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Review of Salmon Escapement Goals in Southeast Alaska, 2017

by

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Table 3.–Southeast Region coho salmon escapement goals, 2009–2016 escapements, and 2017 escapement goal recommendations.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **System** | **Assessment**  **method** | **Goal**  **typea** | **Escapement**  **goal** | **Year**  **established** | **Escapement** | | | | |  |
| **2012** | **2013** | **2014** | **2015** | **2016** | **Escapement goal**  **recommendation** |
| Hugh Smith Lake | Weir | BEG | 500–1,600 | 2009 | 1,908 | 3,148 | 4,110 | 956 | 948 |  |
| Klawock River | Weir | BEG | 4,000–9,000 | 2013 | 7,507 | 8,323 | 7,698 | 12,780 | 24,242 |  |
| Taku Riverb | MR | BEG | 50,000–90,000 | 2015 | 70,775 | 68,117 | 124,171 | 60,178 | 87,704 |  |
| Auke Creek | Weir | BEG | 200–500 | 1994 | 837 | 736 | 1,533 | 517 | 204 |  |
| Montana Creek | FS, IE | SEG | 400–1,200 | 2006 | 394 | 367 | 911 | 1,204 | 717 |  |
| Peterson Creek | FS, IE | SEG | 100–250 | 2006 | 190 | 126 | 284 | 202 | 52 |  |
| Ketchikan Survey Index | HS | BEG | 4,250–8,500 | 2006 | 11,960 | 11,295 | 16,675 | 10,128 | 13,420 |  |
| Sitka Survey Index | FS, IE | BEG | 400–800 | 2006 | 1,157 | 1,414 | 2,161 | 2,244 | 2,943 |  |
| Ford Arm Lake | Weir | BEG | 1,300–2,900 | 1994 | 2,282 | 1,573 | 3,025 | 3,281 | - |  |
| Berners River | MR | BEG | 4,000–9,200 | 1994 | 5,480 | 6,280 | 15,480 | 9,940 | 6,733 |  |
| Chilkat River | MR | BEG | 30,000–70,000 | 2006 | 36,961 | 51,324 | 130,200 | 47,372 | 26,280 |  |
| Tawah Creek (Lost River) | FS,IE | SEG | 1,600–4,800 | 2015 | - | 2,593 | 3,555 | 2,015 | 746 |  |
| Situk River | BS,IE | BEG | 3,300–9,800 | 1994 | 3,007 | 14,853 | 8,226 | 7,062 | 6,177 |  |
| Tsiu/Tsivat Rivers | AS,IE | BEG | 10,000–29,000 | 1994 | 10,500 | 47,000 | 27,000 | 19,500 | 31,000 |  |

***Note:*** AS = peak aerial survey, FS = foot survey, BS = boat survey, IE = index escapement, MR = mark-recapture, NA = not available; gray cells indicate lower bound of the escapement goal not met.

a Escapement goal types are biological escapement goal (BEG), sustainable escapement goal (SEG), and lower-bound sustainable escapement goal (LB SEG).

b Preliminary estimate pending publication of final report.

## Stock Assessment Overview

### Coho Salmon

Excellent coho salmon habitat occurs in thousands of streams distributed throughout Southeast Alaska, many of which are small producers about which little is known. Due to the widely distributed nature of the resource, it is practical and feasible to conduct stock assessment projects on only a small fraction of producing streams. Assessment is further challenged by the wet coastal climate of the region, including frequent freshets during the fall months when spawners return to freshwater. The majority of the harvest is taken in fisheries that harvest a mixture of stocks in areas distant from most contributing streams. In addition to wild stocks within Southeast Alaska, important contributions to the region’s total harvest are made by local hatchery stocks (13 total), several transboundary rivers, and by natural systems and hatcheries on the northern British Columbia coast. Overall, 14 systems or groups of systems have escapement goals, including nine with biological escapement goals, four with sustainable escapement goals, and one (Taku River) with a management threshold (Table 3; Appendix C). Most direct stock assessment occurs at two levels: full indicator stock and escapement indicator.

Full indicator stocks are monitored for total adult abundance, spawning escapement (including age, size, and sex), smolt production (abundance, age, and size), marine survival, fishery contributions by area, gear type and time, and exploitation rates. Over time, these parameters are used to evaluate the relationship between spawning escapement and production and to establish biological escapement goals that produce maximum sustained yield. Annual estimates extend from the early 1980s for four systems (Auke Creek, Berners River, Ford Arm Creek, and Hugh Smith Lake) and were later expanded to include the Taku River in 1992 and the Chilkat River in 2000.

Escapement indicators have been established in the Haines, Sitka, Ketchikan, and Yakutat areas where foot or helicopter surveys are systematically conducted. Escapement goals for surveyed streams near Sitka and Ketchikan apply to the sum of peak survey counts on an aggregate of streams in each area (5 near Sitka and 14 near Ketchikan). Only peak survey counts that meet standards for timing, survey conditions, and completeness are included in the indices, and statistical interpolations are made for missing counts on individual streams in the index to maintain comparability of the index across years. In the Juneau and Yakutat areas, survey-based escapement goals apply to individual streams (two near Juneau and three near Yakutat). In the Haines area, peak survey counts from four tributaries are expanded to estimate total escapement to the Chilkat River.

## Escapement Goal Recommendations

### Coho Salmon:

#### Berners River Coho Salmon

[[One to 1.5 page summary on Berners River coho salmon escapement goal review and recommendation.]]

**Notes from the escapement goal review meeting, January 2017:**

Berners River coho salmon: Leon Shaul

* Current goal (established in 1994) is a BEG of 4,000-9,200 fish counted on surveys conducted in October.
* Leon provided a detailed update on stock assessment information, and stock-recruit analysis of brood years 1989–2010 using Hockey Stick model, which provided best fit over other methods and is more consistent with population dynamics of coho salmon.
  + Evaluation of the different models (question from Sarah and Lowell) was through AIC and Least Squares fitting (Least Sum of Squares), as well as potentially visual/graphical.
  + Leon confirmed that the HS model almost always out-performs Ricker since over-escapement for coho isn’t applicable.
* Escapement estimates were converted from nominal escapement to effective escapement based on sex ratios and average egg biomass to account for reproductive potential. Returns were adjusted to a constant marine survival rate.
  + Related to Figure 6, Ed asked what if this scenario of decreasing female fecundity changes (for the better); this means the bumping up of the Lower Bound was unnecessary or not warranted; folks figured this adjustment really wouldn’t allow for more flexible management actions (only 800 fish). folks agreed however it makes sense. Bob Clark mentioned this wasn’t as relative for Chinook.
* Analysis of all years (1989–2010) resulted in a narrow 90% MSY range of about 3,600–6,400 spawners.
  + There seemed to be consensus that a narrow BEG range is not preferred
* Analysis then adjusted to account for expected lower productivity potential at lower escapements and to ensure that upper reference point was sufficiently high to account for periods of high freshwater productivity. A broader range would also allow for a more realistically achievable BEG range.
* Results suggested a lower bound of 4,500 spawners and an upper bound of 10,000 spawners, which translates to a BEG of 3,600–8,100 when converted to survey counts.
* Steve asked the Fishery Scientists to provide a technical review of Leon’s forthcoming manuscript, which could further assist with escapement goal review needs.

**RECOMMENDATION**: The analysis and recommended escapement goal of 3,600–8,100 fish counted on surveys seemed reasonable.

#### Tsiu-Tsivat Rive Coho Salmon

Coho salmon runs in the Tsiu and Tsivat rivers, located approximately 190 km northwest of Yakutat, are harvested primarily in the District 192-42 commercial set gillnet fishery that takes place in the estuary immediately below where the two rivers meet. The commercial set gillnet coho salmon harvest averaged 39,574 fish from 1973 to 2016 (Appendix Table C 1). Tsiu-Tsivat river coho salmon are also harvested in inriver sport fisheries and offshore commercial troll fisheries (Clark and Clark 1994). Escapement information consists of aerial survey counts, which have been conducted weekly since the early 1970s in conjunction with management of the commercial fishery, and both rivers are surveyed to obtain a total index count (Zeiser 2015). In 1994, ADF&G established a biological escapement goal of 10,000–29,000 coho salmon counted on a peak survey, based on a stock-recruit analysis by Clark and Clark (1994).

Review of the Tsiu-Tsivat river escapement goal is best suited to the percentile approach as stock assessment information is limited primarily to maximum survey counts (available for 38 of 44 years since 1973; Appendix Table). Lack of total escapement estimates, limited age composition data, and lack of commercial troll harvest estimates precludes escapement goal analysis based on production models. The Tsiu-Tsivat river coho salmon run fits the criteria of a Tier 3 stock following the percentile approach recommended by Clark et al. (2014; Table 6 [[ in the body of the EG review report]]). There is high measurement error and low contrast in Tsiu-Tsivat river coho salmon escapement survey counts (the maximum count divided by the minimum count = 6.7). Although commercial troll harvest information is lacking, the harvest rate has likely averaged less than 0.40. Potential harvest rate was assessed in two steps. First, escapement survey counts were multiplied by 5.3, the median ratio of peak survey counts to total escapement at two other Yakutat-area coho salmon streams (Appendix Table C 2), to approximate total escapement. Second, known terminal harvest (set gillnet and sport) was divided by harvest + total escapement to approximate harvest rate, which averaged less than 0.30. The commercial troll harvest rate in 1986, the only year that information is available, was thought to be 0.08 (Clark and Clark 1994); however, the commercial troll harvest rate on Situk River coho salmon (another Yakutat-area run) was estimated to be 0.03 in 2005 and 0.05 in 2006 (Shaul et al. 2010), and was likely to have been even lower on Tsiu-Tsivat river coho salmon. It is highly probable, therefore, that the overall harvest rate on Tsiu-Tsivat river coho salmon has averaged less than 0.40.

The 5th and 65th percentiles of Tsiu-Tsivat river coho salmon escapement survey counts produced a range of 10,940–30,000 fish, which is very close to the current escapement goal of 10,000–29,000 fish. The current escapement goal was met or exceeded in every year since 1973, with the exception of years when survey effort was curtailed by inclement weather. The escapement goal review committee recommended maintaining the current escapement goal of 10,000–29,000 coho salmon counted on a peak aerial survey, but recommended changing the goal from a biological to a sustainable escapement goal.

#### Ford Arm Coho Salmon

Funding for stock assessment at Ford Arm Lake was discontinued in FY17 due to state budget cuts.

**RECOMMENDATION:** eliminate the goal.

# Appendix C. Coho Salmon Escapement Goal Performance

Appendix C 1.–Berners and Chilkat rivers coho salmon.

Coho salmon from the Berners River in lower Lynn Canal and the Chilkat River in upper Lynn Canal are harvested primarily in the northern Southeast troll fishery and the Lynn Canal drift gillnet fishery, with lesser exploitation rates by purse seine fisheries and marine and freshwater sport fisheries (Shaul et al. 2011; Elliott 2013). The Chilkat River stock is also exploited by a subsistence fishery conducted in the Chilkat River and Chilkat Inlet. Both systems have similar mainland valley rearing habitat, including wetlands, ponds, and sloughs. The Berners River is a compact system with concentrated, high-quality coho spawning and rearing habitat. It has a late, highly migratory run that typically increases in the outside troll catch throughout August, primarily in the vicinity of Cross Sound and northward, peaks around 1 September, and continues to contribute to the troll catch until late-September. Compressed timing, combined with the specific physical features of the Berners River drainage, make it possible to consistently observe and count a high proportion of the total escapement during foot and helicopter surveys in mid- to late October. The Chilkat River is a much larger, more complex system, with several important spawning areas. Although coded-wire tag recoveries indicate that the majority of returning Chilkat River fish exhibit late, compressed migratory behavior similar to the Berners River stock, the Chilkat run also includes earlier segments that enter the river beginning in late August and early September, with peak spawning in upper tributaries (Assignation Creek and the Tahini River) typically occurring in early October.

**Escapement Goals and Stock Status:** Preliminary results of an ongoing analysis of the existing biological escapement goal of 4,000–9,200 spawners for the Berners River (Clark et al. 1994) suggest that little if any adjustment is warranted. The biological escapement goal for the Chilkat River is 30,000–70,000 (Ericksen and Fleischman 2006). Escapements in both rivers were below their respective goals in 2007, but both stocks have been within or above the current goals in all other years since 1989 (Appendix Figures C 1 and C 2).

Total adult returns to the Berners and Chilkat rivers have been closely correlated (R2 = 0.88) over the 14-year period since full assessment of the Chilkat River stock was initiated in 2000 (Appendix Figures C 1 and C 2). Both runs exhibited a marked decline beginning in 2005. The estimated total adult return to the Berners River remained at a high level (average 38,000 fish) for a 15-year period, 1990–2004, before declining abruptly to an average of 15,000 fish during 2005–2013 (Appendix Figure C 1). The compounded effect of 38% declines in both smolt production and marine survival resulted in a 61% reduction in the average number of returning adults between the periods. The recent cooling trend in the Northeast Pacific was likely an important agent in both declines. Berners River smolt production closely tracked total precipitation during July–November, as measured at the Juneau Airport for a decade and a half, before smolt abundance began consistently falling below predictions based on precipitation (Shaul et al. 2011). The cause of the change is unknown, but thought likely to have been caused by reduced over-winter survival of juveniles in off-channel rearing habitats, perhaps due to oxygen levels reaching critical levels during longer periods of ice cover with an increase in the ratio of snow to rain in precipitation falling in winter and early spring months.

The decrease in marine survival may also have been affected by climatic conditions in local marine waters during early ocean residence. However, there are also indications that increased mortality during later ocean residence, particularly in years of poor growth, has reduced over-all marine survival. During the most-recent 10-year period, marine survival was strongly positively correlated with the average size of both male and female 1-ocean spawners and with the ratio of females to males in the escapement. The best predictive models developed thus far to explain average spawner size explain 54% if inter-annual variation in average length of males, and 64% for females, with the Pacific Decadal Oscillation (an index of North Pacific climate) and pink salmon abundance (as measured by the commercial catch of fish rearing primarily in the Gulf of Alaska) both explaining about equal proportions of variation in average size. Females have averaged both smaller and fewer (relative to males) in poor growth years, resulting in substantially fewer (>30%) eggs-per-spawner, on average, in years of poor growth (usually odd years).



Appendix Figure C 1.–Total estimated run size, catch, and escapement of coho salmon bound for the Berners River, 1982–2016, and biological escapement goal of 4,000–9,200 fish counted on a peak survey. (Harvest estimates are not available for 1984).



Appendix Figure C 2.–Total estimated run size, catch, and escapement of coho salmon bound for the Berners and Chilkat rivers, 1982–2016, and biological escapement goal of 30,000–70,000 spawners. (Catch estimates are not available for 1987–1999.)

Appendix C 2.–Taku River coho salmon.

The transboundary Taku River may be the single largest coho salmon-producing system in the region, and it supports a diversity of runs, ranging from early-run stocks bound for high interior tributaries that are harvested primarily in sockeye-directed fisheries, to fall-run stocks located primarily in mainstem tributaries that are harvested primarily in coho-directed troll and drift gillnet fisheries. Escapement estimates were first made in 1987 and run reconstruction estimates are available since 1992 (Shaul et al. 2011). The inriver run past Canyon Island, near the U.S./Canada boundary, is estimated through a mark-recapture project. Marking is conducted at research fish wheel sites in the canyon, and recovery sampling is conducted in test and Canadian commercial fisheries. Results of a 1991 radio-telemetry study indicated that the fish wheel estimate represented about 78% of the total system escapement, with about 22% spawning in Alaska below Canyon Island (Eiler et al. 1993).

**Escapement Goals and Stock Status:** A biological escapement goal has not yet been established for the Taku River. The 1999 Pacific Salmon Treaty specified that the U.S. would pass a minimum of 38,000 fish above the border, which effectively translates to an escapement of about 35,000 spawners after an expected Canadian inriver catch of about 3,000 fish. In 2013, the Transboundary River Panel of the Pacific Salmon Commission agreed to a provisional escapement target of 70,000 spawners, pending completion of a biological analysis (TTC 2014). Estimated escapements in the past three years, ranging from 68,100–70,700 in 2011–2013, have been close to the interim objective (Appendix Figure C 3).



Appendix Figure C 3.–Total estimated run size, catch, and escapement of coho salmon bound from the Taku River above Canyon Island, 1987–2016, and biological escapement goal of 50,000–90,000 spawners. (Marine catch estimates are not available 1987–1991.)

Appendix C 3.–Auke Creek coho salmon.

Auke Creek, located in Juneau, is a long-term indicator stock with migratory characteristics similar to the nearby Berners and Chilkat rivers. However, because of its location outside the boundaries of major drift gillnet fishing areas, it is subjected to lower average all-fishery exploitation rates (long-term average 39%) compared with nearby major river stocks in Lynn Canal and Taku Inlet that are targeted by drift gillnet fisheries. Rearing habitat in Auke Creek is dominated by the environment of Auke Lake. As a result of the high (100%) tagging rate on smolts and precise total accounting of returning adults, the Auke Creek stock is an important indicator of the troll exploitation rate on northern inside stocks that is used in estimation of regional wild coho salmon abundance.

**Escapement Goals and Stock Status:** A biological escapement goal of 200–500 fish was established in 1994 (Clark et al. 1994). Smolt production underwent a protracted decline over the course of two decades from an average of 8,000 smolts during 1979–1984 to a lowest 5-year average of 4,100 smolts during 2002–2006, prior to a sharp rebound to an average of 7,500 smolts since 2010. Although the trend in smolt production is thought to be related to changes in rearing habitat, specific reasons for the decline and recent rebound are poorly understood. Auke Creek produces smolts that are large, on average, and tend to survive well at sea with a high proportion of males returning as age-.0 jacks. Average marine survival decreased from 23% during 1990–2004 to 17% during 2005–2013, similar to the pattern exhibited by other northern inside stocks. Escapements have consistently remained within or above the upper half of the escapement goal range (Appendix Figure C 4), even throughout a recent period of both lower smolt production and survival and lower total returns that averaged only 753 adults 2004–2011. Exploitation rates have been moderate over the past decade (2004–2013) at an average of 37% (range: 17–33%), of which the majority (26%) was harvested by the troll fishery, with exploitation rates by other fisheries averaging 1% purse seine, 8% drift gillnet, and 2% marine sport.



Appendix Figure C 4.–Total estimated run size, catch, and escapement (weir counts) of coho salmon returning to Auke Creek, 1980–2016, and biological escapement goal of 200–500 spawners.

Appendix C 4.–Ford Arm Creek coho salmon.

Ford Arm Creek, located on western Chichagof Island, is currently the only outer coastal coho salmon indicator stock in the region. The system is small but pristine, with a variety of rearing habitats (lake, pond, and stream). Unlike other wild coho indicator stocks, the Ford Arm Creek population is a less migratory “milling” stock that is already concentrated along the coast by the beginning of the summer troll season (1 July) and is heavily exploited by hook and line fisheries through early September.

**Escapement Goals and Stock Status:** A biological escapement goal of 1,300–2,900 spawners was established in 1994 (Clark et al. 1994). The goal was recently reviewed but left unchanged (Shaul et al. 2014). Although marine survival has shown a level long-term trend, nutrients from increasing pink salmon escapements in the 1990s and 2000s are thought to be the primary factor responsible for a doubling of average adult returns from 1982–1991 to 1992–2009 (Shaul et al. 2014). While total nutrient inputs from spawning salmon have remained high in recent years, average coho salmon returns have declined since the mid-2000s to an intermediate level, possibly reflecting effects of a recent cooling trend in the North Pacific climate cycle. Age 1-ocean Ford Arm Creek spawners have exhibited a dramatic long-term decrease in average size between 1982–1986 and 2011–2013 (43% decrease in weight for males, 29% for females) that was likely caused by a decline in their principal high seas prey, gonatid squids. The decline in size of females has likely had a substantial effect on the per capital reproductive potential of the spawning escapement. Coincidentally, during 2011–2013, the stock exhibited uncharacteristic migratory behavior in which a large number of fish left the ocean earlier than in previous years and migrated into local inlets where a substantial fraction were harvested incidentally by a purse seine fishery targeting pink salmon. The estimated purse seine exploitation rate averaged 34% during 2011–2013, compared with only 4% during 1982–2010. Although the troll fishery harvested an average of 39% of the total run in 2011–2013 (down from 53%) and the marine sport fishery accounted for 2% (down from 4%), overall exploitation rates during 2011–2013 were still relatively high (average 75%; range: 63–82%). However, the biological escapement goal continued to be met (Appendix Figure C 5).



Appendix Figure C 5.–Total estimated run size, catch, and escapement (weir counts) of coho salmon returning to Ford Arm Creek, 1982–2015, and biological escapement goal of 1,300–2,900 spawners. Due to budget cuts, this project was discontinued after the 2015 season.

Appendix C 5.–Hugh Smith Lake coho salmon.

Hugh Smith Lake, located on the mainland southeast of Ketchikan, is currently the only wild coho salmon indicator stock in southern Southeast. Returning adults are counted at a weir across the short lake outlet and spawn in two inlet streams, Cobb and Buschmann creeks. A limited amount of rearing habitat is available in the inlet streams, but most juveniles rear around wood and rock structure along the steep lakeshore and in the extensive log jam at the outlet. Smolt production has varied around a stable trend, averaging 31,800 smolts. Marine survival has been more variable, ranging from 4–21% around a long-term average of 13%. Marine survival and adult abundance were strongly correlated with the Berners River (located 490 km to the north) from the early-1980s until the mid-2000s. However, in contrast with the Berners River, where both smolt production and marine survival have both declined since the mid-2000s, the 2008–2013 average survival rate of 15.4% for the Hugh Smith Lake stock was higher than the 1983–2007 average (12.3%). A geographic shift in marine survival in favor of southern areas of the region is also evident in hatchery stocks (Shaul et al. 2011).

**Escapement Goals and Stock Status:** A biological escapement goal was first established at 500–1,100 spawners in 1994 (Clark et al. 1994) and expanded to 500–1,600 spawners in 2009 (Shaul et al. 2009). In contrast with northern Southeast indicator stocks, a coincidence of favorable freshwater and marine conditions resulted in a series of average or larger returns to Hugh Smith Lake during the most recent 6-year period (2008–2013), with the estimated 2013 return (6,936 adults) being the second largest on record. Despite liberal fishing opportunity in most of those years, including reduced or eliminated mid-season troll fishery closures, extended Tree Point drift gillnet fishery openings, and 10-day troll season extensions, the all-fishery exploitation rate during 2008–2013 averaged only 50% (range: 45–54%) compared with an average of 75% (range: 68–82%) in the 1990s. The stock recently appears to have been making landfall farther south during the recent cooling trend in the North Pacific climate cycle compared with the warmer period in late-1980s and 1990s, resulting in reduced exposure to intensive fisheries to the north. The combined result of strong returns and moderate exploitation rates has been escapements that consistently exceeded even the recently expanded escapement goal range during the past 6 years (Appendix Figure C 6).



Appendix Figure C 6.–Total estimated run size, catch, and escapement (weir counts) of coho salmon returning to Hugh Smith Lake, 1982–2016, and biological escapement goal of 500–1,600 spawners.

Appendix C 6.–Montana and Peterson creeks coho salmon.

Escapement goals have been established based on peak survey counts for two stocks accessible from the Juneau road system, Montana and Peterson creeks. Both stocks are likely harvested at moderate rates, similar to nearby Auke Creek, where the all-fishery exploitation rate during 1980–2013 averaged 39% (range: 20–55%).

**Escapement Goals and Stock Status:** Escapement goals were initially established as biological escapement goals of 200–500 for Montana Creek and 100–350 for Peterson Creek, based on an analysis by Clark (1995b) but were more recently changed to sustainable escapement goals of 400–1,200 spawners for Montana Creek and 100–250 spawners for Petersen Creek (Clark 2005). The Peterson Creek escapement goal has been met or exceeded annually since surveys were initiated in 1981. The Montana Creek escapement goal was not met in 9 years out of 33, including the two most recent years—394 spawners in 2012 and 357 spawners in 2013 (Appendix Figure C 7). Escapements to Montana Creek during 1982–2013 closely tracked escapements in the Berners River (R2 = 0.60) where returns and escapements have declined substantially since the mid-2000s, due in about equal part to lower smolt production and marine survival during a recent cooling trend in the North Pacific climate cycle. Recent peak counts for Peterson Creek have been more variable, with historically high counts above the goal in 2008 and 2010 mixed with lower counts of 123–138 spawners near the lower bound of the escapement goal in 2009, 2011, and 2013 (Appendix Figure C 7).



Appendix Figure C 7.–Peak coho salmon escapement survey counts and sustainable escapement goals for two Juneau roadside streams, Montana Creek and Peterson Creek, 1981–2016.

Appendix C 7.–Sitka Area coho salmon survey index.

Five small streams within and north of Sitka Sound, that comprise the Sitka survey index, have been surveyed one or more times annually by foot since 1982. The streams include Starrigavan Creek, Sinitsin Creek, St. John’s Creek, Nakwasina River, and Eagle River.

**Escapement Goals and Stock Status:** Shaul and Tydingco (2006) recommended the current biological escapement goal of 400–800 spawners for the aggregate count in the 5 index streams, based on an analysis that assumes productivity (smolts per spawner at maximum sustained yield) for Sitka Sound stocks to be average for coho stocks that have been studied. Escapement counts have exceeded the lower bound of the escapement goal in every year except one (1987) and have exceeded the goal range annually since 2000 (Appendix Figure C 8).



Appendix Figure C 8.–Aggregate peak coho salmon escapement survey counts and biological escapement goal for five index streams in the Sitka area, 1982–2016.

Appendix C 8.–Ketchikan Area coho salmon survey index.

Coho salmon escapements in 14 streams in District 1, comprising the Ketchikan survey index, have been surveyed annually since 1987. The surveys are conducted by helicopter and are usually done separately in two circuits, with the northern circuit comprising tributaries of the Chickamin River (Indian River, Barrier Creek, King Creek, Choca Creek) and streams in Burroughs Bay near the mouth of the Unuk River (Herman Creek, Grant Creek, Eulachon River, Klahini River). The southern circuit includes Carroll River, Blossom River, Keta River, Marten River, Humpback Creek, and the Tombstone River. Two surveys of each stream are tentatively scheduled (contingent on favorable weather and water conditions), with the early survey scheduled for 28 September–1 October and the later survey scheduled for 15–20 October. The largest (peak) survey for each stream is summed with the others in the total index. Only peak survey counts that meet standards for timing, survey conditions, and completeness are included in the annual index, and missing counts are interpolated in order to maintain a comparable aggregate escapement index (Shaul et al. 2011).

**Escapement Goals and Stock Status:** Shaul and Tydingco (2006) recommended the current biological escapement goal of 4,250–8,500 spawners for the aggregate count in the 14 index streams, based on an analysis that assumes productivity (smolts per spawner at maximum sustained yield) for Ketchikan area stocks to be average for coho stocks that have been studied. Since 1987, escapements counts exceeded the lower bound of the escapement goal in every year but one (in 1990), were within the escapement goal range 13 times, and exceeded the escapement goal range 13 times (Appendix Figure C 9).



Appendix Figure C 9.–Aggregate peak coho salmon escapement survey counts and biological escapement goal for 14 index streams in the Ketchikan area, 1987–2016.

Appendix C 9.–Klawock River coho salmon.

The Klawock River is located on the west side of Prince of Wales Island, near the town of Klawock. The Prince of Wales Hatchery Association operates a hatchery (Klawock River Hatchery) and weir on the Klawock River, approximately 300 m below Klawock Lake. Over the past decade, the hatchery released an average of 3.6 million coho smolt per year in Klawock Lake. A portion of the annual coho salmon run is used for broodstock and cost recovery. The remainder of the run is allowed to pass through the weir to spawn naturally. Progeny from these fish are regarded as “wild” (Der Hovanisian 2013).

**Escapement Goals and Stock Status:** Prior to 2007, an informal, maximum escapement goal of 6,000 coho salmon was established for the Klawock River (Der Hovanisian 2013). A sustainable escapement goal range of 4,000–9,000 fish was established in 2007 (though the goal was not formally adopted until 2013; Der Hovanisian 2013; and see Appendix E in Munro and Volk 2014). The goal was based on smolt-per-spawner and theoretical stock-recruit analyses, because, although some coho salmon run abundance and escapement data were available for 1999–2005, exploitation rate, marine survival rate, and smolt age composition information was not available, and estimates from nearby Chuck Creek were used as surrogates (Der Hovanisian 2013). The annual Prince of Wales Hatchery management plan[[1]](#footnote-1) currently includes stipulations for the hatchery to operate the weir from early July through 30 November, and includes a weekly escapement schedule that provides for a target escapement of 6,500 coho salmon. Escapements were within or above the escapement goal range in all years since 1997 (Appendix Figure C 10).



Appendix Figure C 10.–Klawock River coho salmon escapement (weir counts), 1997–2016, and sustainable escapement goal range of 4,000–9,000 fish.

Appendix C 10.–Yakutat Area coho salmon.

Yakutat stocks are harvested primarily in set gillnet and sport fisheries that target runs to discrete systems, but trollers fishing on mixed stocks off the coast account for some of the catch. Yakutat area escapements have been assessed through foot, boat, and aerial surveys. Although the data series starts in 1972, the quality and comparability of peak survey counts in the Yakutat area are somewhat lower than is the case in other areas of the Southeast Region. Most surveys have been conducted early in the run to support inseason management of the set gillnet fisheries. Comparable peak escapement surveys have been conducted relatively consistently in recent years on only three systems: the Lost, Situk, and Tsiu/Tsivat rivers.

**Escapement Goals and Stock Status:** Biological escapement goals based on peak survey counts were developed for Yakutat coho salmon stocks in 1994 (Clark and Clark 1994), including 2,200–6,500 for the Lost River, 3,300–9,800 for the Situk River, and 10,000–29,000 for the Tsiu/Tsivat River. The upper bound of the Lost River goal of 2,200–6,500 spawners was dropped in 2009, and it was re-designated a lower-bound sustainable escapement goal, following a geological shift that resulted in the Lost River draining into the Situk-Ahrnklin Lagoon instead of directly into the Gulf of Alaska. This shift made it difficult to actively manage the commercial set gillnet fishery for a goal specific for the Lost River. Mark-recapture studies were conducted to estimate escapements of coho salmon in both the Situk (2004–2006) and Lost (2003–2004) rivers in hopes of providing a calibration for index counts; however, mark-recapture estimates were not consistent with index counts and meaningful expansion factors could not be estimated (Shaul et al. 2010). Index counts were substantially lower than total escapement in all years and accounted for minor and variable portions of total escapements. Based on estimates of average smolt production from the Lost River, Shaul et al. (2010) suggested that the current escapement goal for the Lost River is conservatively high if intrinsic productivity of the stock is similar to other coho indicator stocks. However, they did not recommend that the goal be changed based on that observation, because of inconsistency in the estimated survey expansions.

In the most recent review of the Lost River goal (in this report) it was determined that a return to a target range would be useful for management of the freshwater sport fishery. Also, a review of historical counts indicated that locations included in the index had not been consistent over time. Therefore, the historical index was reconstructed based only on peak counts obtained from Tawah Creek, a primary tributary where the majority of historical survey counts were conducted and the area most conducive to providing comparable survey counts (Appendix Table C 1). The department recommends changing the goal to a sustainable escapement goal range of 1,400–4,200 fish counted on a peak survey of Tawah Creek, based on the 15th–75th percentiles of historical counts, and changing the name of the goal to Tawah Creek (Lost River).

The utility of peak survey counts in assessing historical escapement in the Yakutat area is limited by decreasing survey effort near the peak of spawner abundance at the end of the fishery and by frequently deteriorating weather conditions after mid-September. Survey effort on these systems declined from 1995 to 2000, but has improved somewhat since 2001. The combined escapement index for Yakutat shows peaks in the early to mid-1990s and in 2002, with relatively strong escapements in the Situk and Tsiu rivers in 2013 (Appendix Figure C 11). The North Pacific climate cycle has likely been influential in returns and escapements to Yakutat. Peak counts have averaged lower (by a range of 18–53%) for the three systems during 2005–2013, compared with the period encompassing the warm phase of the Pacific Decadal Oscillation (1977–1998), but still averaged 0–81% higher than average counts during the prior cold regime (1972–1976).



Appendix Figure C 11.–Peak coho salmon escapement survey counts in the Yakutat area, compared to escapement goals, 1972–2016. (Horizontal lines indicate escapement goal ranges. Blank columns in time series indicate that peak survey counts were not available.)

Appendix Table C 1.–Available escapement and harvest data for Tsiu-Tsivat river coho salmon.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Escapement  Index | Commercial  Set Gillnet  Harvest | Commercial  Troll  Harvest | Sport  Harvest | Total  Harvest | Appoximate  Harvest  Ratea |
| 1973 | 30,000 | 8,803 | NA | NA | 8,803 | NA |
| 1974 | 15,000 | 8,258 | NA | NA | 8,258 | NA |
| 1975 | 8,150 | 0 | NA | NA | 0 | NA |
| 1976 | 30,000 | 3,129 | NA | NA | 3,129 | NA |
| 1977 | 25,000 | 5,691 | NA | NA | 5,691 | NA |
| 1978 | 40,000 | 34,392 | NA | NA | 34,392 | NA |
| 1979 | 25,000 | 32,621 | NA | NA | 32,621 | NA |
| 1980 | 18,000 | 28,711 | NA | NA | 28,711 | NA |
| 1981 | 20,000 | 30,109 | NA | NA | 30,109 | NA |
| 1982 | 40,000 | 46,436 | NA | NA | 46,436 | NA |
| 1983 | 16,500 | 20,119 | NA | NA | 20,119 | NA |
| 1984 | 30,000 | 51,322 | NA | NA | 51,322 | NA |
| 1985 | 52,350 | 63,922 | NA | NA | 63,922 | NA |
| 1986 | 14,100 | 21,193 | 8,120 | NA | 29,313 | 28% |
| 1987 | NA | 35,300 | NA | NA | 35,300 | NA |
| 1988 | 16,000 | 56,146 | NA | NA | 56,146 | NA |
| 1989 | 38,000 | 62,989 | NA | NA | 62,989 | NA |
| 1990 | 16,800 | 33,867 | NA | NA | 33,867 | NA |
| 1991 | 16,600 | 38,333 | NA | 835 | 39,168 | 31% |
| 1992 | 30,000 | 92,406 | NA | 866 | 93,272 | 37% |
| 1993 | NA | 56,765 | NA | NA | 56,765 | NA |
| 1994 | 55,000 | 64,205 | NA | 451 | 64,656 | 18% |
| 1995 | 30,000 | 50,399 | NA | 456 | 50,855 | 24% |
| 1996 | NA | 35,702 | NA | 1,244 | 36,946 | NA |
| 1997 | 22,000 | 58,647 | NA | 2,283 | 60,930 | 35% |
| 1998 | 14,000 | 71,066 | NA | 764 | 71,830 | 49% |
| 1999 | NA | 61,617 | NA | 1,728 | 63,345 | NA |
| 2000 | 12,000 | 59,080 | NA | 2,057 | 61,137 | 49% |
| 2001 | 17,000 | 31,748 | NA | 1,783 | 33,531 | 27% |
| 2002 | 31,000 | 0 | NA | 2,713 | 2,713 | 2% |
| 2003 | 35,850 | 0 | NA | 4,286 | 4,286 | 2% |
| 2004 | NA | 3,512 | NA | 2,372 | 5,884 | NA |
| 2005 | 10,600 | 25,429 | NA | 2,325 | 27,754 | 33% |
| 2006 | 14,200 | 26,438 | NA | 2,158 | 28,596 | 28% |
| 2007 | 14,000 | 22,323 | NA | 2,752 | 25,075 | 25% |
| 2008 | 25,200 | 49,295 | NA | 3,317 | 52,612 | 28% |
| 2009 | 28,000 | 43,920 | NA | 3,399 | 47,319 | 24% |
| 2010 | 11,000 | 77,792 | NA | 3,862 | 81,654 | 59% |
| 2011 | 21,000 | 34,934 | NA | 2,490 | 37,424 | 25% |
| 2012 | NA | 45,827 | NA | ***2,500*** | 48,327 | NA |
| 2013 | 47,000 | 44,887 | NA | ***2,500*** | 47,387 | 16% |
| 2014 | 27,000 | 37,613 | NA | ***2,500*** | 40,113 | 22% |
| 2015 | 19,500 | 16,993 | NA | ***2,500*** | 19,493 | 16% |
| 2016 | 31,000 | 11,210 | NA | ***2,500*** | 13,710 | 8% |
| Average: | 24,917 | 39,574 | NA | 2,186 | 42,045 | 27% |

a The Harvest rate was estimated as the harvest divided by the estimated total run (harvest + peak survey count × 5.3).

Appendix Table C 2.–Estimated escapements and survey expansion factors for coho salmon at the Situk and Lost rivers in the Yakutat area.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| System | Year | Escapement  Estimate | SE | Maximum  Survey Count | Expansion  Factor | Data Source: |
| Situk River | 2004 | 54,014 | 17,000 | 10,284 | 5.3 | Waltemyer et al. 2005 |
| Situk River | 2005 | 35,079 | 12,310 | 2,514 | 14.0 | Eggers and Tracy 2007 |
| Situk River | 2006 | 24,804 | 8,582 | 7,951 | 3.1 | Eggers and Tracy 2007 |
| Lost River | 2003 | 23,685 | 7,835 | 6,396 | 3.7 | Clark et al. 2006 |
| Lost River | 2004 | 47,566 | 18,560 | 5,047 | 9.4 | Clark et al. 2005 |
| Median |  |  |  |  | 5.3 |  |

1. 2014 Klawock River Hatchery Annual Management Plan, unpublished document

   http://www.adfg.alaska.gov/index.cfm?adfg=fishingHatcheriesPlanning.annual (Accessed 10/27/2014). [↑](#footnote-ref-1)