DRAFT 2022 Columbia Basin Research Report

A Bayesian multidirectional, multistate model to resolve the migration pathways of adult Steelhead returning to the Columbia River Basin

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Contents

Introduction

Most populations of Steelhead (anadromous *Oncorhynchus mykiss*) in the Columbia River Basin, including all those that are found above Bonneville Dam, are listed under the Endangered Species Act. The five Columbia River Basin distinct population segments (DPSs) were first listed in the late 1990s, and are all currently listed as threatened. Despite their protected status and continued recovery efforts, counts of returning Steelhead to Bonneville Dam are currently lower than they were at the time of listing, and recently completed 5-year reviews for Columbia River Steelhead reaffirmed their status as threatened.

Relative to other salmonids, Steelhead from the Columbia River Basin spend longer in freshwater as adults. Essentially all populations of Steelhead in the Columbia River Basin are stream-maturing [@Busby1996], meaning that these fish enter freshwater in a sexually immature state and then spend up to a year in freshwater prior to spawning. Also known as summer Steelhead, these fish enter freshwater between May and October and spawn the following spring, typically between March and April [@Busby1996]. Between their entry into freshwater and arrival at spawning grounds, Columbia River Steelhead exhibit considerable variability in their migration patterns. All Columbia River Steelhead overwinter in freshwater; the majority of individuals are known to overwinter in tributaries, but up to 20% of individuals in a given year have been observed to overwinter within the hydrosystem [@Keefer2008]. Additionally, as individuals migrate upstream toward natal tributaries, the majority of individuals have been observed to temporarily stage in nonnatal tributaries downstream of their natal tributary [@High2006]. This behavior increases with increasing mainstem river temperature, indicating the use of these colder waters as coldwater refugia [@High2006].

Descending dams, also known as fallback [@Boggs2004], is another common behavior observed in Steelhead, with about 20% of Steelhead observed to fall back over at at least one mainstem dam [@Boggs2004]. This behavior can occur as individuals are migrating upstream to natal tributaries, but can also occur once individuals have ascended mainstem dams upstream of natal tributaries (a behavior known as overshoot), in which case this fallback is called post-overshoot fallback and is necessary for individuals to return to natal tributaries. Overshoot and fallback are consequential for the ability of individuals to successfully spawn, and therefore are consequential for the persistence of ESA-listed populations. Individuals that fall back during their upstream migration have been observed to have lower escapement rates (rates of successful spawning) to tributaries or hatcheries [@Bjornn2000; @Keefer2005]. Furthermore, migration success to natal tributaries decreases with overshooting rates [@Richins2018], and many overshooting fish are observed to stray to tributaries upstream of the overshoot dam. The decreased migration success with overshoot and fallback is likely due to the hazardous nature of downstream passage for adults, which is often limited to the powerhouse during the primary months that Steelhead are overwintering [@Khan2013]. Mortality rates for Steelhead passing downstream at dams are highly variable, but recent estimates of 48-hour survival at McNary Dam indicate around 90% survival for individuals passing through turbines and 97% survival for individuals passing through the spillway [@Normandeau2014]. Mortality in downstream passage routes is implicated by low survival rates of Steelhead kelts, which decrease with increasing number of dams that must be navigated as they move downstream to the ocean, with mortality rates of 84-96% for kelts released at Lower Granite Dam, 38-40% at McNary Dam, and 20-37% at John Day Dam [@Westrheim2005].

Because of the association between overshoot and fallback and decreased migration success, previous studies have investigated the influence of various factors on these rates. Rates of overshoot have been shown to vary considerably among populations, but have a positive relationship with increasing mainstem water temperature and hatchery rearing upstream of the natal tributary [@Richins2018]. In spring-summer Chinook,

fallback rates have a positive relationship with river discharge [@Boggs2004].

Methods

Accessing PIT tag data

PIT tag data was accessed through PTAGIS. Only known-origin individuals (based on known release sites) were included in this dataset. To ensure that only individuals marked as juveniles were kept in the dataset, all individuals that were greater than 350 mm at time of marking were removed from the dataset. To select returning adults, only individuals that were seen in the adult fishways at Bonneville Dam were selected. To ensure that there was enough data for each population included in this dataset, only populations (defined as tributaries in which PIT-tagged juveniles were released) that had at least 250 individuals distributed across 8 run years were kept. Additionally, only populations with instream PIT tag detections sites in their natal tributaries were kept; if sufficient instream detection sites only became available during the later part of our study period, only individuals from those years were kept. Run years were separated by June 1 of each year, and run year 2005/2006 (beginning on June 1, 2005) was selected as the first year in our dataset. In total, populations from 17 natal tributaries met this criteria; 11 tributaries of the Columbia (Deschutes River, John Day River, Hood River, Fifteenmile Creek, Umatilla River, Yakima River, Walla Walla River, Wenatchee River, Entiat River, Okanogan River, and Methow River) and six tributaries of the Snake (Tucannon River, Asotin Creek, Clearwater River, Salmon River, Grande Ronde River, and Imnaha River). Once the tag codes were identified for each of these tributary populations, a complete tag history report was run in PTAGIS for all of the tag codes in our dataset.

Processing PIT tag data into detections at various sites

In order to convert detections of fish at individual PIT tag antennas into a history of movements between different reaches of the Columbia, Snake, and their tributaries, the first step with the PIT tag data from PTAGIS was to interpret detections at different PIT tag antennas. For instream tributary detection sites, as well as mainstem sites in between dams, no processing was required, and these detections were interpreted as the fish being in that associated state. For detection sites at dams, additional processing was required to interpret detections.

The first step was to identify the multiple passage routes associated with each dam. In many cases, multiple passage routes were grouped together into a single interrogation site, and assigning antennas to these different passage routes was necessary to interpret how fish were utilizing these passage routes. For example, antennas at Ice Harbor Dam are all grouped together in the initial PTAGIS query as "Ice Harbor Dam (combined)", when these antennas are actually in three different passage routes: the North Shore Ladder, the South Shore Ladder, and the Juvenile Bypass System.

The second step was to identify, when possible, entrance and exit antennas within each upstream passage route. Entrance and exit antennas were only distinguished when either two distinct groupings of antennas existed in separate parts of the same passage route, or in the case of Bonneville Dam, when there are enough consecutive weirs with PIT tag detection antennas to separate these weirs into entrance and exit antennas. By distinguishing entrance and exit antennas, we were able to identify when fish detections in adult fishways were not ascents, but were rather aborted ascent attempts or descents. When fish were only seen at entrance

antennas, this was noted to be an aborted ascension attempt. When fish were first seen at the exit antennas at an adult fish ladder and last seen at the entrance antennas of the same fish ladder, this was noted to be a descent through the ladder. If a fish was first seen at the entrance antennas and last seen at the exit antennas, this was noted to be an ascent. Entrance and exit antennas were identified at all adult fishways except for McNary Dam Washington Shore Ladder (prior to March 2006), Priest Rapids Dam, Rock Island Dam, Rocky Reach Dam, Wells Dam (prior to 2013), and Ice Harbor Dam.

An additional step was to identify antennas in adult fish facilities/traps at ladders. For most dams, detections in the adult fish facility were treated the same as detections in other parts of the adult ladder, as trapping did not take place and thus fish were not removed. However, in the case of Wells Dam, fish that were trapped were removed and either moved to the hatchery or trucked off-site. As such, any terminal detections in the trap at Wells Dam were treated as trapping events.

Once the antennas had been appropriately assigned, a 48 hour threshold was utilized to distinguish separate visits to a site. However, in some passage routes, due to fish being observed in the same route for days at a time, no time threshold was utilized, and instead the sequence of antennas was used to distinguish separate visits to a site. For example, because individual fish were observed not exiting the Washington shore passage route at Bonneville Dam for upwards of 100 days, new visits to this site were only distinguished as new visits to the entrance antennas, regardless of time between detections at other antennas in the passage route.

Turning detections at different sites into state visits

With antennas appropriately assigned to different passage routes and the sequence of antenna detections used at the adult fishways to interpret directionality, the output from the previous script was used as input into the next script, which converted a history of detections at sites into a history of movements between states, as defined in Figure 1. For instream detection sites in either the mainstem or the tributaries, detections at these sites were interpreted as the fish being in the appropriate state. For detections at sites in the fish passage routes at dams, the directionality of movement, as assigned in the previous script, was used to inform transitions between states. Ascents at dams indicated a transition from the downstream state to the upstream state; descents at dams (either through the juvenile bypass system or through descents through the ladder) indicated a transition from the upstream state to the downstream state. Aborted ascension attempts were noted, but interpreted as no transition from the current state.

Until the installation of the PIT tag antennas in the spillway at Lower Granite Dam in 2020, PIT tag detection capabilities have been limited to the adult fish ladders and the juvenile bypass system at each dam. As such, PIT tag antennas have historically been unable to directly monitor fallback at dams, unless an individual subsequently reascends the dam [@Boggs2004]. With the installation of instream antennas in natal tributaries, fallback to home has been monitored [@Richins2018], by noting when individuals entered natal tributaries downstream of a dam that was previously ascended. In this study, we monitored fallback to the greatest extent possible with the current configuration of PIT tag antennas by using our knowledge of the connections between states in our model to note when downstream movements must have occurred. In this way, we included fallback that occurred on the mainstem downstream of the natal tributary (similar to [@Boggs2004]), fallback to home (similar to [@Richins2018]), and other fallback movements, such as fallback upstream of the natal tributary that did not end in homing.

Once we determined a history of movement between states, we then subset this movement history to eliminate any movement that occurred as a juvenile or as a kelt, in order to isolate only the portion of the adult migration prior to reaching spawning areas. Juvenile history was identified as any detections within 90 days of release or on or before June 15 of the release year. Kelt movement was identified as any downstream movement occurring between March and July (following spawning). Repeat spawners were also identified in the dataset based on detections at the Bonneville adult ladders occurring at least 180 days after they were initially seen at Bonneville. For the purposes of our analysis, repeat spawners were treated as new fish when they returned to Bonneville.

The model in stan

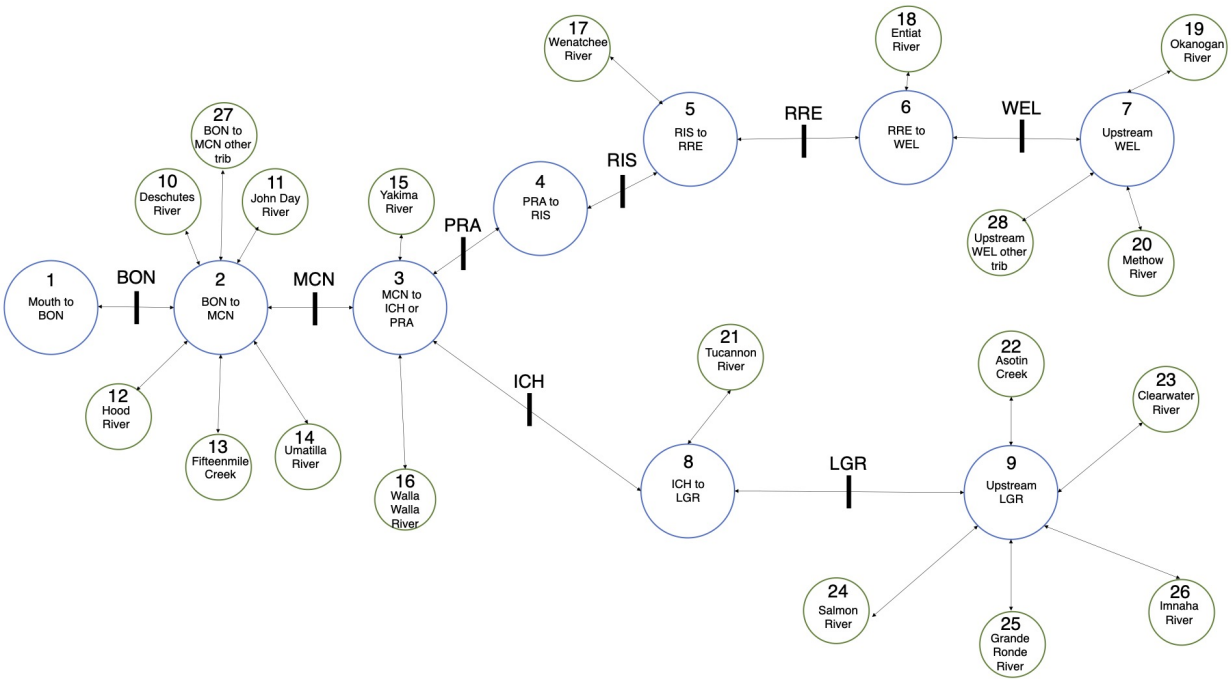

Figure 1: The model schematic.

The history of state transitions for each individual PIT-tagged fish, as well as the information on that fish's natal origin, were the inputs for the multistate model. The multistate model was implemented in a Bayesian framework in Stan [@Carpenter2017]. The multistate model is constructed as a series of states, defined as either reaches of the mainstem Columbia or Snake Rivers between dams with active PIT tag antennas for the duration of our study period or tributaries that flow into the Columbia or Snake Rivers (Figure 1). All fish in our model begin when they are first detected as adults in the fish ladders at Bonneville Dam. At each state in our model, each fish is assigned a probability of moving to any of the states connected to the current states. This probability is evaluated through a multinomial logit.

Due to the computational requirements of evaluating the detection histories of over 60,000 individual fish, the model was fit to three different datasets, corresponding to the three Steelhead DPSs found exclusively upstream of Bonneville Dam: the Middle Columbia DPS, the Upper Columbia DPS, and the Snake River Basin DPS. To reduce the number of parameters in the model,

All code is available at https://github.com/markusmin/steelhead.

Results

Median movement probabilities (with credible intervals) by DPS and by origin

Table 1: Movement probabilities for Middle Columbia Steelhead, outside of the DPS boundaries.

from	to	mean	q5	q95
mainstem, RIS to RRE	mainstem, PRA to RIS	0.384	0.328	0.443
mainstem, RIS to RRE	mainstem, RRE to WEL	0.390	0.330	0.446
mainstem, RIS to RRE	Wenatchee River	0.041	0.013	0.080
mainstem, RIS to RRE	loss	0.185	0.133	0.252
mainstem, RRE to WEL	mainstem, RIS to RRE	0.304	0.189	0.426
mainstem, RRE to WEL	mainstem, upstream of WEL	0.428	0.319	0.551
mainstem, RRE to WEL	Entiat River	0.021	0.001	0.067
mainstem, RRE to WEL	loss	0.247	0.136	0.373
mainstem, upstream of WEL	mainstem, RRE to WEL	0.437	0.272	0.581
mainstem, upstream of WEL	Okanogan River	0.044	0.003	0.152
mainstem, upstream of WEL	Methow River	0.130	0.034	0.260
mainstem, upstream of WEL	loss	0.388	0.232	0.545
mainstem, upstream of LGR	mainstem, ICH to LGR	0.380	0.359	0.403
mainstem, upstream of LGR	Asotin Creek	0.012	0.007	0.018
mainstem, upstream of LGR	Clearwater River	0.018	0.011	0.026
mainstem, upstream of LGR	Salmon River	0.002	0.000	0.005
mainstem, upstream of LGR	Grande Ronde River	0.016	0.010	0.023
mainstem, upstream of LGR	Imnaha River	0.003	0.001	0.007
mainstem, upstream of LGR	loss	0.569	0.543	0.590
Wenatchee River	mainstem, RIS to RRE	0.511	0.168	0.864
Wenatchee River	loss	0.489	0.136	0.832
Entiat River	mainstem, RRE to WEL	0.069	0.000	0.522
Entiat River	loss	0.931	0.478	1.000
Okanogan River	mainstem, upstream of WEL	0.087	0.000	0.618
Okanogan River	loss	0.913	0.382	1.000
Methow River	mainstem, upstream of WEL	0.661	0.240	0.962
Methow River	loss	0.339	0.038	0.760
Tucannon River	mainstem, ICH to LGR	0.096	0.067	0.127
Tucannon River	loss	0.904	0.873	0.933
Asotin Creek	mainstem, upstream of LGR	0.010	0.000	0.049
Asotin Creek	loss	0.990	0.951	1.000
Clearwater River	mainstem, upstream of LGR	0.068	0.002	0.224

Table 1: Movement probabilities for Middle Columbia Steelhead, outside of the DPS boundaries. *(continued)*

from	to	mean	q5	q95
Clearwater River	loss	0.932	0.776	0.998
Salmon River	mainstem, upstream of LGR	0.039	0.000	0.287
Salmon River	loss	0.961	0.713	1.000
Grande Ronde River	mainstem, upstream of LGR	0.007	0.000	0.037
Grande Ronde River	loss	0.993	0.963	1.000
Imnaha River	mainstem, upstream of LGR	0.028	0.000	0.180
Imnaha River	loss	0.972	0.820	1.000

Table 2: Movement probabilities for Middle Columbia Steelhead by natal origin, inside the DPS boundaries.

from	to	mean	q5	q95	origin
mainstem, mouth to BON	mainstem, BON to MCN	0.916	0.795	0.989	Deschutes River
mainstem, mouth to BON	mainstem, BON to MCN	0.994	0.957	1.000	Fifteenmile Creek
mainstem, mouth to BON	mainstem, BON to MCN	0.962	0.914	0.994	John Day River
mainstem, mouth to BON	mainstem, BON to MCN	0.958	0.900	0.994	Umatilla River
mainstem, mouth to BON	mainstem, BON to MCN	0.996	0.985	1.000	Yakima River
mainstem, mouth to BON	mainstem, BON to MCN	0.972	0.943	0.994	Walla Walla River
mainstem, mouth to BON	loss	0.084	0.011	0.205	Deschutes River
mainstem, mouth to BON	loss	0.006	0.000	0.043	Fifteenmile Creek
mainstem, mouth to BON	loss	0.038	0.006	0.086	John Day River
mainstem, mouth to BON	loss	0.042	0.006	0.100	Umatilla River
mainstem, mouth to BON	loss	0.004	0.000	0.015	Yakima River
mainstem, mouth to BON	loss	0.028	0.006	0.057	Walla Walla River
mainstem, BON to MCN	mainstem, mouth to BON	0.016	0.010	0.023	Deschutes River
mainstem, BON to MCN	mainstem, mouth to BON	0.011	0.005	0.020	Fifteenmile Creek
mainstem, BON to MCN	mainstem, mouth to BON	0.008	0.006	0.012	John Day River
mainstem, BON to MCN	mainstem, mouth to BON	0.008	0.006	0.011	Umatilla River
mainstem, BON to MCN	mainstem, mouth to BON	0.007	0.003	0.011	Yakima River
mainstem, BON to MCN	mainstem, mouth to BON	0.016	0.013	0.019	Walla Walla River
mainstem, BON to MCN	mainstem, MCN to ICH or PRA	0.007	0.003	0.012	Deschutes River
mainstem, BON to MCN	mainstem, MCN to ICH or PRA	0.090	0.075	0.109	Fifteenmile Creek
mainstem, BON to MCN	mainstem, MCN to ICH or PRA	0.464	0.452	0.476	John Day River
mainstem, BON to MCN	mainstem, MCN to ICH or PRA	0.338	0.323	0.352	Umatilla River
mainstem, BON to MCN	mainstem, MCN to ICH or PRA	0.759	0.731	0.787	Yakima River
mainstem, BON to MCN	mainstem, MCN to ICH or PRA	0.781	0.768	0.793	Walla Walla River
mainstem, BON to MCN	Deschutes River	0.366	0.342	0.389	Deschutes River
mainstem, BON to MCN	Deschutes River	0.136	0.112	0.167	Fifteenmile Creek
mainstem, BON to MCN	Deschutes River	0.041	0.036	0.045	John Day River
mainstem, BON to MCN	Deschutes River	0.062	0.055	0.070	Umatilla River
mainstem, BON to MCN	Deschutes River	0.059	0.045	0.073	Yakima River
mainstem, BON to MCN	Deschutes River	0.027	0.024	0.032	Walla Walla River
mainstem, BON to MCN	John Day River	0.001	0.000	0.003	Deschutes River
mainstem, BON to MCN	John Day River	0.006	0.002	0.012	Fifteenmile Creek
mainstem, BON to MCN	John Day River	0.238	0.227	0.248	John Day River
mainstem, BON to MCN	John Day River	0.000	0.000	0.001	Umatilla River
mainstem, BON to MCN	John Day River	0.000	0.000	0.001	Yakima River
mainstem, BON to MCN	John Day River	0.000	0.000	0.000	Walla Walla River

Table 2: Movement probabilities for Middle Columbia Steelhead by natal origin, inside the DPS boundaries. *(continued)*

from	to	mean	q5	q95	origin
mainstem, BON to MCN	Hood River	0.003	0.001	0.006	Deschutes River
mainstem, BON to MCN	Hood River	0.000	0.000	0.001	Fifteenmile Creek
mainstem, BON to MCN	Hood River	0.001	0.000	0.001	John Day River
mainstem, BON to MCN	Hood River	0.003	0.001	0.005	Umatilla River
mainstem, BON to MCN	Hood River	0.000	0.000	0.001	Yakima River
mainstem, BON to MCN	Hood River	0.000	0.000	0.000	Walla Walla River
mainstem, BON to MCN	Fifteenmile Creek	0.000	0.000	0.000	Deschutes River
mainstem, BON to MCN	Fifteenmile Creek	0.218	0.190	0.248	Fifteenmile Creek
mainstem, BON to MCN	Fifteenmile Creek	0.000	0.000	0.000	John Day River
mainstem, BON to MCN	Fifteenmile Creek	0.000	0.000	0.000	Umatilla River
mainstem, BON to MCN	Fifteenmile Creek	0.000	0.000	0.000	Yakima River
mainstem, BON to MCN	Fifteenmile Creek	0.000	0.000	0.000	Walla Walla River
mainstem, BON to MCN	Umatilla River	0.000	0.000	0.000	Deschutes River
mainstem, BON to MCN	Umatilla River	0.002	0.000	0.005	Fifteenmile Creek
mainstem, BON to MCN	Umatilla River	0.018	0.014	0.022	John Day River
mainstem, BON to MCN	Umatilla River	0.307	0.294	0.321	Umatilla River
mainstem, BON to MCN	Umatilla River	0.000	0.000	0.001	Yakima River
mainstem, BON to MCN	Umatilla River	0.000	0.000	0.000	Walla Walla River
mainstem, BON to MCN	BON to MCN other tributaries	0.001	0.000	0.002	Deschutes River
mainstem, BON to MCN	BON to MCN other tributaries	0.026	0.017	0.037	Fifteenmile Creek
mainstem, BON to MCN	BON to MCN other tributaries	0.001	0.001	0.002	John Day River
mainstem, BON to MCN	BON to MCN other tributaries	0.003	0.002	0.005	Umatilla River
mainstem, BON to MCN	BON to MCN other tributaries	0.001	0.000	0.004	Yakima River
mainstem, BON to MCN	BON to MCN other tributaries	0.000	0.000	0.001	Walla Walla River
mainstem, BON to MCN	loss	0.607	0.582	0.629	Deschutes River
mainstem, BON to MCN	loss	0.511	0.477	0.541	Fifteenmile Creek
mainstem, BON to MCN	loss	0.228	0.219	0.238	John Day River
mainstem, BON to MCN	loss	0.279	0.265	0.295	Umatilla River
mainstem, BON to MCN	loss	0.173	0.149	0.194	Yakima River
mainstem, BON to MCN	loss	0.176	0.165	0.188	Walla Walla River
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.394	0.145	0.671	Deschutes River
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.472	0.347	0.599	Fifteenmile Creek
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.508	0.489	0.528	John Day River
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.478	0.453	0.501	Umatilla River
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.010	0.005	0.017	Yakima River
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.045	0.039	0.051	Walla Walla River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.008	0.000	0.034	Deschutes River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.001	0.000	0.008	Fifteenmile Creek
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.014	0.010	0.019	John Day River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.021	0.014	0.029	Umatilla River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.138	0.116	0.162	Yakima River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.020	0.017	0.024	Walla Walla River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.236	0.055	0.478	Deschutes River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.120	0.059	0.199	Fifteenmile Creek
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.212	0.199	0.225	John Day River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.192	0.168	0.212	Umatilla River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.035	0.025	0.048	Yakima River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.574	0.558	0.590	Walla Walla River

Table 2: Movement probabilities for Middle Columbia Steelhead by natal origin, inside the DPS boundaries. *(continued)*

from	to	mean	q5	q95	origin
mainstem, MCN to ICH or PRA	Yakima River	0.007	0.000	0.039	Deschutes River
mainstem, MCN to ICH or PRA	Yakima River	0.001	0.000	0.007	Fifteenmile Creek
mainstem, MCN to ICH or PRA	Yakima River	0.001	0.000	0.002	John Day River
mainstem, MCN to ICH or PRA	Yakima River	0.002	0.000	0.005	Umatilla River
mainstem, MCN to ICH or PRA	Yakima River	0.761	0.735	0.791	Yakima River
mainstem, MCN to ICH or PRA	Yakima River	0.001	0.000	0.001	Walla Walla River
mainstem, MCN to ICH or PRA	Walla Walla River	0.010	0.000	0.052	Deschutes River
mainstem, MCN to ICH or PRA	Walla Walla River	0.020	0.002	0.053	Fifteenmile Creek
mainstem, MCN to ICH or PRA	Walla Walla River	0.005	0.003	0.008	John Day River
mainstem, MCN to ICH or PRA	Walla Walla River	0.008	0.004	0.013	Umatilla River
mainstem, MCN to ICH or PRA	Walla Walla River	0.000	0.000	0.001	Yakima River
mainstem, MCN to ICH or PRA	Walla Walla River	0.279	0.264	0.293	Walla Walla River
mainstem, MCN to ICH or PRA	loss	0.344	0.107	0.608	Deschutes River
mainstem, MCN to ICH or PRA	loss	0.384	0.262	0.492	Fifteenmile Creek
mainstem, MCN to ICH or PRA	loss	0.259	0.242	0.274	John Day River
mainstem, MCN to ICH or PRA	loss	0.300	0.277	0.324	Umatilla River
mainstem, MCN to ICH or PRA	loss	0.055	0.041	0.071	Yakima River
mainstem, MCN to ICH or PRA	loss	0.081	0.073	0.089	Walla Walla River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.517	0.000	1.000	Deschutes River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.508	0.000	1.000	Fifteenmile Creek
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.509	0.365	0.656	John Day River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.552	0.342	0.713	Umatilla River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.603	0.523	0.684	Yakima River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.525	0.443	0.603	Walla Walla River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.380	0.000	0.829	Deschutes River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.388	0.000	0.832	Fifteenmile Creek
mainstem, PRA to RIS	mainstem, RIS to RRE	0.387	0.264	0.498	John Day River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.352	0.228	0.519	Umatilla River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.312	0.242	0.383	Yakima River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.374	0.307	0.449	Walla Walla River
mainstem, PRA to RIS	loss	0.103	0.000	0.262	Deschutes River
mainstem, PRA to RIS	loss	0.105	0.000	0.261	Fifteenmile Creek
mainstem, PRA to RIS	loss	0.104	0.066	0.145	John Day River
mainstem, PRA to RIS	loss	0.095	0.057	0.146	Umatilla River
mainstem, PRA to RIS	loss	0.084	0.057	0.112	Yakima River
mainstem, PRA to RIS	loss	0.101	0.071	0.141	Walla Walla River
mainstem, ICH to LGR	mainstem, MCN to ICH or PRA	0.236	0.010	0.544	Deschutes River
mainstem, ICH to LGR	mainstem, MCN to ICH or PRA	0.306	0.102	0.560	Fifteenmile Creek
mainstem, ICH to LGR	mainstem, MCN to ICH or PRA	0.277	0.243	0.314	John Day River
mainstem, ICH to LGR	mainstem, MCN to ICH or PRA	0.325	0.273	0.376	Umatilla River
mainstem, ICH to LGR	mainstem, MCN to ICH or PRA	0.556	0.390	0.735	Yakima River
mainstem, ICH to LGR	mainstem, MCN to ICH or PRA	0.259	0.244	0.276	Walla Walla River
mainstem, ICH to LGR	mainstem, upstream of LGR	0.357	0.212	0.461	Deschutes River
mainstem, ICH to LGR	mainstem, upstream of LGR	0.325	0.205	0.416	Fifteenmile Creek
mainstem, ICH to LGR	mainstem, upstream of LGR	0.338	0.317	0.362	John Day River
mainstem, ICH to LGR	mainstem, upstream of LGR	0.316	0.288	0.342	Umatilla River
mainstem, ICH to LGR	mainstem, upstream of LGR	0.208	0.122	0.290	Yakima River
mainstem, ICH to LGR	mainstem, upstream of LGR	0.347	0.329	0.365	Walla Walla River

Table 2: Movement probabilities for Middle Columbia Steelhead by natal origin, inside the DPS boundaries. *(continued)*

from	to	mean	q5	q95	origin
mainstem, ICH to LGR	Tucannon River	0.114	0.067	0.154	Deschutes River
mainstem, ICH to LGR	Tucannon River	0.104	0.066	0.139	Fifteenmile Creek
mainstem, ICH to LGR	Tucannon River	0.108	0.097	0.120	John Day River
mainstem, ICH to LGR	Tucannon River	0.101	0.089	0.115	Umatilla River
mainstem, ICH to LGR	Tucannon River	0.066	0.039	0.094	Yakima River
mainstem, ICH to LGR	Tucannon River	0.111	0.102	0.120	Walla Walla River
mainstem, ICH to LGR	loss	0.292	0.175	0.376	Deschutes River
mainstem, ICH to LGR	loss	0.265	0.169	0.345	Fifteenmile Creek
mainstem, ICH to LGR	loss	0.276	0.260	0.296	John Day River
mainstem, ICH to LGR	loss	0.258	0.235	0.283	Umatilla River
mainstem, ICH to LGR	loss	0.169	0.105	0.234	Yakima River
mainstem, ICH to LGR	loss	0.283	0.271	0.299	Walla Walla River
Deschutes River	mainstem, BON to MCN	0.003	0.000	0.008	Deschutes River
Deschutes River	mainstem, BON to MCN	0.248	0.173	0.330	Fifteenmile Creek
Deschutes River	mainstem, BON to MCN	0.642	0.582	0.692	John Day River
Deschutes River	mainstem, BON to MCN	0.486	0.413	0.549	Umatilla River
Deschutes River	mainstem, BON to MCN	0.950	0.889	0.990	Yakima River
Deschutes River	mainstem, BON to MCN	0.808	0.744	0.861	Walla Walla River
Deschutes River	loss	0.997	0.992	1.000	Deschutes River
Deschutes River	loss	0.752	0.670	0.827	Fifteenmile Creek
Deschutes River	loss	0.358	0.308	0.418	John Day River
Deschutes River	loss	0.514	0.451	0.587	Umatilla River
Deschutes River	loss	0.050	0.010	0.111	Yakima River
Deschutes River	loss	0.192	0.139	0.256	Walla Walla River
John Day River	mainstem, BON to MCN	0.032	0.000	0.157	Deschutes River
John Day River	mainstem, BON to MCN	0.014	0.000	0.064	Fifteenmile Creek
John Day River	mainstem, BON to MCN	0.001	0.000	0.003	John Day River
John Day River	mainstem, BON to MCN	0.031	0.000	0.251	Umatilla River
John Day River	mainstem, BON to MCN	0.223	0.000	1.000	Yakima River
John Day River	mainstem, BON to MCN	0.520	0.000	1.000	Walla Walla River
John Day River	loss	0.968	0.843	1.000	Deschutes River
John Day River	loss	0.986	0.936	1.000	Fifteenmile Creek
John Day River	loss	0.999	0.997	1.000	John Day River
John Day River	loss	0.969	0.749	1.000	Umatilla River
John Day River	loss	0.777	0.000	1.000	Yakima River
John Day River	loss	0.480	0.000	1.000	Walla Walla River
Hood River	mainstem, BON to MCN	0.369	0.026	0.793	Deschutes River
Hood River	mainstem, BON to MCN	0.652	0.000	1.000	Fifteenmile Creek
Hood River	mainstem, BON to MCN	0.953	0.688	1.000	John Day River
Hood River	mainstem, BON to MCN	0.993	0.957	1.000	Umatilla River
Hood River	mainstem, BON to MCN	0.665	0.000	1.000	Yakima River
Hood River	mainstem, BON to MCN	0.407	0.000	1.000	Walla Walla River
Hood River	loss	0.631	0.207	0.974	Deschutes River
Hood River	loss	0.348	0.000	1.000	Fifteenmile Creek
Hood River	loss	0.047	0.000	0.312	John Day River
Hood River	loss	0.007	0.000	0.043	Umatilla River
Hood River	loss	0.335	0.000	1.000	Yakima River
Hood River	loss	0.593	0.000	1.000	Walla Walla River

Table 2: Movement probabilities for Middle Columbia Steelhead by natal origin, inside the DPS boundaries. *(continued)*

from	to	mean	q5	q95	origin
Fifteenmile Creek	mainstem, BON to MCN	0.278	0.000	1.000	Deschutes River
Fifteenmile Creek	mainstem, BON to MCN	0.001	0.000	0.005	Fifteenmile Creek
Fifteenmile Creek	mainstem, BON to MCN	0.257	0.000	1.000	John Day River
Fifteenmile Creek	mainstem, BON to MCN	0.279	0.000	1.000	Umatilla River
Fifteenmile Creek	mainstem, BON to MCN	0.242	0.000	1.000	Yakima River
Fifteenmile Creek	mainstem, BON to MCN	0.517	0.000	1.000	Walla Walla River
Fifteenmile Creek	loss	0.722	0.000	1.000	Deschutes River
Fifteenmile Creek	loss	0.999	0.995	1.000	Fifteenmile Creek
Fifteenmile Creek	loss	0.743	0.000	1.000	John Day River
Fifteenmile Creek	loss	0.721	0.000	1.000	Umatilla River
Fifteenmile Creek	loss	0.758	0.000	1.000	Yakima River
Fifteenmile Creek	loss	0.483	0.000	1.000	Walla Walla River
Umatilla River	mainstem, BON to MCN	0.354	0.000	1.000	Deschutes River
Umatilla River	mainstem, BON to MCN	0.047	0.000	0.309	Fifteenmile Creek
Umatilla River	mainstem, BON to MCN	0.068	0.027	0.117	John Day River
Umatilla River	mainstem, BON to MCN	0.001	0.000	0.004	Umatilla River
Umatilla River	mainstem, BON to MCN	0.332	0.000	1.000	Yakima River
Umatilla River	mainstem, BON to MCN	0.460	0.000	1.000	Walla Walla River
Umatilla River	loss	0.646	0.000	1.000	Deschutes River
Umatilla River	loss	0.953	0.691	1.000	Fifteenmile Creek
Umatilla River	loss	0.932	0.883	0.973	John Day River
Umatilla River	loss	0.999	0.996	1.000	Umatilla River
Umatilla River	loss	0.668	0.000	1.000	Yakima River
Umatilla River	loss	0.540	0.000	1.000	Walla Walla River
Yakima River	mainstem, MCN to ICH or PRA	0.166	0.000	1.000	Deschutes River
Yakima River	mainstem, MCN to ICH or PRA	0.190	0.000	1.000	Fifteenmile Creek
Yakima River	mainstem, MCN to ICH or PRA	0.016	0.000	0.060	John Day River
Yakima River	mainstem, MCN to ICH or PRA	0.020	0.000	0.085	Umatilla River
Yakima River	mainstem, MCN to ICH or PRA	0.004	0.001	0.009	Yakima River
Yakima River	mainstem, MCN to ICH or PRA	0.532	0.054	0.973	Walla Walla River
Yakima River	loss	0.834	0.000	1.000	Deschutes River
Yakima River	loss	0.810	0.000	1.000	Fifteenmile Creek
Yakima River	loss	0.984	0.940	1.000	John Day River
Yakima River	loss	0.980	0.915	1.000	Umatilla River
Yakima River	loss	0.996	0.991	0.999	Yakima River
Yakima River	loss	0.468	0.027	0.946	Walla Walla River
Walla Walla River	mainstem, MCN to ICH or PRA	0.402	0.000	1.000	Deschutes River
Walla Walla River	mainstem, MCN to ICH or PRA	0.074	0.000	0.475	Fifteenmile Creek
Walla Walla River	mainstem, MCN to ICH or PRA	0.391	0.152	0.669	John Day River
Walla Walla River	mainstem, MCN to ICH or PRA	0.565	0.272	0.852	Umatilla River
Walla Walla River	mainstem, MCN to ICH or PRA	0.405	0.000	1.000	Yakima River
Walla Walla River	mainstem, MCN to ICH or PRA	0.011	0.006	0.017	Walla Walla River
Walla Walla River	loss	0.598	0.000	1.000	Deschutes River
Walla Walla River	loss	0.926	0.525	1.000	Fifteenmile Creek
Walla Walla River	loss	0.609	0.331	0.848	John Day River
Walla Walla River	loss	0.435	0.148	0.728	Umatilla River
Walla Walla River	loss	0.595	0.000	1.000	Yakima River
Walla Walla River	loss	0.989	0.983	0.994	Walla Walla River

Table 2: Movement probabilities for Middle Columbia Steelhead by natal origin, inside the DPS boundaries. *(continued)*

from	to	mean	q5	q95	origin
BON to MCN other tributaries	mainstem, BON to MCN	0.058	0.000	0.400	Deschutes River
BON to MCN other tributaries	mainstem, BON to MCN	0.145	0.030	0.319	Fifteenmile Creek
BON to MCN other tributaries	mainstem, BON to MCN	0.215	0.018	0.570	John Day River
BON to MCN other tributaries	mainstem, BON to MCN	0.697	0.368	0.927	Umatilla River
BON to MCN other tributaries	mainstem, BON to MCN	0.035	0.000	0.179	Yakima River
BON to MCN other tributaries	mainstem, BON to MCN	0.977	0.851	1.000	Walla Walla River
BON to MCN other tributaries	loss	0.942	0.600	1.000	Deschutes River
BON to MCN other tributaries	loss	0.855	0.681	0.970	Fifteenmile Creek
BON to MCN other tributaries	loss	0.785	0.430	0.982	John Day River
BON to MCN other tributaries	loss	0.303	0.073	0.632	Umatilla River
BON to MCN other tributaries	loss	0.965	0.821	1.000	Yakima River
BON to MCN other tributaries	loss	0.023	0.000	0.149	Walla Walla River

Table 3: Movement probabilities for Upper Columbia Steelhead, outside of the DPS boundaries.

from	to	mean	q5	q95
mainstem, mouth to BON	mainstem, BON to MCN	0.976	0.960	0.990
mainstem, mouth to BON	loss	0.024	0.010	0.040
mainstem, BON to MCN	mainstem, mouth to BON	0.012	0.010	0.013
mainstem, BON to MCN	mainstem, MCN to ICH or PRA	0.749	0.744	0.754
mainstem, BON to MCN	Deschutes River	0.013	0.012	0.014
mainstem, BON to MCN	John Day River	0.000	0.000	0.000
mainstem, BON to MCN	Hood River	0.000	0.000	0.000
mainstem, BON to MCN	Fifteenmile Creek	0.000	0.000	0.000
mainstem, BON to MCN	Umatilla River	0.000	0.000	0.000
mainstem, BON to MCN	BON to MCN other tributaries	0.000	0.000	0.000
mainstem, BON to MCN	loss	0.226	0.221	0.231
mainstem, ICH to LGR	mainstem, MCN to ICH or PRA	0.096	0.003	0.248
mainstem, ICH to LGR	mainstem, upstream of LGR	0.890	0.727	0.990
mainstem, ICH to LGR	Tucannon River	0.004	0.000	0.017
mainstem, ICH to LGR	loss	0.009	0.000	0.042
mainstem, upstream of LGR	mainstem, ICH to LGR	0.330	0.124	0.558
mainstem, upstream of LGR	Asotin Creek	0.009	0.000	0.034
mainstem, upstream of LGR	Clearwater River	0.109	0.007	0.340
mainstem, upstream of LGR	Salmon River	0.009	0.000	0.047
mainstem, upstream of LGR	Grande Ronde River	0.009	0.000	0.062
mainstem, upstream of LGR	Imnaha River	0.010	0.000	0.061
mainstem, upstream of LGR	loss	0.525	0.259	0.790
Deschutes River	mainstem, BON to MCN	0.872	0.830	0.908
Deschutes River	loss	0.128	0.092	0.170
Hood River	mainstem, BON to MCN	0.956	0.741	1.000
Hood River	loss	0.044	0.000	0.259
Clearwater River	mainstem, upstream of LGR	0.070	0.000	0.458
Clearwater River	loss	0.930	0.542	1.000

Table 4: Movement probabilities for Upper Columbia Steelhead by natal origin, inside the DPS boundaries.

from	to	mean	q5	q95	origin
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.010	0.008	0.012	Wenatchee River
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.007	0.004	0.011	Entiat River
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.011	0.008	0.015	Okanogan River
mainstem, MCN to ICH or PRA	mainstem, BON to MCN	0.009	0.008	0.012	Methow River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.980	0.977	0.984	Wenatchee River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.985	0.978	0.992	Entiat River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.978	0.972	0.984	Okanogan River
mainstem, MCN to ICH or PRA	mainstem, PRA to RIS	0.981	0.978	0.984	Methow River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.001	0.000	0.001	Wenatchee River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.000	0.000	0.001	Entiat River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.001	0.000	0.001	Okanogan River
mainstem, MCN to ICH or PRA	mainstem, ICH to LGR	0.001	0.000	0.001	Methow River
mainstem, MCN to ICH or PRA	Yakima River	0.000	0.000	0.000	Wenatchee River
mainstem, MCN to ICH or PRA	Yakima River	0.000	0.000	0.000	Entiat River
mainstem, MCN to ICH or PRA	Yakima River	0.000	0.000	0.000	Okanogan River
mainstem, MCN to ICH or PRA	Yakima River	0.000	0.000	0.000	Methow River
mainstem, MCN to ICH or PRA	Walla Walla River	0.000	0.000	0.000	Wenatchee River
mainstem, MCN to ICH or PRA	Walla Walla River	0.000	0.000	0.000	Entiat River
mainstem, MCN to ICH or PRA	Walla Walla River	0.000	0.000	0.000	Okanogan River
mainstem, MCN to ICH or PRA	Walla Walla River	0.000	0.000	0.000	Methow River
mainstem, MCN to ICH or PRA	loss	0.009	0.007	0.011	Wenatchee River
mainstem, MCN to ICH or PRA	loss	0.007	0.004	0.011	Entiat River
mainstem, MCN to ICH or PRA	loss	0.010	0.007	0.013	Okanogan River
mainstem, MCN to ICH or PRA	loss	0.009	0.007	0.010	Methow River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.015	0.012	0.018	Wenatchee River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.020	0.010	0.033	Entiat River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.016	0.011	0.023	Okanogan River
mainstem, PRA to RIS	mainstem, MCN to ICH or PRA	0.012	0.010	0.014	Methow River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.951	0.944	0.957	Wenatchee River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.966	0.950	0.979	Entiat River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.969	0.960	0.977	Okanogan River
mainstem, PRA to RIS	mainstem, RIS to RRE	0.963	0.959	0.966	Methow River
mainstem, PRA to RIS	loss	0.035	0.030	0.040	Wenatchee River
mainstem, PRA to RIS	loss	0.014	0.006	0.024	Entiat River
mainstem, PRA to RIS	loss	0.014	0.009	0.022	Okanogan River
mainstem, PRA to RIS	loss	0.026	0.023	0.029	Methow River
mainstem, RIS to RRE	mainstem, PRA to RIS	0.013	0.010	0.016	Wenatchee River
mainstem, RIS to RRE	mainstem, PRA to RIS	0.009	0.004	0.018	Entiat River
mainstem, RIS to RRE	mainstem, PRA to RIS	0.004	0.001	0.008	Okanogan River
mainstem, RIS to RRE	mainstem, PRA to RIS	0.010	0.008	0.012	Methow River
mainstem, RIS to RRE	mainstem, RRE to WEL	0.583	0.570	0.596	Wenatchee River
mainstem, RIS to RRE	mainstem, RRE to WEL	0.981	0.968	0.990	Entiat River
mainstem, RIS to RRE	mainstem, RRE to WEL	0.973	0.964	0.982	Okanogan River
mainstem, RIS to RRE	mainstem, RRE to WEL	0.954	0.949	0.958	Methow River
mainstem, RIS to RRE	Wenatchee River	0.319	0.307	0.331	Wenatchee River
mainstem, RIS to RRE	Wenatchee River	0.007	0.002	0.015	Entiat River
mainstem, RIS to RRE	Wenatchee River	0.002	0.000	0.005	Okanogan River
mainstem, RIS to RRE	Wenatchee River	0.002	0.001	0.003	Methow River

Table 4: Movement probabilities for Upper Columbia Steelhead by natal origin, inside the DPS boundaries. *(continued)*

from	to	mean	q5	q95	origin
mainstem, RIS to RRE	loss	0.085	0.078	0.092	Wenatchee River
mainstem, RIS to RRE	loss	0.003	0.000	0.008	Entiat River
mainstem, RIS to RRE	loss	0.020	0.012	0.027	Okanogan River
mainstem, RIS to RRE	loss	0.034	0.030	0.038	Methow River
mainstem, RRE to WEL	mainstem, RIS to RRE	0.228	0.213	0.243	Wenatchee River
mainstem, RRE to WEL	mainstem, RIS to RRE	0.027	0.016	0.039	Entiat River
mainstem, RRE to WEL	mainstem, RIS to RRE	0.002	0.001	0.005	Okanogan River
mainstem, RRE to WEL	mainstem, RIS to RRE	0.006	0.004	0.008	Methow River
mainstem, RRE to WEL	mainstem, upstream of WEL	0.564	0.548	0.579	Wenatchee River
mainstem, RRE to WEL	mainstem, upstream of WEL	0.362	0.330	0.395	Entiat River
mainstem, RRE to WEL	mainstem, upstream of WEL	0.978	0.969	0.985	Okanogan River
mainstem, RRE to WEL	mainstem, upstream of WEL	0.930	0.924	0.935	Methow River
mainstem, RRE to WEL	Entiat River	0.032	0.027	0.037	Wenatchee River
mainstem, RRE to WEL	Entiat River	0.585	0.552	0.623	Entiat River
mainstem, RRE to WEL	Entiat River	0.000	0.000	0.001	Okanogan River
mainstem, RRE to WEL	Entiat River	0.000	0.000	0.000	Methow River
mainstem, RRE to WEL	loss	0.175	0.166	0.188	Wenatchee River
mainstem, RRE to WEL	loss	0.027	0.016	0.038	Entiat River
mainstem, RRE to WEL	loss	0.020	0.013	0.028	Okanogan River
mainstem, RRE to WEL	loss	0.064	0.059	0.069	Methow River
mainstem, upstream of WEL	mainstem, RRE to WEL	0.205	0.192	0.219	Wenatchee River
mainstem, upstream of WEL	mainstem, RRE to WEL	0.618	0.571	0.666	Entiat River
mainstem, upstream of WEL	mainstem, RRE to WEL	0.022	0.015	0.031	Okanogan River
mainstem, upstream of WEL	mainstem, RRE to WEL	0.029	0.026	0.032	Methow River
mainstem, upstream of WEL	Okanogan River	0.002	0.000	0.004	Wenatchee River
mainstem, upstream of WEL	Okanogan River	0.005	0.001	0.014	Entiat River
mainstem, upstream of WEL	Okanogan River	0.667	0.639	0.692	Okanogan River
mainstem, upstream of WEL	Okanogan River	0.025	0.021	0.028	Methow River
mainstem, upstream of WEL	Methow River	0.124	0.109	0.140	Wenatchee River
mainstem, upstream of WEL	Methow River	0.202	0.163	0.245	Entiat River
mainstem, upstream of WEL	Methow River	0.050	0.039	0.064	Okanogan River
mainstem, upstream of WEL	Methow River	0.232	0.223	0.243	Methow River
mainstem, upstream of WEL	Upstream WEL other tributaries	0.003	0.001	0.006	Wenatchee River
mainstem, upstream of WEL	Upstream WEL other tributaries	0.004	0.000	0.014	Entiat River
mainstem, upstream of WEL	Upstream WEL other tributaries	0.002	0.000	0.005	Okanogan River
mainstem, upstream of WEL	Upstream WEL other tributaries	0.000	0.000	0.001	Methow River
mainstem, upstream of WEL	loss	0.666	0.644	0.687	Wenatchee River
mainstem, upstream of WEL	loss	0.171	0.129	0.211	Entiat River
mainstem, upstream of WEL	loss	0.259	0.232	0.281	Okanogan River
mainstem, upstream of WEL	loss	0.714	0.703	0.724	Methow River
Wenatchee River	mainstem, RIS to RRE	0.043	0.034	0.052	Wenatchee River
Wenatchee River	mainstem, RIS to RRE	0.977	0.856	1.000	Entiat River
Wenatchee River	mainstem, RIS to RRE	0.963	0.803	1.000	Okanogan River
Wenatchee River	mainstem, RIS to RRE	0.905	0.742	0.986	Methow River
Wenatchee River	loss	0.957	0.948	0.966	Wenatchee River
Wenatchee River	loss	0.023	0.000	0.144	Entiat River
Wenatchee River	loss	0.037	0.000	0.197	Okanogan River
Wenatchee River	loss	0.095	0.014	0.258	Methow River

Table 4: Movement probabilities for Upper Columbia Steelhead by natal origin, inside the DPS boundaries. *(continued)*

from	to	mean	q5	q95	origin
Entiat River	mainstem, RRE to WEL	0.116	0.066	0.180	Wenatchee River
Entiat River	mainstem, RRE to WEL	0.027	0.014	0.043	Entiat River
Entiat River	mainstem, RRE to WEL	0.412	0.000	1.000	Okanogan River
Entiat River	mainstem, RRE to WEL	0.520	0.000	1.000	Methow River
Entiat River	loss	0.884	0.820	0.934	Wenatchee River
Entiat River	loss	0.973	0.957	0.986	Entiat River
Entiat River	loss	0.588	0.000	1.000	Okanogan River
Entiat River	loss	0.480	0.000	1.000	Methow River
Okanogan River	mainstem, upstream of WEL	0.022	0.000	0.119	Wenatchee River
Okanogan River	mainstem, upstream of WEL	0.887	0.337	1.000	Entiat River
Okanogan River	mainstem, upstream of WEL	0.004	0.001	0.008	Okanogan River
Okanogan River	mainstem, upstream of WEL	0.001	0.000	0.003	Methow River
Okanogan River	loss	0.978	0.881	1.000	Wenatchee River
Okanogan River	loss	0.113	0.000	0.663	Entiat River
Okanogan River	loss	0.996	0.992	0.999	Okanogan River
Okanogan River	loss	0.999	0.997	1.000	Methow River
Methow River	mainstem, upstream of WEL	0.128	0.095	0.165	Wenatchee River
Methow River	mainstem, upstream of WEL	0.615	0.480	0.731	Entiat River
Methow River	mainstem, upstream of WEL	0.023	0.001	0.070	Okanogan River
Methow River	mainstem, upstream of WEL	0.007	0.004	0.011	Methow River
Methow River	loss	0.872	0.835	0.905	Wenatchee River
Methow River	loss	0.385	0.269	0.520	Entiat River
Methow River	loss	0.977	0.930	0.999	Okanogan River
Methow River	loss	0.993	0.989	0.996	Methow River
Upstream WEL other tributaries	mainstem, upstream of WEL	0.006	0.000	0.032	Wenatchee River
Upstream WEL other tributaries	mainstem, upstream of WEL	0.032	0.000	0.210	Entiat River
Upstream WEL other tributaries	mainstem, upstream of WEL	0.019	0.000	0.123	Okanogan River
Upstream WEL other tributaries	mainstem, upstream of WEL	0.026	0.000	0.215	Methow River
Upstream WEL other tributaries	loss	0.994	0.968	1.000	Wenatchee River
Upstream WEL other tributaries	loss	0.968	0.790	1.000	Entiat River
Upstream WEL other tributaries	loss	0.981	0.877	1.000	Okanogan River
Upstream WEL other tributaries	loss	0.974	0.785	1.000	Methow River

Discussion

Next steps

More covariates