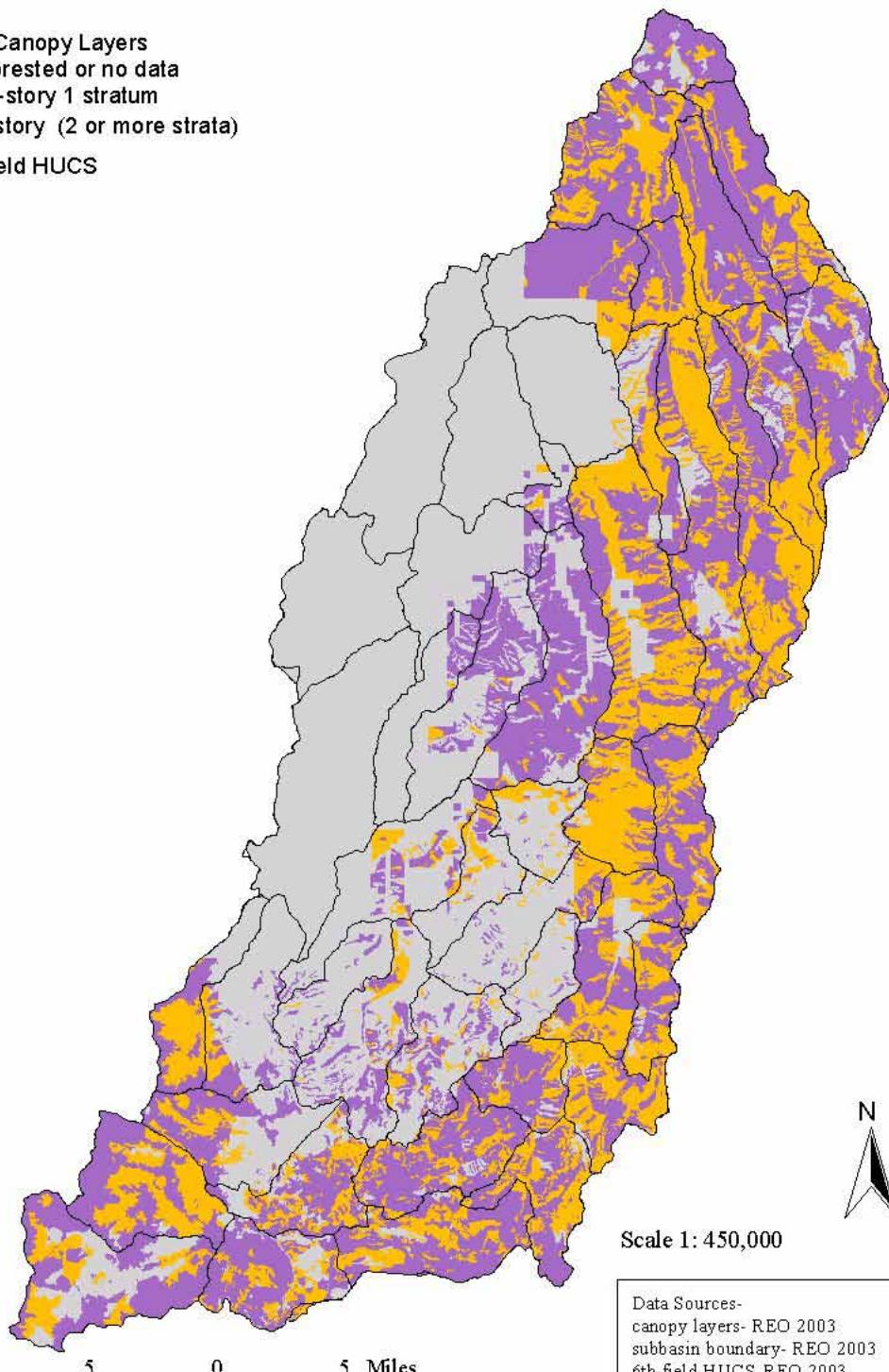


Distribution of tree sizes, Imnaha subbasin.



Forest canopy cover in the Imnaha subbasin.

Number of Canopy Layers
non-forested or no data
single-story 1 stratum
mult-story (2 or more strata)
6th Field HUCS



Number of forest canopy layers in the Imnaha subbasin.

Appendix J. Definitions of Key Environmental Correlates (Johnson and O’Neil 2001).

FOREST, SHRUBLAND AND GRASSLAND HABITAT ELEMENTS

Biotic, naturally occurring attributes of forest and shrubland communities and the information that follows are for positive relationships only.

1.1 forest/woodland vegetative elements or substrates - *Biotic components found within a forested context and these are positive influences only.*

1.1.1 down wood - Includes downed logs, branches, and rootwads.

1.1.1.1 decay class - A system by which down wood is classified based on its deterioration.

1.1.1.1.1 hard [class 1, 2] - Little wood decay evident; bark and branches present; log resting on branches, not fully in contact with ground; includes classes 1 and 2 as described in Thomas (1979).

1.1.1.1.2 moderate [class 3] - Moderate decay present; some branches and bark missing or loose; most of log in contact with ground; includes class 3 as described in Thomas (1979).

1.1.1.1.3 soft [class 4, 5] - Well decayed logs; bark and branches missing; fully in contact with ground; includes classes 4 and 5 as described in Thomas (1979).

1.1.1.2 down wood in riparian areas - Includes down wood in the terrestrial portion of riparian zones in forest habitats. Does not refer to in-stream woody debris.

1.1.1.3 down wood in upland areas - Includes downed wood in upland areas of forest habitats.

1.1.2 litter - The upper layer of loose, organic (primarily vegetative) debris on the forest floor. Decomposition may have begun, but components still recognizable.

1.1.3 duff - The matted layer of organic debris beneath the litter layer. Decomposition more advanced than in litter layer; intergrades with uppermost humus layer of soil.

1.1.4 shrub layer - Refers to the shrub strata within forest stands.

1.1.4.1 shrub size - Refers to shrub height.

1.1.4.2 percent shrub canopy cover - Percent of ground covered by vertical projection of shrub crown diameter.

1.1.4.3 shrub canopy layers - Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies in the forest understory.

1.1.5 moss - Large group of green plants without flowers but with small leafy stems growing in clumps.

1.1.6 flowers - A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.

1.1.7 lichens - Any of a various complex of lower plants made up of an alga and a fungus

growing as a unit on a solid surface.

1.1.8 forbs - Broad-leaved herbaceous plants. Does not include: grasses, sedges or rushes.

1.1.9 cactus - Any of a large group of drought-resistant plants with fleshy, usually jointed stems and leaves replaced by scales or prickles.

1.1.10 fungi - Mushrooms, molds, yeasts, rusts, etc.

1.1.11 roots, tubers, underground plant parts - Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.

1.1.12 ferns - Any of a group of flowerless, seedless vascular green plants.

1.1.13 herbaceous layer - Understory non-woody vegetation layer beneath shrub layer (forest context). May include forbs, grasses, ferns.

1.1.14 trees - Includes both coniferous and hardwood species.

1.1.14.1 snags - Standing dead trees.

1.1.14.1.1 decay class - A system by which snags are classified based on their deterioration.

1.1.14.1.1.1 hard - Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown (1985).

1.1.14.1.1.2 moderate - Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown (1985).

1.1.14.1.1.3 soft - Well decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown (1985).

1.1.14.2 snag size - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

1.1.14.2.1 seedling <1" dbh

1.1.14.2.2 sapling/pole 1"-9" dbh

1.1.14.2.3 small tree 10"-14" dbh

1.1.14.2.4 medium tree 15"-19" dbh

1.1.14.2.5 large tree 20"-29" dbh

1.1.14.2.6 giant tree >= 30" dbh

1.1.14.3 tree size - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

1.1.14.3.1 seedling <1" dbh

1.1.14.3.2 sapling/pole 1"-9" dbh

1.1.14.3.3 small tree 10"-14" dbh

1.1.14.3.4 medium tree 15"-19" dbh

1.1.14.3.5 large tree 20"-29" dbh

1.1.14.3.6 giant tree >= 30" dbh

1.1.14.4 mistletoe brooms/witches brooms - Dense masses of deformed branches caused by any type of broom-forming parasite (fungal or plant).

1.1.14.5 dead parts of live tree - Portions of live trees with rot; can include broken tops; branches with decay; tree base with rot.

1.1.14.6 hollow living trees (chimney trees) - Tree bole with large hollow chambers.

1.1.14.7 tree cavities - Smaller chamber in a tree; can be in bole, limbs, or forks of live or dead trees. May be excavated or result from decay or damage.

1.1.14.8 bark - Includes crevices/fissures, and loose or exfoliating bark.

1.1.14.9 live remnant/legacy trees - A live mature or old-growth tree remaining from the previous stand. Context is remnant trees in recently harvested or burned stands up through young forested stands. See dead parts of live trees, hollow living trees, tree cavities, and bark to see which species benefit from remnant trees with these attributes.

1.1.14.10 large live tree branches - Large branches often growing horizontally out from the tree bole.

1.1.14.11 tree canopy layer - Refers to the strata occupied by tree crowns.

1.1.14.11.1 sub-canopy - The space below the predominant tree crowns.

1.1.14.11.2 above canopy - The space above the predominant tree crowns

1.1.14.11.3 tree bole - The tree trunk.

1.1.14.11.4 canopy - The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.

1.1.15 fruits/seeds/nuts - Plant reproductive bodies that are used by animals.

1.1.16 edges - The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together.

1.2 shrubland/grassland vegetative elements or substrates - *Biotic components found within a shrubland or grassland context and these are positive influences only.*

1.2.1 herbaceous layer - Zone of understory non-woody vegetation beneath shrub layer (non-forest context). May include forbs, grasses.

1.2.2 fruits/seeds/nuts - Plant reproductive bodies that are used by animals.

1.2.3 moss - Large group of green plants without flowers but with small leafy stems growing in clumps.

1.2.4 cactus - Any of a large group of drought-resistant plants with fleshy, usually jointed stems and leaves replaced by scales or prickles.

1.2.5 flowers - A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.

1.2.6 shrubs - Plant with persistent woody stems and less than 16 feet tall; usually produces several basal shoots as opposed to a single bole.

1.2.6.1 shrub size - Refers to shrub height.

- 1.2.6.1.1 small** <20"
- 1.2.6.1.2 medium** 20"- 6.5'
- 1.2.6.1.3 large** 6.6' – 16.5'

1.2.6.2 percent shrub canopy cover - Percent of ground covered by vertical projection of shrub crown diameter.

1.2.6.3 shrub canopy layer - Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies.

1.2.6.3.1 sub-canopy - The space below the predominant shrub crowns.

1.2.6.3.2 above canopy - The space above the predominant shrub crowns.

1.2.7 fungi - Mushrooms, molds, yeasts, rusts, etc.

1.2.8 forbs - Broad-leaved herbaceous plants. Does not include: grasses, sedges or rushes.

1.2.9 bulbs/tubers - Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.

1.2.10 grasses - Members of the Graminae family.

1.2.11 cryptogamic crusts - Non-vascular plants that grow on the soil surface. Primarily lichens, mosses and algae. Often found in arid or semi-arid regions. May form soil surface pinnacles.

1.2.12 trees (located in a shrubland/grassland context) - Small groups of trees or isolated individuals.

1.2.12.1 snags - Standing dead trees.

1.2.12.1.1 decay class - System by which snags are classified based on their deterioration.

1.2.12.1.1.1 hard - Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown (1985).

1.2.12.1.1.2 moderate - Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown (1985).

1.2.12.1.1.3 soft - Well decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown (1985).

1.2.12.2 snag size (dbh) - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

- 1.2.12.2.1 shrub/seedling** <1" dbh
- 1.2.12.2.2 sapling/pole** 1"-9" dbh
- 1.2.12.2.3 small tree** 10"-14" dbh
- 1.2.12.2.4 medium tree** 15"-19" dbh
- 1.2.12.2.5 large tree** 20"-29" dbh
- 1.2.12.2.6 giant tree** >= 30" dbh

1.2.12.3 tree size - Measured in diameter at breast height (dbh) the standard measurement for standing trees taken at 4.5 feet above the ground.

- | | |
|----------------------------------|-------------|
| 1.2.12.3.1 shrub/seedling | <1" dbh |
| 1.2.12.3.2 sapling/pole | 1"-9" dbh |
| 1.2.12.3.3 small tree | 10"-14" dbh |
| 1.2.12.3.4 medium tree | 15"-19" dbh |
| 1.2.12.3.5 large tree | 20"-29" dbh |
| 1.2.12.3.6 giant tree | >= 30" dbh |

1.2.13 edges - The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together

2) ECOLOGICAL HABITAT ELEMENTS

Selected interspecies relationships within the biotic community, and they include both positive and negative influences.

2.1 exotic species - Exotic species are defined as any non-native plant or animal, including cats, dogs, and cattle.

2.1.1 plants - This field refers to the relationship between an exotic plant species and animal species.

2.1.2 animals - This field refers to the relationship between an exotic animal species and the animal species.

2.1.2.1 predation - The species queried is preyed upon by or preys upon an exotic species.

2.1.2.2 direct displacement - The species queried is physically displaced by an exotic species, either by competition or actual disturbance.

2.1.2.3 habitat structure change - The species queried is affected by habitat structural changes caused by an exotic species, for example, cattle grazing.

2.1.2.4 other - Any other effects of an exotic species on a native species (not used by panelists).

2.2 insect population eruptions - The species directly benefits from insect population eruptions (i.e., benefits from the insects themselves, not the resulting tree mortality or loss of foliage).

2.2.1 mountain pine beetle - The species directly benefits from mountain pine beetle eruptions.

2.2.2 spruce budworm - The species directly benefits from spruce budworm eruptions.

2.2.3 gypsy moth - The species directly benefits from gypsy moth eruptions.

2.3 beaver/muskrat activity - The results of beaver activity including dams, lodges, and ponds, that are beneficial to other species.

2.4 burrows - Aquatic or terrestrial cavities produced by burrowing animals that are beneficial to other species.

3) NON-VEGETATIVE, ABIOTIC, TERRESTRIAL HABITAT ELEMENTS

Non-living components found within any ecosystem. Primarily positive influences with a few exceptions as indicated.

3.1 rocks - Solid mineral deposits.

3.1.1 gravel - Particle size from 0.2 - 7.6 cm in diameter; gravel bars associated with streams and rivers are a separate category.

3.1.2 talus - Accumulations of rocks at the base of cliffs or steep slopes; rock/boulder sizes varied and determine what species can inhabit the spaces between them.

3.1.3 talus-like - Refers to areas that contain many rocks and boulders but are not associated with cliffs or steep slopes.

3.2 soils - Various soil characteristics.

3.2.1 soil depth - The distance from the top layer of the soil to the bedrock or hardpan below.

3.2.2 soil temperature - Any measure of soil temperature or range of temperatures that are key to the queried species.

3.2.3 soil moisture - The amount of water contained within the soil.

3.2.4 soil organic matter - The accumulation of decomposing plant and animal materials found within the soil.

3.2.5 soil texture - Refers to size distribution and amount of mineral particles (sand, silt, and clay) in the soil; examples are sandy clay, sandy loam, silty clay etc.

3.3 rock substrates - Various rock formations.

3.3.1 avalanche chute - An area where periodic snow or rock slides prevent the establishment of forest conditions; typically shrub and herb dominated (sitka alder and/or vine maple).

3.3.2 cliffs - A high, steep formation, usually of rock. Coastal cliffs are a separate category under Marine Habitat Elements.

3.3.3 caves - An underground chamber open to the surface with varied opening diameters and depths; includes cliff-face caves, intact lava tubes, coastal caves, and mine shafts.

3.3.4 rocky outcrops and ridges - Areas of exposed rock.

3.3.5 rock crevices - Refers to the joint spaces in cliffs, and fissures and openings between slab rock; crevices among rocks and boulders in talus fields are a separate category (talus).

3.3.6 barren ground - Bare exposed soil with >40% of area not vegetated; includes mineral licks and bare agricultural fields; natural bare exposed rock is under the rocky outcrop category.

3.3.7 playa (alkaline, saline) - Shallow desert basins that are without natural drainage-ways where water accumulates and evaporates seasonally.

3.4 snow - Selected features of snow.

3.4.1 snow depth - Any measure of the distance between the top layer of snow and the ground below.

3.4.2 glaciers, snow field - Areas of permanent snow and ice.

4) FRESHWATER RIPARIAN AND AQUATIC BODIES HABITAT ELEMENTS

Includes selected forms and characteristics of any body of freshwater.

4.1 water characteristics - *Includes various freshwater attributes. Ranges of continuous attributes that are key to the queried species, if known, will be in the comments.*

4.1.1 dissolved oxygen - Amount of oxygen passed into solution.

4.1.2 water depth - Distance from the surface of the water to the bottom substrate.

4.1.3 dissolved solids - A measure of dissolved minerals in water.

4.1.4 water pH - A measure of water acidity or alkalinity.

4.1.5 water temperature - Water temperature range that is key to the queried species, if known, is in the comments field.

4.1.6 water velocity - Speed or momentum of water flow.

4.1.7 water turbidity - Refers to the amount of roiled sediment within the water.

4.1.8 free water - Water derived from any source.

4.1.9 salinity and alkalinity - The presence of salts.

4.2 rivers & streams - Various characteristics of streams and rivers.

4.2.1 oxbows - A pond or wetland created when a river bend is cut off from the main channel of the river.

4.2.2 order and class - Systems of stream classification.

4.2.2.1 intermittent - Streams/rivers which contain non-tidal flowing water for only part of the year, water may remain in isolated pools.

4.2.2.2 upper perennial - Streams/rivers with a high gradient, fast water velocity, no tidal influence, some water flowing throughout the year, substrate consists of rock, cobbles, or gravel with occasional patches of sand, little floodplain development.

4.2.2.3 lower perennial - Streams/rivers with a low gradient, slow water velocity, no tidal influence, some water flowing throughout the year, substrate consists mainly of sand and mud, floodplain is well developed.

4.2.3 zone - System of water body classification based on the horizontal strata of the water column.

4.2.3.1 open water - Open water areas not closely associated with the shoreline or bottom.

4.2.3.2 submerged/benthic - Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.

4.2.3.3 shoreline - Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.2.4 in-stream substrate - The bottom materials in a body of water.

4.2.4.1 rocks - Rocks > 256 mm (10") in diameter.

4.2.4.2 cobble/gravel - Rocks or pebbles, 4-256 mm in diameter (10), substrata may consist of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

4.2.4.3 sand/mud - Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.

4.2.5 vegetation - Herbaceous plants.

4.2.5.1 submergent vegetation - Rooted aquatic plants that do not emerge above the water surface.

4.2.5.2 emergent vegetation - Rooted aquatic plants that emerge above the water surface.

4.2.5.3 floating mats - Un-rooted plants that form vegetative masses on the surface of the water.

4.2.6 coarse woody debris in streams and rivers - Any piece of woody material (debris piles, stumps, root wads, fallen trees) that intrudes into or lies within a river or stream.

4.2.7 pools - Portions of the stream with reduced current velocity, often with water deeper than surrounding areas.

4.2.8 riffles - Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.

4.2.9 runs/glides - Areas of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

4.2.10 overhanging vegetation - Herbaceous plants that cascade over stream and river banks and are < 1 meter above the water surface.

4.2.11 waterfalls - Steep decent of water within a stream or river.

4.2.12 banks - Rising ground that borders a body of water.

4.2.13 seeps or springs - A concentrated flow of ground water issuing from openings in the ground.

4.3 ephemeral pools - Pools that contain water for only brief periods of time usually associated with periods of high precipitation.

4.4 sand bars - Exposed areas of sand or mud substrate.

4.5 gravel bars - Exposed areas of gravel substrate.

4.6 lakes/ponds/reservoirs - Various characteristics of lakes, ponds, and reservoirs.

4.6.1 zone - System of water body classification based on the horizontal strata of the water column.

4.6.1.1 open water - Open water areas not closely associated with the shoreline or bottom substrates.

4.6.1.2 submerged/benthic - Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.

4.6.1.3 shoreline - Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.6.2 in-water substrate - The bottom materials in a body of water.

4.6.2.1 rock - Rocks > 256 mm (10 inches) in diameter.

4.6.2.2 cobble/gravel - Rocks or pebbles, 4-256 mm in diameter, substrata may consist of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

4.6.2.3 sand/mud - Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.

4.6.3 vegetation - Herbaceous plants.

4.6.3.1 submergent vegetation - Rooted aquatic plants that do not emerge above the water surface.

4.6.3.2 emergent vegetation - Rooted aquatic plants that emerge above the water surface.

4.6.3.3 floating mats - Unrooted plants that form vegetative masses on the surface of the water.

4.6.4 size - Refers to whether or not the species is differentially associated with water bodies based on their size.

4.6.4.1 ponds - <2ha

4.6.4.2 lakes - >=2ha

4.7 wetlands/marshes/wet meadows/bogs and swamps - Various components and characteristics related to any of these systems.

4.7.1 riverine wetlands - Wetlands found in association with rivers.

4.7.2 context - When checked, indicates that the setting of the wetland, marsh, wet meadow, bog or swamp is key to the queried species.

4.7.2.1 forest - Wetlands within a forest.

4.7.2.2 non-forest - Wetlands that are not surrounded by forest.

4.7.3 size - When checked, indicates that the queried species is differentially associated with a wetland, marsh, wet meadow, bog or swamp based on the size of the water body.

4.7.4 marshes - Frequently or continually inundated wetlands characterized by emergent herbaceous vegetation (grasses, sedges, reeds) adapted to saturated soil conditions.

4.7.5 wet meadows - Grasslands with waterlogged soil near the surface but without standing water for most of the year.

4.8 islands - A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water.

4.9 seasonal flooding - Flooding that occurs periodically due to precipitation patterns.

5) MARINE HABITAT ELEMENTS

Selected biotic and abiotic components and characteristics of marine systems.

5.1 zone - System of marine classification based on water depth, and relationship to substrate.

5.1.1 supratidal - The zone that extends landward from the higher high water line up to either the top of a coastal cliff or the landward limit of marine process (i.e., storm surge limit).

5.1.2 intertidal - The zone between the higher high water line and the lower low water line.

5.1.3 nearshore subtidal - The zone that extends from the lower low water line seaward to the 20 meter isobath, typically within 1 kilometer of shore.

5.1.4 shelf - The area between the 20 and 200 meter isobath, typically within 60 kilometers of shore.

5.1.5 oceanic - The zone that extends seaward from the 200 meter isobath.

5.2 substrates - The bottom materials in a body of water.

5.2.1 bedrock - The solid rock underlying surface materials.

5.2.2 boulders - Large, worn, rocks > 256 mm (10 inches) in diameter.

5.2.3 hardpan - Consolidated clays forming a substratum firm enough to support an epibenthos and too firm to support a normal infauna (clams, worms, etc.), but with an unstable surface which sloughs frequently.

5.2.4 cobble - Rocks or pebbles, 64-256 mm in diameter, may be a mix of cobbles, gravel, shells, and sand, with no one type exceeding 70 percent cover.

5.2.5 mixed-coarse - Substrata consisting of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

5.2.6 gravel - Small rocks or pebbles, 4-64 mm in diameter.

5.2.7 sand - Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.

5.2.8 mixed-fine - Mixture of sand and mud particles < 4 mm in diameter, little gravel present.

5.2.9 mud - Fine substrata < 0.06 mm in diameter, little gravel present, usually mixed with organics.

5.2.10 organic - Substrata composed primarily of organic matter such as wood chips, leaf litter, or other detritus.

5.3 energy - Degree of exposure to oceanic swell, currents, and wind waves.

5.3.1 protected - No sea swells, little or no current, and restricted wind fetch.

5.3.2 semi-protected - Shorelines protected from sea swell, but may receive waves generated by moderate wind fetch, and/or moderate to weak tidal currents.

5.3.3 partially exposed - Oceanic swell attenuated by offshore reefs, islands, or headlands, but shoreline substantially exposed to wind waves, and/or strong to moderated

tidal currents.

5.3.4 exposed - Highly exposed to oceanic swell, wind waves, and/or very strong currents.

5.4 vegetation - Includes herbaceous plants and plants lacking vascular systems.

5.4.1 mixed macro algae - Includes brown, green, and red algae.

5.4.2 kelp - Subaquatic rooted vegetation found in the nearshore marine environment.

5.4.3 eelgrass - Subaquatic rooted vegetation found in an estuarine environment.

5.5 water depth - Refers to the vertical layering of the water column.

5.5.1 surface layer - The uppermost part of the water column.

5.5.1.1 tide rip - A current of water disturbed by an opposing current, especially in tidal water or by passage over an irregular bottom.

5.5.1.2 surface microlayer(*neuston*) - The thin uppermost layer of the water's surface.

5.5.2 euphotic - Upper layer of a water body that receives sufficient sunlight for the photosynthesis of plants.

5.5.3 disphotic - Area below the euphotic zone where photosynthesis ceases.

5.5.4 demersal/benthic - Submerged lands including vegetated and unvegetated areas.

5.6 water temperature - Measure of ocean water temperature.

5.7 salinity - The presence and concentration of salts; salinity range that is key to the species, if it is known, will be in the comments field. Positive or negative influences were noted.

5.8 forms - Morphological elements within marine areas.

5.8.1 beach - An accumulation of unconsolidated material (sand, gravel, angular fragments) formed by waves and wave-induced currents in the intertidal and subtidal zones.

5.8.2 off-shore islands/rocks/sea stacks/off-shore cliffs - A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water at higher high water for large (spring) tide. Includes off-shore marine cliffs.

5.8.3 marine cliffs (*mainland*) - A sloping face steeper than 20 degrees usually formed by erosional processes and composed of either bedrock and/or unconsolidated materials.

5.8.4 delta - An accumulation of sand, silt, and gravel deposited at the mouth of a stream where it discharges into the sea.

5.8.5 dune - In a marine context; a mound or ridge formed by the transportation and deposition of wind-blown material (sand and occasionally silt).

5.8.6 lagoon - Shallow depression within the shore zone continuously occupied by salt or brackish water lying roughly parallel to the shoreline and separated from the open sea by a barrier.

5.8.7 salt marsh - A coastal wetland area which is periodically inundated by tidal brackish or salt water and which supports significant (15% cover) non-woody vascular vegetation (e.g., grasses, rushes, sedges) for at least part of the year.

5.8.8 reef - A rock outcrop, detached from the shore, with maximum elevations below the high-water line.

5.8.9 tidal flat - A level or gently sloping (less than 5 degrees) constructional surface exposed at low tide, usually consisting primarily of sand or mud with or without detritus, and resulting from tidal processes.

5.9 water clarity - As influenced by sediment load.

6) (No Data) - Formerly contained topographic information such as elevation that has been moved to the life history matrix.

7) FIRE AS A HABITAT ELEMENT

Refers to species that benefit from fire. The time frame after which the habitat is suitable for the species, if known, will be found in the comments field.

8) ANTHROPOGENIC - RELATED HABITAT ELEMENTS

This section contains selected examples of human-related Habitat Elements that may be a key part of the environment for many species. These Habitat Element's may have either a negative or positive influence on the queried species.

8.1 campgrounds/picnic areas - Sites developed and maintained for camping and picnicking.

8.2 roads - Roads that are either paved or unpaved.

8.3 buildings - Permanent structures.

8.4 bridges - Permanent structures typically over water or ravines.

8.5 diseases transmitted by domestic animals - Some domestic animal diseases may be a source of mortality or reduced vigor for wild species.

8.6 animal harvest or persecution - Includes illegal harvest/poaching, incidental take (resulting from fishing net by-catch, or by hay mowing, for example), and targeted removal for pest control.

8.7 fences/corrals - Wood, barbed wire, or electric fences.

8.8 supplemental food - Food deliberately provided for wildlife (e.g. bird feeders, ungulate feeding programs, etc.) as well as spilled or waste grain along railroads and cattle feedlots.

8.9 refuse - Any source of human-derived garbage (includes landfills).

8.10. supplemental boxes, structures and platforms - Includes bird houses, bat boxes, raptor and waterfowl nesting platforms.

8.11 guzzlers and waterholes - Water sources typically built for domestic animal use.

8.12 toxic chemical use - Proper use of regulated chemicals; documented effects only.

8.12.1 herbicides/fungicides - Chemicals used to kill vegetation and fungi.

8.12.2 insecticides - Chemicals used to kill insects.

8.12.3 pesticides - Chemicals used to kill vertebrate species.

8.12.4 fertilizers - Chemicals used to enhance vegetative growth.

8.13 hedgerows/windbreaks - Woody and/or shrubby vegetation either planted or that develops naturally along fencelines and field borders.

8.14 sewage treatment ponds - Settling ponds associated with sewage treatment plants.

8.15 repellents - Various methods purposely used against wildlife species that damage crops or property (excluding pesticides and insecticides).

8.15.1 chemical (*taste, smell, or tactile*) - Chemical substances that repel wildlife.

8.15.2 noise or visual disturbance - Non-chemical methods to deter wildlife.

8.16 culverts - Drain crossings under roads or railroads.

8.17 irrigation ditches/canals - Ditches built to transport water to agricultural crops or to handle runoff.

8.18 powerlines/corridors - Utility lines, poles, and rights-of-way associated with transmission, telephone, and gas lines.

8.19 pollution - Human-caused environmental contamination.

8.19.1 chemical

8.19.2 sewage

8.19.3 water

8.20. piers

8.21 mooring piles, dolphins, buoys

8.22 bulkheads, seawalls, revetment

8.23 jetties, groins, breakwaters

8.24 water diversion structures

8.25 log boom

8.26 boats/ships

8.27 dredge spoil islands

8.28 hatchery facilities and fish

Appendix K. Key Environmental Correlates identified to impact habitat selection by the Imnaha subbasin focal species (Johnson and O'Neil 2001).

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
All	Forest, Shrubland, and Grassland Habitat Elements	All Terrestrial Focal Species	none noted
1.1	forest/woodland vegetative elements or substrates	Long-toed salamander Flammulated owl White-headed woodpecker Boreal owl Olive-sided flycatcher Yellow warbler Mountain quail Bald eagle Rocky Mountain elk American marten Rocky Mountain goat Bighorn sheep Mule deer	none noted none noted none noted none noted none noted none noted none noted none noted none noted none noted Will also use slash piles as shelter. none noted Cover is key for this species. Cover can include down wood, moss, rocks, or other items. none noted Cover is key for this species. Cover can include down wood, moss, rocks, or other items. none noted
1.1.1	down wood (includes downed logs, branches, and rootwads, in any context)	Long-toed salamander Rocky Mountain elk American marten Mule deer	none noted none noted none noted none noted
1.1.1.2	down wood in riparian areas	Long-toed salamander American marten	Cover is key for this species. Cover can include down wood, moss, rocks, or other items. none noted
1.1.1.3	down wood in upland areas	Long-toed salamander American marten	Cover is key for this species. Cover can include down wood, moss, rocks, or other items. none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.1.2	litter	Long-toed salamander	In some situations, in large riverine and cotton wood forest, litter might be an important cover element, in other situations its role is unknown.
1.1.3	duff	Long-toed salamander	Suspected to be important, but not studied. Cover is a key in some form for this species. Cover can include down wood, moss, rocks, or other items.
1.1.4	shrub layer	Yellow warbler Mountain quail Rocky Mountain elk Mule deer	none noted
1.1.4.1	shrub size	Mountain quail	none noted
1.1.4.2	percent shrub canopy cover	Mountain quail	none noted
1.1.5	moss	Long-toed salamander Rocky Mountain goat	Cover is key for this species. Cover can include down wood, moss, rocks, or other items. none noted
1.1.7	lichens	Rocky Mountain goat	Used as food.
1.1.8	forbs	Mountain quail	48% of their diet consists of legumes, Lotus, sweat peas, and alfalfa. The last one is highly preferred, especially when it is planted alongside roads, and not in the fields.
1.1.11	roots, tubers, underground plant parts	Rocky Mountain elk Bighorn sheep Mule deer	none noted
1.1.13	herbaceous layer	Mountain quail Rocky Mountain elk Bighorn sheep Mule deer	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.1.14	trees	Flammulated owl White-headed woodpecker Boreal owl	none noted none noted Positive relationship between leaning trees and juvenile owls; they often climb them.
		Olive-sided flycatcher	Trees or snags that project above the surrounding canopy are of particular importance.
		Bald eagle	none noted
		American marten	none noted
		Rocky Mountain goat	none noted
		Flammulated owl	none noted
		White-headed woodpecker	none noted
		Boreal owl	none noted
		Olive-sided flycatcher	Used as hunting perches; snags that project above the surrounding canopy are particularly important.
		Bald eagle	none noted
		American marten	none noted
		White-headed woodpecker	none noted
		White-headed woodpecker	none noted
1.1.14.1	snags	Flammulated owl	none noted
1.1.14.1.1	decay class	White-headed woodpecker	none noted
1.1.14.1.1.2	moderate [class 3]	White-headed woodpecker	none noted
1.1.14.2	snag size (dbh)	Flammulated owl	none noted
		White-headed woodpecker	Large snags are used for nesting.
		Boreal owl	none noted
		Bald eagle	none noted
		American marten	none noted
		Flammulated owl	none noted
		Boreal owl	none noted
1.1.14.2.3	small tree 10–14in. dbh	Flammulated owl	none noted
1.1.14.2.4	medium tree 15–19in. dbh	Flammulated owl White-headed woodpecker Boreal owl	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.1.14.2.5	large tree 20–29in. dbh	American marten Flammulated owl White-headed woodpecker Boreal owl Bald eagle	none noted
1.1.14.2.6	giant tree \geq 30in. dbh	American marten Flammulated owl White-headed woodpecker Boreal owl Bald eagle	none noted
1.1.14.3	tree size (dbh)	American marten Flammulated owl White-headed woodpecker Boreal owl Bald eagle	none noted Large, live pine trees are important for foraging.
1.1.14.3.3	small tree 10–14in. dbh	American marten Flammulated owl Boreal owl	none noted none noted
1.1.14.3.4	medium tree 15–19in. dbh	Flammulated owl White-headed woodpecker Boreal owl	none noted
1.1.14.3.5	large tree 20–29in. dbh	American marten Flammulated owl White-headed woodpecker Boreal owl Bald eagle	none noted
1.1.14.3.6		American marten Flammulated owl	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
	giant tree ≥ 30in. dbh	White-headed woodpecker Boreal owl Bald eagle American marten	
1.1.14.4	mistletoe brooms/witches brooms	American marten	none noted
1.1.14.5	dead parts of live tree	Bald eagle	For hunting perches, roosts, nest placement.
1.1.14.7	tree cavities	Flammulated owl Boreal owl	Secondary cavity nester. none noted
1.1.14.9	live remnant/legacy trees	American marten White-headed woodpecker Olive-sided flycatcher Bald eagle	May use for denning if large enough; also checks cavities for prey. Pines for foraging. none noted none noted
1.1.14.10	large live tree branches	American marten	none noted
1.1.14.11	tree canopy layer	Flammulated owl Olive-sided flycatcher Bald eagle	none noted none noted none noted
1.1.14.11.1	subcanopy	American marten Flammulated owl Bald eagle	In general, martens avoid stands that are less than 30% canopy cover. none noted Winter roosting.
1.1.14.11.2	above canopy	Bald eagle	Prefers perches sticking above canopy.
1.1.15	fruits/seeds/nuts	White-headed woodpecker Mountain quail	Pine seeds are important during fall. none noted
1.1.16	edges	Long-toed salamander Boreal owl	none noted Forest/grassland edge for foraging.

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
		Olive-sided flycatcher	Use juxtaposition of early and late successional stages.
		Mountain quail	none noted
		Bald eagle	none noted
		Rocky Mountain elk	none noted
		Rocky Mountain goat	none noted
		Bighorn sheep	none noted
		Mule deer	none noted
1.2	shrubland/grassland vegetative elements or substrates	Long-toed salamander	none noted
		Mountain quail	
		Grasshopper sparrow	
		Bald eagle	
		Rocky Mountain elk	
		Rocky Mountain goat	
		Bighorn sheep	
		Mule deer	
1.2.1	herbaceous layer	Mountain quail	none noted
		Grasshopper sparrow	
		Rocky Mountain elk	
		Rocky Mountain goat	
		Bighorn sheep	
		Mule deer	
1.2.2	fruits/seeds	Mountain quail	none noted
1.2.3	moss	Rocky Mountain goat	none noted
1.2.5	flowers	Mountain quail	none noted
1.2.6	shrubs	Mountain quail	none noted
		Rocky Mountain elk	
		Bighorn sheep	
		Mule deer	

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.2.6.1	shrub size (height)	Mountain quail Bighorn sheep	
1.2.6.1.1	small (< 20 in.)	Bighorn sheep	
1.2.6.1.2	medium (20in.–6.5ft.)	Mountain quail	
1.2.6.1.3	large (6.6ft.–16.5ft.)	Mountain quail	
1.2.8	Shrub Canopy Layer	Mountain quail Rocky Mountain elk Bighorn sheep Mule deer	none noted
1.2.9	bulbs/tubers	Mountain quail	none noted
1.2.10	grasses	Grasshopper sparrow Rocky Mountain elk Bighorn sheep	none noted
1.2.12	trees (located in a shrubland/grassland context)	Long-toed salamander Bald eagle Rocky Mountain elk Bighorn sheep	Down wood from trees might be important element in grasslands and shrublands. none noted Isolated or in small groups of trees or snags, regardless of size are important for thermal cover in the summer.
1.2.12.1	snags	Bald eagle	none noted
1.2.12.2	snag size (dbh)	Bald eagle	none noted
1.2.12.2.5	large tree 20–29 in. dbh	Bald eagle	none noted
1.2.12.2.6	giant tree ≥ 30 in. dbh	Bald eagle	none noted
1.2.12.3	tree size (dbh)	Bald eagle	none noted
1.2.12.3.2	tree size (dbh)	Bighorn sheep	none noted
1.2.12.3.3	sapling/pole 1–9 in. dbh	Bighorn sheep	Isolated trees.
1.2.12.3.5	small tree 10–14 in. dbh	Bighorn sheep	
	large tree 20–29 in. dbh	Bald eagle	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.2.12,3.6	giant tree ≥ 30 in. dbh	Bald eagle	none noted
1.2.13	edges	Long-toed salamander Mountain quail Bald eagle Rocky Mountain elk Rocky Mountain goat Bighorn sheep Mule deer	Edges where grassland or shrubland meets an aquatic habitat. none noted none noted none noted none noted none noted none noted none noted
2	Ecological Habitat Elements	Long-toed salamander Flammulated owl White-headed woodpecker Yellow warbler Mountain quail Bald eagle Rocky Mountain elk American marten	none noted
2.1	exotic species	Yellow warbler Mountain quail Rocky Mountain elk	none noted
2.1.1	exotic plants	Long-toed salamander Mountain quail Rocky Mountain elk	Effects unknown. Might be positive or negative (purple loosestrife). Feeds on lotus (pea vine). Himalayan blackberry and Scotch broom are negative; forage seed mixes are positive.
2.2	insect population eruptions (specify whether negative or positive relationship in comments)	Flammulated owl White-headed woodpecker Yellow warbler	none noted
2.2.2	spruce budworm	Flammulated owl	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
		White-headed woodpecker Yellow warbler	
2.3	beaver/muskrat activity (dams, lodges, ponds) (Positive only)	Long-toed salamander Bald eagle	Likely to provide breeding habitat. Beaver ponds.
2.4	burrows (aquatic or terrestrial) (Positive only)	Long-toed salamander American marten	Terrestrial burrows are important, particularly in drier habitats. none noted
3	Nonvegetative, Abiotic Habitat Elements	Long-toed salamander Mountain quail Rocky Mountain goat Bighorn sheep	none noted
3.1	rocks	Long-toed salamander Mountain quail Bighorn sheep	none noted
3.1.1	gravel	Long-toed salamander	Important as retreat sites (cover or overwintering).
3.1.2	talus	Mountain quail Long-toed salamander Bighorn sheep	Source of grit (smallest particle sizes). Important as retreat sites (cover or overwintering). none noted
3.1.3	talus-like habitats	Long-toed salamander	Important as retreat sites (cover or overwintering).
3.2	soils	Rocky Mountain goat	none noted
3.3	rock substrates	Bighorn sheep Rocky Mountain goat	Rock substrates are the key element for mountain goat; presence of rock is a primary determining factor of their occurrence. none noted
3.3.1	avalanche chute	Bighorn sheep	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
3.3.2	cliffs	Rocky Mountain goat Bighorn sheep	none noted
3.3.4	rocky outcrops and ridges	Rocky Mountain goat Bighorn sheep	none noted
3.3.5	rock crevices	Rocky Mountain goat Bighorn sheep	none noted
3.3.6	barren ground	Rocky Mountain goat Bighorn sheep	Mineral licks.
3.4	snow	Rocky Mountain goat	none noted
3.4.2	glaciers, snow field (permanent snow/ice)	Rocky Mountain goat	none noted
4	Freshwater Riparian & Aquatic Bodies Habitat Elements	Long-toed salamander Olive-sided flycatcher Yellow warbler Mountain quail Bald eagle Rocky Mountain elk American marten Mountain goat Bighorn sheep Mule deer	none noted
4.1	water characteristics (specify whether negative or positive relationship in comments)	Long-toed salamander Bald eagle Rocky Mountain elk Rocky Mountain goat Bighorn sheep Mule deer	none noted
4.1.1	dissolved oxygen	Long-toed salamander	There is a low dissolved oxygen threshold.
4.1.2	water depth	Long-toed salamander	Long-toed salamanders require shallows for breeding and larval development.

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
4.1.6	water velocity	Long-toed salamander	Require still water.
4.1.7	water turbidity	Long-toed salamander	Negative relationship between water turbidity and reproduction.
4.1.8	free water (derived from any source)	Bald eagle Rocky Mountain elk Rocky Mountain goat Bighorn sheep Mule deer Long-toed salamander Mountain quail Bald eagle	Need clear water to see prey. none noted Free water is necessary in drier habitats (East of the Cascades). none noted none noted none noted none noted Provide breeding habitat. none noted none noted
4.2	rivers & streams	Long-toed salamander Mountain quail	none noted
4.2.1	oxbows	Long-toed salamander Bald eagle	none noted
4.2.2	order and class	Long-toed salamander Bald eagle	none noted
4.2.2.1	intermittent	Long-toed salamander	Provide breeding habitat.
4.2.2.2	upper perennial	Bald eagle	none noted
4.2.2.3	lower perennial	Bald eagle	none noted
4.2.3	zone	Long-toed salamander Bald eagle	none noted
4.2.3.1	open water	Long-toed salamander Bald eagle	none noted
4.2.3.3	shoreline pools	Long-toed salamander Bald eagle	none noted
4.2.7	seeps or springs	Long-toed salamander Mountain quail	
4.2.13	ephemeral pools	Long-toed salamander	There must be standing bodies of water present, lasting long enough to permit metamorphosis.
4.3			

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
4.4	sand bars	Bald eagle	Where fish or waterfowl are present.
4.5	gravel bars	Bald eagle	none noted
4.6	lakes/ponds/reservoirs	Bald eagle	none noted
4.6.1	zone	Long-toed salamander	none noted
4.6.1.1	open water	Bald eagle	none noted
4.6.1.3	shoreline	Long-toed salamander	High degree of water fluctuations has a negative impact on salamanders.
4.6.2	in-water substrate	Bald eagle	Hiding places and cover from predatory invertebrates.
4.6.2.1	rock	Long-toed salamander	
4.6.2.2	cobble/gravel		
4.6.2.3	sand/mud		
4.6.3	vegetation	Long-toed salamander	Oviposition sites and cover from fish and other predators.
4.6.3.1	submergent vegetation		
4.6.3.2	emergent vegetation		
4.6.3.3	floating mats		
4.7	wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)	Long-toed salamander Olive-sided flycatcher Yellow warbler	none noted Open bogs are favored, plus other wetland habitats where tall, remnant live trees and snags are present. none noted
		Bald eagle	none noted
		Rocky Mountain elk	none noted
		American marten	none noted
		Mule deer	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
4.7.1	riverine wetlands	Long-toed salamander	Provided that standing bodies of water are present lasting long enough to promote metamorphosis.
		Yellow warbler	none noted
		Bald eagle	none noted
		Rocky Mountain elk	none noted
		American marten	none noted
		Rocky Mountain elk	none noted
		American marten	
4.7.2	context	Mule deer	
		Rocky Mountain elk	Important for wallows.
		American marten	In Westside forests in Washington, Martens are closely associated with riparian zones, probably because that is where the largest live and dead trees are for den and rest sites.
		Mule deer	Important for fawn rearing.
		Rocky Mountain elk	Particularly in calving season.
4.7.2.2	nonforest	Mule deer	Important for fawn rearing.
		Long-toed salamander	none noted
		Bald eagle	
4.7.4	marshes	Long-toed salamander	
		Rocky Mountain elk	
		Mule deer	
4.7.5	wet meadows	Long-toed salamander	
		Rocky Mountain elk	
		Mule deer	
4.9	seasonal flooding	Long-toed salamander	Provide hydrology for riparian overflow pools and oxbows, where AMMA breed.
		Bald eagle	none noted
		Bald eagle	none noted
5	Marine Habitat Elements	Bald eagle	none noted
		Bald eagle	none noted
5.1	zone	Bald eagle	none noted
		Bald eagle	none noted
5.1.1	supratidal	Bald eagle	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
5.1.2	intertidal	Bald eagle	none noted
5.1.3	nearshore subtidal forms	Bald eagle	none noted
5.8	beach	Bald eagle	none noted
5.8.1	off-shore islands/rocks/sea stacks/off-shore cliffs	Bald eagle	none noted
5.8.2	marine cliffs (mainland)	Bald eagle	none noted
5.8.3	delta	Bald eagle	none noted
5.8.4	lagoon	Bald eagle	none noted
5.8.6	salt marsh	Bald eagle	none noted
5.8.7	tidal flat	Bald eagle	none noted
7	Fire as a Habitat Element	Long-toed salamander	May have a positive effect, but it needs further study. It is known that it increases the amount of woody debris, especially in juniper forests, and possibly increases water resistance.
		White-headed woodpecker	Fire maintains an open pine habitat.
		Olive-sided flycatcher	Species is highly associated with post-fire habitats.
		Mountain quail	May open habitat.
		Grasshopper sparrow	none noted
		Rocky Mountain elk	none noted
		Bighorn sheep	Hot fires improve sheep habitats.
		Mule deer	Generally positive.
8	Anthropogenic-related Habitat Elements	Boreal owl	none noted
		Yellow warbler	
		Mountain quail	
		Bald eagle	
		Rocky Mountain elk	

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
	Bighorn sheep		
	Mule deer		
8.1	supplemental boxes, structures and platforms roads	Long-toed salamander Boreal owl	Nest boxes.
8.2	supplemental food	Long-toed salamander	Heavily traveled roads have negative effects as barriers and can result in high mortality. This species may use rock roadfill for cover and breeding.
8.8	refuse (includes landfills) guzzlers and waterholes	Mountain quail Rocky Mountain elk Bighorn sheep Mule deer Bald eagle	Bird feeders. none noted none noted none noted Landfills, trash dumps.
8.9	irrigation ditches/canals powerlines/corridors	Long-toed salamander Rocky Mountain elk Mule deer Long-toed salamander Yellow warbler Mountain quail Bald eagle	none noted Powerline right-of-ways create shrubby open habitat in forests.
8.11			Powerline right-of-ways create shrubby open habitat in forests.
8.17			Positive relationship: perching on powerlines; negative relationship: electrocution hazard.
8.18			none noted
8.21	mooring piles, dolphins, buoys	Bald eagle	none noted
8.28	hatchery facilities and fish	Bald eagle	none noted

Appendix L. QHA methods used.

Overview (the following overview section was taken from the NPCC website, <http://www.nwcouncil.org/fw/subbasinplanning/admin/guides/qha.htm>)

The Qualitative Habitat Assessment Model (QHA) was selected for use in the Imnaha subbasin assessment. The QHA provides a structured, “qualitative” approach to analyzing the relationship between a given fish species and its habitat. It does this through a systematic assessment of the condition of several aquatic habitat attributes (sediment, water temperature, etc.) that are thought to be key to biological production and sustainability. Attributes are assessed for each of several stream reaches or small watersheds within a larger hydrologic system. Habitat attribute findings are then considered in terms of their influence on a given species and life stage.

QHA relies on the expert knowledge of natural resource professionals with experience in a given local area to describe physical conditions in the target stream and to create a hypothesis about how the habitat would be used by a given fish species. The hypothesis is the “lens” through which physical conditions in the stream are viewed. The hypothesis consists of weights that are assigned to life stages and habitat attributes, as well as a description of how reaches are used by different life stages. These result in a composite weight that is applied to a physical habitat score in each reach. This score is the difference between a rating of physical habitat in a reach under the current condition and a theoretical “reference” condition.

The ultimate result is an indication of the relative restoration and protection value for each reach and habitat attribute. QHA also provides a means to compare restoration and protection ratings to other biological and demographic information of the user’s choosing. QHA includes features for documenting the decision process and describing the level of confidence that users have in the various ratings.

Reaches

Reaches were delineated for the subbasin using the most recent StreamNet fish distribution layers. An ArcView shape file was created by combining the steelhead, fall chinook, spring/summer chinook, and bull trout fish distributions. This file was summarized to create reach breaks at each change in stream name or fish species use type. Breaking reaches at changes in fish use allowed for easy population of the use tables in the habitat hypothesis portion of the model.

The resulting reach layer was then intersected with the Wallowa-Whitman National Forest 6th field HUCs, so that data generated in the Imnaha Subbasin Multi-Species BA could be used in QHA. The following example explains the rational for the delineation of the four reaches in HUC 07B.

Reach Name	Reach Description
07B Camp Creek 1	Mouth of Camp Creek, upstream 8,794 feet, spring/summer chinook rearing, and steelhead spawning
07B Camp Creek 2	New reach delineated due to change in fish use, reach continues to be used by steelhead for spawning but StreamNet no longer shows chinook rearing
07B Camp Creek 3	New reach delineated due to change in fish use to steelhead rearing. Reach ended where fish use ends
07B Trail Creek	Only focal fish bearing tributary of Camp Creek in 07B, used by steelhead for spawning. Reach ended where fish use ends

This methodology resulted in the identification of 115 reaches in the Imnaha subbasin. This number falls within the 20–400 guidance suggested by the QHA user’s guide.

Associating Current Condition Data from the Imnaha Subbasin Multi-Species BA with the Reaches

The Multi-species Matrix developed for the subwatersheds of the Imnaha subbasin by the Wallowa-Whitman National Forest (Appendix Table 5) has numerous attributes in common with the inputs to QHA. These data were used as inputs to QHA as illustrated in Appendix Table 6. Data from the BA are 6th field HUC scale data, and their application at the reach scale may not be appropriate in all cases. Their inclusion is meant as a starting point to be modified by local experts at the meeting.

Attributes in the BA were rated by subwatershed as “functioning appropriately”, “functioning at risk”, or “functioning at unacceptable risk”. QHA requires users to rate attributes according to the following scale: 0 = < 20% of normative, 1 = 40% of normative, 2 = 60% of normative, 3 = 80% of normative, and 4 = 100% of normative. Subwatersheds with an attribute rated as “functioning appropriately” in the BA were assigned a 3.5 for the corresponding attribute in QHA (Appendix Table 5) for all reaches in that subwatershed. Similarly, subwatersheds with an attribute rated as “functioning at risk” in the BA were assigned a 2.0 in QHA, and subwatersheds with an attribute rated as “functioning at unacceptable risk” in the BA were assigned a 0.5 in QHA for all reaches in that subwatershed.

Appendix Table 5. Current multi-species matrix ratings for subwatersheds of the Imnaha subbasin (USFS 2003d).

Diagnostic or Pathway	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Subpopulation Characteristics within Subpopulation Watersheds			
Subpopulation Size	7Q	All except 7Q	
Growth and Survival		All	
Life History Diversity and Isolation	7Q	All except 7Q	
Persistence and Genetic Integrity	8 and 9—All	7—All	
Water Quality			
Temperature*	7G,7I,7J(St),7L(St),7N, 7Q,7R 8G, 8H,8J,8L 9F,9J,9K,9L,9M,9N,9O,9P	7E,7J(BT)7L(BT),7M,7O,7R(St) 8F(St) 9B(St),9E(St),9I(St),9J(St) 9K(St),9L(BT),9M(BT)	7A,7D,7H,7K,7P, 8A,8B,8C,8D,8E,8F(BT),8K 9A,9B(BT),9C,9D,9E(BT),9G 9H,9I(BT)
Sediment/Substrate	7E,7I,7K,7L,7M,7N,7Q 8A,8H,8K,8L 9B,9C,9D,9I,9J,9L,9M,9N,9O,9P	7D(St),7H,7P,7R 8B,8C,8D,8E,8F,8G,8J 9A,9G, 9H	7A,7D(BT),7J,7O 9E,9F,9K
Chemical Contamin.	All		
Habitat Elements			
Physical Barriers	7—All except 7H, 7I, 7J, 7O, 7P, and 7Q 8—All 9—All except 9J, 9K, 9L, 9M, 9R	7H, 7I, 7O, 7P, and 7Q 9J, 9K, 9L, 9M, 9R	7J
Large Woody Material	7I,7J,7L,7M,7N,7O,7P,7Q,7R 8F,8G,8J,8L 9B,9D,9E,9F,9I,9K,9L,9M 9N,9O,9P	7K 8K 9H,9J	7A,7D,7E,7H 8A,8B,8C,8D,8E,8H 9A,9C,9G
Pool Quality/Freq.		All BT	All St
Off-Channel Habitat	7E,7I,7J,7L,7N,7O,7P,7Q,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9B,9C,9D,9E,9F,9G,9I,9J,9K,9L 9M,9N,9O,9P	7A,7D,7H,7K,7M 8D 9A,9H	
Refugia	7E,7I,7J,7L,7N,7O,7P,7Q,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9B,9C,9D,9E,9F,9G,9I,9J,9K,9L 9M,9N,9O,9P	7A,7D,7H,7K,7M 8D 9A,9H	
Channel Condition and Dynamics			
Width/Depth Ratio	7D,7E,7H,7I,7L,7M,7N,7O,7P,7Q, 7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9A,9B,9C,9D,9E,9F,9G,9I,9K,9L, 9M 9N,9O,9P	7A,7J,7K 8D 9H,9J	
Streambank Condition	7E,7I,7L,7M,7N,7P,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K 9B,9C,9D,9E,9F,9G,9I,9J,9K,9L 9M,9N,9O,9P	7A,7D,7H,7J,7K,7O,7Q 8D,8L 9A,9H,9R	
Floodplain Connectivity	7E,7I,7J,7L,7N,7O,7P,7Q,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9B,9C,9D,9E,9F,9I,9J,9K,9L,9M 9N,9O,9P	7A,7D,7H,7K,7M 8D 9A,9G,9H	

Diagnostic or Pathway	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Watershed Conditions			
Road Density/Drainage Network	7E(St),7H(St),7I,7K,7N(St),7R(St) 8A,8C,8D,8E,8F,8G,8H,8J,8K,8L 9B,9C,9N,9O,9P	7A,7D(St),7E(BT),7H(BT),7L(St), ,7M,7N(BT),7R(BT) 8B 9A,9D,9G,9H,9J(St)	7D(BT),7J,7L(BT),7O,7P,7Q 9E,9F,9I,9J(BT),9K,9L,9M
Disturbance History/Peak/Base Flows	7E 8A,8B,8C,8F,8G,8H,8J,8K,8L 9B,9C,9G,9H,9I,9J,9L,9M,9N,9O, 9P	7A,7D,7H,7I,7J,7K,7L,7M,7N, 7O,7P,7Q,7R 8D,8E 9A,9D,9E,9F,9K	
Riparian Habitat Conservation Areas	7I,7L,7N,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9B,9C,9G,9I,9J,9L,9M,9N,9O,9P	7A,7D,7E,7H,7J,7K,7M, 7O,7P,7Q 8D 9A,9D,9E,9F,9H,9K	
Disturbance Regime	7I,7N,7Q 8-All 9-All	7A,7D,7E,7H,7J,7K,7L, 7M,7O,7P,7R	

Appendix Table 6. Relationship between BA and QHA attributes.

Multi-Species BA Attribute	QHA Attribute
Temperature	High Temperature
Sediment/Substrate	Fine Sediment
Chemical Contamin	Pollutants
Physical Barriers	Obstructions
Streambank Condition	Channel Stability
Disturbance History/Peak/Low Flows	High Flows
	Low Flows
Riparian Habitat Conservation Areas	Riparian Condition
Large Woody Material	Habitat Condition (Average scores of 3 [tech team removed Pool quality/freq on September 9, 2003] BA attributes)
Off-Channel Habitat	
Refugia	
No suitable equivalent	Low Temperature
No suitable equivalent	Oxygen

Note the codes in the HUC5 column of the QHA worksheet identify fish use, not 5th field HUC codes.

Reference Condition

The reference condition was set at 4 = 100% of normative for all the attributes and reaches in the subbasin. Any subwatersheds considered to be “functioning appropriately” in the BA had 3.5s assigned to their reaches in QHA. For this reason, no areas of the Imnaha are viewed as pristine in the current QHA model. Many of these reaches may need to have their values adjusted up at the meeting.

Habitat Hypothesis

The Habitat Utilization Hypothesis used in the Imnaha Draft QHA are the same as those used in the Flathead QHA run. They should be reviewed by local experts and evaluated for their applicability in the Imnaha.

The life stage use information was built into the reach delineation and is based on StreamNet GIS data. At the present time, the reference condition and current condition are the same. This situation will need to be evaluated at the meeting.

Habitat score, habitat ranking, and tornado sheets are generated by QHA. Once we refine the model, Ecovista will work with regional QHA experts and local biologists to interpret this information and work it into the Imnaha subbasin plan.

Timeline of incorporation QHA model

9/9

Local biologists edited the draft numbers from the BA. Changes were highlighted in blue.

The review panel filled out missing data values (also highlighted in blue) and filled in habitat hypothesis and reach use data for steelhead and bull trout.

10/28

Experts reviewed steelhead and bull trout worksheets, made slight adjustments. Local biologists modified the steelhead worksheet so it was applicable to fall chinook and spring/summer chinook.

Appendix M. Critical Functional Link Species of the Blue-Mountain Province and their Functions (IBIS 2003).

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
1_1_1_13	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Bark/cambium/bole feeder	American Beaver	<i>Castor canadensis</i>	Open Water—Lakes, Rivers, and Streams
1_1_1_13	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Bark/cambium/bole feeder	Black Bear	<i>Ursus americanus</i>	Alpine Grasslands and Shrublands Westside Grasslands Interior Grasslands
1_1_1_3	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Browser (leaf, stem eater)	Wild Turkey	<i>Meleagris gallopavo</i>	Westside Grasslands
1_1_1_3	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Browser (leaf, stem eater)	White-tailed Deer (eastside)	<i>Odocoileus virginianus ochrourus</i>	Agriculture, Pastures, and Mixed Enviros
1_1_1_6	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Sap feeder	House Finch	<i>Carpodacus mexicanus</i>	Agriculture, Pastures, and Mixed Enviros Urban and Mixed Environs
1_1_1_7	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Root feeders	Northern Pocket Gopher	<i>Thomomys talpoides</i>	Agriculture, Pastures, and Mixed Enviros
1_1_1_7	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Root feeders	Black Bear	<i>Ursus americanus</i>	Westside Grasslands Herbaceous Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Nectivore (nectar feeder)	Black-chinned Hummingbird	<i>Archilochus alexandri</i>	Shrub-steppe
<u>1_1_1_8</u>	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Nectivore (nectar feeder)	Rufous Hummingbird	<i>Selasphorus rufus</i>	Westside Grasslands
<u>1_1_1_9</u>	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): Fungivore (fungus feeder)	Deer Mouse	<i>Peromyscus maniculatus</i>	Urban and Mixed Environments
<u>1_1_2_1_3</u>	Trophic relationships: Heterotrophic consumer: Secondary consumer: Invertebrate eater Freshwater or marine zooplankton	Long-toed Salamander	<i>Ambystoma macrodactylum</i>	Upland Aspen Forest Alpine Grasslands and Shrublands Westside Grasslands Montane Coniferous Wetlands
<u>1_1_2_2_1</u>	Trophic relationships: Heterotrophic consumer: Secondary consumer: Vertebrate eater: Piscivorous (fish eater)	Raccoon	<i>Procyon lotor</i>	Urban and Mixed Environments
<u>1_1_5</u>	Trophic relationships: Heterotrophic consumer: Cannibalistic	Black Bear	<i>Ursus americanus</i>	Mesic Lowlands Conifer-Hardwood Forest Upland Aspen Forest Alpine Grasslands and Shrublands Westside Grasslands
<u>1_1_6</u>	Trophic relationships: Heterotrophic consumer: Coprophagous (feeds on fecal material)	American Pika	<i>Ochotona princeps</i>	Alpine Grasslands and Shrublands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
1_1_6	Trophic relationships: Heterotrophic consumer: Coprophagous (feeds on fecal material)	Snowshoe Hare	<i>Lepus americanus</i>	Mesic Lowlands Conifer-Hardwood Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Montane Coniferous Wetlands
1_1_7	Trophic relationships: Heterotrophic consumer: Feeds on human garbage/refuse	Mew Gull	<i>Larus canus</i>	Open Water—Lakes, Rivers, and Streams
1_1_7_1	Trophic relationships: Heterotrophic consumer: Feeds on human garbage/refuse: Aquatic (e.g., offal and bycatch of fishing boats)	Mew Gull	<i>Larus canus</i>	Open Water—Lakes, Rivers, and Streams
3_1	Organismal relationships: Controls or depresses insect population peaks	Big Brown Bat	<i>Eptesicus fuscus</i>	Urban and Mixed Environments
3_15	Organismal relationships: Pirates food from other species	American Crow	<i>Corvus brachyrhynchos</i>	Agriculture, Pastures, and Mixed Environments
3_16	Organismal relationships: Interspecific hybridization	American Crow	<i>Corvus brachyrhynchos</i>	Urban and Mixed Environments
3_2	Organismal relationships: Controls terrestrial vertebrate populations (through predation or displacement)	Raccoon	<i>Procyon lotor</i>	Urban and Mixed Environments
3_3	Organismal relationships: Pollination vector	Rufous Hummingbird	<i>Selasphorus rufus</i>	Alpine Grasslands and Shrublands Westside Grasslands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_4_1	Organismal relationships: Transportation of viable seeds, spores, plants or animals: Disperses fungi	Deer Mouse	<i>Peromyscus maniculatus</i>	Westside Grasslands Agriculture, Pastures, and Mixed Enviroms Urban and Mixed Enviroms
3_4_4	Organismal relationships: Transportation of viable seeds, spores, plants or animals: Disperses insects and other invertebrates	Golden-mantled Ground Squirrel	<i>Spermophilus lateralis</i>	Lodgepole Pine Forest and Woodlands Upland Aspen Forest
3_4_6	Organismal relationships: Transportation of viable seeds, spores, plants or animals: Disperses vascular plants	Golden-mantled Ground Squirrel	<i>Spermophilus lateralis</i>	Upland Aspen Forest
3_5	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms	Great Blue Heron	<i>Ardea herodias</i>	Open Water—Lakes, Rivers, and Streams
3_5_1	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: Creates feeding opportunities (other than direct prey relations)	Great Blue Heron	<i>Ardea herodias</i>	Open Water—Lakes, Rivers, and Streams
3_5_1_1	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: Creates sapwells in trees	Red-breasted Sapsucker	<i>Sphyrapicus ruber</i>	Mesic Lowlands Conifer-Hardwood Forest Westside Grasslands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_5_2	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: Creates roosting, denning, or nesting opportunities	Great Blue Heron	<i>Ardea herodias</i>	Mesic Lowlands Conifer-Hardwood Forest Westside Grasslands Open Water—Lakes, Rivers, and Streams Herbaceous Wetlands Interior Riparian-Wetlands
3_5_2	Organismal Relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: Creates roosting, denning, or nesting opportunities	Red Squirrel	<i>Tamiasciurus hudsonicus</i>	Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands
3_6_2	Organismal Relationships: Primary creation of structures (possibly used by other organisms): Ground structures	Bushy-tailed Woodrat	<i>Neotoma cinerea</i>	Upland Aspen Forest Shrub-steppe Agriculture, Pastures, and Mixed Environments Montane Coniferous Wetlands Interior Riparian-Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
	Organismal relationships: Primary creation of structures (possibly used by other organisms): Aquatic structures			Mesic Lowlands Conifer-Hardwood Forest
3_6_3	American Beaver	<i>Castor canadensis</i>		Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Montane Coniferous Wetlands
3_7_1	Organismal relationships: User of structures created by other species: Aerial structures	Black Tern	<i>Chlidonias niger</i>	Open Water—Lakes, Rivers, and Streams
3_7_1	Organismal relationships: User of structures created by other species: Aerial structures	Virginia Opossum	<i>Didelphis virginiana</i>	Agriculture, Pastures, and Mixed Enviroms Urban and Mixed Enviroms
3_7_2	Organismal relationships: User of structures created by other species: Ground structures	Deer Mouse	<i>Peromyscus maniculatus</i>	Montane Mixed Conifer Forest Upland Aspen Forest Subalpine Parkland Alpine Grasslands and Shrublands Agriculture, Pastures, and Mixed Enviroms Urban and Mixed Enviroms Montane Coniferous Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
<u>3_7_3</u>	Organismal relationships: User of structures created by other species: Aquatic structures	Fisher	<i>Martes pennanti</i>	Subalpine Parkland Lodgepole Pine Forest and Woodlands Upland Aspen Forest Westside Grasslands Interior Grasslands Shrub-steppe
<u>3_7_3</u>	Organismal relationships: User of structures created by other species: Aquatic structures	Mink	<i>Mustela vison</i>	
<u>3_8</u>	Organismal relationships: Nest parasite	House Finch	<i>Carpodacus mexicanus</i>	Urban and Mixed Environ
<u>3_8_1</u>	Organismal relationships: Nest parasite: Interspecies parasite	Redhead	<i>Aythya americana</i>	Open Water—Lakes, Rivers, and Streams
<u>3_8_1</u>	Organismal relationships: Nest parasite: Interspecies parasite			Mesic Lowlands Conifer-Hardwood Forest Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Westside Grasslands Interior Grasslands Shrub-steppe Agriculture, Pastures, and Mixed Environ Montane Coniferous Wetlands
<u>3_8_1</u>		Brown-headed Cowbird	<i>Molothrus ater</i>	

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
	Organismal relationships: Nest parasite: Common interspecific host			Open Water—Lakes, Rivers, and Streams
<u>3_8_2</u>	Organismal relationships: Nest parasite: Common interspecific host	Greater Scaup	<i>Aythya marila</i>	
<u>3_8_2</u>	Organismal relationships: Primary cavity excavator in snags or live trees	House Finch	<i>Carpodacus mexicanus</i>	Urban and Mixed Environments Interior Grasslands
<u>3_9</u>	Wood structure relationships (either living or dead wood): Physically fragments down wood	Black Bear	<i>Ursus americanus</i>	Herbaceous Wetlands
<u>6_1</u>	Wood structure relationships (either living or dead wood): Physically fragments standing wood	White-tailed Deer (eastside)	<i>Odocoileus virginianus ochraceus</i>	Agriculture, Pastures, and Mixed Environments
<u>6_2</u>	Water relationships: Impounds water by creating diversions or dams	Black Bear	<i>Ursus americanus</i>	Alpine Grasslands and Shrublands Herbaceous Wetlands Mesic Lowlands Conifer-Hardwood Forest
<u>7_1</u>		American Beaver	<i>Castor canadensis</i>	Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Open Water—Lakes, Rivers, and Streams Herbaceous Wetlands Montane Coniferous Wetlands Interior Riparian-Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
7_2	Water relationships: Creates ponds or wetlands through wallowing	American Beaver	<i>Castor canadensis</i>	Open Water—Lakes, Rivers, and Streams Alpine Grasslands and Shrublands
7_2	Water relationships: Creates ponds or wetlands through wallowing	Rocky Mountain Elk	<i>Cervus elaphus nelsoni</i>	Interior Grasslands Shrub-steppe
8_1	Vegetation structure and composition relationships: Creates standing dead trees (snags)	Black Bear	<i>Ursus americanus</i>	Alpine Grasslands and Shrublands Westside Grasslands Interior Grasslands
8_2	Vegetation structure and composition relationships: Herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)	Moose	<i>Alces alces</i>	Open Water—Lakes, Rivers, and Streams
8_3	Vegetation structure and composition relationships: Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)	Canada Goose	<i>Branta canadensis</i>	Open Water—Lakes, Rivers, and Streams Agriculture, Pastures, and Mixed Enviroms
8_3	Vegetation structure and composition relationships: Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)	Montane Vole	<i>Microtus montanus</i>	Mesic Lowlands Conifer-Hardwood Forest

Appendix N. Regional impacts of out-of-subbasin limiting factors impacting anadromous focal species.

Information on out-of-subbasin effects to aquatic species is taken from the memo by Mobrand Biometrics (2003) describing how these effects were addressed in regional EDT modeling efforts. EDT estimates survival and capacity of a focal species (e.g., spring/summer chinook salmon) within a defined study area (e.g., a subbasin) based on habitat characteristics and combines this with predefined survival rates outside the study area. These predefined survival rates have been termed the “out-of-subbasin effects”. These survival rates have been determined only for spring/summer and fall chinook salmon; no rates are available regarding steelhead.

As a contribution to the need to supply subbasin planners with a set of assumptions regarding the out-of-subbasin effects, Mobrand Biometrics (2003) provided the assumptions that are currently incorporated in the Ecosystem Diagnosis and Treatment model that is being used by subbasin planners. These assumptions in EDT about out-of-subbasin effects were developed as part of the NPCC’s Multi-species Framework Project. Calculations behind the results provided here were documented in the final project report to the NPCC from Mobrand Biometrics and in Marcot et al. (2002). The framework assumptions were intended to capture conditions prevailing in the region around the year 2000. The current assumptions in EDT about out-of-subbasin effects are based on passage and hydrologic modeling done by the NPCC, NMFS, and other participants in the Framework Project.

The out-of-subbasin effects are defined by Mobrand Biometrics (2003) as the total survival rate of juvenile fish from the mouth of the subbasin to their return to the subbasin as adults. Out-of-subbasin effects account for survival conditions through the hydropower system, the Columbia River below Bonneville Dam, the estuary, the ocean, and any harvest occurring outside the subbasin. To be specific, out-of-subbasin effects equals survival through the hydropower system times survival in the lower Columbia River times survival through the estuary times survival in the ocean times overall harvest rate. This definition of the out-of-subbasin effects makes it equivalent to the smolt-to-adult survival rate or SAR that has been used in other modeling efforts. The SAR is specific for a species and is related to the position of the subbasin within the Columbia Basin and especially relative to its position within the hydropower system. In other words, because the SAR (out-of-subbasin effects) is affected by survival through the hydropower system (see the equation above), the SAR is affected by the number of dams that fish must traverse to get to and from the subbasin. As a result, we see SARs generally decline going upstream through the Columbia Basin.

Because the out-of-subbasin assumptions reduce to the SARs that result from the model, Mobrand Biometrics (2003) represents the combined effect of all current assumptions in EDT about out-of-subbasin effects as the SARs for spring/summer and fall chinook salmon projected from various points in the Columbia Basin (Appendix Table 7). These SARs include all considerations for dam passage, survival below Bonneville Dam, survival through the Columbia estuary and the ocean and assumed harvest outside the subbasin. The hope is that by focusing on the SARs (which can be related to empirical survival estimates), the region can avoid becoming embroiled in debates over details of individual survival components as part of the subbasin planning process. This is consistent with direction provided by the NPCC in previous reports on the issue of out-of-subbasin effects.

The results in Appendix Table 7 are provided to clarify the assumptions that are available to subbasin planners regarding the SARs in EDT. SAR has been estimated from empirical data in a few subbasins in the PATH process and elsewhere. Mobrand Biometrics has compared the estimated SARs in EDT to available empirical estimates of SARs and find them generally in agreement.

Appendix Table 7. Smolt-to-adult survival rates (SAR) for spring/summer and fall chinook currently used in the Ecosystem Diagnosis and Treatment model.

	<i>Spring Chinook</i>		<i>Fall Chinook migrants</i>	
	SAR	Expl. Rate	SAR	Expl. Rate
Lower Granite Pool	0.9%	6.8%	0.4%	45%
Little Goose Pool	1.0%		0.4%	
Lower Monumental Pool	1.1%		0.5%	
Ice Harbor Pool	1.3%		0.6%	
Lower Snake	1.4%		0.8%	
McNary Pool	1.4%	6.8%	0.7%	45%
John Day Pool	1.5%		0.8%	
The Dalles Pool	2.0%		0.9%	
Bonneville Pool	2.2%		1.0%	
Lower Columbia	3.1%		1.4%	
Wells Pool	0.7%	6.8%	0.3%	45%
Rock Island Pool	0.9%		0.4%	
Wanapum Pool	1.1%		0.4%	
Priest Rapids Pool	1.2%		0.6%	
Hanford Reach	1.4%		0.8%	

The results in Appendix Table 7 approximate the survival rates that would be applied to spring/summer and fall chinook entering the Columbia River or Snake River at the points in the table. For example, spring/summer chinook entering the Snake River at the head of Lower Granite pool (from the Imnaha subbasin) would be subject to a SAR of 0.9% in EDT. This SAR incorporates an assumed harvest on spring/summer chinook of 6.8%. Fall chinook from the Imnaha subbasin would be subject to a SAR of 0.4% in EDT. This SAR incorporates an assumed harvest on spring/summer chinook of 45%. The SARs for fall chinook represent survival of actively migrating juveniles. Because fall chinook also include a component of fish that rear for some period within the mainstem Columbia and Snake rivers, total survival of fall chinook from each point may differ from the results in Appendix Table 7.

The SARs in Appendix Table 7 represent survival under “typical” conditions in the Columbia River and the ocean. Empirical estimates of SAR that have been reported in the PATH process and elsewhere vary widely between years reflecting environmental variation including regime shifts in ocean survival conditions. However, the EDT assessment is intended to characterize the potential of current habitat in a subbasin with respect to a focal species and does not include environmental variability.

Appendix Table 8 and Appendix Table 10 provide the schedule of survival rates at each dam for each month of the year for spring/summer and fall chinook salmon. In EDT, fish leave the subbasin and enter the mainstem across a range of months. They move down at travel speeds related to flow, encountering daily survival rates in the reservoirs. Fish are then passed through a dam where they encounter the survival rates in the tables below. A portion of the fish may be transported downstream. The dam survival rates below were calculated using NMFS's SimPass model with conditions specified in the Biological Opinion prevailing in 2000. Other mainstem passage survival assumptions are described in Marcot et al. (2002).

Appendix Table 8. Yearling (spring/summer) chinook dam survival rates currently used in EDT (Marcot et al. 2002).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Granite	0.9	0.9	0.93	0.98	0.98	0.98	0.95	0.95	0.95	0.95	0.9	0.9
Little Goose	0.9	0.9	0.93	0.98	0.98	0.98	0.95	0.95	0.95	0.95	0.9	0.9
Lower Monumental	0.9	0.9	0.93	0.96	0.96	0.96	0.94	0.94	0.94	0.94	0.9	0.9
Ice Harbor	0.9	0.9	0.94	0.97	0.97	0.97	0.97	0.97	0.95	0.95	0.9	0.9
McNary	0.9	0.9	0.94	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97
John Day	0.9	0.9	0.93	0.96	0.96	0.96	0.96	0.96	0.94	0.94	0.9	0.9
The Dalles	0.9	0.9	0.94	0.98	0.98	0.98	0.98	0.98	0.9	0.9	0.9	0.9
Bonneville	0.9	0.9	0.92	0.95	0.95	0.95	0.95	0.95	0.93	0.93	0.9	0.9
Rocky Reach	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Rock Island	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Wanapum	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Priest Rapids	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Wells	0.9	0.9	0.9	0.97	0.97	0.97	0.97	0.97	0.89	0.89	0.89	0.89

Appendix Table 9. Subyearling (fall) chinook dam survival rates currently used in EDT (Marcot et al. 2002).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Granite	0.9	0.9	0.95	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.9	0.9
Little Goose	0.9	0.9	0.94	0.96	0.96	0.96	0.94	0.94	0.94	0.94	0.9	0.9
Lower Monumental	0.9	0.9	0.94	0.95	0.95	0.95	0.95	0.94	0.94	0.93	0.9	0.9
Ice Harbor	0.9	0.9	0.93	0.96	0.96	0.96	0.96	0.96	0.94	0.94	0.9	0.9
McNary	0.9	0.9	0.96	0.98	0.98	0.98	0.98	0.98	0.95	0.95	0.95	0.95
John Day	0.9	0.9	0.95	0.97	0.97	0.97	0.97	0.97	0.95	0.95	0.9	0.9
The Dalles	0.9	0.9	0.93	0.98	0.98	0.98	0.98	0.98	0.9	0.9	0.9	0.9
Bonneville	0.9	0.9	0.91	0.93	0.93	0.93	0.93	0.93	0.91	0.91	0.9	0.9
Rocky Reach	0.89	0.89	0.91	0.93	0.93	0.93	0.93	0.93	0.89	0.89	0.89	0.89
Rock Island	0.89	0.89	0.9	0.93	0.93	0.93	0.93	0.93	0.89	0.89	0.89	0.89
Wanapum	0.89	0.89	0.91	0.92	0.92	0.92	0.92	0.92	0.89	0.89	0.89	0.89
Priest Rapids	0.89	0.89	0.9	0.92	0.92	0.92	0.92	0.92	0.89	0.89	0.89	0.89
Wells	0.89	0.89	0.94	0.97	0.97	0.97	0.97	0.97	0.89	0.89	0.89	0.89

Appendix O. Raw data and results of the qualitative habitat assessment (QHA) model

Various input and output information from the QHA model is presented to provide transparency regarding data inputs, and allow readers the opportunity to consider possible alternative interpretations of outputs. All data inputs represent professional judgments since no suitable and timely method could be developed for defensibly transforming real habitat data into categorical classifications used by the QHA model. Regional biologists within the ODFW, NPT, USFS, NOAA Fisheries, and USFWS, who were most familiar with habitat conditions within the various sixth field HUCs verified the data used in the model. No changes were requested or made to original data inputs based on technical team review.

The following information is presented by focal species (*e.g.*, spring/summer chinook salmon, fall chinook, summer steelhead, bull trout) in this appendix:

Model Inputs:

1. Existing conditions
2. Reference conditions
3. Species habitat hypotheses
4. Species range

Model Outputs:

1. Habitat scores
2. Habitat ranks

Readers interested in detailed explanation of the QHA model development and function are referred to the QHA Users Guide (Mobrand Biometrics 2003). The following scoring/ranking system is applicable to reference and current habitat scoring used throughout the QHA model.

Scoring	
Confidence Rating	Attribute Rating
0 = Unknown	0 = 0% of normative
1 = Expert Opinion	1 = 25% of normative
2 = Well Documented	2 = 50% of normative
	3 = 75% of normative
	4 = 100% of normative

Existing Conditions – Spring/summer chinook

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	2.0	2.0	1.5	1.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
07B Camp Creek 1	2.5	2.5	2.0	2.0	2.0	1.5	4.0	4.0	2.5	4.0	2.0
07D Little Sheep Creek 1	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
07E Bear Gulch	2.0	3.5	2.5	3.5	3.5	3.5	4.0	4.0	2.0	3.5	3.5
07K Big Sheep Creek 1	2.0	2.0	2.0	3.5	2.0	2.0	4.0	4.0	0.5	3.5	3.5
07M Big Sheep Creek	2.0	3.5	2.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5	3.5
07P Big Sheep Creek 3	2.0	3.5	3.5	2.0	2.0	2.0	4.0	4.0	2.0	3.5	2.0
07Q Lick Creek 1	2.0	2.0	3.5	3.5	2.0	2.0	4.0	4.0	3.5	3.5	2.0
07R Big Sheep Creek Headwaters	3.0	3.0	3.5	2.5	2.0	2.0	4.0	4.0	3.5	3.5	3.0
08A Imnaha River	3.5	3.5	2.5	3.5	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08B Imnaha River	2.5	3.5	2.5	2.0	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08C Imnaha River 2	3.5	3.5	2.5	2.0	2.8	2.8	4.0	4.0	0.5	3.5	3.5
08D Imnaha River 3 (town)	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
08E Horse Creek	3.5	3.5	2.5	2.0	2.0	2.0	4.0	4.0	2.0	3.5	3.5
08H Lightning Creek	3.5	3.5	2.5	3.5	2.0	3.5	4.0	4.0	3.5	3.5	3.5
08K Cow Creek	3.5	3.5	3.0	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09A Imnaha River	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
09B Freezeout Creek 1	3.5	3.5	3.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09C Imnaha River	3.5	3.5	2.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09D Grouse Creek 1	2.0	3.5	3.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5	1.0
09G Imnaha River 6	3.5	3.5	2.5	2.0	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09H Summit Creek 1	2.0	2.0	2.0	2.0	2.0	2.0	4.0	4.0	2.0	3.5	3.5
09I Crazymans Creek 1	3.5	3.5	3.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09J Imnaha River	3.5	3.5	3.0	3.5	2.0	3.5	4.0	4.0	2.0	3.5	2.0
09L Imnaha River	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09M Imnaha River	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	4.0
09N Imnaha River	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09P South Fork Imnaha River 1	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	4.0

Reference Conditions – Spring/summer chinook

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07B Camp Creek 1	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
07D L. Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07E Bear Gulch	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07K Big Sheep Creek 1	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	4.0
07M Big Sheep Creek	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	4.0
07P Big Sheep Creek 3	3.0	4.0	4.0	3.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0
07Q Lick Creek 1	3.0	3.0	4.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	3.0
07R Big Sheep Creek Headwaters											
	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08A Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08B Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08C Imnaha River 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08D Imnaha River 3 (town)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08E Horse Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08H Lightning Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
08K Cow Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09A Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09B Freezeout Creek 1	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09C Imnaha River	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09D Grouse Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09G Imnaha River 6	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09H Summit Creek 1	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09I Crazyman Creek 1	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09J Imnaha River	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09L Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09M Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09N Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09P South Fork Imnaha River 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0

Species Habitat Hypothesis – Spring/summer chinook

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Life Stage Rank (1-4)	4.0	3.0	3.0	2.0

Assign a weight to each attribute (0-2) relative to its importance to the life stage

Riparian Condition	1.0	2.0	2.0	0.5
Channel stability	2.0	2.0	2.0	0.5
Habitat Diversity	1.5	2.0	2.0	0.5
Fine sediment	2.0	2.0	2.0	0.5
High Flow	2.0	1.0	1.0	1.0
Low Flow	2.0	2.0	2.0	2.0
Oxygen	2.0	2.0	2.0	2.0
Low Temp	0.5	0.5	0.5	0.0
High Temp	2.0	2.0	2.0	2.0
Pollutants	2.0	2.0	1.0	1.0
Obstructions	1.0	1.0	1.0	2.0

Species Range – Spring/summer chinook

Assign a weight to each attribute (0-2) relative to the reach's importance to the life stage

Reach Name	Spawn and incubation	Current Range (0-4)			Reference Range (0-4)			
		Summer rearing	Winter rearing	Migration	Spawn and incubation	Summer rearing	Winter rearing	Migration
07A Big Sheep Creek	0.0	1.0	1.0	2.0	0.0	1.0	1.0	2.0
07B Camp Creek 1	0.0	2.0	1.0	2.0	0.0	2.0	1.0	2.0
07D Little Sheep Creek 1	0.0	2.0	0.5	2.0	0.0	2.0	1.0	2.0
07E Bear Gulch	0.0	0.5	0.0	0.0	0.0	1.0	0.0	0.0
07K Big Sheep Creek 1	1.0	1.0	0.5	2.0	2.0	2.0	1.0	2.0
07M Big Sheep Creek	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0
07P Big Sheep Creek 3	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0
07Q Lick Creek 1	1.0	1.0	1.0	2.0	2.0	2.0	1.5	2.0
07R Big Sheep Creek Headwaters	1.0	1.7	0.5	1.0	1.5	2.0	1.0	1.0
08A Imnaha River	0.0	1.0	1.0	2.0	0.0	1.0	1.0	2.0
08B Imnaha River	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
08C Imnaha River 2	0.0	1.0	0.5	2.0	0.0	1.5	1.0	2.0
08D Imnaha River 3 (town)	0.0	1.0	1.0	2.0	0.0	1.5	1.5	2.0
08E Horse Creek	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
08H Lightning Creek	0.0	1.0	0.5	2.0	0.0	2.0	1.0	2.0
08K Cow Creek	0.0	1.0	0.5	2.0	0.0	2.0	1.0	2.0
09A Imnaha River	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
09B Freezeout Creek 1	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
09C Imnaha River	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
09D Grouse Creek 1	0.5	2.0	1.0	1.0	2.0	2.0	2.0	2.0
09G Imnaha River 6	2.0	2.0	0.8	2.0	2.0	2.0	1.0	2.0
09H Summit Creek 1	0.0	1.0	0.5	2.0	0.0	1.0	0.5	2.0
09I Crazyman Creek 1	0.0	1.0	0.5	2.0	0.0	1.0	0.5	2.0
09J Imnaha River	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0
09L Imnaha River	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0
09M Imnaha River	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0
09N Imnaha River	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0
09P South Fork Imnaha River 1	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0

Habitat Scores – Spring/summer chinook

Reach Name		Reach Score									
		Riparian Condition					Channel stability				
		Habitat Diversity					Fine sediment				
		Low Temperature					High Flow				
		Oxygen					Low Flow				
		Pollutants					High Temperature				
		Obstructions									
08K Cow Creek	-0.20	-0.20	-0.17	0.20	0.09	-0.31	0.00	-0.18	-0.21	0.23	0.08
09A Imnaha River	-0.13	-0.11	0.09	-0.11	0.09	-0.18	0.00	0.00	-0.21	0.23	0.15
09B Freezeout Creek 1	-0.20	0.20	0.20	0.20	0.09	-0.31	0.00	-0.18	-0.21	0.23	0.06
09C Imnaha River	-0.20	0.20	-0.14	0.20	0.09	-0.31	0.00	-0.18	-0.21	0.23	0.07
09D Grouse Creek 1	-0.29	0.22	0.42	0.40	0.42	-0.16	0.27	0.00	0.27	0.38	0.28
09G Imnaha River 6	-0.49	0.48	0.63	0.40	0.36	0.29	0.74	0.00	0.42	0.62	0.18
09H Summit Creek 1	-0.15	-0.11	-0.11	-0.11	0.09	-0.18	0.00	0.00	-0.18	-0.21	0.23
09I Crazymann Creek 1	-0.20	0.20	0.20	0.20	0.09	-0.31	0.00	0.00	-0.18	-0.21	0.23
09J Imnaha River	-0.53	-0.51	0.66	0.50	0.66	0.30	0.77	0.00	0.44	0.64	0.26
09L Imnaha River	-0.63	-0.51	0.66	0.58	0.66	0.53	0.77	0.00	0.77	0.73	0.46
09M Imnaha River	-0.64	-0.51	0.66	0.58	0.66	0.53	0.77	0.00	0.77	0.73	0.52
09N Imnaha River	-0.63	-0.51	0.66	0.58	0.66	0.53	0.77	0.00	0.77	0.73	0.46
09P South Fork Imnaha River 1	-0.64	-0.51	0.66	0.58	0.66	0.53	0.77	0.00	0.77	0.73	0.52

Habitat Ranks – Spring/summer chinook

Reach Name		Riparian Condition										Channel Complexity										
		Flow					Sediment					Vegetation					Soil Health					
		High Flow		Low Flow			High Sediment		Low Sediment			High Vegetation		Low Vegetation			High Soil Health		Low Soil Health			
		Score	Rank	Score	Rank	Score	Score	Rank	Score	Rank	Score	Score	Rank	Score	Rank	Score	Score	Rank	Score	Rank	Score	
		Riparian Condition										Channel Complexity										
07A Big Sheep Creek		26	4	4	6	8	7	3	10	10	9	2	1	10	5	5	4	2	7	3	10	10
07B Camp Creek		12	3	3	5	5	9	7	10	10	2	1	8	6	6	6	2	2	8	1	9	1
07D Little Sheep Creek		20	4	4	7	4	8	3	10	10	9	1	2	2	4	4	3	4	7	2	10	10
07E Bear Gulch		28	6	1	5	1	8	1	10	10	6	1	8	28	1	4	3	4	8	4	10	10
07K Big Sheep Creek		13	8	5	6	2	7	4	10	10	9	1	3	4	6	3	4	7	5	2	10	10
07M Big Sheep Creek		9	8	1	7	1	8	5	10	10	5	3	4	12	3	5	7	5	4	1	10	10
07P Big Sheep Creek		11	7	1	3	6	7	4	10	10	4	2	7	6	4	7	8	3	5	1	10	10
07Q Lick Creek		8	7	6	4	2	7	5	10	10	1	3	7	13	3	2	9	7	4	1	10	10
07R Big Sheep Creek Headwaters		7	6	4	3	5	9	7	10	10	1	2	8	9	5	4	9	2	3	1	10	10
08A Omaha River		14	2	2	7	2	7	1	10	10	9	6	2	18	4	4	2	4	9	3	10	10
08B Omaha River		23	6	4	6	8	5	1	10	10	9	3	2	15	3	6	3	2	9	5	10	10

Innaha Subbasin Assessment

451

May 2004

Existing Conditions – Fall Chinook

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
08A Imnaha River	3.5	3.5	2.5	3.5	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08B Imnaha River	2.5	3.5	2.5	2.0	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08C Imnaha River 2	3.5	3.5	2.5	2.0	2.8	2.8	4.0	4.0	0.5	3.5	3.5
08D Imnaha River 3 (town)	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5

Reference Conditions – Fall Chinook

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
08A Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08B Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08C Imnaha River 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08D Imnaha River 3 (town)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Species Habitat Hypothesis – Fall Chinook

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Life Stage Rank (1-4)	4.0	3.0	3.0	3.0

Assign a weight to each attribute (0-2) relative to its importance to the life stage

Riparian Condition	0.5	1.0	1.0	0.5
Channel stability	2.0	1.0	1.0	0.5
Habitat Diversity	1.0	2.0	2.0	0.5
Fine sediment	2.0	2.0	2.0	0.5
High Flow	2.0	1.5	1.5	1.5
Low Flow	2.0	2.0	2.0	2.0
Oxygen	2.0	2.0	2.0	2.0
Low Temp	1.0	0.0	0.0	0.0
High Temp	0.5	0.5	0.5	0.5
Pollutants	2.0	2.0	2.0	2.0
Obstructions	0.0	1.0	1.0	2.0

Species Range – Fall Chinook

Reach Name	Current Range (0-4)				Reference Range (0-4)			
	Spawn and incubation	Summer rearing	Winter rearing	Migration	Spawn and incubation	Summer rearing	Winter rearing	Migration
08A Imnaha River	2.0	1.5	1.5	2.0	2.0	1.5	1.5	2.0
08B Imnaha River	2.0	1.5	1.5	2.0	2.0	1.5	1.5	2.0
08C Imnaha River 2	2.0	1.5	1.5	2.0	2.0	1.5	1.5	2.0
08D Imnaha River 3 (town)	2.0	1.5	1.5	2.0	2.0	1.5	1.5	2.0

Habitat Scores – Fall Chinook

Reach Name	Reach Score	Protection Scores				Restoration Scores			
		Oxygen	Flow	Sediment	Diversity	Temperature	Pollutants	Structures	Obstructions
O8A Imnaha River	-0.52	-0.30	-0.53	-0.39	-0.70	-0.73	-0.75	0.00	-0.03
O8B Imnaha River	-0.48	-0.22	-0.53	-0.39	-0.40	-0.73	-0.75	0.00	-0.03
O8C Imnaha River 2	-0.47	-0.30	-0.53	-0.39	-0.40	-0.58	-0.69	0.00	-0.03
O8D Imnaha River 3 (town)	-0.37	-0.17	-0.30	-0.24	-0.40	-0.42	-0.50	0.00	-0.03

Habitat Ranks – Fall Chinook

Reach Name	Reach Rank	Protection Ranks										Restoration Ranks									
		High Flow	Low Flow	Fine Sediment	Channel Form	Channel Complexity	High Temperature	Low Temperature	Oxygen	Pollutants	Obstructions	High Flow	Low Flow	Fine Sediment	Channel Form	Channel Complexity	High Temperature	Low Temperature	Oxygen	Pollutants	Obstructions
08A Imnaha River	1	8	5	7	4	3	2	10	10	9	1	6	4	9	7	2	6	5	1	10	10
08B Imnaha River	2	8	4	7	5	3	2	10	10	9	1	6	3	5	8	3	1	7	2	10	10
08C Imnaha River 2	3	8	4	7	5	3	2	10	10	9	1	6	2	9	7	4	1	3	2	10	10
08D Imnaha River 3 (town)	4	8	6	7	4	3	2	10	10	9	1	5	1	7	5	4	3	2	1	10	10

Existing Conditions – Summer steelhead

Reach Name	Riparian Condition	Channel stability	Habitat diversity	Fine sediment	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek Mouth	2.0	2.0	1.5	1.0	2.0	4.0	0.5	3.5	3.5	3.5
07B Lower Camp Creek	2.5	2.3	2.5	2.3	2.0	2.4	4.0	2.5	4.0	2.8
07C Upper Camp Creek	2.0	2.3	2.0	2.0	2.0	2.7	4.0	4.0	4.0	3.0
07D Little Sheep Creek 1	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5
07E Summit Creek (Bear&Downey Gulch)	2.0	3.2	2.5	2.0	3.5	3.5	4.0	4.0	2.0	3.5
07F Devils Gulch	3.0	3.0	3.0	2.5	2.0	3.5	4.0	4.0	3.0	3.0
07G Lightning Creek	2.0	2.0	2.0	2.0	2.0	2.5	4.0	3.5	2.0	2.5
07H Little Sheep Creek 2	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5
07I McCully Creek	3.5	3.5	3.5	3.5	2.0	2.0	4.0	4.0	3.5	3.5
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	2.0	2.0	3.5	0.5	2.0	2.0	4.0	4.0	3.5	3.5
07K Big Sheep Creek 1	2.0	2.0	2.0	3.5	2.0	2.0	4.0	4.0	0.5	3.5
07L Squaw Creek	3.0	3.5	3.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5
07M Big Sheep Creek 2	2.0	3.5	2.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5
07N Marr Creek	3.0	3.5	3.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5
07O Carroll Creek	2.0	2.0	3.5	0.5	2.0	2.0	4.0	4.0	2.0	3.5
07P Big Sheep Creek 3	2.0	3.5	3.5	2.0	2.0	2.0	4.0	4.0	2.0	3.5
07Q Lick Creek	2.0	2.0	3.5	2.0	2.0	2.0	4.0	4.0	3.5	2.0
07R Big/Little Sheep	3.3	3.3	3.5	2.2	2.0	2.0	4.0	4.0	3.5	3.3

Reach Name	Riparian Condition	Channel Stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Temperature Low	Temperature High	Pollutants	Obstructions
Headwaters											
08A Imnaha River Confluence	3.5	2.5	3.5	3.5	3.0	4.0	4.0	4.0	0.5	3.5	3.5
08B Imnaha River 1	2.7	2.5	2.0	3.5	3.4	4.0	4.0	4.0	0.5	3.5	3.5
08C Imnaha River 2	3.2	3.2	2.5	2.0	2.9	4.0	4.0	4.0	0.5	3.5	3.5
08D Imnaha River 3 (Town)	2.0	2.0	1.5	2.0	2.0	4.0	4.0	4.0	0.5	3.5	3.5
08E Horse Creek Confluence	3.5	3.5	2.5	2.0	2.0	4.0	4.0	4.0	2.0	3.5	3.5
08F Pumpkin Creek	3.5	3.5	2.0	3.5	3.5	4.0	4.0	4.0	2.0	3.5	3.5
08G Horse Creek Upper	3.5	3.5	2.0	3.5	3.5	4.0	4.0	4.0	3.5	3.5	3.5
08H Lightning Creek Confluence	3.5	3.5	2.5	3.5	2.0	3.5	4.0	4.0	4.0	3.5	3.5
08I Sleepy Creek	3.5	3.5	3.5	3.5	3.5	4.0	4.0	4.0	4.0	3.5	3.5
08J Lightning Creek Upper	3.5	3.5	3.5	2.0	3.5	4.0	4.0	4.0	4.0	3.5	3.5
08K Cow Creek Confluence	3.5	3.5	3.0	3.5	2.0	3.5	4.0	4.0	4.0	2.0	3.5
08L Cow Creek Upper	3.5	2.0	2.0	3.5	3.5	4.0	4.0	4.0	4.0	3.5	3.5
09A Imnaha River 4	2.0	2.0	1.5	2.0	2.0	4.0	4.0	4.0	4.0	0.5	3.5
09B Freezeout Creek	3.5	3.5	3.5	3.5	2.0	3.5	4.0	4.0	4.0	2.0	3.5
09C Imnaha River 5	3.5	3.5	2.5	3.5	2.0	3.5	4.0	4.0	4.0	2.0	3.5
09D Grouse Creek Confluence	2.0	3.5	3.5	2.0	2.7	4.0	4.0	4.0	4.0	2.0	3.5
09E Rich Creek/Shadow Canyon											
	2.0	3.5	3.0	2.0	3.0	4.0	4.0	4.0	2.0	3.5	3.5
09F Grouse Creek Upper	2.0	2.0	3.5	2.0	2.0	2.4	4.0	4.0	4.0	3.5	3.5
09G Imnaha River 6	3.5	3.5	2.5	2.0	2.0	3.5	4.0	4.0	4.0	2.0	3.5

Reach Name	Riparian Condition	Channel stability	Habitat diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09H Summit Creek	2.0	2.0	2.0	2.0	4.0	4.0	4.0	4.0	2.0	3.5	3.5
09I Crazyman Creek	3.5	3.5	3.5	2.0	3.5	4.0	4.0	4.0	2.0	3.5	3.5
09J Imnaha River 7	3.5	3.0	3.5	2.0	3.5	4.0	4.0	4.0	2.0	3.5	3.5
09K Gumboot Creek	2.0	3.5	3.5	2.0	2.0	4.0	4.0	4.0	2.0	3.5	3.5
09L Imnaha River 8	3.5	3.5	3.5	3.5	3.5	4.0	4.0	4.0	3.5	4.0	3.5
09M Imnaha River 9	3.5	3.5	3.5	3.5	3.5	4.0	4.0	4.0	3.5	4.0	3.5
09N Imnaha River	3.5	3.5	3.5	3.5	3.5	4.0	4.0	4.0	3.5	4.0	3.5
09O North Fork Imnaha River	3.5	3.0	3.5	3.5	3.5	4.0	4.0	4.0	3.5	4.0	3.5
09P South Fork Imnaha River	3.5	3.5	3.5	3.5	3.5	4.0	4.0	4.0	3.5	4.0	2.0

Reference Conditions – Summer steelhead

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek Mouth	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07B Lower Camp Creek	4.0	4.0	3.8	4.0	3.0	3.8	4.0	4.0	4.0	4.0	3.6
07C Upper Camp Creek	3.5	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
07D Little Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07E Summit Creek (Bear&DowneyGulch)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07F Devils Gulch	4.0	4.0	4.0	4.0	3.5	3.5	4.0	4.0	4.0	4.0	4.0
07G Lightning Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07H Little Sheep Creek 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07I McCully Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07K Big Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07L Squaw Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07M Big Sheep Creek 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07N Marr Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07O Carroll Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07P Big Sheep Creek 3	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07Q Lick Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07R Big/Little Sheep Headwaters	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08A Imnaha River Confluence	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08B Imnaha River 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08C Imnaha River 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08D Imnaha River 3 (Town)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08E Horse Creek Confluence	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08F Pumpkin Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08G Horse Creek Upper	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08H Lightning Creek Confluence	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
08I Sleepy Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08J Lightning Creek Upper	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08K Cow Creek Confluence	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
08L Cow Creek Upper	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09A Imnaha River 4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09B Freezeout Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09C Imnaha River 5	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09D Grouse Creek Confluence	4.0	4.0	4.0	4.0	4.0	3.7	4.0	4.0	4.0	4.0	4.0
09E Rich Creek/Shadow Canyon	4.0	4.0	4.0	4.0	4.0	3.5	4.0	4.0	4.0	4.0	4.0
09F Grouse Creek Upper	4.0	4.0	4.0	4.0	4.0	3.2	4.0	4.0	4.0	4.0	4.0
09G Imnaha River 6	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09H Summit Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09I Crazymans Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09J Imnaha River 7	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09K Gumboot Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09L Imnaha River 8	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09M Imnaha River 9	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09N Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09O North Fork Imnaha River	4.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09P South Fork Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Species Habitat Hypothesis – Summer Steelhead

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Life Stage Rank (1-4)	4.0	3.0	3.0	2.0

Assign a weight to each attribute (0-2) relative to its importance to the life stage

Riparian Condition	0.5	1.0	1.0	0.5
Channel stability	2.0	1.0	1.0	0.5
Habitat Diversity	1.0	2.0	2.0	0.5
Fine sediment	2.0	2.0	2.0	0.5
High Flow	2.0	1.5	1.5	1.5
Low Flow	2.0	2.0	2.0	2.0
Oxygen	2.0	2.0	2.0	2.0

Low Temp	1.0	0.0	0.0	0.0
High Temp	0.5	0.5	0.5	0.5
Pollutants	2.0	2.0	2.0	2.0
Obstructions	0.0	1.0	1.0	2.0

Species Range – Summer Steelhead

Reach Name	Current Range (0-4)				Reference Range (0-4)			
	Spawn and incubation	Summer rearing	Winter rearing	Migration	Spawn and incubation	Summer rearing	Winter rearing	Migration
07A Big Sheep Creek Mouth	0	2	2	2	0	2	2	2
07B Lower Camp Creek	1.5	0.5	0.5	2	1.5	2	2	2
07C Upper Camp Creek	1.4	0.6	0.6	2	1	1	1	2
07D Little Sheep Creek 1	2	2	2	2	2	2	2	2
07E Summit Creek (Bear&DowneyGulch)	2	2	2	2	2	2	2	2
07F Devils Gulch	2	2	2	2	2	2	2	2
07G Lightning Creek	2	2	2	2	2	2	2	2
07H Little Sheep Creek 2	2	2	2	2	2	2	2	2
07I McCully Creek	1	1	1	1	1.5	1.5	1.5	1.5
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	1	1	1	1	1.5	1.5	1.5	1.5
07K Big Sheep Creek 1	2	2	2	2	2	2	2	2
07L Squaw Creek	2	2	2	2	2	2	2	2
07M Big Sheep Creek 2	2	2	2	2	2	2	2	2
07N Marr Creek	2	2	2	2	2	2	2	2
07O Carroll Creek	2	2	2	2	2	2	2	2
07P Big Sheep Creek 3	2	2	2	2	2	2	2	2
07Q Lick Creek	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
07R Big/Little Sheep Headwaters	1	1	1	1	1.625	1.625	1.625	1.625
08A Imnaha River Confluence	0	2	2	2	0	2	2	2
08B Imnaha River 1	0.7	1.3	1.3	2	1.8	2	2	2
08C Imnaha River 2	0.25	1.75	1.75	2	1	2	2	2

Reach Name	Current Range (0-4)				Reference Range (0-4)			
	Spawn and incubation	Summer rearing	Winter rearing	Migration	Spawn and incubation	Summer rearing	Winter rearing	Migration
08D Imnaha River 3 (Town)	0.5	1.5	1.5	2	1	2	2	2
08E Horse Creek Confluence	2	2	2	2	2	2	2	2
08F Pumpkin Creek	2	2	2	2	2	2	2	2
08G Horse Creek Upper	2	2	2	2	2	2	2	2
08H Lightning Creek Confluence	2	2	2	2	2	2	2	2
08I Sleepy Creek	1	1	1	1	1	1	1	1
08J Lightning Creek Upper	2	2	2	2	2	2	2	2
08K Cow Creek Confluence	2	2	2	2	2	2	2	2
08L Cow Creek Upper	2	2	2	2	2	2	2	2
09A Imnaha River 4	2	2	2	2	2	2	2	2
09B Freezeout Creek	2	2	2	2	2	2	2	2
09C Imnaha River 5	2	2	2	2	2	2	2	2
09D Grouse Creek Confluence	2	2	2	2	2	2	2	2
09E Rich Creek/Shadow Canyon	2	2	2	2	2	2	2	2
09F Grouse Creek Upper	2	2	2	2	2	2	2	2
09G Imnaha River 6	2	2	2	2	2	2	2	2
09H Summit Creek	2	2	2	2	2	2	2	2
09I Crazymann Creek	2	2	2	2	2	2	2	2
09J Imnaha River 7	2	2	2	2	2	2	2	2
09K Gumboot Creek	2	2	2	2	2	2	2	2
09L Imnaha River 8	2	2	2	2	2	2	2	2
09M Imnaha River 9	2	2	2	2	2	2	2	2
09N Imnaha River	2	2	2	2	2	2	2	2
09O North Fork Imnaha River	1	0	0	0.75	1	0	0	0.75
09P South Fork Imnaha River	0.75	0	0	0.75	1	0	0	0.75

Habitat Scores – Summer Steelhead

	Reach Name	Protection Scores		Restoration Scores						Obstructions		
		Rreach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants
	07A Big Sheep Creek Mouth	-0.3	-0.2	-0.2	-0.1	-0.1	-0.3	0.0	0.0	-0.6	-0.5	0.3
	07B Lower Camp Creek	-0.3	-0.2	-0.2	-0.2	-0.2	0.0	0.0	-0.3	-0.5	-0.2	0.2
	07C Upper Camp Creek	-0.3	-0.2	-0.2	-0.2	-0.3	0.0	0.0	-0.2	-0.6	-0.2	0.3
	07D Little Sheep Creek 1	-0.4	-0.4	-0.3	-0.4	-0.4	0.0	0.0	-0.1	-0.9	-0.5	0.1
	07E Summit Creek (Bear&DowneyGulch)	-0.5	-0.4	-0.6	-0.5	-0.4	-0.5	-0.7	0.0	0.0	-0.9	-0.4
	07F Devils Gulch	-0.6	-0.6	-0.6	-0.5	-0.3	-0.7	0.0	0.0	-0.7	-0.8	-0.5
	07G Lightning Creek	-0.4	-0.4	-0.4	-0.4	-0.3	-0.5	0.0	0.0	-0.5	-0.6	-0.3
	07H Little Sheep Creek 2	-0.4	-0.4	-0.3	-0.4	-0.3	-0.4	0.0	0.0	-0.1	-0.9	-0.3
	07I McCully Creek	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	0.0	0.0	-0.4	-0.4	-0.1
	07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	-0.2	-0.2	-0.3	0.0	-0.2	0.0	0.0	-0.4	-0.4	0.0	0.0
	07K Big Sheep Creek 1	-0.4	-0.4	-0.4	-0.7	-0.3	-0.4	0.0	0.0	-0.1	-0.9	-0.5

Protection Scores		Restoration Scores										
		Pollutants					Obstructions					
Reach Name	Reach Score	Low Temperature		High Temperature		Low Flow		High Flow		Oxygen		
		0.6	-0.5	-0.7	-0.7	-0.3	-0.4	0.0	0.0	-0.5	-0.9	
		07M Big Sheep Creek	-0.5	-0.7	-0.7	-0.3	-0.4	0.0	0.0	-0.5	-0.9	
		07M Big Sheep Creek	-0.5	-0.7	-0.7	-0.3	-0.4	0.0	0.0	-0.5	-0.9	
		07N Marr Creek	-0.6	-0.5	-0.7	-0.7	-0.3	-0.4	0.0	0.0	-0.5	-0.9
		07O Carroll Creek	-0.4	-0.4	-0.7	-0.1	-0.3	-0.4	0.0	0.0	-0.5	-0.9
		07P Big Sheep Creek	-0.5	-0.4	-0.7	-0.7	-0.4	-0.3	-0.4	0.0	-0.5	-0.9
		07Q Lick Creek	-0.5	-0.3	-0.3	-0.6	-0.6	-0.3	-0.4	0.0	-0.5	-0.9
		07R Big/Little Sheep Headwaters	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	0.0	-0.4	-0.4	-0.8
		08A Imnaha River Confluence	-0.4	-0.5	-0.4	-0.3	-0.5	-0.3	0.0	-0.1	-0.6	-0.5
Location	Condition	08B Imnaha River 1	-0.3	-0.3	-0.4	-0.2	-0.3	-0.5	0.0	-0.1	-0.5	-0.4
		08C Imnaha River 2	-0.3	-0.4	-0.4	-0.3	-0.2	-0.2	0.0	0.0	-0.6	-0.4
		08D Imnaha River 3 (Town)	-0.3	-0.2	-0.2	-0.2	-0.3	0.0	0.0	-0.1	-0.5	-0.4
		08E Horse Creek Confluence	-0.5	-0.6	-0.7	-0.5	-0.4	-0.3	0.0	0.0	-0.5	-0.9
		08F Pumpkin Creek	-0.6	-0.6	-0.7	-0.4	-0.5	-0.7	0.0	0.0	-0.5	-0.9
Elevation	Condition	08G Horse Creek Upper	-0.6	-0.6	-0.7	-0.7	-0.4	-0.5	-0.7	-0.7	-0.9	-0.5
		08H Horse Creek Middle	-0.6	-0.6	-0.7	-0.7	-0.4	-0.5	-0.7	-0.7	-0.9	-0.5

	Reach Name	Reach Score	Protection Scores		Restoration Scores		Obstructions	Pollutants	High Temperature	Low Temperature	Oxygen	Low Flow	High Flow	Fine Sediment	Riparian Condition	Channel Stability	Habitat Diversity	Fine Sediment	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
			Reach Score	Riparian Condition	Channel Stability	Habitat Diversity																		
08H Lightning Creek Confluence	-0.6	-0.7	-0.5	-0.7	-0.3	-0.7	0.0	0.0	-0.8	-0.9	-0.5	0.1	0.1	0.3	0.1	0.2	0.1	0.0	0.0	0.0	0.1	0.1	0.1	
08I Sleepy Creek	-0.3	-0.3	-0.3	-0.3	-0.4	0.0	0.0	-0.4	-0.4	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	
08J Lightning Creek Upper	-0.6	-0.7	-0.7	-0.4	-0.5	-0.7	0.0	0.0	-0.8	-0.9	-0.5	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.0	0.0	0.1	0.1	0.1	
08K Cow Creek Confluence	-0.6	-0.7	-0.6	-0.7	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.0	0.0	0.5	0.1	0.1	
08L Cow Creek Upper	-0.6	-0.6	-0.4	-0.7	-0.7	-0.5	-0.7	0.0	0.0	-0.8	-0.9	-0.5	0.1	0.1	0.4	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	
09A Imnaha River 4	-0.4	-0.4	-0.3	-0.4	-0.3	-0.4	0.0	0.0	-0.1	-0.9	-0.5	0.4	0.4	0.5	0.4	0.3	0.4	0.0	0.0	0.0	0.8	0.1	0.1	
09B Freezeout Creek	-0.6	-0.6	-0.7	-0.7	-0.3	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.1	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.5	0.1	0.1	
09C Imnaha River 5	-0.6	-0.6	-0.7	-0.5	-0.7	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.1	0.1	0.3	0.1	0.2	0.1	0.0	0.0	0.5	0.1	
09D Grouse Creek Confluence	-0.6	-0.4	-0.7	-0.7	-0.7	-0.3	-0.6	0.0	0.0	-0.5	-0.9	-0.4	0.2	0.4	0.1	0.1	0.3	0.2	0.0	0.0	0.5	0.1	0.1	
09E Rich Creek/Shadow Canyon	-0.6	-0.4	-0.7	-0.7	-0.6	-0.3	-0.6	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.4	0.1	0.1	0.2	0.3	0.1	0.0	0.0	0.5	0.1	
09F Grouse Creek Upper	-0.5	-0.4	-0.4	-0.7	-0.4	-0.3	-0.5	0.0	0.0	-0.8	-0.9	-0.5	0.2	0.4	0.1	0.4	0.3	0.2	0.0	0.0	0.1	0.1	0.1	
09G Imnaha River 6	-0.6	-0.6	-0.7	-0.5	-0.4	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.1	0.1	0.3	0.4	0.2	0.1	0.0	0.0	0.5	0.1	

	Reach Name	Protection Scores		Restoration Scores		Obstructions					
		Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
	09H Summit Creek	-0.5	-0.4	-0.4	-0.4	-0.3	-0.4	0.0	-0.5	-0.9	-0.5
	09I Crazyman Creek	-0.6	-0.6	-0.7	-0.7	-0.3	-0.7	0.0	0.0	-0.5	-0.5
	09J Imnaha River 7	-0.6	-0.6	-0.7	-0.7	-0.3	-0.7	0.0	-0.5	-0.9	-0.5
	09K Gumboot Creek	-0.5	-0.4	-0.7	-0.7	-0.4	-0.3	-0.4	0.0	-0.5	-0.5
	09L Imnaha River 8	-0.7	-0.6	-0.7	-0.7	-0.5	-0.7	0.0	0.0	-0.8	-1.0
	09M Imnaha River 9	-0.7	-0.6	-0.7	-0.7	-0.5	-0.7	0.0	0.0	-0.8	-1.0
	09N Imnaha River	-0.7	-0.6	-0.7	-0.7	-0.7	-0.5	0.0	0.0	-0.8	-1.0
	09O North Fork Imnaha River	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	0.0	0.0	-0.2	-0.1
	09P South Fork Imnaha River	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	-0.1	-0.2

Habitat Ranks – Summer Steelhead

Reach Name	Reach Rank	Protection Ranks				Restoration Ranks						
		Oxygen	Low Flow	Fine Sediment	Channel Complexity	Riparian Condition	Channel Form	High Flow	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek Mouth	40	4	5	6	8	7	3	10	10	9	1	2
07B Lower Camp Creek	41	7	4	5	6	9	3	10	10	2	1	8
07C Upper Camp Creek	43	9	3	7	6	8	2	10	10	4	1	5
07D Little Sheep Creek 1	31	6	4	8	5	7	3	10	10	9	1	2
07E Summit Creek (Bear&DowneyGulch)	20	9	3	5	8	4	2	10	10	6	1	7
07F Devils Gulch	14	6	4	8	9	2	10	10	3	1	7	26
07G Lightning Creek	30	7	4	4	6	8	2	10	10	3	1	9
07H Little Sheep Creek 2	34	5	3	7	4	6	2	10	10	9	1	8
07I McCully Creek	38	6	3	3	5	8	7	10	10	2	1	36
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	44	6	5	3	8	7	4	10	10	2	1	9
07K Big Sheep Creek 1	28	7	5	5	2	8	4	10	10	9	1	3
07L Squaw Creek	15	5	2	2	4	9	8	10	10	7	1	6
07M Big Sheep Creek 2	22	8	2	4	3	9	7	10	10	6	1	5
07N Marr Creek	15	5	2	2	4	9	8	10	10	7	1	6

Reach Name	Reach Rank	Protection Ranks		Restoration Ranks	
		Oxygen	Flow	Pollutants	Structures
07O Carroll Creek	29	6	5	2	9
07P Big Sheep Creek	25	7	2	2	6
07Q Lick Creek	26	7	6	3	4
07R Big Little Sheep Headwaters	39	5	4	3	8
08A Imnaha River Confluence	33	3	5	7	6
08B Imnaha River 1	37	5	3	6	8
08C Imnaha River 2	36	4	5	6	8
08D Imnaha River 3 (Town)	42	4	5	7	6
08E Horse Creek Confluence	23	3	2	4	8
08F Pumpkin Creek	10	5	3	3	9
08G Horse Creek Upper	4	6	4	4	9
08H Lightning Creek Confluence	7	6	4	7	5
08I Sleepy Creek	35	7	4	4	6
08J Lightning Creek Upper	4	6	4	4	9
08K Cow Creek Confluence	11	5	3	6	4
08L Cow Creek Upper	6	6	9	4	5

Reach Name	Reach Rank	Protection Ranks		Restoration Ranks		Oxygen	Low Flow	Channel Complexity	Channel Form	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Dissolved Oxygen							
		Protection Rank	Reach Rank	Protection Rank	Reach Rank																				
09A Imnaha River 4	31	6	4	8	5	7	3	10	10	9	1	2	2	6	4	2	5	7	3	10	10	1	8	9	
09B Freezeout Creek	8	6	3	3	5	9	2	10	10	8	1	7	34	8	5	5	7	2	4	10	10	1	3	9	
09C Imnaha River 5	13	5	3	6	4	9	2	10	10	8	1	7	28	8	6	2	7	3	5	10	10	1	4	9	
09D Grouse Creek Confluence	19	8	2	4	9	5	10	10	6	1	7	21	2	7	7	9	3	4	10	10	1	1	6	5	
09E Rich Creek/Shadow Canyon	17	8	2	2	5	9	4	10	10	7	1	6	24	2	7	7	4	3	6	10	10	1	1	5	9
09F Grouse Creek Upper	21	8	6	3	7	9	4	10	10	2	1	5	17	3	1	8	2	4	5	10	10	7	6	9	
09G Imnaha River 6	18	4	3	5	8	9	2	10	10	7	1	6	25	8	7	3	2	4	6	10	10	1	5	9	
09H Summit Creek	27	8	5	5	7	9	4	10	10	3	1	2	8	6	3	3	5	7	2	10	10	1	8	9	
09I Crazyman Creek	8	6	3	3	5	9	2	10	10	8	1	7	34	8	5	5	7	2	4	10	10	1	3	9	
09J Imnaha River 7	11	5	3	6	4	9	2	10	10	8	1	7	30	8	6	2	7	3	5	10	10	1	4	9	
09K Gumboot Creek	24	8	2	2	7	9	6	10	10	5	1	4	11	4	7	7	3	5	2	10	10	1	6	9	
09L Imnaha River 8	1	7	4	4	6	8	3	10	10	2	1	9	41	6	3	3	5	7	2	9	9	1	9	8	
09M Imnaha River 9	1	7	4	4	6	8	3	10	10	2	1	9	41	6	3	3	5	7	2	9	9	1	9	8	
09N Imnaha River	1	7	4	4	6	8	3	10	10	2	1	9	41	6	3	3	5	7	2	9	9	1	9	8	
09O North Fork Imnaha River	45	8	4	7	5	3	6	10	10	2	1	9	46	5	7	4	7	2	3	7	7	1	7	6	
09P South Fork Imnaha River	46	8	2	7	4	4	6	10	10	2	1	9	45	8	2	7	4	4	6	9	9	3	9	1	

Existing Conditions – Bull Trout

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	2.0	2.0	1.5	0.5	2.0	2.0	4.0	4.0	0.5	2.0	3.5
07D Little Sheep Creek 1	0.5	3.5	1.5	1.5	2.0	2.0	4.0	4.0	0.5	2.0	3.5
07H Little Sheep Creek	3.5	3.5	1.5	1.5	2.0	1.5	4.0	4.0	0.5	1.0	2.0
07I McCully Creek	2.5	3.5	3.5	2.0	3.5	3.3	4.0	4.0	3.5	2.0	0.5
07J Little Sheep Creek Headwaters	3.4	3.5	3.5	2.0	3.0	2.0	4.0	4.0	2.0	3.5	0.5
07K Big Sheep Creek 1	1.5	2.0	2.0	2.0	2.0	2.0	4.0	4.0	0.5	2.0	3.5
07M Big Sheep Creek 2	1.5	3.5	2.5	2.0	3.5	3.5	4.0	4.0	2.0	2.0	3.5
07P Big Sheep Creek 3	1.5	2.0	3.5	2.8	2.8	2.8	4.0	4.0	0.5	3.5	2.0
07Q Lick Creek	1.0	3.5	3.5	3.5	2.0	3.0	4.0	4.0	3.5	3.5	2.0
07R Big Sheep Creek 4 (headwaters)	2.0	3.0	3.0	2.5	2.5	2.6	4.0	4.0	3.0	3.5	0.5
08A Imnaha River Confluence	3.5	3.5	2.5	2.0	2.0	3.5	4.0	4.0	0.5	3.5	3.5
08B Imnaha River 1	2.0	2.0	2.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
08C Imnaha River 2	2.0	3.5	2.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
08D Imnaha River 3	2.0	3.5	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
09A Imnaha River 4	3.5	3.5	1.5	2.0	3.5	3.5	4.0	4.0	0.5	3.5	3.5
09C Imnaha River 5	3.5	3.5	2.5	2.0	3.5	3.5	4.0	4.0	0.5	3.5	3.5
09G Imnaha River 6	3.5	3.5	2.5	2.0	3.5	3.5	4.0	4.0	0.5	3.5	3.5
09J Imnaha River 7	3.5	3.5	3.0	2.0	3.5	3.5	4.0	4.0	2.5	3.5	2.0
09L Imnaha River 8	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	2.5	4.0	3.5
09M Imnaha River 9	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09N Imnaha River	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09O North Fork Imnaha River	4.0	3.0	4.0	2.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09P South Fork Imnaha River	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Reference Conditions – Bull Trout

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07D Little Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07H Little Sheep Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07I McCully Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07J Little Sheep Creek Headwaters	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07K Big Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07M Big Sheep Creek 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07P Big Sheep Creek 3	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07Q Lick Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07R Big Sheep Creek 4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08A Imnaha River Confluence	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08B Imnaha River 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08C Imnaha River 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08D Imnaha River 3	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09A Imnaha River 4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
09C Imnaha River 5	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0	4.0
09G Imnaha River 6	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0	4.0
09J Imnaha River 7	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09L Imnaha River 8	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09M Imnaha River 9	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09N Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09O North Fork Imnaha River	4.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09P South Fork Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Species Habitat Hypothesis – Bull Trout

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Life Stage Rank (1-4)	3.0	3.0	3.0	2.0

Assign a weight to each attribute (0-2) relative to its importance to the life stage

Riparian Condition	1.0	2.0	2.0	0.5
Channel stability	2.0	2.0	2.0	0.5
Habitat Diversity	1.0	2.0	2.0	0.5
Fine sediment	2.0	2.0	2.0	0.5
High Flow	2.0	1.0	1.0	0.5
Low Flow	2.0	2.0	2.0	2.0
Oxygen	2.0	2.0	2.0	2.0
Low Temp	0.5	0.0	0.0	0.0
High Temp	2.0	2.0	2.0	2.0
Pollutants	2.0	2.0	2.0	2.0
Obstructions	1.0	1.0	1.0	2.0

Species Range – Bull Trout

Reach Name	Current Range (0-4)				Reference Range (0-4)			
	Spawn and incubation	Summer rearing	Winter rearing	Migration	Spawn and incubation	Summer rearing	Winter rearing	Migration
07A Big Sheep Creek	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07D Little Sheep Creek 1	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07H Little Sheep Creek	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07I McCully Creek	1.3	0.8	0.8	2.0	2.0	1.5	1.5	2.0
07J Little Sheep Creek Headwaters	0.8	0.8	0.3	2.0	1.0	1.0	1.0	2.0
07K Big Sheep Creek 1	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07M Big Sheep Creek 2	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07P Big Sheep Creek 3	1.0	0.5	0.5	2.0	1.0	1.0	1.0	2.0
07Q Lick Creek	2.0	1.0	1.0	0.0	2.0	1.0	1.0	0.0
07R Big Sheep Creek 4 (headwaters)	2.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0
08A Imnaha River Confluence	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
08B Imnaha River 1	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
08C Imnaha River 2	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
08D Imnaha River 3	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
09A Imnaha River 4	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
09C Imnaha River 5	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
09G Imnaha River 6	1.5	0.0	0.0	2.0	2.0	0.0	0.0	2.0
09J Imnaha River 7	2.0	0.5	1.0	2.0	2.0	1.0	1.0	2.0
09L Imnaha River 8	2.0	0.5	1.0	2.0	2.0	1.0	1.0	2.0
09M Imnaha River 9	2.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0
09N Imnaha River	2.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0
09O North Fork Imnaha River	2.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0
09P South Fork Imnaha River	2.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0

Habitat Scores – Bull Trout

	Reach Name	Protection Scores		Restoration Scores								
		Rreach Score	Riparian Condition	Channel stability	Habitat Diversity	Oxygen	Flow					
07A Big Sheep Creek	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0	0.1	0.0
07D Little Sheep Creek 1	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0	0.1	0.0
07H Little Sheep Creek	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
07I McCully Creek	-0.3	-0.2	-0.4	-0.2	-0.3	-0.5	0.0	-0.5	0.0	0.2	0.1	0.1
07J Little Sheep Creek Headwaters	-0.2	-0.2	-0.2	-0.1	-0.2	0.0	0.0	-0.2	0.0	0.2	0.1	0.3
07K Big Sheep Creek 1	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.2	0.0	0.0	0.1
07M Big Sheep Creek 2	-0.1	0.0	0.0	0.0	-0.2	0.0	0.0	-0.1	-0.2	0.0	0.0	0.0
07P Big Sheep Creek 3	-0.2	-0.1	-0.2	-0.2	-0.2	-0.3	0.0	-0.1	-0.4	-0.2	0.2	0.0
07Q Lick Creek	-0.3	-0.1	-0.5	-0.4	-0.5	-0.2	-0.4	0.0	0.0	-0.5	-0.1	0.1
07R Big Sheep Creek 4 (headwaters)	-0.5	-0.3	-0.5	-0.4	-0.5	-0.3	-0.6	0.0	-0.6	-0.8	-0.1	0.3
08A Imnaha River Confluence	-0.1	0.0	0.0	0.0	-0.2	0.0	0.0	-0.2	-0.2	0.0	0.0	0.0
08B Imnaha River 1	-0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	0.0
08C Imnaha River 2	-0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	0.0
08D Imnaha River 3	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	-0.2	0.0	0.0	0.0

Habitat Ranks – Bull Trout

Reach Name	Reach Rank	Protection Ranks										Restoration Ranks										
		Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Riparian Condition	Channel complexity	Fine sediment	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions		
07A Big Sheep Creek	22	4	4	8	9	4	2	10	10	4	2	1	11	6	6	5	4	6	2	10	1	6
07D Little Sheep Creek 1	21	9	4	7	7	5	2	10	10	5	2	1	12	4	9	5	5	7	2	10	1	2
07H Little Sheep Creek	23	4	4	8	8	6	2	10	10	6	3	1	10	8	8	5	5	7	2	10	2	7
07I McCully Creek	9	8	3	4	7	5	2	10	10	1	6	9	2	4	7	8	3	9	5	10	10	4
07J Little Sheep Creek Headwaters	11	6	2	5	8	7	3	10	10	3	1	9	4	8	7	9	4	5	2	10	2	6
07K Big Sheep Creek 1	20	9	4	4	4	4	2	10	10	4	2	1	13	4	5	5	5	5	2	10	1	5
07M Big Sheep	16	9	5	7	8	5	5	1	10	10	3	3	1	18	3	8	7	4	8	4	10	2

Reach Name	Protection Ranks	Reach Rank							Restoration Ranks	
		Riparian Condition			Channel Stability		Habitat Diversity			
		High Flow	Low Flow	Oxygen	Fine Sediment	Channel Form	Stream Complexity	Obstructions		
		13	4	7	8	4	1	10	8	
		12	6	4	8	7	4	1	10	9
		7	6	3	7	8	5	1	10	4
		6	8	3	8	3	6	2	10	10
		4	6	4	6	2	10	10	2	1
		1	5	4	5	9	5	1	10	10
		3	4	8	4	9	4	1	10	10
		1	5	4	5	9	5	1	10	10
		21	2	2	2	2	1	2	2	2
		23	2	2	2	1	2	2	2	2
		21	2	2	2	1	2	2	2	2