

Coho Salmon Stock Status in Southeast Alaska: A Review of Trends in Productivity, Harvest, and Abundance through 2019

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May 2021



**Pacific Salmon Commission
Technical Report No. 45**

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For

Pacific Salmon Commission
Northern Panel

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Correct citation for this publication:

Priest, J.T., S.C. Heinl, and L.D. Shaul. 2021. Coho Salmon Stock Status in Southeast Alaska: A Review of Trends in Productivity, Harvest, and Abundance through 2019. Pacific Salmon Comm. Tech. Rep. No. 45: 67 p.

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ABSTRACT

The status of Southeast Alaska coho salmon *Oncorhynchus kisutch* stocks through 2019 was assessed from information on full indicator stocks (coded wire tag program) and escapement-only abundance monitoring. Data evaluated included estimates of escapement, smolt abundance, marine survival, harvest (exploitation), and total abundance. Monitored escapements have remained mostly within or above established escapement goal ranges—we identified no stocks of concern as defined in state policy. Runs to systems in Southeast Alaska have shown substantial geographic synchrony, disrupted at times coincident with climatic shifts in the northeast Pacific. Southeast Alaska and transboundary river runs increased after 1977 and reached a peak in the early to mid-1990s before trending lower over the past two decades. All stocks have been greatly affected by recent drastic declines in marine survival: over the past decade (2010–2019) the average marine survival has declined 13–41% compared to long-term averages, with most of the decline occurring in the past 4–5 years. Smolt production from many indicator stocks has been at average or below levels but within observed ranges. Harvest rates in Southeast Alaska fisheries have also declined since the 1990s, primarily in the commercial troll fishery. During 2010–2019, average all-fishery harvest rates have been relatively moderate for indicator stocks: Berners River (41%), Auke Creek (34%), Hugh Smith Lake (52%), Chilkat River (38%), and Taku River (46%). Given these competing influences—moderate smolt production, low marine survival, and decreasing harvest—coho salmon populations appear to be sustainable over the near term. Overall, coho salmon stocks in the Northern Boundary area have demonstrated the species’ resilience to occasional low escapement events and recent harvest rates have been, in most cases, amply conservative to achieve sustainable spawning escapement needs.

Key words: Coho salmon, *Oncorhynchus kisutch*, Southeast Alaska, commercial harvest trends, harvest rate.

INTRODUCTION

Coho salmon (*Oncorhynchus kisutch*) are important to a variety of commercial, recreational, and food fisheries (including subsistence and personal use) throughout northwestern North America. This report provides updates to an earlier assessment (NBTC 2002) of the Southeast Alaska coho salmon stocks and commensurate fisheries through the 2019 run year and addresses a request by the Pacific Salmon Commission Northern Panel for a status update on these stocks. In addition to reporting trends in Southeast Alaska harvest and indicators of spawning escapement, we will provide an overview of trends in abundance, smolt production, marine survival rates, stock-specific harvest, and harvest rates for selected wild indicator stocks implanted with coded wire tags (CWTs). We will compare and contrast trends in these variables across the Southeast Alaska region and relate this information to factors/conditions that drive stock productivity. For the purposes of this report, the geographic region of Southeast Alaska extends from Cape Suckling south and east to Dixon Entrance (Figure 1), including the transboundary Taku River.

DESCRIPTION OF FISHERIES AND STOCKS

Southeast Alaska

Excellent coho salmon habitat occurs throughout Southeast Alaska (Figure 1). Coho salmon are produced from more than 2,350 streams in Southeast Alaska (Johnson and Blossom 2019), most of which are small producers about which little is known (Gunstrom 1988; NBTC 2002; Shaul et al. 2019). Important coho salmon streams are found both on “outer coast” streams that drain directly into the Pacific Ocean as well as “inside waters” of the Alexander Archipelago (e.g., Chatham Strait, Frederick Sound, and Clarence Strait, et al.). In addition to wild stocks within Southeast Alaska, important contributions to the region’s total harvest are made by 13 hatcheries in Southeast Alaska, several transboundary rivers (e.g., Alek, Taku, and Stikine), and by streams on the northern British Columbia coast (i.e., waters north of Vancouver Island). During the most

recent 10-year period (2010–2019), hatcheries contributed an average of 25% (range 16–29%) of the Southeast Alaska common property commercial harvest, and over 99% of those hatchery fish were contributed by Southeast Alaska hatcheries.

Harvest of coho salmon supports a broad array of fisheries which provide substantial economic support for Southeast Alaska. An average of 2.3 million coho salmon were harvested annually in commercial fisheries in Southeast Alaska over the past decade (2010–2019; Table 1). The troll fishery accounted for 66% of that harvest, followed by smaller portions in drift gillnet (15%), purse seine (13%), and set gillnet (6%; Yakutat area only) fisheries. Alaska hatcheries contributed 20% of the fish harvested in commercial fisheries. Over this same period, the annual exvessel value of the commercial coho salmon harvest averaged \$23 million a year (range: \$13–34 million). Recreational fisheries occur in both freshwater and saltwater areas and constitute an important harvest component. Directed subsistence fisheries are primarily small scale and account for a small portion of the overall harvest.

The Alaska Department of Fish and Game (ADF&G) implemented an improved stock assessment program in the early 1980s to better understand and manage coho salmon stocks. New assessment projects were implemented to monitor population and fishery parameters for selected CWT indicator stocks (Shaul 1994; Shaul and Crabtree 1998). In addition, a systematic escapement survey program was developed in some areas to augment information provided from the more intensive indicator stock projects. These programs have improved the understanding among fishery researchers and managers of the status of Southeast Alaska coho salmon stocks and have formed the basis for improved management (Shaul et al. 2008, 2014, 2017, and 2019).

The principal management objective for Southeast Alaska coho salmon fisheries is to achieve maximum sustained yield (MSY) from wild stocks. Hatchery contributions and natural production are identified inseason in key fisheries using CWTs. Fisheries directed primarily at harvesting coho salmon are managed based on wild stock fishery performance to achieve escapement goals while harvesting the surplus. Escapement goal ranges have been established for a number of wild indicator stocks and surveyed systems. A secondary management objective is to achieve long-term commercial gear-type allocations that were established by the Alaska Board of Fisheries in 1989. These allocations preserve a 1969 to 1988 historical base distribution of 61% for troll gear, 19% for purse seine gear, 13% for drift gillnet gear, and 7% for set gillnet gear (Alaska Board of Fisheries 1990).

The broad distribution of coho salmon production across over 2,350 streams of varying size necessitates that much of the harvest occur in highly mixed stock fisheries where the stocks intermingle. Most of the harvest occurs in the commercial troll and marine sport fisheries, particularly for the many small to medium sized populations. Incidental harvest also occurs in mixed stock commercial purse seine fisheries that primarily target pink salmon (*O. gorbuscha*; Clark et al. 2006a). Except for years of substantial deviations from average abundance or fleet size, commercial trollers fish a relatively stable season with little fluctuation in harvest proportions of the total runs. This pattern of fishing has resulted in a relatively even distribution of the troll harvest across regional stocks. Most active management to harvest surpluses and achieve escapement goals is conducted in drift and set gillnet fisheries that target coho salmon runs to single major systems or local concentrations of productive systems.

HISTORICAL HARVEST

COMMERCIAL HARVEST

Commercial harvest of coho salmon in Southeast Alaska and northern British Columbia began in the late-1800s, and harvests increased until the late-1930s and 1940s when troll fisheries began broadly targeting the species (Figure 2; NBTC 2002). Prior to 1998, harvests between the two regions oscillated between periods of strong positive and negative correlations, separated by abrupt shifts in scale that coincided approximately with known ocean climatic regime shifts (Shaul et al. 2007). Prior to Alaska statehood in 1959, peaks in the 10-year average harvest reached 1.33 million fish in northern British Columbia (1936–1945) and 2.11 million fish in Southeast Alaska (1942–1951).

After 1955, harvests diverged strongly in favor of northern British Columbia during the two decades ending in 1977 (NBTC 2002). This period coincided with cold conditions in the northeast Pacific that strongly favored more southern salmon stocks from systems in the California Current and bifurcation zone over those entering the sea in the Alaska Current system (Hickey and Royer 2001). During 1956–1977, commercial harvests in Southeast Alaska averaged only 887 thousand fish compared with an average 1.17 million fish in northern British Columbia, including the all-time record northern British Columbia commercial harvest of 2.07 million coho salmon in 1968.

Southeast Alaska harvests underwent dramatic recovery after the 1977 regime shift (Beamish and Bouillon 1993) and peaked in the 1990s at an average of 2.63 million wild fish and 3.21 million total fish. The all-time record Southeast Alaska harvest of 4.79 million wild fish and 5.52 million total fish occurred in 1994. The average commercial harvest in northern British Columbia declined to an average 605 thousand fish during 1992–1997, during a period of extreme divergence in coho salmon runs to streams north and south of Dixon Entrance and very poor survival for coho salmon stocks in Washington, Oregon, and southern British Columbia (Shaul et al. 2007).

The commercial harvest of 219 thousand coho salmon in northern British Columbia in 1997 was the lowest on record and led to drastic conservation measures for Canadian coho salmon stocks, including management restrictions and fleet restructuring (NBTC 2002). Coho salmon harvest by northern British Columbia commercial fisheries over the past two decades have remained low since these limitations were implemented. Harvest of both wild and hatchery-produced coho salmon in Southeast Alaska have trended lower from the 1990s peak to an average of 1.74 million wild fish and 2.30 million total fish during 2010–2019 (Table 1). Southeast Alaska coho salmon harvest (wild and total) in 2018 and 2019 were the lowest on record since 1988 (Figure 2).

SPORT AND SUBSISTENCE HARVEST

The Southeast Alaska sport harvest of coho salmon is less than commercial harvest, averaging 9–13% of the annual total coho salmon harvest since 2000. Sport harvest increased dramatically during the 1990s (Clark et al. 2006a), primarily caused by increased effort by non-resident anglers (Chadwick et al. 2017) and the rapid development of the charter industry. The trend in Southeast Alaska sport harvests has been relatively level since the late-1990s, reaching a peak of 409,000 fish in 2005 (Figure 3). The average harvest during the most recent 10-year period (2010–2019) was 258,000 fish, of which 230,000 fish (89%) were harvested in saltwater and 30,000 fish (11%) were harvested in freshwater. Although emergency inseason management actions to reduce harvest have been infrequent, bag or possession limits have been reduced in response to inseason indicators of low abundance.

Directed subsistence fishing for coho salmon occurs in a few streams in the region, and small numbers are also harvested incidentally in both subsistence and personal use fisheries that are directed primarily at harvesting sockeye salmon (*O. nerka*). The 10-year (2010–2019) average combined subsistence and personal use harvest in state managed fisheries, as reported on returned permits, averaged only 2,700 fish. Regulations that allowed for directed subsistence fishing for coho salmon were expanded in 2005 under federal rules in many freshwater areas (OSM 2005).

MANAGEMENT

Management of coho salmon in Alaska is delegated to ADF&G and separated into two divisions (Commercial Fisheries and Sport Fish) depending on harvest type. The majority of coho salmon harvested in Southeast Alaska are from commercial fisheries. Southeast Alaska commercial fisheries for coho salmon are managed under specific management plans for each fishery. The *Management of coho salmon troll fishery* (5 AAC 29.110) for the troll fishery contains several decision points that potentially trigger early or midseason closures for conservation and allocation, and/or an extension of the troll coho season for up to 10 days after the regulatory closing date of 20 September. Some provisions of the plan were written in the late 1970s and 1980s when direct information on coho salmon abundance was limited to fishery catch and effort statistics. In recent years, fishery managers have tried to balance the specific provisions of the management plan with increasing capability to assess monitored stocks and their escapement needs. Inseason management has increasingly focused on achieving escapement goals that produce MSY as a specific priority objective.

In addition to stipulations specified in state management plans, the Pacific Salmon Treaty (treaty) contains provisions for the conservation of Southeast Alaska, northern British Columbia, and transboundary river coho salmon stocks (PSC 2020, Chapter 7). The treaty requirements essentially mirror Alaska state regulations for potential early and midseason troll fishery closures. However, the treaty also contains provisions that trigger a closure of the troll fishery in the boundary areas of southern Southeast Alaska and northern British Columbia when regional stock abundance is indicated to be low based on fishery performance thresholds. Transboundary river management of coho salmon stocks are regulated through treaty agreements for the Taku, Stikine, and Alsek Rivers to achieve conservation, allocation, and enhancement objectives (TTC 2019).

The projected commercial harvest of wild coho salmon was established in the 1980s as a proxy for total abundance in determining the need for an early-season troll fishery closure under Alaska regulatory statute (5 AAC 29.110). Specifically, the department may close the coho salmon troll fishery for up to 7 days, on or after 25 July, if the total projected commercial harvest of wild coho salmon is less than 1.1 million fish. When this regulation was established, the commercial harvest of wild fish was considered the best available proxy for aggregate wild coho salmon abundance returning to the region. To account for annual variability in harvest rates, an index of total abundance was developed based on the estimated troll harvest of wild coho salmon and an index of the troll harvest rate using estimates for four wild indicator stocks distributed across the region (Auke Creek, Berners River, Ford Arm Creek, and Hugh Smith Lake; Shaul et al. 2011). These indicator stock projects were selected because of their precise accounting of escapement, their long-term stock assessment history, and their geographic distribution. The primary purpose of the index has been to provide an additional tool to estimate total abundance of wild coho salmon available to the troll fishery in Southeast Alaska waters from throughout the range of contributing stocks.

In 2000 and 2001, the Alaska Board of Fisheries adopted the *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223) into state regulation to ensure that the state's salmon stocks would be conserved, managed, and developed using the sustained yield principle. Formal escapement goals are currently maintained for 13 stocks of coho salmon. Escapement goals are classified as either biological or sustainable escapement goals as defined in (5 AAC 39.222) under section (f) as follows:

“(3) ‘biological escapement goal’ or ‘(BEG)’ means the escapement that provides the greatest potential for maximum sustained yield; ...” and

“(36) ‘sustainable escapement goal’ or ‘(SEG)’ means a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated or managed for...”

Most escapement goals for coho salmon were established based on a Ricker relationship between spawners and recruits (Ricker 1975), but other models have proven more appropriate for coho salmon, including Beverton-Holt (Beverton and Holt 1957; Barrowman et al. 2003), hockey stick (Barrowman and Myers 2000), and bent hockey stick (Shaul et al. 2013) models.

STOCK STATUS

Coho salmon stocks are widely distributed and are known to be present in more than 2,350 primary anadromous streams in Southeast Alaska (Johnson and Blossom 2019); however, it is practical and feasible to conduct stock assessment projects on only a small fraction of those streams. The status of coho salmon stocks in Southeast Alaska was judged by trends in adult escapement of indicator stocks relative to established goals, smolt production and marine survival, changes in harvest rates, and regional wild abundance. The highest resolution in stock status is provided by full indicator stocks with established CWT programs which provide annual estimates of escapement, smolt production, marine survival, and harvest by fishery. While relatively few intensively monitored full indicator systems exist, broad geographic coverage with lower resolution is provided by visual counts or estimates of spawning escapement over broader groups of systems. Most direct assessment of the stocks occurs at two levels: full indicator stock and escapement indicator.

Full indicator stocks are marked as smolts or pre-smolts with CWTs, which makes it possible to estimate their smolt production (from the marked rate-at-return) and contribution to the fisheries by systematically sampling fishery harvests and escapements. These programs were expanded in the 1990s and 2000s (Shaul et al. 2011) but were subsequently reduced to six systems by 2015, including Auke Creek, Berners River, Ford Arm Creek, Hugh Smith Lake, Chilkat River, and Taku River. The Ford Arm Creek project was discontinued after 2015. Complications with the Chilkat and Taku River tagging and recovery programs have meant that while these stocks have a full component of CWT, they are not used in annual assessments for commercial fishery management. Full indicator stock programs provide detailed population information needed to establish and manage for BEGs. Specific parameters that are estimated for these stocks include total adult abundance, spawning escapement (including age, size, and sex), smolt production (abundance, age, and size), marine survival, fishery harvest by area, gear type, and time, and harvest rates. Over time, these parameters are used to evaluate the relationship between spawning escapement and production and to establish BEGs that produce MSY. One major advantage of the smolt estimation programs associated with coho salmon indicator stocks is that they make it possible to filter out

variation in return abundance caused by variation in marine survival and to improve resolution of the relationship between escapement and brood-year production (Shaul et al. 2007).

Escapement surveys are conducted on streams where a weir is infeasible and clear water allows for aerial, walking, or boat-based counts. Only peak survey counts that met standards for timing, survey conditions, and completeness were included in escapement surveys and indices. Most of the consistent indicators of coho salmon escapement were established in the early to mid-1980s (Table 2).

STOCK-SPECIFIC ESCAPEMENT MONITORING

Currently, 13 systems or groups of coho salmon systems have formal escapement goals, including 8 with BEGs and 5 with SEGs (Heinl et al. 2017). Escapements are assessed by weir (e.g., Hugh Smith Lake), mark–recapture (e.g., Taku River), and foot, boat, or fixed wing/helicopter aerial survey. Escapement assessments for full indicator stocks form the second tag recovery event for mark–recapture estimates of smolt population abundance. Annual escapements and escapement goals are summarized for northern inside stocks (Figure 4), Sitka / outer coast stocks (Figure 5), Ketchikan / Southern stocks (Figure 6), and Yakutat area stocks (Figure 7). For the full indicator stocks, estimates of total escapement and harvest are shown in Figures 8–10, as well as Appendices A1–A7 and B1–B6. Although an SEG was established for the Klawock River on the west coast of Prince of Wales Island (Der Hovanisian 2013), a hatchery operated on the river has meant that the Klawock River run consists almost entirely of hatchery-produced coho salmon (Stopha 2016); therefore, Klawock River coho salmon information will not be summarized in this report.

Full Indicator Stocks

Auke Creek

Auke Creek, located on the Juneau road system, supports a small run of coho salmon. Annual smolt and adult spawning populations have been accurately counted at a weir (operated by the National Marine Fisheries Service), and coded wire tagging studies have provided estimates of harvest, marine survival, and age composition since 1980 (Shaul et al. 2019). As a result of the high coded wire tagging rate on smolts (100%) and accurate total accounting of returning adults, the Auke Creek stock is an important indicator of the commercial troll harvest rate on northern inside stocks and is used in inseason estimation of regional wild coho salmon abundance. Rearing habitat in the Auke Creek drainage is dominated by the environment of Auke Lake. The BEG of 200–500 coho salmon was established in 1994, based on a stock-recruit analysis (Clark et al. 1994). Since 1980, escapements averaged 654 fish (range 146–1,533 fish) and total runs averaged 1,081 fish (range 273–3,055 fish). From 2010 to 2019, escapements were below the escapement goal range just once (Figure 4). Trends in the total run (escapement plus harvest), are similar to those of escapement (Figure 8). Average escapements and total runs over the past decade (2010–2019) were 20% and 31% below the long-term averages, respectively, with most of this decline occurring during the last five years (2015–2019; Figure 11).

Berners River

The Berners River is located in Berners Bay, Lynn Canal, approximately 65 km northwest of Juneau, Alaska. The Berners River is a compact system with concentrated high-quality coho salmon spawning and rearing habitat that is an important contributor to the fisheries in northern Southeast Alaska. Coded wire tagging studies of the Berners River coho salmon run have provided annual estimates of harvest, escapement, smolt production, marine survival, and age composition

since 1982 (Shaul et al. 2017, 2019). Pre-smolts were tagged during summer months at the Berners River in most years starting in 1976; however, the focus of the program switched entirely to tagging smolt in 1989, and large numbers of smolt have been tagged annually since 1990. As a result, the Berners River coho salmon run is an important indicator of the commercial troll harvest rate on northern inside stocks and is used in inseason estimation of regional wild coho salmon abundance. The escapement is assessed based on standardized foot and helicopter survey counts conducted in late fall. Compressed timing of spawning, 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 surveys. The current BEG of 3,600–8,100 spawners was established in 2018, based on stock-recruit analysis of the 1989–2010 brood years and unexpanded escapement survey counts (Shaul et al. 2017; Figure 4; Table 2). In that analysis, annual spawning escapement was standardized to a constant per capita egg biomass, based on the sex ratio and average egg biomass of female spawners (Shaul et al. 2017). Since 1982, escapements averaged 12,017 fish (range 4,406–34,382 fish) and total runs averaged 26,763 fish (range 8,636–77,209 fish). Average adult production was 60% lower in 2005–2014 compared to the previous 15-year period (1990–2004; Shaul et al. 2017). Despite substantially lower runs over the last decade (Figure 11), since 2010 Berners River coho salmon escapement was below the BEG only once (2018) and exceeded the BEG in three years.

Ford Arm Creek

Ford Arm Creek, draining Ford Arm Lake, is located on western Chichagof Island, approximately 67 km northwest of Sitka, Alaska. Ford Arm Creek was the only long-term indicator stock in the Sitka / outer coast area that had a long-term escapement data record and an established BEG (Figure 5; Table 2). Coded wire tagging studies of Ford Arm Creek pre-smolt occurred from 1981–2014 (i.e., through the 2015 smolt outmigration year). Monitoring of this population (pre-smolt tagging and adult escapement enumeration at a weir) was discontinued after 2015 due to state budget cuts. The Ford Arm Creek stock is available to fisheries in coastal waters from early July through early September and is harvested intensively by commercial troll and marine sport fisheries, as well as incidental harvest in the Khaz Bay pink salmon purse seine fishery. A BEG range of 1,300–2,900 spawners was established in 1994, based on a stock-recruit analysis (Clark et al. 1994). The goal was reviewed by Shaul et al. (2014), who recommended maintaining the BEG of 1,300–2,900 spawners. From 1982 to 2015, escapements averaged 3,235 fish (range 1,552–7,109 fish) and total runs averaged 8,454 fish (range 3,233–16,124 fish). The escapement goal range was achieved in 18 years and exceeded in 15 years during the 33-year history of the project (Figure 5). During the last 10 years of the project, the BEG was met or exceeded in all years. Since 2010, the relative change of the total run to Ford Arm Creek was above the 1985–2009 baseline in two of six years (Figure 11).

Hugh Smith Lake

Hugh Smith Lake is located on the mainland, approximately 65 km southeast of Ketchikan, Alaska. The Hugh Smith Lake coho salmon run is currently the only wild, coded wire tagged coho salmon indicator stock in southern Southeast Alaska. Coded wire tagging studies and weir counts have provided annual estimates of harvest, escapement, smolt production, marine survival, and age composition since 1982 (Shaul et al. 2009, 2019). Thus, the Hugh Smith Lake coho salmon run is an important indicator of the commercial troll harvest rate on southern inside stocks and is used in inseason estimation of regional wild coho salmon abundance. Returning adults are exposed to a broad array of troll, net, and sport fisheries from northern Southeast Alaska to northern British

Columbia, and harvest rates average higher for Hugh Smith Lake coho salmon than for coho salmon indicator stocks in northern inside areas of Southeast Alaska. Escapements are counted at a weir across the short lake outlet stream, and fish spawn in two inlet streams. Since rearing habitat in the inlet streams is limited, most juvenile coho salmon rear around wood and rock structure along the steep-sided lakeshore and in an extensive log jam at the lake outlet. The BEG of 500–1,600 spawners was established in 2009, based on stock-recruit analysis of brood years 1982–2004 (Shaul et al. 2009). Since 1982, escapements averaged 1,500 fish (range 433–4,110 fish) and total runs averaged 3,950 fish (range 1,347–9,464 fish). Over the past 38 years, escapements have been below the current BEG range once (1989), above it in 14 years, and within goal range in 23 years (Figure 6; Table 2). The BEG was consistently exceeded during 2008–2014 and within the BEG during 2015–2019, though average escapements and total runs over the past five years were 33% and 45% below the long-term averages, respectively. Since 2010, the total run to Hugh Smith Lake was below the 1985–2009 average in five of the past 10 years; all five runs below average were during 2015–2019 (Figure 11).

Chilkat River

The Chilkat River, a large glacial system located near Haines, Alaska, supports one of the largest coho salmon runs in Southeast Alaska. The Chilkat River coho salmon run is predominately composed of fish that exhibit typical late migratory timing; however, the run also includes earlier segments that enter the river beginning in late August and early September. Chilkat River coho salmon are harvested primarily in the northern Southeast Alaska commercial troll fishery and the Lynn Canal drift gillnet fishery. The Chilkat River also supports one of the largest coho salmon sport fisheries in Southeast Alaska (Elliott 2013).

Coded wire tagging studies have been conducted annually since 1999 and provide estimates of harvest, smolt production, and marine survival. Standardized foot survey index counts at four Chilkat River tributaries have been performed annually since 1987. Total Chilkat River coho salmon escapements concurrently estimated from mark–recapture studies conducted in five years (1990, 1998, 2002, 2003, and 2005) were used to calibrate peak survey counts (Elliott 2013). Though CWT studies could qualify this system as a full indicator stock, the large escapement estimate expansion factor (33.6) and Chinook salmon (*O. tshawytscha*) focus of the Chilkat CWT program have meant that this stock has not been used to calculate the regional troll fisheries harvest rate which is used to estimate wild coho salmon abundance in the region. The BEG range of 30,000–70,000 coho salmon was established in 2006, based on a stock-recruit analysis (Ericksen and Fleischman 2006). Since 2000, escapements averaged 70,690 fish (range 24,770–204,925 fish) and total runs averaged 120,892 fish (range 38,270–339,984 fish). Escapement estimates have met or exceeded the BEG in 9 of the past 10 years, falling short in 2016 (Figure 4; Table 2).

Taku River

The Taku River is a transboundary system that originates in the Stikine plateau of northwestern British Columbia and terminates at Taku Inlet, approximately 30 km southeast of Juneau, Alaska. The Taku River drainage contains many tributaries with diverse river types, including glacial systems, clearwater streams, and lacustrine inputs. These varied habitats support what is likely the single largest coho salmon-producing system in Southeast Alaska and supports a diversity of run components. Early-run stocks are bound for upriver tributaries and fall-run stocks spawn primarily in mainstem tributaries. Aggregate Taku River coho salmon runs are managed through the Pacific Salmon Treaty. Joint U.S./Canada mark–recapture studies have provided inriver estimates of

abundance since 1987 and CWT studies have provided estimates of harvest, smolt production, and marine survival since 1992 (Pestal and Johnston 2015). Results of a 1992 radio-telemetry study indicated that the inriver mark-recapture abundance estimate represented about 78% of the total system escapement, and about 22% of the escapement spawned in Alaska waters below the U.S.-Canada border (Williams et al. 2016). Though CWT studies could qualify this system as a full indicator stock, limitations in the juvenile coho salmon sampling (e.g., lower tagging rates than other systems) meant that this stock was not used to calculate the regional troll fisheries harvest rate to estimate wild coho salmon abundance in the region.

The current BEG of 50,000–90,000 spawners was established in 2015, based on a stock-recruit analysis of the 1987–2009 brood years (Pestal and Johnston 2015). Since 1992, escapements averaged 92,391 fish (range 32,345–219,360 fish) and total runs averaged 171,350 fish (range 50,886–339,736 fish). Coho salmon escapement in the Taku River has declined over the last 10 years (2010–2019), though the escapement goal was met or exceeded in all years (Figure 4).

Total run estimates for the Taku River have shown a similar general pattern of abundance to nearby mainland systems (Berners and Chilkat Rivers), with peaks in 1994 and 2002 (Figure 9 and Figure 10). However, estimates for the transboundary Taku River were comparatively lower during 1996–2000 and higher during 2003–2010 in relation to abundance in those Lynn Canal rivers (Figure 9).

Escapement-Only Indicator Stocks

While weir and/or tagging abundance estimates provide the highest accuracy, the high labor and expenses have meant that many systems are assessed using visual counts. These projects provide greater geographic coverage in some areas, albeit at a much lower level of resolution. Freshets resulting from high and variable rainfall in the fall months often make it difficult to obtain consistent surveys. Escapement-only indicator stocks have been established at five streams and two survey indices composed of multiple rivers.

Ketchikan Area Index

The Ketchikan area coho salmon survey index is composed of 14 streams, most of which drain into Behm Canal, that have been surveyed annually since 1987. Surveys are conducted by helicopter, and the largest (peak) survey count 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 escapement index over time (Shaul et al. 2011). Interpolations were made for missing counts under the assumption that the expected value is determined for a given stream and year in a multiplicative way (i.e., counts across streams for a given year are multiples of counts for other years, and counts across years for a stream are multiples of counts for other streams), using an iterative procedure (Brown 1974). A BEG of 4,250–8,500 aggregate spawners was established in 2006, based on a theoretical stock-recruit analysis that assumed marine survival and harvest rates of Ketchikan area stocks were similar to the coded wire tagged wild indicator stock at nearby Hugh Smith Lake, and assumed productivity (smolts per spawner at MSY) to be average for coho salmon stocks that have been studied (Shaul and Tydingco 2006). Since 1987, escapement counts averaged 9,035 fish (range 3,444–16,754 fish). The index followed a generally upward trend from 1987 to the early to mid-2000s, with highly variable counts occurring during 2006–2012 followed by consistently high counts during 2013–2019 (Figure 6; Table 2). During the past 33 years (1987–2019), escapement counts fell short of the BEG only once (in 1990), were within the range in 14 years, and were above-goal over half of the time (18 years).

Sitka Area Index

The Sitka coho salmon survey index is composed of five small streams within and north of Sitka Sound that have been surveyed annually since 1982. The largest (peak) survey count 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 escapement index over time (Shaul et al. 2011). Interpolations of missing counts were performed using the same iterative methodology as the Ketchikan Area Index (Brown 1974). The sum of peak escapement survey counts for the five small streams in the Sitka Area Index trended downward in the late 1980s, then increased sharply in the early 1990s (Figure 5; Table 2). Counts have remained relatively stable for the past 20 years and reached a record count in 2016. A BEG of 400–800 aggregate spawners was established in 2006, based on a theoretical stock-recruit analysis that assumed marine survival and harvest rates of Sitka area stocks were similar to the CWT results from the Nakwasina River (one of the index rivers) and assumed productivity (smolts per spawner at MSY) to be average for coho salmon stocks that have been studied (Shaul and Tydingco 2006). Since 1982, escapement counts averaged 1,380 fish (range 293–2,943 fish). The escapement index exceeded the lower goal bound in every year except one (1987), and exceeded the upper goal bound in all of the 10 most recent years, averaging 2.2 times the upper goal bound.

Montana Creek and Peterson Creek

Coho salmon escapements along the Juneau road system at Montana and Peterson creeks have been monitored by foot surveys conducted annually since 1981 (Clark 2005). Both stocks are likely harvested in mixed stock troll, seine, and sport fisheries, with some additional harvest in inside drift gillnet fisheries. The current SEGs of 400–1,200 spawners for Montana Creek and 100–250 spawners for Peterson Creek were established in 2006, based on theoretical stock-recruit analysis that assumed harvest rates were similar to the coded wire tagged wild indicator stock at nearby Auke Creek, and a range of probable productivity values were examined to estimate escapement counts that would encompass 90% or more of maximum sustained yield (Clark 2005). Since 1981, Montana Creek escapement counts averaged 841 fish (range 60–2,512 fish) and Peterson Creek escapement counts averaged 248 fish (range 20–660 fish). The Montana Creek escapement goal was met or exceeded in 29 of 39 years; peak survey counts were below goal in three of the past 10 years (2010–2019). The Peterson Creek escapement goal was met or exceeded annually for 35 consecutive years, 1981–2015, but peak counts fell sharply under goal to 52 fish in 2016 and 20 fish in 2017.

Yakutat Area Stocks

Several Yakutat coho salmon stocks have been monitored for escapement since 1972. The quality and comparability of peak survey counts is lower for Yakutat stocks than for monitored stocks in other areas of Southeast Alaska due to late run timing and frequently deteriorating weather conditions after mid-September, and a decrease in survey effort near the peak of spawner abundance at the end of the fishing season. Comparable peak escapement surveys have been conducted relatively consistently in recent years at only three systems: Tawah Creek, Situk River, and Tsiu-Tsivat River (Figure 7). Mark-recapture studies were conducted to estimate escapements of coho salmon at the Situk River from 2004 to 2006 (Eggers and Tracy 2007, Shaul et al. 2010) and the Lost River in 2003 and 2004 (Clark et al. 2006b) in hopes of providing a calibration of the index counts; however, mark-recapture estimates were not consistent with peak survey counts.

Index counts were substantially lower than estimated total escapement in all years and accounted for minor and variable portions of the total escapement, and, as a result, meaningful expansion factors could not be estimated. Escapement goals based on peak annual survey counts are currently maintained for the Tsiu-Tsivat River (SEG 10,000–29,000 fish), the Situk River (BEG 3,300–9,800 fish), and Tawah Creek (SEG 1,400–4,200 fish). Since 1972, Tawah Creek escapement counts averaged 3,203 fish (range 746–9,460 fish), Situk River escapement counts averaged 7,833 fish (range 1,630–40,000 fish), and Tsiu-Tsivat River escapement counts averaged 24,336 fish (range 8,150–55,000 fish). During the past 10 years (2010–2019), peak escapement survey counts were obtained in nine years at Tawah Creek and the Tsiu-Tsivat River and in all 10 years at the Situk River. During that period, escapement goals were met or exceeded every year that counts were obtained at the Tsiu-Tsivat River, in nine of 10 years at the Situk River, and seven of nine years at Tawah Creek (Figure 7).

SMOLT AND PRE-SMOLT PRODUCTION

Recent smolt production estimates are available through 2018 for five coded wire tagged indicator stock systems (Auke Creek, Berners River, Chilkat River, Taku River, Hugh Smith Lake), and pre-smolt estimates in the summer prior to smolt emigration are available for Ford Arm Creek through the 2014 smolt outmigration year (Table 3). Estimates in Table 3 are listed by smolt outmigration year for adult returns in the following year.

Auke Creek

Total Auke Creek coho salmon smolt production averaged 6,246 fish (range 3,616–10,714 fish) from 1980 to 2018 (Table 3). Smolt production exhibited a long-term linear decline from an average of about 8,000 smolt in the first five years of the project to an average of about 4,200 smolt in the five years 2005–2009 (Figure 12). This decline appeared unrelated to the size of the brood year spawning escapement (Shaul et al. 2011). Smolt production rebounded substantially after 2008 and averaged about 7,000 smolt through 2018. As a result, there has not been a significant decrease in smolt production over the entire time series 1980–2019 (time series linear regression; $p=0.102$).

Berners River

Total Berners River coho salmon smolt production averaged 175,990 fish (range 89,078–326,369 fish) from 1990 to 2018 (Table 3). Only pre-smolt were tagged at the Berners River prior to 1989; however, the program shifted to tagging smolt in 1989, and large numbers of smolt have been tagged annually since 1990. Berners River smolt production reached low levels during the five years 2004–2008 (average 116,000 smolt), similar to the period of lowest smolt production observed at nearby Auke Creek (2005–2009). That decline may have been related to a trend toward colder spring temperatures beginning in the mid-2000s, with probable longer annual periods of snow-on-ice coverage on off-channel habitats (Shaul et al. 2017). The low point in smolt production in 2007 (89,000 fish) followed a winter of record snowfall that also adversely affected habitat availability. Average smolt production increased over the past decade to 172,000 fish, similar to the 1990–2008 average of 180,000 fish, and there has not been a significant decrease in smolt production over the entire time series 1990–2018 (time series linear regression; $p=0.250$; Figure 12).

Ford Arm Creek

Smolt population estimates are unavailable for Ford Arm Creek, but the number of pre-smolts was estimated based on CWT marking of pre-smolts in summer and recovery sampling of returning adults two years later (Shaul et al. 2014). Total Ford Arm Creek pre-smolt estimates averaged 83,812 fish (range 38,509–149,090 fish) from 1980 to 2013 (Table 3). Pre-smolt estimates increased markedly from an average of 60,700 fish during earlier years of the project (1980–1991) to an average of 94,600 fish during 1992–2013 (Figure 12). There was a significant increase in smolt production over the entire time series, 1981–2015 (time series linear regression; $p=0.001$). Because only pre-smolts were tagged at Ford Arm Creek, estimates of abundance in the capture year were approximately 8–10 months before the smolt outmigration year and thus do not account for overwinter mortality.

Hugh Smith Lake

Total Hugh Smith Lake coho salmon smolt production averaged 33,037 fish (range 20,055–53,227 fish) from 1982 to 2018 (Table 3). Over the past decade, 2009–2018, the average smolt estimate (37,200 fish) was 18% higher but not significantly different than the 1982–2008 average (31,500 fish; t-test; $p=0.071$), and there has been no significant annual change in smolt abundance (time series linear regression; $p=0.316$; Figure 12) over time. Smolt production from Hugh Smith Lake has followed a relatively stable long-term trend and has shown the least variability among indicator stocks. This low variability is possibly due to a lake environment (where most freshwater rearing occurs) that is hydrologically, thermally, and structurally more stable compared with riverine rearing habitat.

Chilkat River

Total Chilkat Lake coho salmon smolt production averaged 1,136,511 fish (range 498,938–2,970,458 fish) from 1999 to 2018 (Table 3). Smolt production declined from an average 1,410,000 smolt during 1999–2008 to an average 860,000 smolt during 2009–2018 (time series linear regression; $p=0.006$; Figure 12). The long-term decline in estimated smolt production is a major factor in recent below-average coho salmon runs to the Chilkat River drainage.

Taku River

Total Taku River coho salmon smolt production averaged 1,805,024 fish (range 700,632–3,755,274 fish) from 1991 to 2018 (Table 3). Smolt production increased from an average 1,295,000 smolt during the 1990s to an average 2,780,000 smolt during 2001–2009, then declined to an average 1,397,000 smolt since 2010 (Figure 12). Smolt abundance trends in the Taku River generally follow similar patterns as those in the Chilkat River, particularly a decline in smolt abundance in both rivers over the last two decades.

MARINE SURVIVAL

Marine survival estimates are available beginning in the early-1980s, at the beginning of a period of increased harvests of coho salmon (Figure 2). Marine survival rates for wild indicator stocks increased after the early 1980s and reached a peak in the early to mid-1990s before declining to more moderate levels from 1995 to 2014 (Figure 13; Table 4). Since 2014, marine survival has generally been low.

There is some evidence that marine survival was adversely affected by abnormally warm marine conditions (the “Blob”) beginning around summer 2014 (Bond et al. 2015). Average marine

survival for the period 2015–2019 was below the average marine survival for all monitored systems: Auke Creek (2015–2019 average = 7.6%; 1980–2014 average = 19.3%), Berners River (2015–2019 average = 7.6%; 1990–2014 average = 16.2%), Chilkat River (2015–2019 average = 9.6%; 2000–2014 average = 11.1%), Taku River (2015–2019 average = 8.7%; 1992–2014 average = 10.8%), and Hugh Smith Lake (2015–2019 average = 6.1%; 1983–2014 average = 13.0%). Recent increases in marine survival among systems (Figure 13) indicates that the initial effects of the marine heat wave may be diminishing.

Southeast Alaska

Smolt–adult survival rates at Auke Creek 1980–2019 have averaged 17.9% (range 4.1–35.3%). Combined survival for Auke Creek smolts returning as both jacks and adults through the 1980s increased to a combined peak of 46% in 1994 (Figure 14). Adult Auke Creek marine survival peaked again at 28% in 2001 and has since trended lower: the 1981–2009 average smolt–adult marine survival was 20.2% compared to the 2010–2019 average of 11.7%. Most of this decline occurred during 2015–2019, when smolt–adult survival rates ranged from 5% to 12%.

Smolt–adult survival rates at Berners River followed similar trends to Auke Creek. Average 1990–2019 marine survival for Berners River smolt was 14.9% (range 4.9–30.2%). Marine survival decreased in the last decade (2010–2019 average=10.2%) compared to the two previous decades (1990–2009 average=17.3%). Marine survival rates between Berners and Auke Creek showed a strong positive correlation ($R^2 = 0.69$), indicating their geographic proximity and similar weather and environmental conditions likely affects both systems similarly. Most of the decrease in Berners River marine survival has occurred since 2015: the lowest three years of marine survival were in 2017, 2016, and 2018.

In contrast to the relatively high survival for coho salmon smolts from Berners River and Auke Creek, survival for smolts from the Chilkat and Taku Rivers has been moderate. Marine survival estimates for the smolt populations leaving the Chilkat River have been relatively stable over the past two decades. Chilkat River smolt survival during the most recent decade (2010–2019 average=11.3%) is slightly higher than the first decade of the project (2000–2009 average=10.3%). Smolt-to-adult survival rates for coho salmon in the transboundary Taku River have been estimated during 1992–2019, averaging 10.4% (Table 4). Taku River coho salmon marine survival rates are slightly lower during the most recent decade (2010–2019 average=9.8%) than during the previous years of the project (1992–2009 average=10.8%).

Smolt–adult survival rates at Hugh Smith Lake have typically been lower than similar sized northern inside stocks. The 1983–2019 average survival rate was 12.1% (range 3.0–21.1%). While there has been a decrease in marine survival for Hugh Smith Lake coho salmon, the decline has not been as substantial as other monitored stocks. The 1983–2009 average marine survival was 12.6%; the 2010–2019 marine survival was 10.9%.

Outer coastal stocks in northern Southeast Alaska, represented by Ford Arm Creek, have shown a somewhat different pattern. Ford Arm Creek pre-smolts returning from 1982 to 2015 survived at an average rate of 10.6%. Survival rates peaked during the 1990s but overall, there was no clear trend in survival (Figure 13; Table 4). Survival rates remained stable near 8% during the final six years of the Ford Arm Creek project (2010–2015). Survival rate estimates for Ford Arm Creek include about 10 months of freshwater mortality and, therefore, are not a pure indicator of marine survival. It is unknown what Ford Arm Creek smolt survival has been since the project ended.

Marine survival typically has been lower for Hugh Smith Lake coho salmon in southern Southeast Alaska compared to northern inside indicator stocks. This relationship began to differ beginning in 2009: during 1990–2008, average smolt–adult survival at Hugh Smith Lake was 13.3%, two-thirds of the average rate for Auke Creek and Berners River (20.0%). Marine survival rates showed a strong positive correlation between northern and southern indicator systems during this period ($R^2 = 0.57$; $p < 0.001$). However, the relationship changed abruptly in the 2008 sea-entry year (2009 adult run year) and marine survival has been fairly similar between rivers since then. This shift of relatively worse marine survival in the north occurred during a period of cold climatic conditions in the northeast Pacific as indicated by the Pacific Decadal Oscillation (PDO) Index. The ratio of marine survival rates between the Berners River and Hugh Smith Lake was positively correlated with the September–August PDO index (ending in the sea-entry year) for the 1990–2014 run years (Shaul et al. 2017).

HARVEST RATES

Harvest rates for most Southeast Alaska coho salmon stocks accumulate through multiple fisheries, from outer coastal troll and marine sport fisheries through net, sport, and troll fisheries in migration corridors, followed by inside gillnet fisheries. For some stocks, there are significant freshwater sport and subsistence harvests as well. Compared with the 1980s and 1990s, recent all-fishery harvest rates have trended lower for inside stocks (e.g., Auke Creek, Berners River, and Hugh Smith Lake) but were historically high for the outer coastal Ford Arm Creek stock during 2009–2015 (Figure 15 and Figure 16; Appendices B1–B6).

Total all-gear harvest rate estimates for Auke Creek coho salmon averaged a relatively low rate of 38% (range 20–56%) from 1980 to 2019 (Table 5; Figure 15; Appendix B1), owing primarily to lack of intensive net fishing within its primary migratory pathway compared to other coho salmon indicator stocks. The lowest all-fishery harvest rate estimate (20%) occurred the first year of observations (1980), when the troll fishery had recently been placed under severe restrictions to protect coho salmon runs, primarily to northern inside systems. The highest harvest rate occurred in 2018, when an estimated 56% of the run was harvested, pushed higher that year by above-average harvest in the Lynn Canal and Taku-Snettisham drift gillnet fisheries. The troll fishery has accounted for the majority of the harvest of Auke Creek coho salmon, exploiting the stock at an average rate of 27% (range 6–48%), followed by the drift gillnet (7%), marine sport (3%), and purse seine (1%) fisheries. Restrictions on trolling in northern inside waters were incrementally relaxed during the 1980s, and the troll harvest rate on the Auke Creek stock reached a peak 10-year average of 35% during 1985–1994 then trended lower, to an average of only 20% during the past decade, 2010–2019 (Figure 15).

Total all-gear harvest rate estimates for Berners River coho salmon averaged 56% (range 22–83%) from 1989 to 2019 (Table 5; Figure 15; Appendix B2). The troll fishery was typically the largest harvester of the stock with an average harvest rate of 29% (range 7–54%), followed closely by the drift gillnet fishery at 25% (range 8–52%); in some years the harvest in the drift gillnet fishery exceeded that in the troll fishery. Purse seine and marine sport fisheries were a minor influence in most years, with each exerting an average harvest rate of < 2% on average. The average 2010–2019 all gear harvest rate (46%) was lower than the 1989–2009 average harvest rate (61%), as a result of reduced harvest rate in both the troll and drift gillnet fisheries; e.g., the troll harvest over the past decade 2010–2019 averaged 22% compared to 32% during 1989–2009. Since 1999, the troll harvest rate on the Berners River stock has been higher in odd years (29.0% average)

compared with even years (21.9% average), though this relationship was marginally significant (Welch Two Sample t-test; $p=0.055$). Adult coho salmon also showed a substantially increased average body weight for both sexes in even years (Shaul et al. 2017).

Total all-gear harvest rate estimates for Hugh Smith Lake coho salmon averaged 61% (range 39–82%) from 1982 to 2019 (Table 5; Figure 15; Appendix B4). Hugh Smith Lake coho salmon experience broad exposure to mixed stock fisheries, including both coastal and inside troll fisheries stretching the length of Southeast Alaska, multiple net fisheries, and Canadian fisheries (Shaul et al. 2009). Harvest rates in the Alaska troll fishery averaged 32% (range 17–53%), followed by Alaska drift gillnet fisheries (13%), Alaska purse seine fisheries (8%), and British Columbia troll and sport fisheries (6%). From 1989 to 1999, the total harvest rate averaged 76% (Figure 15), including maximum estimated total harvest rates of 82% in 1989, 1990, and 1994. The harvest rate in British Columbia troll fisheries averaged 7% through the mid-1990s (maximum 18% in 1990) but decreased to zero for several years due to fishing restrictions on coho salmon instituted in 1998, which were aimed primarily at conserving upper Skeena River stocks (NBTC 2002). The total harvest rate on Hugh Smith Lake coho salmon has averaged lower (53%) since 2000. This decrease was distributed across all commercial fisheries (except the drift gillnet fisheries); e.g., harvest by the troll fishery averaged 24% since 2000, compared to a 1989–1999 average of 42% (Figure 15).

Total all-gear harvest rate estimates for Taku River coho salmon averaged 45% (range 28–73%) from 1992 to 2019 (Table 5; Appendix B5). The troll fishery accounted for an average 20% (range 3–31%) of the run, followed by the drift gillnet fishery at 15% (range 3–37%). Variability in harvest rates by fishery were primarily a result of differing management actions between years, particularly in District 111; e.g., the low harvest rate estimate of 3% occurred in 1997 when the District 111 drift gillnet fishery was closed for the season in late-August because of a very weak run. Purse seine, marine sport, and Canadian inriver fisheries accounted for an average of 2%, 3%, and 6% of the run, respectively.

Total all-gear harvest rate estimates for Chilkat River coho salmon averaged 40% (range 17–66%) from 2000 to 2019 (Table 5; Appendix B6). The troll fishery accounted for an average 19% (range 6–42%) of the run, followed closely by the drift gillnet fishery at 18% (range 9–34%). Purse seine and marine and freshwater sport fisheries were a minor influence in most years, with a combined harvest rate of <3% on average. Harvest rates for this stock likely averaged substantially higher in the 1970s and 1980s (prior to establishment of the coho salmon CWT program at Chilkat River), when a much larger drift gillnet fleet targeted abundant Chilkat River fall-run chum salmon (*O. keta*) in Lynn Canal (Shaul et al. 2017).

Total all-gear harvest rate estimates for Ford Arm Creek coho salmon averaged 61% (range 43–82%) from 1982 to 2015 (Table 5; Figure 15; Appendix B3). Harvest rates in the Alaska troll fishery averaged 51% (range 24–68%), followed by purse seine fisheries (8%), and sport fisheries (3%). The all-gear harvest rate trended slightly upward over time to an average 69% in the 10 years through 2015, when the stock assessment project ended. This increase was due to higher-than-average harvest rates (24%) in the commercial purse seine fisheries in District 113 from 2010 to 2015, including a maximum of 58% in 2011, possibly a result of earlier run timing in those years (Shaul et al. 2014). Conversely, the troll harvest rate declined to an average 43% during 2010–2015.

Alaska Troll Fishery Harvest Index

The projected commercial harvest of wild coho salmon has been used as a proxy for total abundance in management of the coho salmon troll fishery under Alaska state regulations (*Management of coho salmon troll fishery*, 5 AAC 29.110). This assumes a stable total harvest rate, whereas harvest rates have, in fact, varied substantially. Shaul (2011, 2019) developed an Alaska troll fishery harvest rate index (originally called an exploitation rate index; Table 5; Figure 16) to track trends in overall troll fishery harvest rates on wild Southeast Alaska coho salmon stocks and to provide a means to estimate total abundance of wild coho salmon available to the troll fishery. The index is a weighted average of troll harvest rate estimates for the coded wire tagged indicator stocks at Hugh Smith Lake, Ford Arm Creek, Auke Creek, and Berners River, all of which have long-term stock assessment histories. Auke Creek and Berners River represent stock aggregates in inside production areas of northern Southeast Alaska, and Hugh Smith Lake represents southern inside stocks near Ketchikan. Since 1989, Auke Creek and Berners River have each been given a 20% weighting in the index to allow the northern inside stocks to be similarly weighted to Hugh Smith Lake (40%). Ford Arm Creek appeared to be representative of more heavily exploited milling-type stocks on the outer coast (Shaul 2014) and was given less weight (20%) out of concern that it is not as broadly representative and is exploited by the troll fishery at rates that are far above average for indicator stocks in the region. For example, the nearby Nakwasina River stock in Sitka Sound, also on the outer coast, is more migratory and has been exploited by the troll fishery at a far lower rate (average 26% during 2000–2007, compared with 52% for Ford Arm Creek; Shaul et al. 2008). The termination of the Ford Arm Creek project in 2015 means that this stock no longer contributes data to the index. Harvest rate values were interpolated (Brown 1974) based on the relationship in harvest rates across all stocks and years to fill in missing values for Ford Arm Creek, 2016–2019.

The Alaska troll fishery harvest rate index averaged 34% (range 17–52%) from 1982 to 2019 (Table 5; Figure 16). The index averaged 39% through 2000, then trended downward to an average 25% during the past decade, 2010–2019 (Figure 16). Though troll harvest rates have declined, troll harvest of wild coho salmon has been relatively stable, with a peak in the early 1990s (Figure 17). There appear to be varied reasons for the decrease in the troll harvest rate, including an overall decrease in the number of boat-days fished and climatic changes, including a period of colder years with negative PDO index values that may have resulted in a southward shift in landfall during run migration, resulting in decreased exposure by more southern stocks to the area of most intensive trolling in northern Southeast Alaska (Shaul et al. 2019).

Troll effort during the primary coho salmon targeting period (statistical weeks 28–40) decreased by over half (53%) in the mid-to-late 1990s from an average of 46,000 (power troll equivalent) boat-days during 1982–1994 to only 21,400 boat-days during 2000–2009, due in part to a period of very low fish prices in the early-2000s (Shaul et al. 2005). Average effort during 2010–2017 rebounded by 9% to 23,400 boat-days. The all-gear wild commercial harvest also fell as a fraction of the abundance index, from an average of 64% during 1982–1999 to only 49% during 2000–2009, and 40% during 2010–2019, as all-gear commercial harvest rates declined.

REGIONAL WILD ABUNDANCE

The estimated regional wild coho salmon abundance is calculated by dividing the power troll fishery harvest of wild coho salmon by the Alaska troll fishery harvest index (Shaul et al. 2019). This estimate of the total number of wild coho salmon *available* to be harvested by the troll fishery

provides the best approximation of the overall regional population. The general trend of the regional wild coho salmon abundance since 1980 has been a significant increase in annual abundance (time series linear regression; $p = 0.048$). The average 2010–2019 abundance of 4.33 million coho salmon was significantly higher than in previous decades (categorical linear regression, $p=0.009$; 1980–1989 average =3.11 million, 1990–1999 average =3.95 million, 2000–2009 average =3.74 million).

The upward trend in estimated wild coho salmon abundance (Figure 18) stands in contrast with lower recent runs to northern inside systems including Auke Creek, Berners River, Chilkat River, and Taku River and with the decrease in the run to Hugh Smith Lake after 2014 (Figure 8 and Figure 9). These contrasting patterns are driven in part by increasing power troll efficiency, altering the historical relationship that produced abundance estimates. In addition, there is also likely a geographic shift in marine survival and adult production with a decline in northern inside stocks since the mid-2000s, and a decrease in marine survival since the 2015 adult run year.

DISCUSSION

SURVIVAL AND ABUNDANCE TRENDS

The number of returning adult coho salmon is driven primarily by smolt production and the proportion of smolt surviving to adulthood. Smolt production of Southeast Alaska indicator stocks is currently similar to long-term averages, while smolt–adult marine survival rates are currently near record lows. Variability in adult returns is often divided approximately equally between freshwater and marine effects. For example, at the Berners River the total variability in adult returns was split between smolt production (48%) and marine survival (52%; Shaul et al. 2017). Together, the approximately average smolt production and recent lower marine survival mean that total adult production is currently lower than average, though still within observed ranges. Since indicator stock monitoring began, total adult runs (combined harvest and escapement) significantly declined over time at Auke Creek (1980–2019; time series linear regression; $p = 0.021$), Berners River (1982–2019; $p = 0.003$), and Chilkat River (2000–2019; $p = 0.010$), significantly increased at Ford Arm Creek (1982–2015; $p = 0.042$), and showed no significant change over time at Hugh Smith Lake (1982–2019; $p = 0.466$) and Taku River (1992–2019; $p = 0.113$). While there have at times been differences in trends between northern and southern Southeast Alaska stocks, the overall trends in abundance are quite similar, and marine survival rates and adult runs have recently been relatively low for all monitored systems.

Factors Affecting Survival and Abundance

Trends in survival and smolt production are typically driven by changes in environmental conditions. Given broad changes in climate conditions in Southeast Alaska (e.g., Littell et al. 2018), many commensurate changes may be expected in fish populations (Mueter et al. 2002; Bryant 2009). Moderately warm conditions in the northeast Pacific during the 1980s and 1990s appeared to favor smolt production for many coho salmon indicator stocks (e.g., Berners, Chilkat, and Taku Rivers) through improved winter–spring freshwater survival (Bryant 2009), as well as late-ocean growth and survival (through improved survival and recruitment of late-ocean prey; Shaul and Geiger 2016). Such temperature-driven effects are not limited to coho salmon and have been documented in other salmonids, such as sockeye salmon juveniles (Edmundson and Mazumder 2001). However, the positive relationship between production metrics and temperatures has not extended to observed warming over the past decade, which has seen a sharp

decline in marine survival and below average adult runs in the past five years. Such changes in historical associations between the environment and population characteristics demonstrate the need for ongoing monitoring.

Production trends in coho salmon stocks in Southeast Alaska can often be quite different than those in nearby systems of northern British Columbia, though they are adjacently located in northwestern North America, share similar habitat, and are affected by comparable environmental conditions. The area in the vicinity of Dixon Entrance, at the northern extent of the bifurcation zone between the Alaska and California Currents, appears to be a transitional area in the salmon response to shifts in North Pacific climate (represented by cyclical indexes including the PDO and NPGO; Hickey and Royer 2001). Commercial harvests in Southeast Alaska and northern British Columbia during 1910–1997 were strongly correlated within extended periods of time, interrupted by abrupt shifts in the relative scale of harvest in favor of one region or the other (Shaul et al. 2007). These differences partly explain the dissimilarities between coho salmon populations of Southeast Alaska and northern British Columbia. Thus, care is needed in extrapolating even to nearby systems.

Adult Abundance Correlation

Coho salmon indicator stocks in inside areas of Southeast Alaska show similar long-term patterns in abundance, particularly from the beginning of monitoring in the 1980s until the mid-2000s. The Auke Creek, Berners River, Taku River, and Hugh Smith Lake stocks all showed relatively consistent long-term trends during this period, with high abundance in the early 1990s and peaks in 1994 and 2002 (Figure 8). These years of high abundance were associated with high commercial harvest of wild coho salmon (Figure 2).

Estimated adult runs to the Berners and Chilkat Rivers, which are both located in Lynn Canal, were closely synchronized during 2000–2019 ($\rho=0.839$; $p < 0.001$; Spearman's rank correlation, where $\rho=1$ is perfect positive association of ranks and $\rho=0$ indicates no association). Adult runs to both systems decreased dramatically beginning in 2005 compared with the previous 15-year period (1990–2004) of higher average production (Figure 9; Figure 19). Adult runs to the Berners River and Hugh Smith Lake also showed remarkable synchrony during the period 1982–2004, though separated by a distance of almost 500 km; however, these populations experienced different conditions during 2007–2014, when production at Hugh Smith Lake increased relative to the Berners and Chilkat Rivers, due to a combination of high marine survival and more stable smolt production at Hugh Smith Lake (Figure 19). Adult runs to Hugh Smith Lake in 2013 and 2014 were near the previous peak in abundance during 1994–1995 (Figure 8). This period coincided with cold conditions associated with low PDO index values in the sea-entry years, during which Hugh Smith Lake runs followed a historical abundance trend more similar to northern British Columbia rivers than compared with the Berners River (Shaul et al. 2017).

Despite this divergence, annual runs to the Berners River and Hugh Smith Lake have maintained a positive correlation since 1982 ($\rho=0.512$; Spearman's rank correlation). Marine survival rates and adult runs to Hugh Smith Lake decreased abruptly from 2015 to 2019, while smolt production remained above average. Overall, although shifts in production have occurred between northern and southern stocks, adult runs have exhibited remarkable synchrony across the length of Southeast Alaska (~500 km), as well as across the short distance between the Berners and Chilkat Rivers (67 km). The total adult run to Ford Arm Creek, on the outer coast, showed only weak positive correlations with most inside systems (Shaul et al. 2014), highlighting the value of monitoring coho salmon stocks located on the outer coast.

HARVEST RATES

Harvest rates on Southeast Alaska coho salmon stocks have, in most cases, trended lower from peak levels observed in the late-1980s and 1990s. Total annual harvest rates of five long-term indicator stocks (Auke Creek, Berners River, Hugh Smith Lake, Ford Arm Creek, Taku River) averaged a relatively moderate 43% during 2010–2019, compared to an average 58% during the 1990s. Decline in troll harvest rates accounted for most of this change, as troll harvest rates on all coho salmon indicator stocks were lower during the last decade compared to the prior decade, and substantially lower compared to the 1990s. The harvest rate index for the Alaska troll fishery has decreased significantly since the 1990s (Figure 16) as the number of permits fished (Hagerman et al. 2020) and fishing effort (number of boat-days) has declined (Table 6). Price and cost pressures have also reduced participation in fall gillnet fisheries, while fishing time has in some cases been reduced to protect runs to specific inside areas when runs are weak. Commercial troll harvest in northern British Columbia has also declined substantially owing to extensive area and time restrictions and fleet restructurings, which has contributed to reduced harvest of the Boundary Area Hugh Smith Lake coho salmon run.

The decline in harvest by the Alaska troll fishery appears to stem from a combination of economic pressures (balance between product value and harvesting costs) and shifts in fishing effort and methods (e.g., decline in fishery participation, changes in geographic effort, increased targeting of hatchery chum salmon near terminal areas; Hagerman et al. 2020). Harvest rates should be considered primarily in the context of run abundance and the primary management objective of meeting escapement requirements to sustain production. The observed decrease in harvest rates has thus far offset the need for management to restrict fishing when abundance fluctuates downward. For example, a reduction in the average all-gear harvest rate on the Hugh Smith Lake stock, from 73% in the 1990s to 52% during 2010–2019, resulted in a near doubling of the proportion of the run that escaped to spawn. As a result, the Hugh Smith Lake coho salmon escapement goal continued to be met despite a substantial decline in marine survival rates. Therefore, recent decreases in harvest pressure has meant a reduction in inseason abundance thresholds for inseason fishery restrictions, mitigating the need for management actions. Such harvest rates are only sustainable if smolt production does not decline or marine survival rates (in particular) do not decrease further.

The lack of an indicator stock that represents outer coast coho salmon populations is a structural problem with the current monitoring program. The Ford Arm Creek stock was distinct from other indicator stocks and showed unique harvest patterns, reflecting distinct fishery harvest trends. The discontinuation of this project in 2015 has meant that the Ford Arm troll harvest rate is interpolated using the average historical relationship. This interpolated harvest rate is then used to calculate the overall Southeast Alaska troll harvest rate index used to calculate the regional wild coho salmon abundance. If the fishery has shifted in recent years or changes in the future (e.g., altered fleet behavior, stock migration routes, harvest rates, etc.), the assumptions between the regional population and the fisheries would be incorrect, potentially leading to underestimation of regional harvest rates.

Factors Affecting Harvest Rate Differences Between Stocks

Differing troll harvest rates among coho salmon indicator stocks are largely explained by migration routes and geographic proximity to fishing fleets, which determine the variety of fisheries that individual stocks are exposed to and the length of time they are present in those fisheries. The

marked decrease in the Alaska troll harvest rate on Hugh Smith Lake coho salmon over the past decade was predominately driven by decreased harvest of this stock in the northern Southeast Alaska troll fishery, indicating fewer Hugh Smith Lake coho salmon migrated through northern Southeast Alaska. Conversely, the relatively non-migratory Ford Arm Creek stock showed proportionately less change compared with more migratory indicator stocks located in inside waters (Shaul et al. 2017). The presence of coastal feeding Ford Arm Creek coho salmon throughout the summer in an area of intensive troll fishing from Cross Sound to Sitka Sound likely increased the availability of this stock to harvest in troll fisheries compared to more migratory stocks. Conversely, the Hugh Smith Lake population is an example of a stock that is subject to prosecution by several mixed stock fisheries along the coast, as well as fisheries outside of state jurisdiction in Canada and around Annette Island.

Abundant coho salmon runs in the Taku and Chilkat Rivers support targeted harvest in terminal drift gillnet fisheries in Lynn Canal and Stephens Passage/Taku Inlet. During the fall, management of those fisheries is focused primarily on harvesting coho salmon bound for those rivers, subject to time and area openings. The location of the Berners River in Lynn Canal also results in substantial harvest of that stock in the Lynn Canal drift gillnet fishery, which primarily targets salmon bound for the Chilkat River. Conversely, the geographic locations of Ford Arm Creek, Hugh Smith Lake, and Auke Creek results in reduced harvest of those coho salmon stocks in drift gillnet fisheries, particularly for the Ford Arm stock, which is located on the outer coast, well distant from traditional drift gillnet fisheries (Appendices B1–B6).

Changes in Canadian fisheries management also impacts harvest rates on Southeast Alaska coho salmon, especially for southern Southeast Alaska stocks. The commercial troll fishery in British Columbia was a substantial factor in total Hugh Smith Lake coho salmon harvest rates through the mid-1990s. The troll harvest rate averaged 7% (range 3–18%) during 1982–1997, after which Canadian harvest decreased to zero for several years due to fishing restrictions on coho salmon aimed primarily at conserving upper Skeena River stocks (NBTC 2002). Relaxation of fishery restrictions since the mid-2000s has resulted in an increased Canadian troll harvest rate on the Hugh Smith Lake stock to an average of 4% during 2010–2019. CWT-based estimates indicate that the Canadian marine sport fishery has become a larger component of harvest of the Hugh Smith stock over the last decade (average 3%). The all-gear Canadian harvest of the Hugh Smith Lake stock during 2010–2019 (average 7%) is relatively similar to the period prior to the Canadian fishery restructuring, 1982–1997 (average 8%).

Relationship Between Wild Abundance and the Southeast Alaska Troll Fishery

The relationship between estimates of wild coho salmon abundance and power troll CPUE on wild coho salmon has fluctuated over time. Over the past decade, the average abundance to CPUE ratio has increased and also become much more variable (Shaul et al. 2019), breaking down the historical relationship between abundance and CPUE. The increase in the trend and greater variability in the power troll efficiency over the past decade likely reflects many factors, including variation in the number of Chinook salmon retention days in the summer troll fishery, increased interest and opportunity (combined with high inter-annual variation in success) in targeting hatchery chum salmon (Hagerman et al. 2020), changes in the geographic distribution of stock abundance, and increased occurrence of warming conditions. In addition, increased uncertainty in inseason abundance estimates is associated with a decline in the troll harvest rate (and increased inter-stock variability) used to estimate wild coho salmon abundance. Together, such factors have

caused substantial divergence of current observations from the historical relationship between the troll harvest rate and estimated wild abundance.

FUTURE OUTLOOK

After thorough review of all Southeast Alaska coho salmon systems with a formal escapement goal, we identified no stocks of concern as defined in state regulation (*Policy for the Management of Sustainable Salmon Fisheries* 5 AAC 39.222). Though freshwater and riparian habitat in many areas of Southeast Alaska was impacted by large-scale logging during the mid-late 1900s (Tiegs et al. 2008), improved forest management in the Tongass National Forest has prevented habitat degradation in many small coho salmon-producing streams (Everest and Reeves 2006; USDA Forest Service 2016). The largely unaltered habitat of Southeast Alaska support what are likely the largest “salmon forests” in the world (Johnson et al. 2019). Stocks only occasionally did not meet escapement minimums; years with poor runs were likely within normal long-term variations in abundance, indicative of larger underlying issues such as systemic recruitment failure. While declining trends in total abundance and marine survival were identified, these are often the result of periodicity in environmental conditions. Whether these trends persist into future years will indicate if there is a shift in baseline conditions or just a low point in cycles.

Continued strong abundance available to the troll fishery is evidence of a strong “portfolio effect”, where higher biological diversity is associated with relatively stable biological returns (Schindler et al. 2010). However, further exacerbation of negative trends in survival rates and total abundance will present managers with challenges. Many of the observed trends among Southeast Alaska coho salmon stocks are cyclical, providing hope that the adverse elements will pass as conditions shift through natural vacillations. Despite such historic vacillations, recent poor marine survival demonstrates the continued need for management actions that account for such conditions.

Recent extreme lows in marine survival across all Southeast Alaska systems present an additional management challenge to historical patterns of harvest. The decline in marine survival is not well understood from a causal perspective and remains an ongoing concern. It is possible that most of this decrease happened primarily in the nearshore, early marine environment (as opposed to growth-related offshore mortality; Shaul and Geiger 2016). Reduced survival of age-0 ocean jacks in Auke Creek (Shaul et al. 2019), which rear in inside waters, indicates that negative effects on survival rates potentially occur primarily in the nearshore environment. Historically, decreased survival has been associated with warmer waters; if forecasted future climatic scenarios (Lader et al. 2020) are correct, this signals a continued poor outlook for marine survival.

Preseason and inseason methods have been developed to assess overall wild coho salmon abundance from power troll CPUE, as well as smolt production and marine survival for some indicator stocks (Shaul et al. 2009, 2014, 2017). While these inseason forecasting models proved relatively accurate through the late 2000s in forecasting returns to some systems (Shaul et al. 2014, 2019), apparent changes over the last decade in fish migration, fishery harvest patterns, smolt production, and marine survival have increased inaccuracies in recent forecasts. For example, overly pessimistic forecasts of marine survival and abundance of the Hugh Smith Lake stock likely resulted from a more southerly distribution of troll harvest, causing over-representation of the stock relative to previous years. Managers have been relatively successful in achieving escapement goals despite forecast limitations. Success of management will depend upon continuing to integrate a wide variety of variables about overall abundance and distribution of returning fish.

Most coho salmon stocks appear to perform well under a broad range of escapements and have high intrinsic productivity that provides rapid recuperation from low escapement events. This flexible population response characteristic of coho salmon is relatively forgiving of management error for both under- and over-escapement and is compatible with the pattern of primarily mixed stock fishing conducted in Southeast Alaska. In general, coho salmon have proven highly resilient under intense harvest, recovering quickly from population shocks. This resilience is due in part to a strong density-dependent survival response during freshwater rearing followed by a high average marine survival rate that is usually several times the survival rate of Chinook salmon smolts (Weitkamp et al. 2011). While evidence of under-seeding of freshwater habitat by spawners is rare, there is also evidence that over-escapement at high spawner densities does not present a problem for future production (Shaul et al. 2017). Successful estuarine and marine rearing of fry that are “surplus” to freshwater habitat (Shaul et al. 2013) suggests that large escapements above freshwater capacity may provide an additional buffer against low marine survival events (Shaul et al. 2011). Thus, the life history features of coho salmon are compatible with the primarily mixed stock pattern of fishing in the Northern Boundary area in which run strength shows substantial geographic variation and escapement to individual systems can be quite variable (Shaul et al. 2011).

Although current ecological conditions are challenging in terms of marine survival and abundance, economic pressures on the troll fishery (e.g., increased operational costs and lower product prices) have forced participants to increasingly self-regulate. These economic pressures on the fisheries have so far reduced the need for active management. While coho salmon abundance is driven by ecological cycles, the economics of directed fisheries will likely continue to be sensitive to abundance. All monitored populations in Southeast Alaska have demonstrated substantial population resilience under harvest.

INFORMATION NEEDS

Perhaps the greatest need is the continuation of the existing coho salmon CWT program in Southeast Alaska. Data produced by these long-term projects are invaluable for comprehending annual issues and broader trends. The CWT and escapement monitoring programs produce annual estimates of harvest by fishery, smolt production, marine survival, and escapement. This information is essential for understanding the forces shaping Southeast Alaska coho salmon and how the species is expected to fare in the near future.

Erosion of state general fund budgets in recent decades required ADF&G to move funding for part of the Northern Boundary coho salmon stock assessment program to short-term funding sources (e.g., PSC Northern Fund) and eliminate one long-term indicator stock program (e.g., Ford Arm Creek). Several other indicator stock programs were also eliminated after being conducted for relatively short periods (e.g., ADF&G Sport Fish CWT monitoring projects at Chuck Creek and Nakwasina River). Such reductions hold the potential to remove the ability to detect population-level issues as well as diminish monitoring resiliency.

The termination of the outer coast Ford Arm Creek coho salmon monitoring project removed a vital part of the regional CWT program. Ford Arm Creek coho salmon were harvested at higher rates in the troll fishery compared to inside stocks and showed only weak positive correlations with most inside systems (Shaul et al. 2009). High troll fishery harvest rates were estimated for both Ford Arm Creek and Chuck Creek (located on the southern outer coast at Heceta Island) coho salmon during 2001–2010 (Shaul et al. 2011), demonstrating the importance of fishery information

from outer coast coho salmon stocks. Since the elimination of the Ford Arm Creek project, Ford Arm Creek harvest rate data used in the Alaska troll harvest rate index have been imputed based on average relationships from prior years. As fisheries continue to shift and the troll fleet alters its geographical presence, the assumption that the outer coast fishery harvests will remain similar to harvests in previous years becomes more tenuous. Without any ability to monitor such populations, it becomes increasingly likely that this population may encounter issues, of which management will be unaware. Further, monitoring an outer coast population allows fishery managers to better prosecute populations during cycles of high abundance. Without knowing the estimated abundance and harvest rates, fisheries are managed conservatively, and less harvest occurs.

Further development of a commensurate full indicator monitoring program in northern British Columbia would complement those data produced on the Alaska side of the border. Such a program could be established in the Northern Boundary or Central Coast regions of British Columbia on representative wild stocks. These data would assist fishery managers and researchers on both sides of the border with understanding regional trends and allow for localized management decisions. Similarly, the establishment of standardized indices of northern British Columbia wild coho salmon abundance would allow for tracking population shifts across decades and provide management with a valuable baseline comparison.

The establishment of a Southeast Alaska coho salmon genetic baseline has the potential to greatly improve research and management of these stocks. Such a genetic baseline would allow for more accurate stock management through better understanding of stock composition of harvests, improved estimates of abundance, and harvest rates, better understanding of the effects of hatchery-wild population interactions, and long-term conservation of regional genetic diversity. Such a program could certainly complement existing CWT indicator stock programs and greatly expand the geographic scope of coho salmon stock assessment or, in some situations, eventually replace the use of CWT indicators if it became sufficiently established and provided similar metrics.

CONCLUSIONS

Overall, coho salmon stocks in Southeast Alaska have sustainable populations with acceptable harvest rates. Trends in escapement demonstrate that coho salmon abundance appears to be cyclical, following regional environmental and biological fluctuations. Harvest of these resources is guided by sustainable management principles and appears to be within biological constraints with no adverse effects from fisheries noted. The main issues affecting coho salmon management include recent environmental conditions that adversely impact abundance (e.g., drastically declining marine survival), changes in fisheries behavior (e.g., difficult to predict shifts in geographical harvest), and reductions in regional monitoring (e.g., no CWT monitoring of populations on the outer coast). Continued monitoring and associated management actions for this valuable species will confer ecological benefits while ensuring the sustainability of harvests for future fisheries participants.

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TABLES AND FIGURES

Table 1.—Commercial harvest of coho salmon by gear type in Southeast Alaska, 1989–2019. Set gillnet data is only from the Yakutat area. Non-state managed fisheries (e.g., Annette Island) and terminal harvest data are included. Data are from Hagerman et al. (2020).

Year	Troll	Drift Gillnet	Purse Seine	Set Gillnet	Total
1989	1,415,517	255,689	333,116	176,816	2,181,138
1990	1,832,604	377,803	379,334	148,891	2,738,632
1991	1,719,082	601,179	411,854	166,731	2,898,846
1992	1,929,945	699,448	505,135	290,149	3,424,677
1993	2,395,887	445,880	477,006	237,446	3,556,219
1994	3,467,599	744,558	970,100	343,903	5,526,160
1995	1,750,262	456,820	627,472	295,030	3,129,584
1996	1,906,769	404,627	447,005	227,802	2,986,203
1997	1,170,534	156,725	189,036	322,776	1,839,071
1998	1,636,711	441,458	475,232	197,669	2,751,070
1999	2,272,653	394,260	422,926	187,186	3,277,025
2000	1,125,219	181,796	210,528	170,948	1,688,491
2001	1,845,627	338,083	556,193	205,344	2,945,247
2002	1,315,062	491,683	479,489	200,888	2,487,122
2003	1,223,458	467,337	400,988	74,343	2,166,126
2004	1,916,675	339,466	405,151	196,930	2,858,222
2005	2,038,296	297,878	348,072	82,887	2,767,133
2006	1,362,983	277,853	114,313	86,085	1,841,234
2007	1,378,062	204,081	252,575	76,550	1,911,268
2008	1,293,030	377,469	215,648	153,712	2,039,859
2009	1,591,547	351,367	298,614	133,808	2,375,336
2010	1,343,032	579,862	203,631	161,584	2,288,109
2011	1,314,210	285,983	352,128	126,215	2,078,536
2012	1,201,724	303,041	280,116	98,677	1,883,558
2013	2,393,790	482,433	553,501	158,046	3,587,770
2014	2,248,371	599,606	394,174	161,977	3,404,128
2015	1,241,100	274,909	294,550	129,069	1,939,628
2016	1,387,590	299,645	267,213	144,032	2,098,480
2017	2,151,782	187,888	276,635	140,844	2,757,149
2018	942,622	272,951	156,810	95,954	1,468,337
2019	973,903	210,621	249,790	100,473	1,534,787
Average	1,670,505	380,723	372,527	170,734	2,594,489

Table 2.—Southeast Alaska adult coho salmon escapement estimates and escapement goal ranges, 1980–2019.

Year	Auke Creek	Montana Creek	Peterson Creek	Berners River ^a	Chilkat River	Taku River	Ford Arm Creek ^b	Sitka Survey Index ^c	Hugh Smith Lake	Ketchikan Survey Index ^d
1980	698	-	-	-	-	-	-	-	-	-
1981	646	227	219	-	-	-	-	-	-	-
1982	447	545	320	7,505	-	-	2,655	1,545	2,144	-
1983	694	636	219	9,840	-	-	1,931	457	1,487	-
1984	651	581	189	2,825	-	-	-	2,063	1,407	-
1985	942	810	276	6,169	-	-	2,324	1,246	903	-
1986	454	60	363	1,752	-	-	1,552	702	1,782	-
1987	668	314	204	3,260	37,432	55,457	1,694	293	1,117	4,792
1988	756	164	542	2,724	29,495	39,450	3,119	403	513	5,007
1989	502	566	242	7,509	48,833	56,808	2,176	576	433	6,761
1990	697	1,711	324	11,050	79,807	72,196	2,192	566	870	3,444
1991	808	1,415	410	11,530	84,517	127,484	2,761	1,510	1,836	5,721
1992	1,020	2,512	403	15,300	77,588	83,729	3,866	1,899	1,426	7,017
1993	859	1,352	112	15,670	58,217	119,330	4,202	1,716	832	7,270
1994	1,437	1,829	318	15,920	194,425	96,343	3,227	1,965	1,753	8,690
1995	460	600	277	4,945	56,737	55,710	2,446	1,487	1,781	8,627
1996	515	798	263	6,050	37,331	44,635	2,500	1,451	950	8,831
1997	609	1,018	186	10,050	43,519	32,345	4,718	809	732	5,025
1998	862	1,160	102	6,802	50,758	61,382	7,049	1,242	983	7,095
1999	845	1,000	272	9,920	57,140	60,768	3,800	776	1,246	8,038
2000	683	961	202	10,650	84,843	64,700	2,304	803	600	8,634
2001	865	1,119	106	19,290	107,697	104,394	2,209	1,515	1,580	11,267
2002	1,176	2,448	195	27,700	204,805	219,360	7,109	1,868	3,291	12,223
2003	585	808	203	10,110	133,045	183,112	6,789	1,101	1,510	11,899
2004	416	364	284	14,450	67,053	129,327	3,539	1,124	840	9,904
2005	450	351	139	5,220	34,575	135,558	4,257	1,668	1,732	14,840
2006	581	1,110	439	5,470	79,050	122,384	4,737	2,647	891	6,901
2007	352	324	226	3,915	24,770	74,246	2,567	1,066	1,244	4,316
2008	600	405	660	6,870	56,369	95,226	5,173	1,117	1,741	16,752
2009	360	698	123	4,230	47,911	103,950	2,181	1,156	2,281	8,710
2010	417	630	467	7,520	84,909	126,830	1,610	1,273	2,878	4,563
2011	517	709	138	6,050	61,099	70,871	1,908	2,222	2,137	5,098
2012	837	394	190	5,480	36,961	70,775	2,282	1,157	1,908	11,960
2013	736	367	126	6,280	51,324	68,117	1,573	1,414	3,048	11,295
2014	1,533	911	284	15,480	130,200	124,171	3,025	2,161	4,110	16,675
2015	517	1,204	202	9,940	47,372	60,178	3,281	2,244	956	10,128
2016	204	717	52	6,733	26,280	87,704	-	2,943	948	13,420
2017	283	634	20	7,040	34,482	57,868	-	1,280	948	11,557
2018	146	1,160	110	3,550	66,085	51,173	-	1,502	619	13,764
2019	345	203	No Count	9,405	34,779	82,759	-	1,480	1,235	7,916
Goal Range										
Lower	200	400	100	3,600	30,000	50,000	1,300	400	500	4,250
Upper	500	1,200	250	8,100	70,000	90,000	2,900	800	1,600	8,500

^a. The Berners River index is the unexpanded survey count.

^b. The Ford Arm Creek project was discontinued after 2015.

^c. The Sitka survey index is the sum of peak survey counts on five streams.

^d. The Ketchikan survey index is the sum of peak survey counts on 14 streams.

Table 3.—Total coho salmon smolt and pre-smolt production estimates for six wild coho salmon-producing systems in Southeast Alaska by sea-entry outmigration (smolt) year, 1980–2018. Ford Arm Creek pre-smolt estimates were converted to the expected smolt year (following year).

Smolt Sea-entry Year	Auke Creek Smolts	Berners River Smolts	Chilkat River Smolts	Taku River Smolts	Hugh Smith Lake Smolts	Ford Arm Creek Pre-smolts
1980	8,789	-	-	-	-	-
1981	10,714	-	-	-	-	79,059
1982	6,967	-	-	-	29,117	63,686
1983	6,849	-	-	-	53,227	-
1984	6,901	-	-	-	32,283	38,509
1985	6,838	-	-	-	23,572	45,748
1986	5,852	-	-	-	21,878	70,322
1987	5,617	-	-	-	36,218	88,983
1988	7,014	-	-	-	27,904	51,658
1989	7,685	-	-	-	26,620	54,851
1990	7,011	131,831	-	-	33,101	56,284
1991	5,137	169,823	-	1,080,551	23,580	61,728
1992	5,690	326,369	-	1,510,032	33,231	57,401
1993	6,596	255,431	-	1,475,874	48,624	82,893
1994	8,647	181,503	-	1,525,330	50,024	134,640
1995	7,495	194,019	-	986,489	22,173	91,605
1996	4,884	133,629	-	759,763	31,921	66,772
1997	3,934	140,107	-	853,662	37,580	80,517
1998	6,111	252,174	-	1,184,195	30,057	132,655
1999	7,420	183,031	1,237,056	1,728,240	20,055	62,444
2000	5,233	268,498	1,185,804	1,846,629	23,327	102,610
2001	4,969	264,380	2,970,458	2,718,816	36,524	102,918
2002	5,980	148,394	1,696,212	2,988,349	26,807	77,081
2003	3,616	184,401	1,938,322	2,961,344	23,495	101,579
2004	3,695	153,532	776,934	3,755,274	40,462	120,632
2005	4,549	124,248	1,807,837	2,149,673	28,244	98,470
2006	4,287	114,091	875,478	3,152,471	37,171	84,017
2007	4,515	89,078	893,032	2,073,988	28,992	72,315
2008	4,053	96,955	716,689	2,949,043	24,181	96,180
2009	3,815	157,633	872,829	2,270,500	25,754	64,349
2010	4,667	129,217	1,026,314	1,526,065	38,033	86,996
2011	6,053	112,392	1,229,468	1,463,444	32,493	86,174
2012	10,333	150,893	788,387	1,330,594	40,797	99,144
2013	6,143	231,680	875,312	888,434	47,131	149,090
2014	9,575	171,515	639,750	700,632	33,444	104,490
2015	5,793	181,638	841,505	1,879,107	38,018	79,059
2016	6,418	325,812	666,396	2,101,774	35,308	-
2017	9,590	129,311	1,193,507	1,618,411	51,174	-
2018	4,178	131,125	498,938	1,061,978	29,838	-
Average	6,246	176,990	1,136,511	1,805,024	33,037	83,672

Table 4.—Estimated survival rates (percent) of coho salmon smolts and pre-smolts from six wild Southeast Alaska indicator stocks from the time of tagging until return as age 1-ocean adults to the fisheries, 1980–2019.

Return Year	Auke Creek Smolts	Berners River Smolts	Chilkat River Smolts	Taku River Smolts	Hugh Smith Lake Smolts	Ford Arm Creek Pre-smolts
1980	9.9	-	-	-	-	-
1981	9.1	-	-	-	-	-
1982	10.6	-	-	-	-	5.9
1983	18.1	-	-	-	13.3	9.7
1984	15.9	-	-	-	7.6	-
1985	24.6	-	-	-	7.6	12.5
1986	16.6	-	-	-	18.5	9.0
1987	21.0	-	-	-	10.3	4.6
1988	17.1	-	-	-	4.1	6.8
1989	14.4	-	-	-	8.6	11.9
1990	21.1	22.3	-	-	18.0	9.6
1991	23.0	26.7	-	-	17.4	10.7
1992	33.0	26.5	-	19.7	20.9	15.1
1993	24.1	16.4	-	16.5	13.0	21.9
1994	35.3	30.2	-	23.0	19.5	13.9
1995	10.9	16.5	-	11.9	13.5	5.0
1996	23.4	12.9	-	9.6	17.7	6.4
1997	19.2	13.3	-	6.7	8.3	14.6
1998	23.1	17.7	-	14.0	11.7	20.0
1999	19.3	14.1	-	9.9	14.1	7.7
2000	18.5	13.1	10.1	6.5	6.8	12.9
2001	28.3	13.7	13.1	9.0	13.4	8.4
2002	26.8	21.4	11.4	11.1	14.8	14.7
2003	25.0	21.2	12.9	9.7	13.7	17.1
2004	20.2	19.8	10.1	8.5	10.8	11.9
2005	16.0	9.7	8.4	5.9	9.1	8.4
2006	20.5	13.8	8.0	10.5	6.8	10.0
2007	11.9	8.4	4.4	4.4	8.9	10.3
2008	24.1	18.0	12.1	8.6	13.1	15.3
2009	15.5	10.1	10.9	8.0	18.3	7.4
2010	16.4	14.7	17.7	10.9	21.0	6.9
2011	13.1	10.3	9.5	8.5	10.4	12.5
2012	10.3	8.8	5.3	7.7	12.8	7.2
2013	20.8	15.0	15.4	10.7	16.7	7.2
2014	20.1	10.1	17.9	16.4	16.3	7.2
2015	12.0	8.2	11.2	15.5	5.7	6.6
2016	4.1	6.4	5.9	6.7	6.4	-
2017	5.0	5.0	7.9	4.9	6.9	-
2018	7.1	6.7	7.1	5.2	2.7	-
2019	10.0	11.5	15.7	11.0	8.7	-
Average	17.9	14.8	10.8	10.4	12.1	10.6

Table 5.—Estimated total harvest rates for coho salmon indicator stocks, 1980–2019. All fisheries and gear groups are combined. Harvest rates for Berners River are based on expanded escapement estimates.

Run Year	Auke Creek	Berners River	Chilkat River	Ford Arm Creek	Taku River	Hugh Smith Lake	Average (all rivers)
1980	19.6%	-	-	-	-	-	19.6%
1981	33.8%	-	-	-	-	-	33.8%
1982	39.5%	-	-	43.4%	-	65.0%	49.3%
1983	44.0%	-	-	68.8%	-	61.6%	58.1%
1984	40.5%	-	-	-	-	65.0%	52.8%
1985	44.0%	-	-	51.6%	-	63.0%	52.9%
1986	53.4%	-	-	62.1%	-	59.2%	58.2%
1987	43.3%	-	-	47.6%	-	50.2%	47.0%
1988	37.1%	-	-	48.1%	-	65.2%	50.1%
1989	54.6%	57.5%	-	64.7%	-	82.0%	65.8%
1990	53.0%	62.6%	-	58.4%	-	81.8%	65.2%
1991	31.5%	62.1%	-	54.1%	-	68.2%	55.2%
1992	45.6%	61.8%	-	58.7%	61.7%	70.9%	60.7%
1993	45.9%	63.6%	-	66.5%	53.0%	80.4%	62.8%
1994	53.0%	74.4%	-	71.9%	72.8%	81.5%	71.5%
1995	43.9%	79.5%	-	64.0%	71.4%	73.5%	67.1%
1996	54.9%	70.4%	-	57.4%	55.1%	75.9%	63.5%
1997	19.6%	22.0%	-	51.7%	39.6%	72.8%	43.6%
1998	39.0%	63.6%	-	56.3%	50.9%	77.5%	58.9%
1999	41.1%	65.4%	-	62.7%	50.5%	70.5%	59.0%
2000	29.5%	46.3%	30.0%	71.4%	43.5%	55.4%	46.7%
2001	38.5%	34.8%	31.4%	74.4%	37.1%	49.3%	45.1%
2002	26.5%	43.1%	41.4%	53.0%	28.6%	39.1%	38.8%
2003	35.3%	66.6%	39.1%	48.6%	31.9%	58.9%	46.5%
2004	44.4%	51.0%	66.7%	70.8%	50.5%	66.3%	59.2%
2005	38.1%	53.9%	46.6%	57.9%	41.4%	52.6%	49.3%
2006	34.0%	60.4%	47.7%	51.7%	48.7%	53.7%	50.2%
2007	34.3%	49.7%	33.9%	70.4%	47.5%	62.4%	50.6%
2008	38.6%	46.6%	48.9%	53.2%	46.5%	53.9%	48.9%
2009	39.3%	49.4%	40.7%	69.4%	55.5%	48.0%	51.3%
2010	45.6%	60.2%	44.9%	63.9%	51.4%	47.0%	53.0%
2011	34.9%	44.2%	37.1%	82.4%	50.2%	45.7%	50.0%
2012	22.3%	30.8%	43.6%	63.1%	44.3%	54.2%	43.9%
2013	41.9%	65.0%	57.6%	78.1%	55.7%	56.5%	59.9%
2014	20.4%	35.9%	17.7%	71.7%	39.8%	46.4%	39.5%
2015	25.1%	32.0%	34.3%	52.2%	47.5%	50.9%	41.2%
2016	25.3%	28.4%	27.4%	-	36.0%	62.7%	36.9%
2017	40.9%	45.3%	34.2%	-	49.3%	48.0%	44.6%
2018	56.3%	48.9%	33.1%	-	45.1%	59.8%	49.7%
2019	28.4%	22.4%	48.2%	-	36.0%	52.5%	38.3%
Average	38.4%	51.5%	40.2%	61.2%	47.9%	61.3%	51.0%

Table 6.—Estimates of wild and hatchery commercial harvest and troll harvest, troll harvest rate index, mean-average power troll wild coho salmon CPUE, total troll effort, and total wild coho salmon abundance available to the Alaska troll fishery, in millions of fish, 1982–2019.

Year	Troll Harvest (Millions of Fish)			Alaska Troll	Estimated	Mean-Avg.	Troll Effort	Commercial Catch (Millions of Fish)		
	Total	Hatchery	Wild	Harvest Rate Index ^a	Total Wild Abundance	Power Troll Wild CPUE ^b	(Power Troll Boat-Days) ^c	Total	Hatchery	Wild
1982	1.322	0.036	1.286	34.27%	3.752	46.6	61,795	2.103	0.036	2.041
1983	1.280	0.053	1.227	37.42%	3.280	42.4	47,675	1.943	0.053	1.868
1984	1.134	0.071	1.062	36.96%	2.874	37.2	46,474	1.881	0.071	1.760
1985	1.606	0.107	1.500	38.67%	3.878	39.6	53,287	2.562	0.107	2.385
1986	2.130	0.280	1.850	44.05%	4.200	45.8	56,529	3.259	0.280	2.865
1987	1.042	0.091	0.951	35.60%	2.671	25.0	47,708	1.487	0.091	1.374
1988	0.500	0.028	0.472	30.58%	1.544	21.7	36,768	1.036	0.028	0.987
1989	1.370	0.122	1.248	52.03%	2.399	51.6	45,047	2.182	0.122	2.007
1990	1.851	0.292	1.560	43.12%	3.617	42.9	43,526	2.740	0.292	2.327
1991	1.721	0.384	1.337	32.04%	4.172	49.3	35,028	2.897	0.384	2.289
1992	1.929	0.420	1.509	38.99%	3.871	50.3	37,724	3.424	0.420	2.685
1993	2.408	0.394	2.014	48.26%	4.173	62.8	43,084	3.556	0.394	3.012
1994	3.462	0.515	2.947	44.30%	6.652	84.8	43,503	5.520	0.515	4.788
1995	1.750	0.336	1.414	34.87%	4.055	54.5	29,660	3.130	0.336	2.547
1996	1.907	0.449	1.458	42.78%	3.408	57.9	26,204	2.986	0.449	2.360
1997	1.170	0.242	0.928	34.49%	2.692	40.5	24,068	1.839	0.242	1.512
1998	1.636	0.329	1.307	40.53%	3.225	60.1	22,574	2.751	0.329	2.204
1999	2.273	0.514	1.758	42.21%	4.165	70.7	25,059	3.277	0.514	2.552
2000	1.125	0.249	0.876	34.66%	2.526	41.0	20,875	1.688	0.249	1.334
2001	1.845	0.365	1.481	33.41%	4.432	78.8	19,971	2.945	0.365	2.391
2002	1.315	0.335	0.980	20.87%	4.696	69.1	19,175	2.487	0.335	1.882
2003	1.223	0.287	0.936	25.01%	3.744	64.1	19,336	2.166	0.287	1.665
2004	1.917	0.312	1.605	40.29%	3.983	83.1	22,972	2.858	0.312	2.407
2005	2.038	0.333	1.705	36.10%	4.723	81.9	24,242	2.767	0.333	2.317
2006	1.363	0.217	1.146	31.69%	3.617	59.2	21,550	1.841	0.217	1.575
2007	1.378	0.309	1.069	39.43%	2.712	51.2	22,903	1.911	0.309	1.519
2008	1.293	0.274	1.019	26.65%	3.825	50.1	20,027	2.040	0.274	1.644
2009	1.592	0.247	1.344	33.96%	3.958	67.9	22,704	2.375	0.247	1.991
2010	1.343	0.285	1.058	29.03%	3.644	50.1	24,799	2.286	0.285	1.815
2011	1.312	0.342	0.970	21.69%	4.472	52.8	25,403	2.077	0.342	1.541
2012	1.201	0.310	0.891	25.30%	3.523	45.7	26,350	1.883	0.310	1.440
2013	2.394	0.733	1.661	32.79%	5.065	87.7	25,218	3.588	0.733	2.570
2014	2.245	0.620	1.625	24.53%	6.626	78.2	21,892	3.361	0.620	2.449
2015	1.241	0.384	0.857	26.58%	3.224	61.0	19,057	1.940	0.384	1.394
2016	1.387	0.338	1.049	22.54%	4.653	53.6	21,778	2.098	0.338	1.649
2017	2.149	0.388	1.762	34.16%	5.157	71.6	22,313	2.754	0.388	2.307
2018	0.942	0.315	0.627	19.01%	3.299	36.1	16,832 ^d	1.468	0.315	1.042
2019	0.975	0.313	0.661	16.79%	3.937	40.2	15,107 ^d	1.535	0.313	1.222
Average	1.599	0.306	1.293	33.83%	3.854	55.5	29,633	2.491	0.306	2.045

^a Index of the harvest (exploitation) rate on available wild coho salmon stocks by the Alaska troll fishery based on a weighted average for four wild indicator stocks (Auke Creek, Berners River, Ford Arm Creek, and Hugh Smith Lake; see text).

^b Average of estimates of wild coho salmon CPUE by power trollers during statistical weeks 28–38.

^c Total troll effort in boat-days during statistical weeks 28–40, with hand troll effort converted to power troll equivalents.

^d Troll effort for 2018 and 2019 are preliminary estimates.

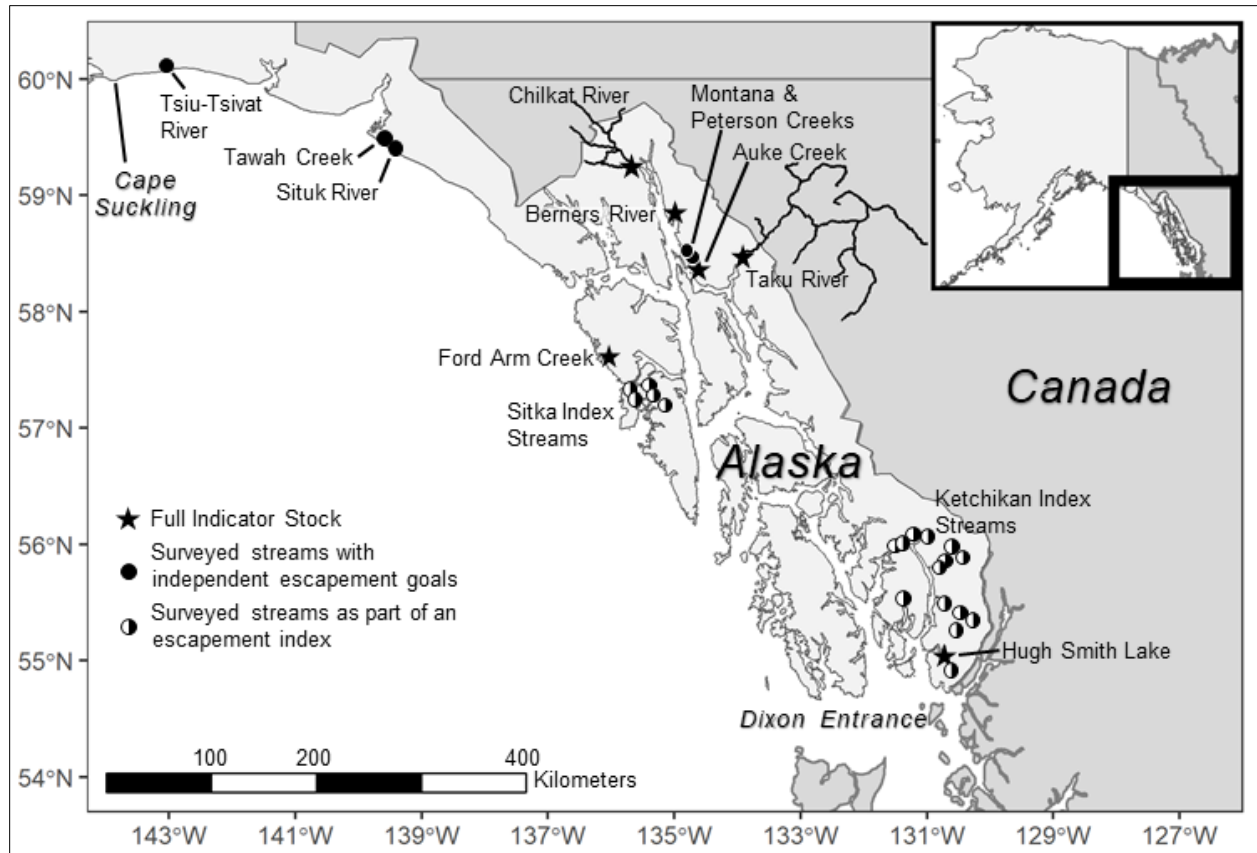


Figure 1.—Map of Southeast Alaska and the northern boundary area of British Columbia, showing the locations of recent coho salmon full indicator stock assessment projects. Stars mark full indicator streams, filled circles mark surveyed streams with independent escapement goals, and half-filled circles are streams monitored as part of an escapement index.

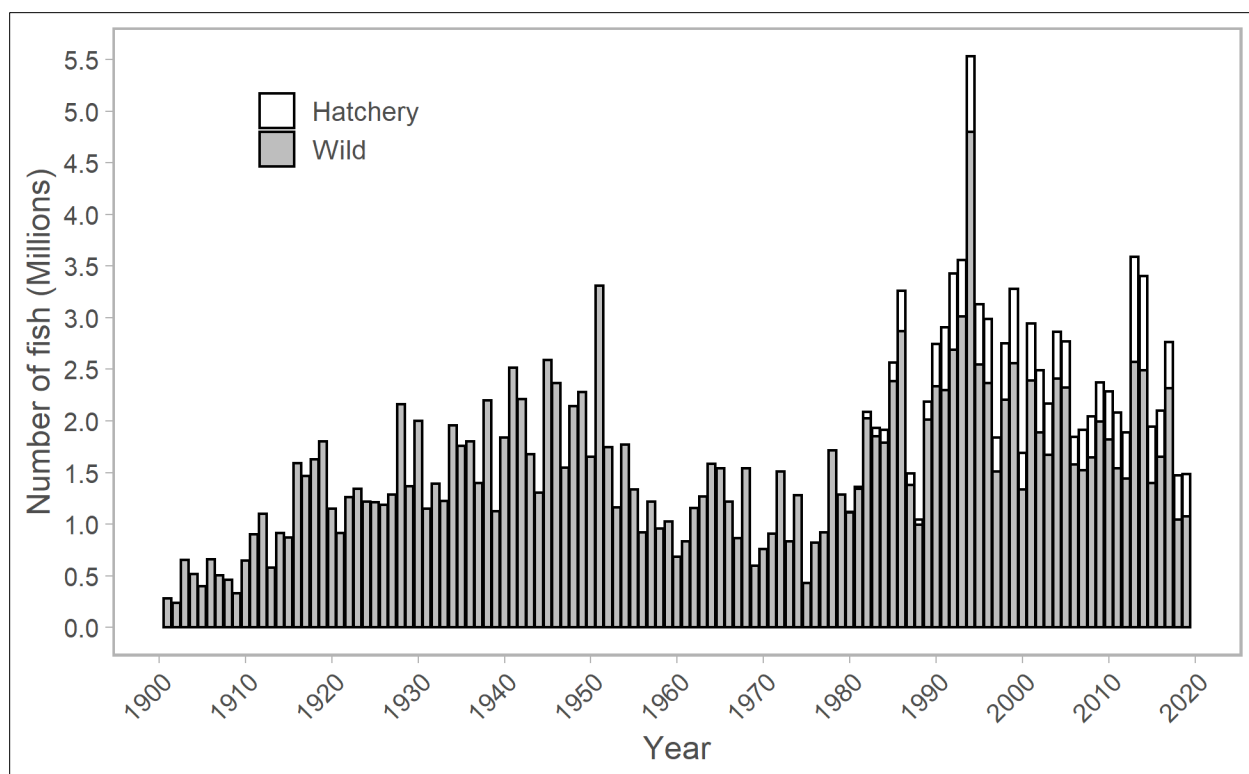


Figure 2.—Commercial harvest of wild and hatchery coho salmon in Southeast Alaska, 1900–2019. Estimates of hatchery contributions began in 1980.

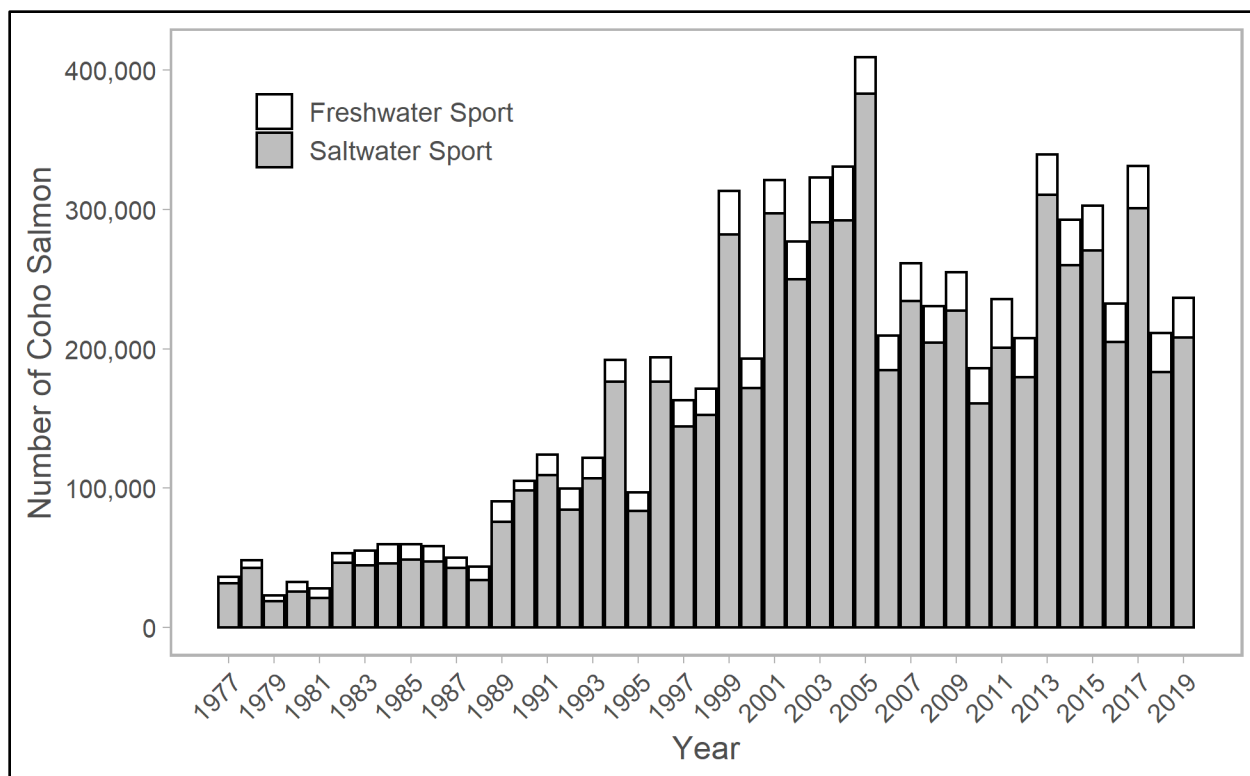


Figure 3.—Sport harvest of coho salmon in saltwater and freshwater in Southeast Alaska, 1977–2019, based on the Division of Sport Fish Statewide Harvest Survey (Alaska Sport Fishing Survey database 2020).

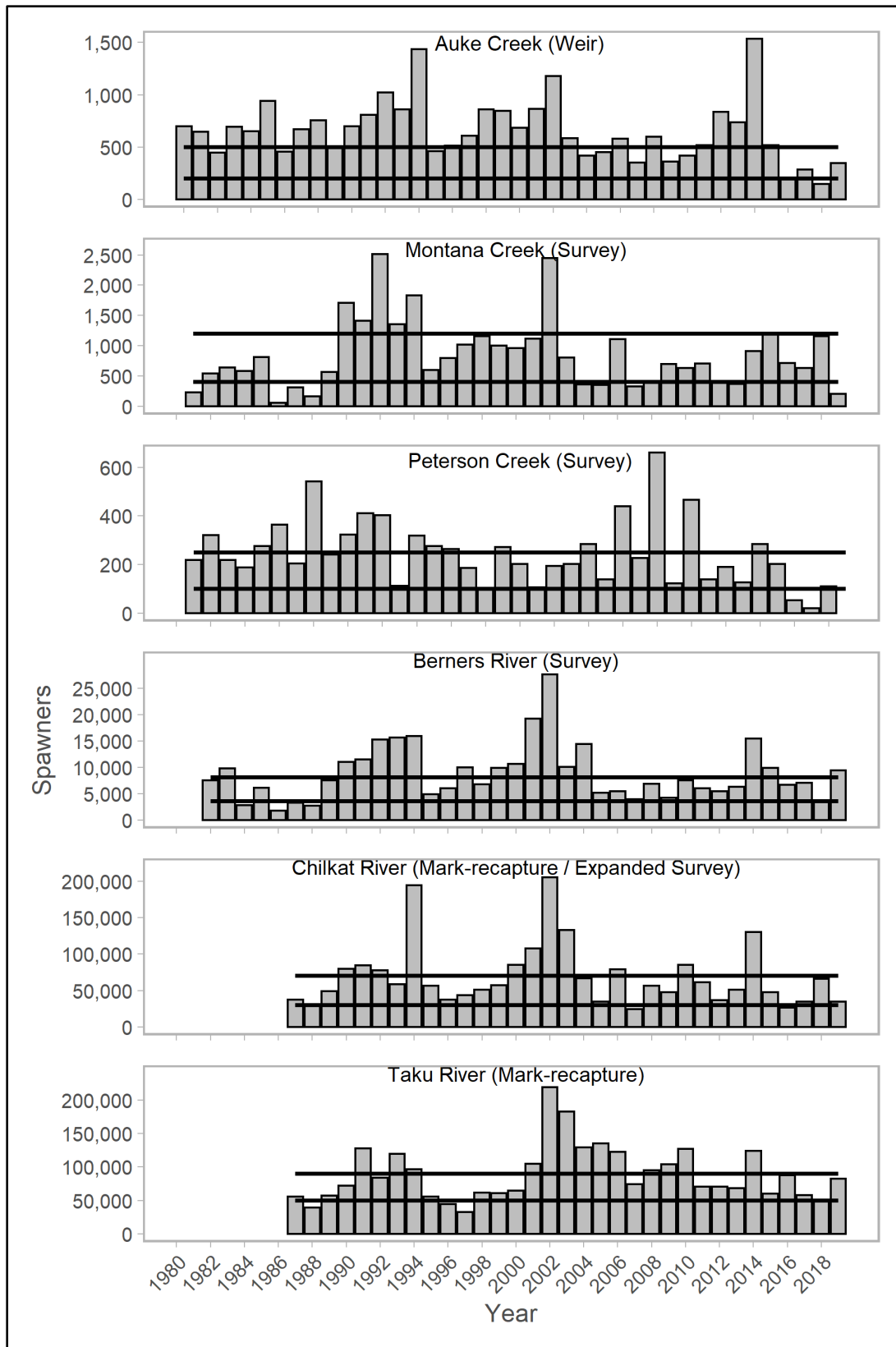


Figure 4.—Coho salmon escapement estimates and indices for streams in the northern inside area with escapement goal bounds, 1980–2019. Horizontal lines are the existing escapement goal bounds.

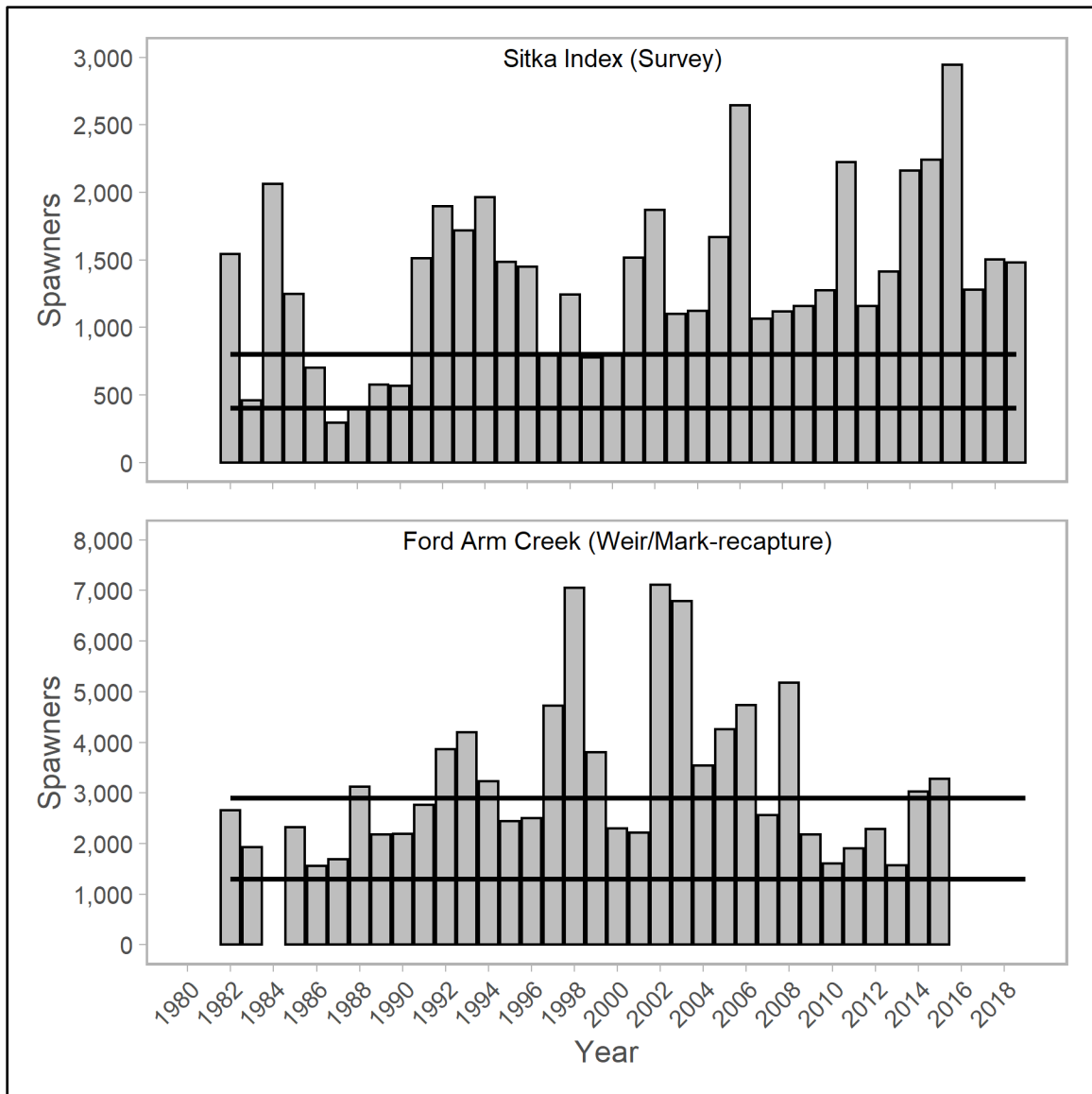


Figure 5.—Coho salmon escapement estimates and indices for streams in the Sitka / outer coastal region, 1982–2019. The Ford Arm Creek project was discontinued after 2015. Horizontal lines are the existing escapement goal bounds.

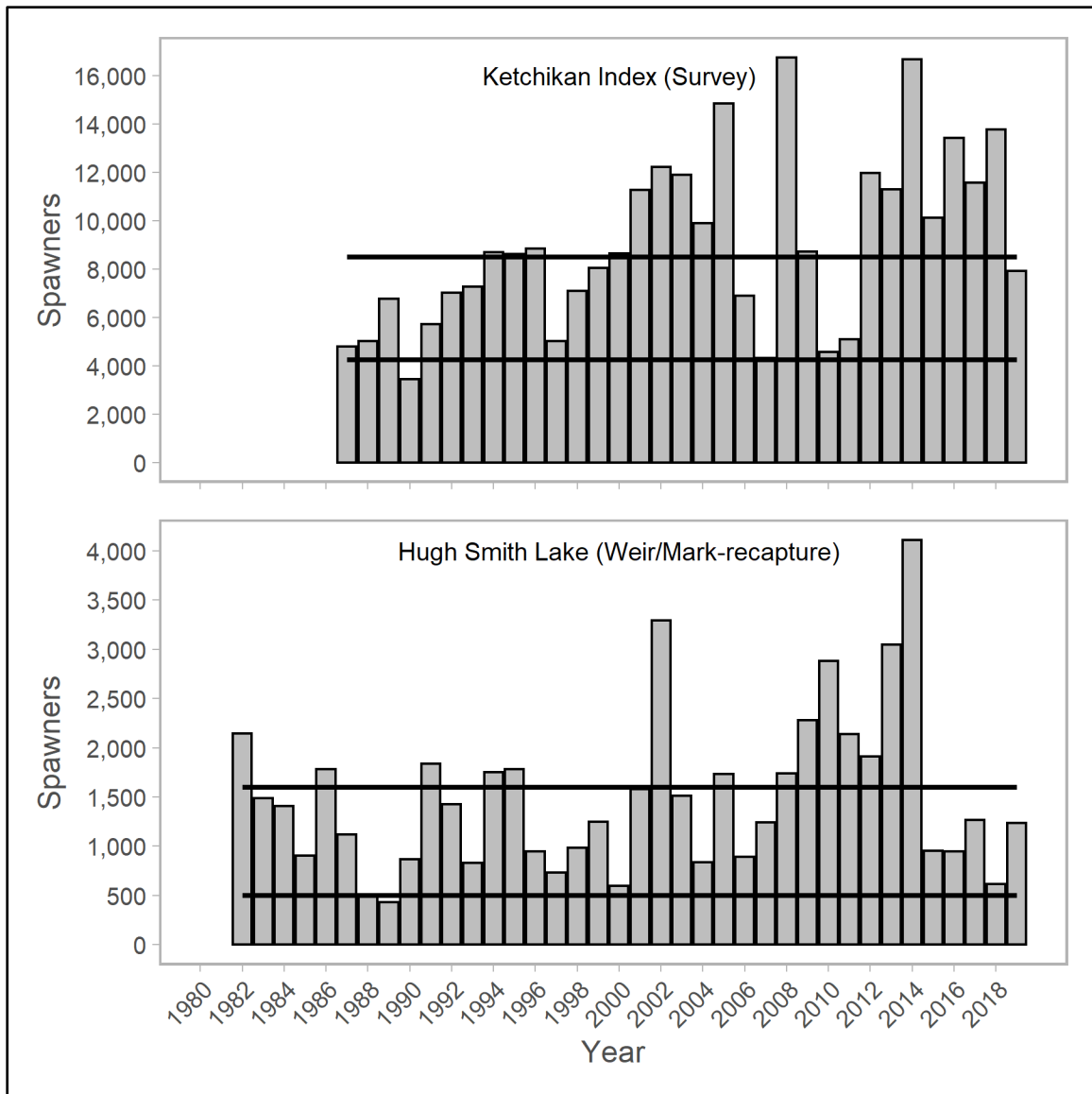


Figure 6.—Sum of peak coho salmon escapement survey counts and escapement estimates for 14 index streams in the Ketchikan area and Hugh Smith Lake, 1982–2019. Horizontal lines are the existing escapement goal bounds.

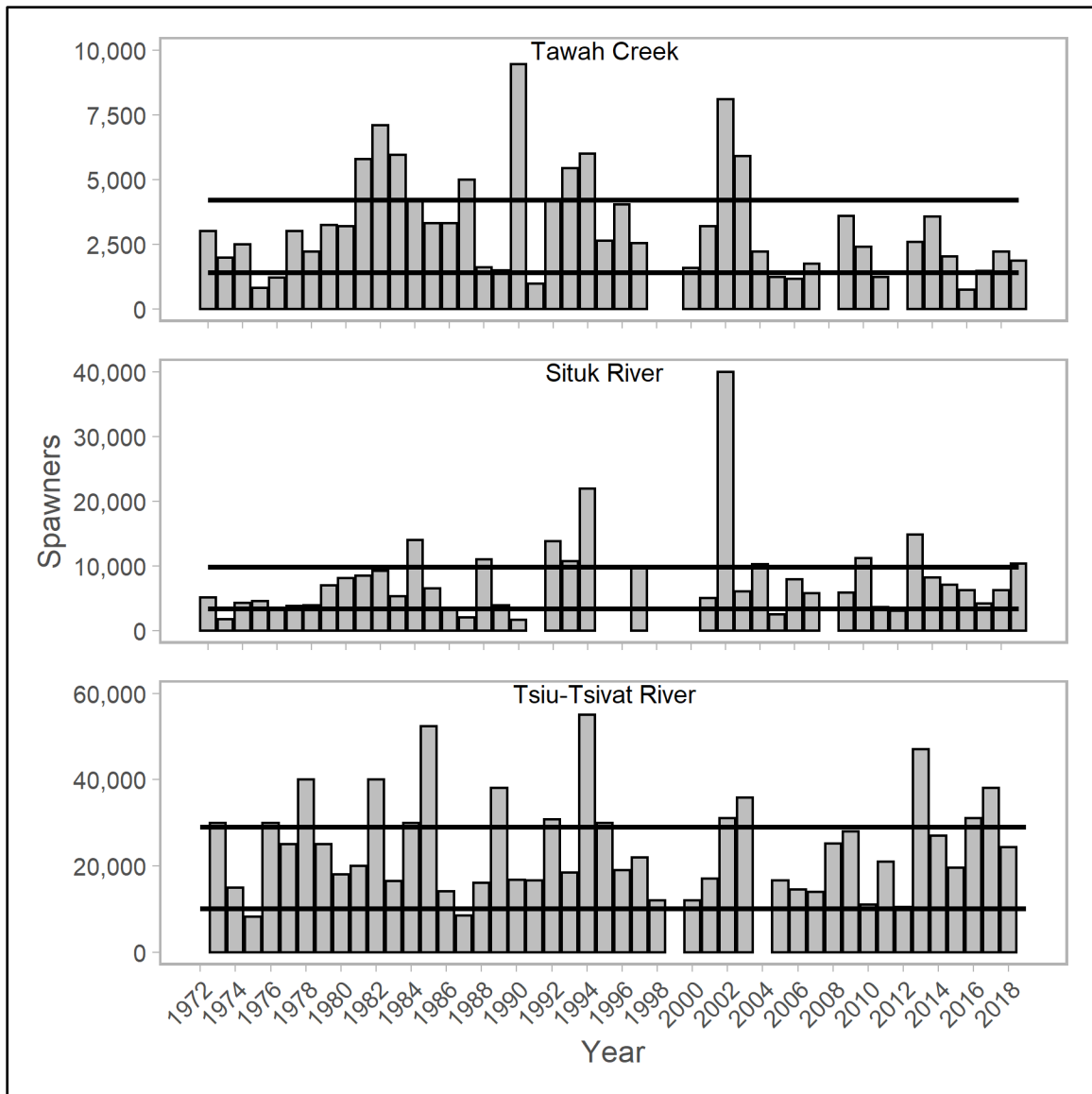


Figure 7.—Peak coho salmon escapement survey counts for three systems in the Yakutat area, 1972–2019. Years when no surveys were able to be conducted are shown by gaps in the data series. Horizontal lines are the existing escapement goal bounds.

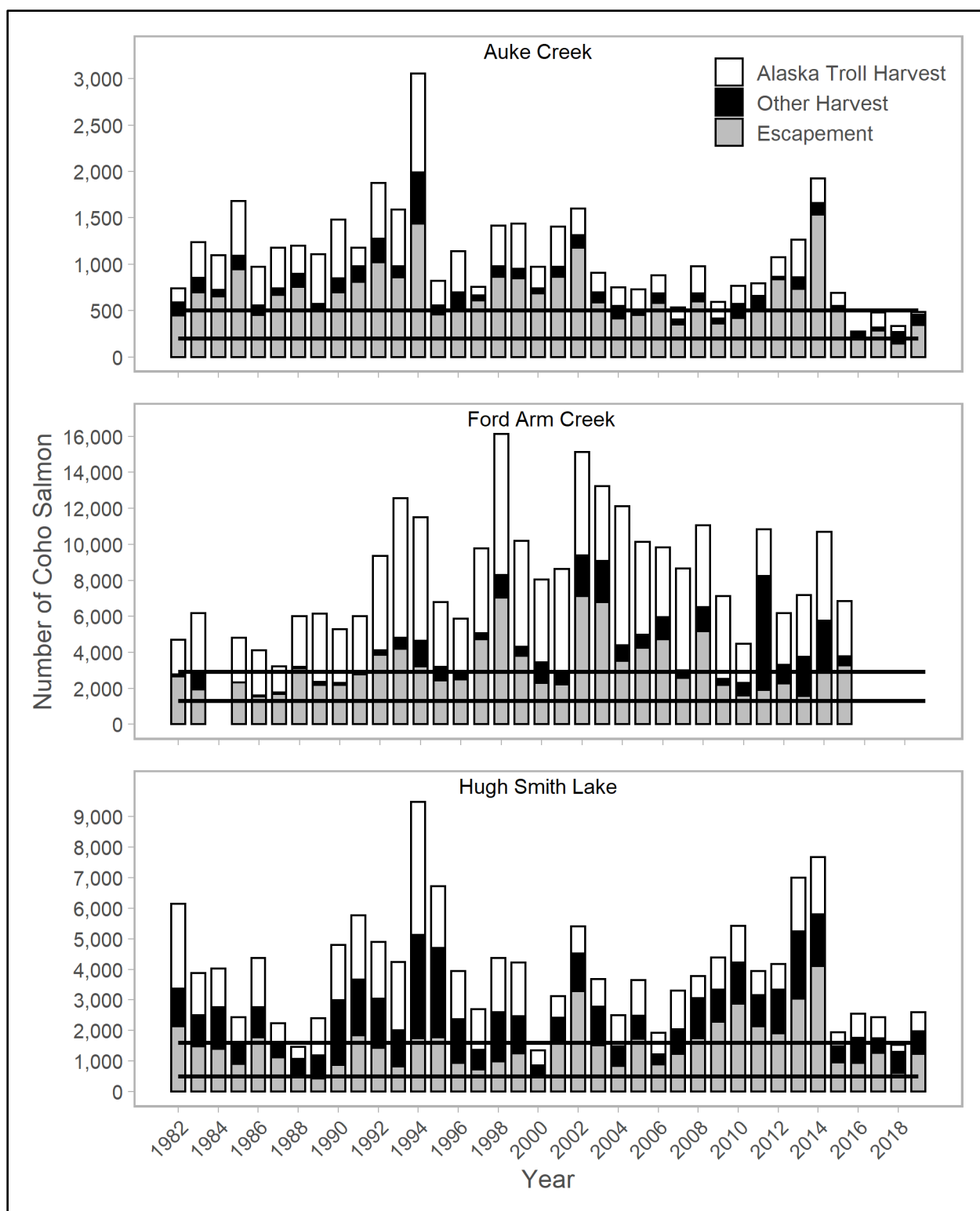


Figure 8.—Total estimated run size (total bar height), harvest, and escapement, and biological escapement goal ranges for four wild Southeast Alaska coho salmon indicator stocks, 1982–2019 (the Ford Arm Creek project was discontinued after 2015). Horizontal lines are the existing escapement goal bounds.

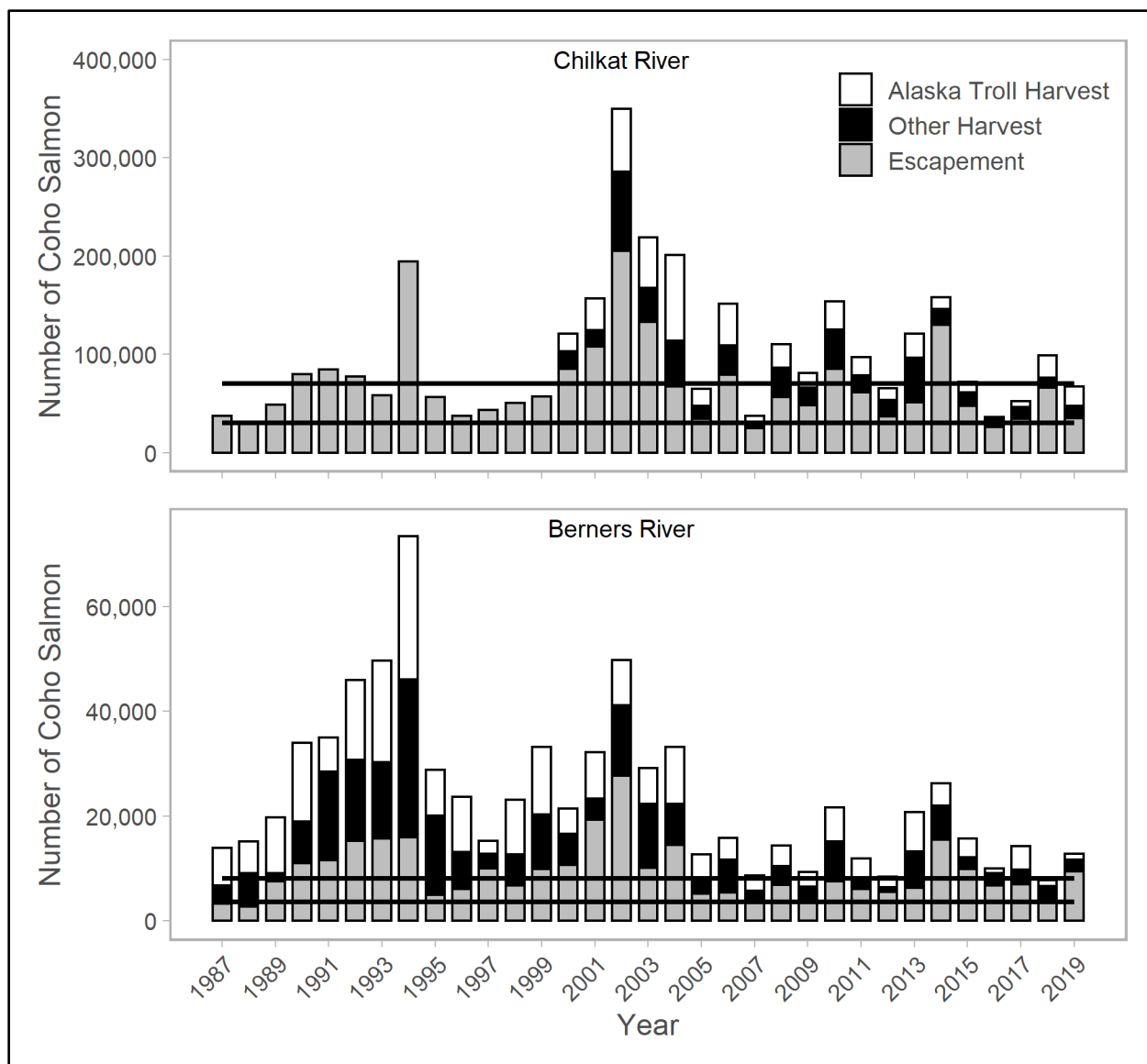


Figure 9.—Total estimated run size (total bar height), harvest, and escapement, and biological escapement goal ranges for coho salmon from the Chilkat and Berners Rivers, 1987–2019. Escapement to the Berners River is represented by the unexpanded survey count. Horizontal lines are the existing escapement goal bounds.

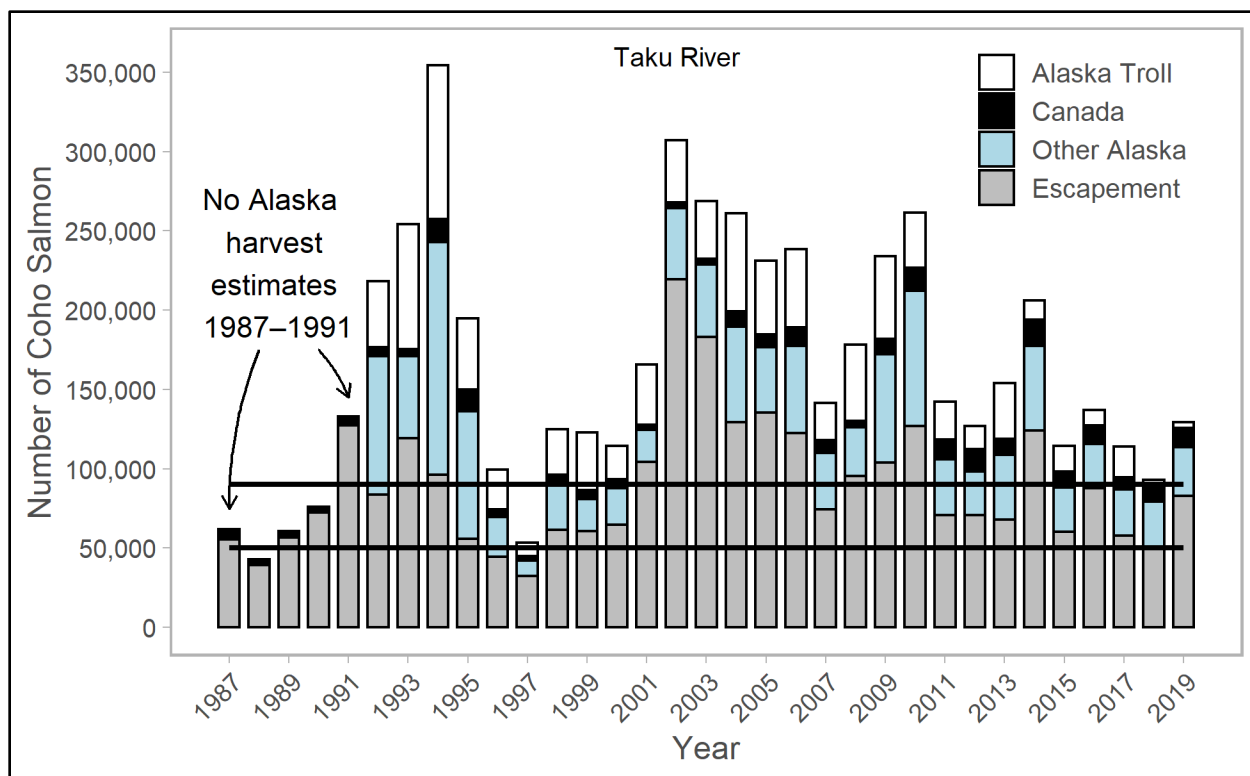


Figure 10.—Total estimated coho salmon runs (total bar height) by harvest group (Alaska troll harvest, Canadian harvest, other Alaska harvest) and escapement, for the transboundary Taku River, 1987–2019. Escapement is above the Canyon Island monitoring location. Horizontal lines are the existing escapement goal bounds.

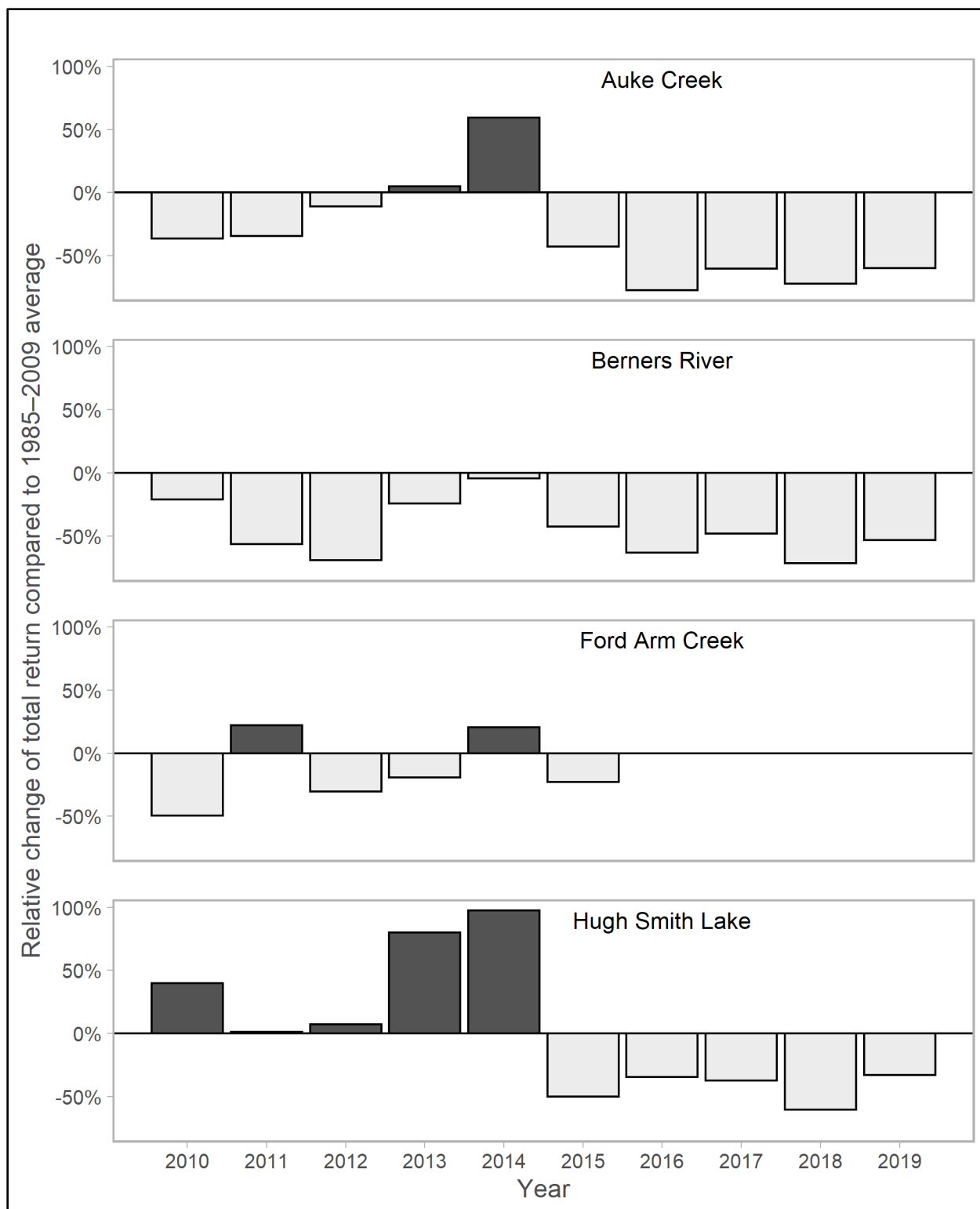


Figure 11.—Annual percent deviation of the 2010–2019 coho salmon total adult return (escapement and harvest) relative to the 1985–2009 average.

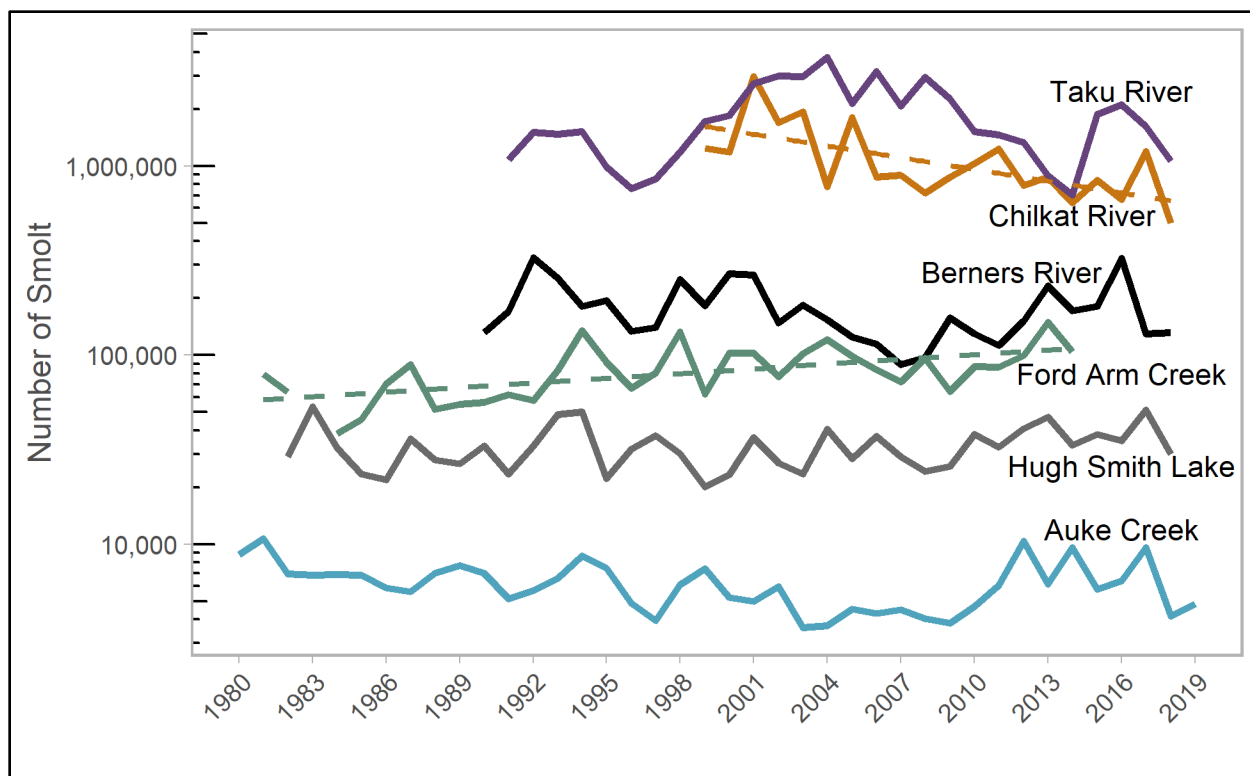


Figure 12.—Annual coho salmon smolt population estimates for six indicator stocks in Southeast Alaska, 1980–2019. Dashed lines indicate a significant linear trend in annual abundance ($p \leq 0.05$). Note that the y-axis is on the log scale.

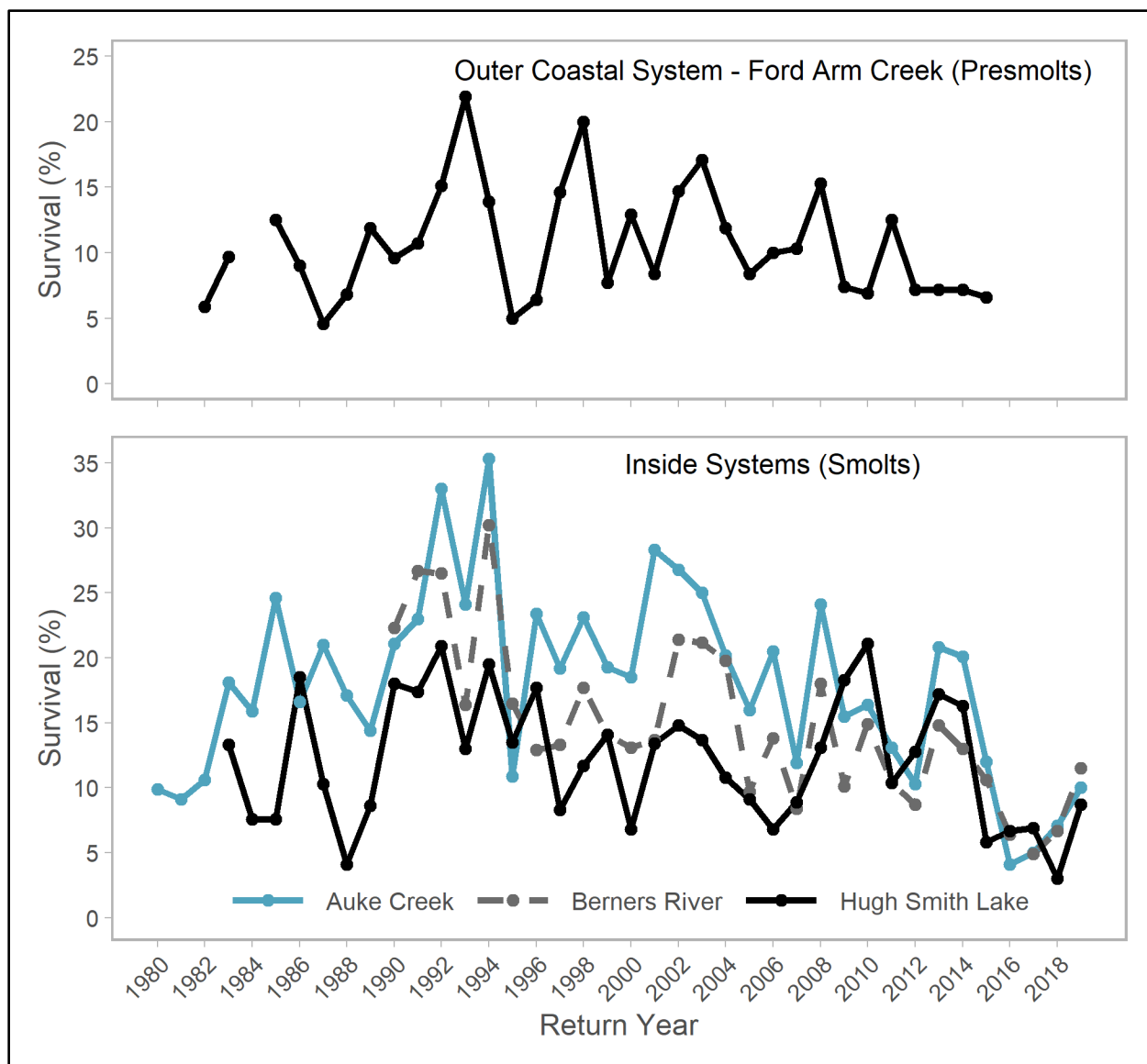


Figure 13.—Estimated marine (smolt–adult) survival rates of wild coho salmon from three systems in inside areas of Southeast Alaska (lower graph) and pre-smolts from one system on the outer coast of Southeast Alaska (upper graph), 1980–2019. Survival rate estimates for Ford Arm Creek pre-smolts (1982–2015) include approximately 10 months of freshwater mortality from July to May.

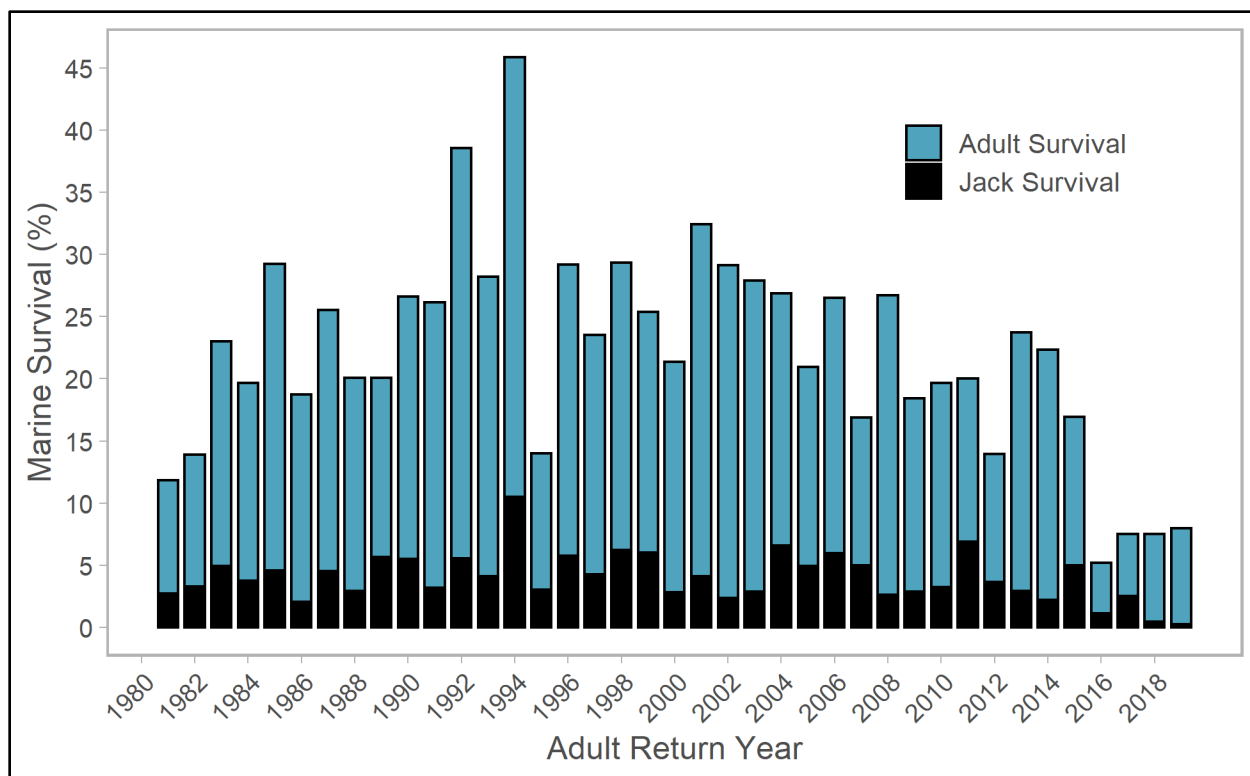


Figure 14.—Estimated marine survival rates of wild Auke Creek coho salmon smolts by ocean age-0 jacks and ocean age-1 adults, during sea-entry years 1980–2018.

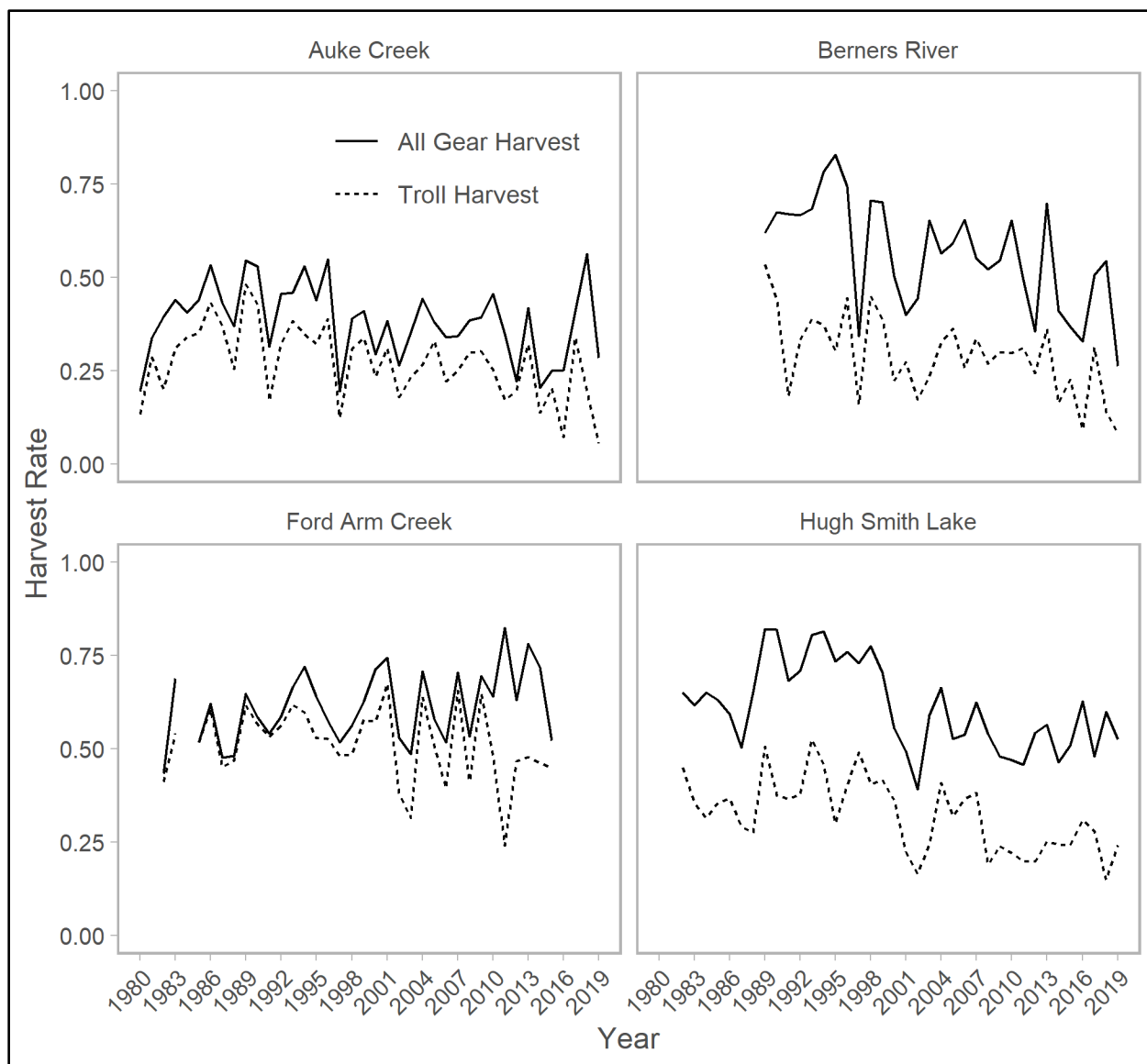


Figure 15.—Estimated harvest rates by all gear types and the Alaska troll fishery for four coded wire tagged Southeast Alaska coho salmon stocks, 1980–2019.

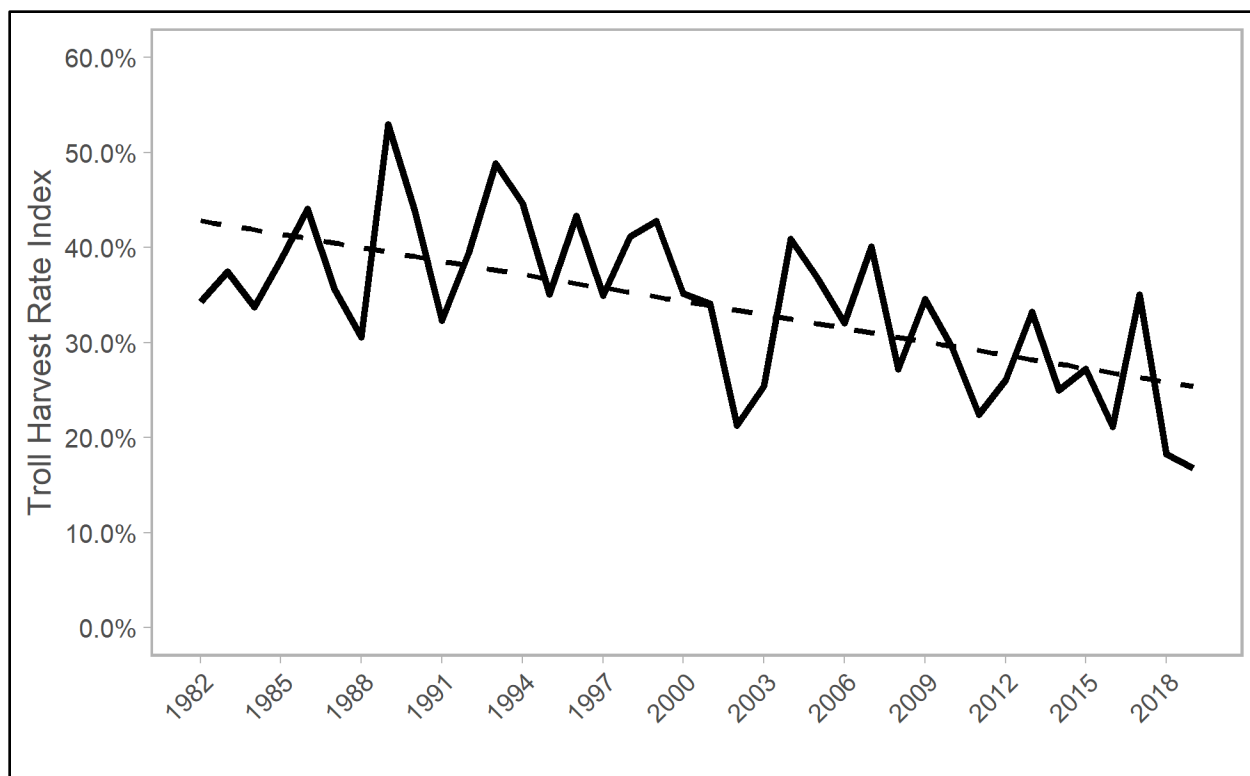


Figure 16.—Estimated harvest rate index by the Alaska troll fishery for Southeast Alaska coho salmon stocks, 1982–2019. Weightings given to individual stocks in the Alaska troll index are 20% each for Auke Creek, Berners River (based on expanded escapement counts), and Ford Arm Creek and 40% for Hugh Smith Lake (prior to 1989, Auke Creek was given a 40% weighting and Berners River 0%). Interpolations were made in computing the Alaska Troll Harvest Index based on Brown (1974) for years when estimates were unavailable. Dashed line is the significant linear trend over time ($p < 0.01$).

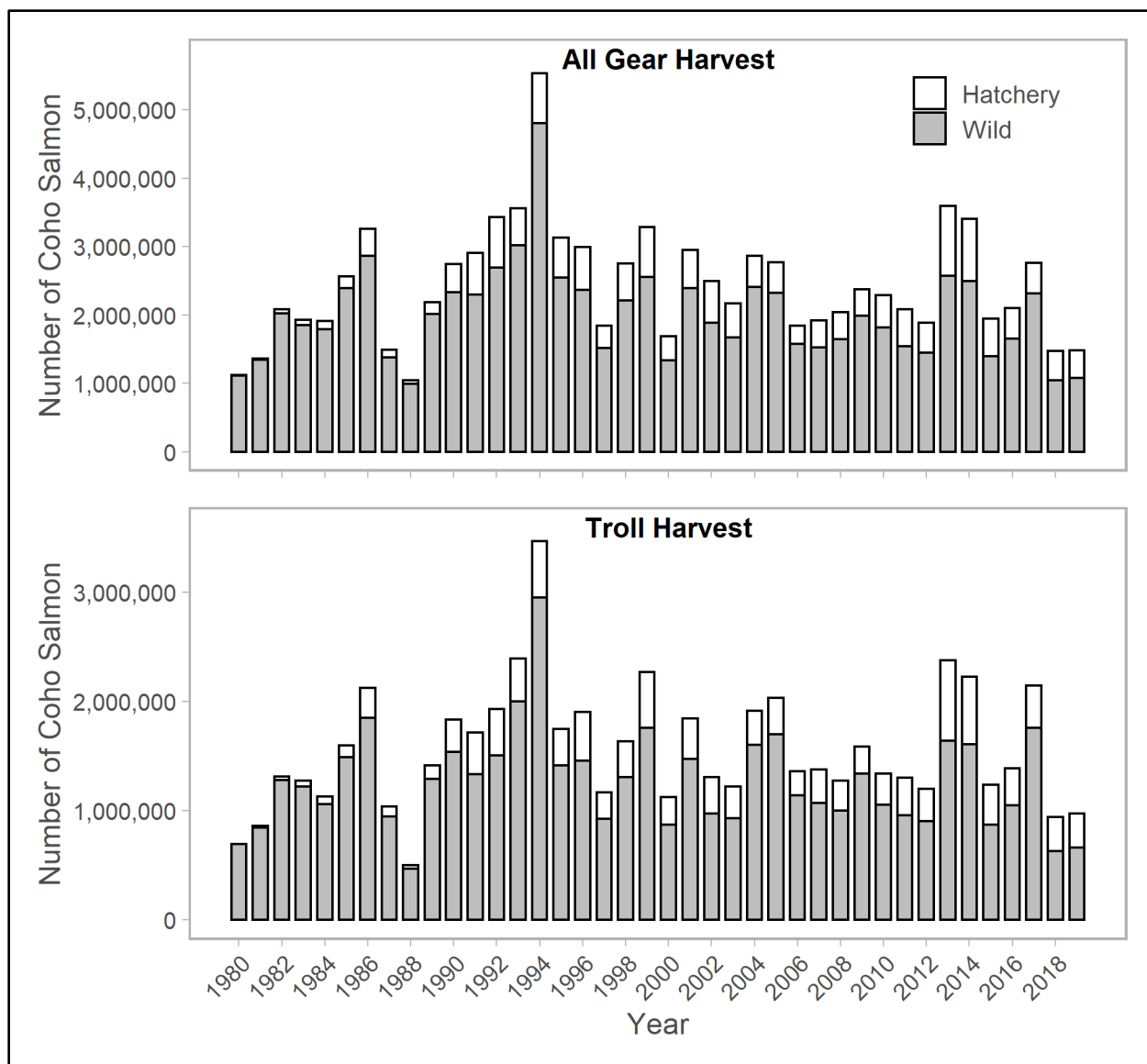


Figure 17.—Annual total and troll harvest of wild and hatchery coho salmon, 1980–2019.

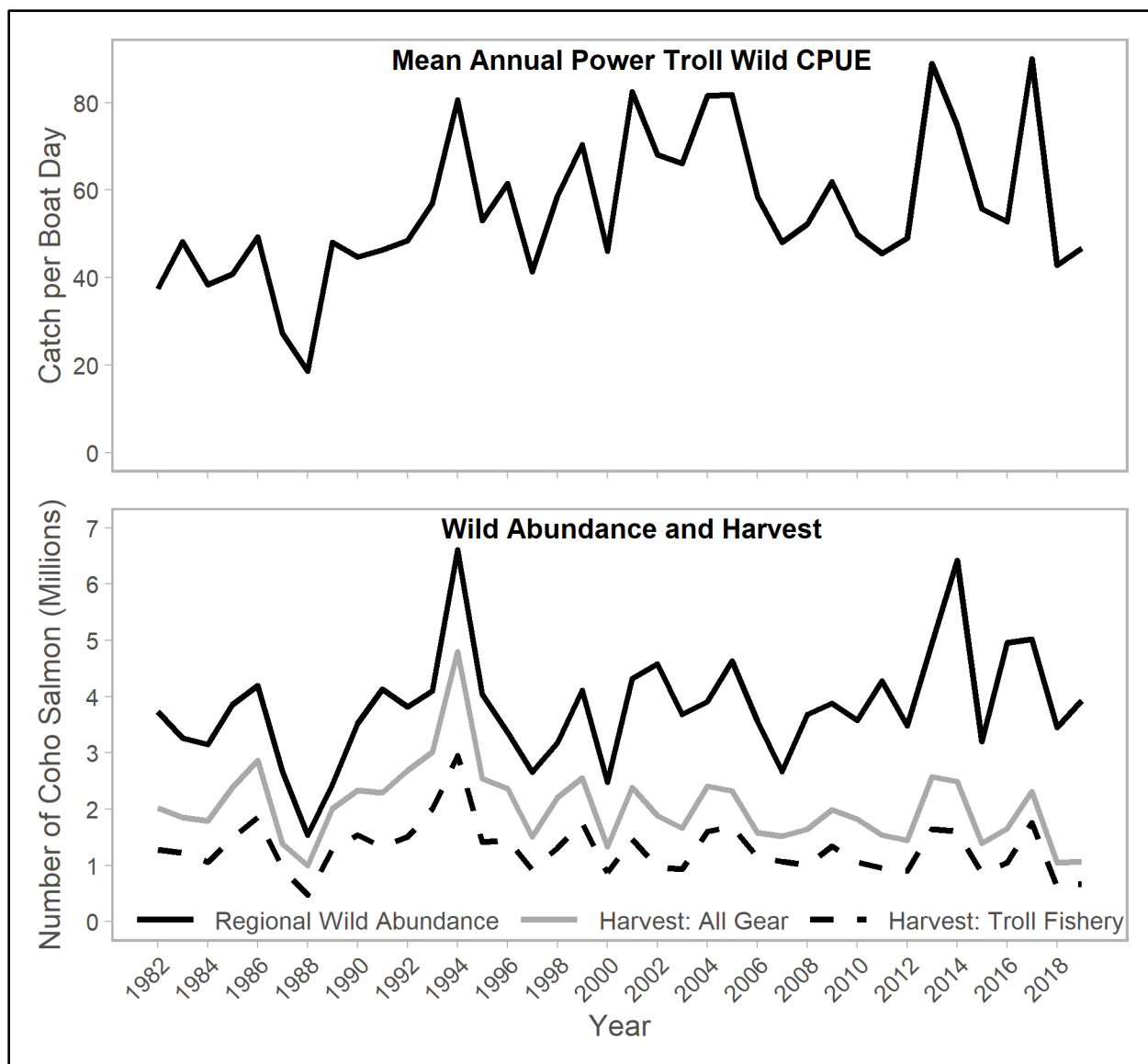


Figure 18.—Estimates of Southeast Alaska wild coho salmon commercial harvest, total wild abundance available to the Alaska troll fishery, and mean-average power troll wild CPUE in statistical weeks 28–38, 1982–2019.

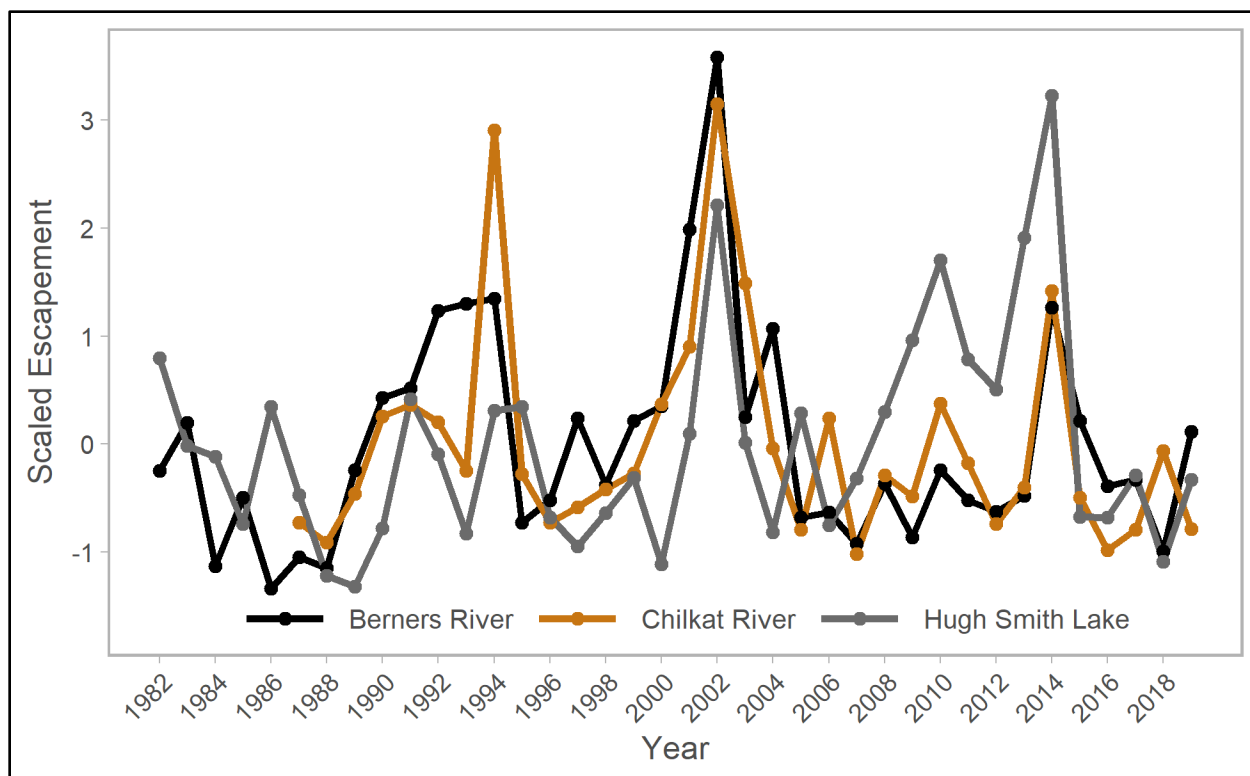


Figure 19.—Scaled escapements of coho salmon runs to the Berners River, Chilkat River, and Hugh Smith Lake, 1982–2019. Berners River returns are based on unexpanded escapement survey counts. Scaled escapements are the standardized score (Z-score), standardized by taking the difference between the annual and average escapement, divided by the standard deviation.

APPENDIX A:
SOUTHEAST ALASKA INDICATOR STOCK
HARVEST AND ESCAPEMENT

Appendix A 1.–Estimated fishery sample size (expanded CWT recoveries), harvest by gear type, escapement, and total run of coho salmon returning to Auke Creek, 1980–2019.

Year	Fishery Sample Size	Number of Fish				Total Harvest	Escapement	Total Run
		Troll	Seine	Drift gillnet	Sport			
1980	15	117	0	29	24	170	698	868
1981	70	280	0	31	19	330	646	976
1982	45	149	117	24	2	292	447	739
1983	129	385	10	28	122	545	694	1,239
1984	124	372	8	13	51	444	651	1,095
1985	177	594	3	71	73	741	942	1,683
1986	110	421	2	60	37	520	454	974
1987	145	438	2	48	23	511	668	1,179
1988	145	306	12	72	55	445	756	1,201
1989	182	533	7	15	49	604	502	1,106
1990	168	635	15	57	78	785	697	1,482
1991	47	200	8	152	11	371	808	1,179
1992	53	603	10	196	46	855	1,020	1,875
1993	169	611	8	92	19	730	859	1,589
1994	330	1,064	224	218	112	1,618	1,437	3,055
1995	82	264	5	65	26	360	460	820
1996	160	446	11	133	36	626	515	1,141
1997	43	94	4	0	50	148	609	757
1998	157	437	17	43	54	551	862	1,413
1999	160	485	5	58	42	590	845	1,435
2000	103	228	6	23	29	286	683	969
2001	149	435	10	41	55	541	865	1,406
2002	125	288	8	77	51	424	1,176	1,600
2003	97	211	4	59	45	319	585	904
2004	62	199	47	71	15	332	416	748
2005	66	240	0	6	31	277	450	727
2006	80	196	0	77	26	299	581	880
2007	47	134	6	30	14	184	352	536
2008	105	292	0	76	9	377	600	977
2009	75	179	0	46	8	233	360	593
2010	86	194	0	134	22	350	417	767
2011	79	137	31	93	16	277	517	794
2012	65	212	4	7	17	240	837	1,077
2013	128	406	28	69	27	530	736	1,266
2014	86	265	0	107	21	393	1,533	1,926
2015	44	140	2	14	17	173	517	690
2016	22	20	0	49	0	69	204	273
2017	39	163	0	19	14	196	283	479
2018	50	65	0	105	18	188	146	334
2019	38	27	0	104	6	138	345	483
Average		312	15	65	34	427	654	1,081

Appendix A 2.—Estimated fishery sample size (expanded CWT recoveries), harvest by gear type, escapement (unexpanded) and total run of coho salmon returning to the Berners River, 1982–2019.

Year	Fishery Sample Size	Number of Fish								Total Run
		Troll	Seine	Drift Gillnet	Sport	B.C. Net	Cost Recovery	Total Harvest	Escapement	
1974	157	9,161	406	4,581	0	0	0	14,148	4,124	18,272
1978	124	7,208	0	4,144	0	0	0	11,352	3,119	14,471
1979	84	4,892	411	1,774	95	0	0	7,172	3,460	10,632
1982	52	14,140	0	10,965	0	0	0	25,104	7,505	32,609
1983	125	17,176	0	6,977	421	0	0	24,574	9,840	34,414
1984	-	-	-	-	-	-	-	-	2,825	-
1985	93	10,861	290	7,016	0	0	0	18,167	6,169	24,336
1986	159	13,565	0	8,804	566	0	0	22,935	1,752	24,687
1987	52	7,211	0	3,317	166	0	0	10,694	3,260	13,954
1988	102	6,060	167	6,196	0	0	0	12,424	2,724	15,148
1989	58	10,583	0	1,665	0	0	0	12,247	7,509	19,756
1990	471	15,007	184	7,351	369	0	0	22,911	11,050	33,961
1991	1,025	6,449	285	16,640	84	0	0	23,457	11,530	34,987
1992	701	15,318	508	14,679	189	0	0	30,695	15,300	45,995
1993	1,498	19,308	166	14,282	180	0	0	33,936	15,670	49,606
1994	2,644	27,339	1,381	27,909	810	10	0	57,449	15,920	73,369
1995	1,383	8,766	25	14,869	210	0	0	23,870	4,945	28,815
1996	601	10,529	234	6,434	406	0	0	17,604	6,050	23,654
1997	312	2,453	231	2,254	278	0	18	5,234	10,050	15,284
1998	613	10,424	395	5,223	293	0	0	16,335	6,802	23,137
1999	948	12,876	200	9,572	578	0	0	23,225	9,920	33,145
2000	692	4,811	171	5,330	497	0	6	10,815	10,650	21,465
2001	747	8,814	178	3,523	347	0	0	12,863	19,290	32,153
2002	787	8,650	312	12,077	1,080	0	0	22,118	27,700	49,818
2003	1,328	6,823	251	11,377	550	0	0	19,001	10,110	29,111
2004	756	10,792	83	7,352	497	0	0	18,724	14,450	33,174
2005	392	4,639	121	2,546	232	0	0	7,538	5,220	12,758
2006	701	4,082	0	6,161	110	0	0	10,352	5,470	15,822
2007	293	2,937	40	1,668	161	0	0	4,807	3,915	8,722
2008	423	3,878	0	3,469	149	0	0	7,497	6,870	14,367
2009	201	2,807	63	2,037	180	0	0	5,087	4,230	9,317
2010	324	6,451	110	7,258	477	0	0	14,297	7,520	21,817
2011	174	3,722	251	1,900	106	0	0	5,979	6,050	12,029
2012	159	2,071	0	929	51	0	0	3,051	5,480	8,531
2013	374	7,521	369	6,289	609	0	0	14,788	6,280	21,068
2014	287	4,301	0	6,241	626	0	0	11,168	15,480	26,648
2015	306	3,543	120	1,869	177	0	0	5,709	9,940	15,649
2016	173	919	11	2,198	87	0	0	3,215	6,733	9,948
2017	153	4,455	863	1,706	234	0	0	7,258	7,040	14,298
2018	269	1,074	0	3,018	124	0	0	4,217	3,550	7,780
2019	131	1,046	0	2,240	81	0	0	3,368	9,405	12,773
Average		8,067	196	6,596	276	0	1	15,135	8,412	23,687

Appendix A 3.—Estimated fishery sample size (expanded CWT recoveries), harvest by gear type, escapement, and total run of coho salmon returning to the Berners River based on the expanded escapement survey count, 1989–2019.

Year	Fishery Sample Size	Number of Fish								Total Run
		Troll	Seine	Drift Gillnet	Sport	B.C.Net	Cost Recovery	Total Harvest	Escapement	
1989	58	10,583	0	1,665	0	0	0	12,247	9,320	21,567
1990	471	15,007	184	7,351	369	0	0	22,911	13,715	36,626
1991	1,025	6,449	285	16,640	84	0	0	23,457	14,311	37,768
1992	701	15,318	508	14,679	189	0	0	30,695	18,991	49,686
1993	1,498	19,308	166	14,282	180	0	0	33,936	19,450	53,386
1994	2,644	27,339	1,381	27,909	810	10	0	57,449	19,760	77,209
1995	1,383	8,766	25	14,869	210	0	0	23,870	6,138	30,008
1996	601	10,529	234	6,434	406	0	0	17,604	7,509	25,113
1997	312	2,453	231	2,254	278	0	18	5,234	12,474	17,708
1998	613	10,424	395	5,223	293	0	0	16,335	8,443	24,778
1999	948	12,876	200	9,572	578	0	0	23,225	12,313	35,538
2000	692	4,811	171	5,330	497	0	6	10,815	13,219	24,034
2001	747	8,814	178	3,523	347	0	0	12,863	23,943	36,806
2002	787	8,650	312	12,077	1,080	0	0	22,118	34,382	56,500
2003	1,328	6,823	251	11,377	550	0	0	19,001	12,549	31,550
2004	756	10,792	83	7,352	497	0	0	18,724	17,936	36,660
2005	392	4,639	121	2,546	232	0	0	7,538	6,479	14,017
2006	701	4,082	0	6,161	110	0	0	10,352	6,789	17,141
2007	293	2,937	40	1,668	161	0	0	4,807	4,859	9,666
2008	423	3,878	0	3,469	149	0	0	7,497	8,527	16,024
2009	201	2,807	63	2,037	180	0	0	5,087	5,250	10,337
2010	324	6,451	110	7,258	477	0	0	14,297	9,334	23,631
2011	174	3,722	251	1,900	106	0	0	5,979	7,509	13,488
2012	159	2,071	0	929	51	0	0	3,051	6,802	9,853
2013	374	7,521	369	6,289	609	0	0	14,788	7,795	22,583
2014	287	4,301	0	6,241	626	0	0	11,168	19,214	30,382
2015	306	3,543	120	1,869	177	0	0	5,709	12,338	18,047
2016	173	919	11	2,198	87	0	0	3,215	8,357	11,572
2017	153	4,455	863	1,706	234	0	0	7,258	8,738	14,298
2018	269	1,074	0	3,018	124	0	0	4,217	4,406	8,636
2019	131	1,046	0	2,240	81	0	0	3,368	11,673	15,041
Average		7,496	211	6,776	315	0	1	14,800	12,017	26,763

Appendix A 4.–Estimated fishery sample size (expanded CWT recoveries), harvest by gear type, escapement, and total run of coho salmon returning to Ford Arm Creek, 1982–2015.

Year	Fishery Sample Size	Number of Fish							Total Run
		Alaska Troll	Seine	Drift Gillnet	Sport	B.C. Troll	Total Harvest	Escapement	
1982	38	1,927	106	0	0	0	2,033	2,655	4,688
1983	93	3,344	912	0	0	0	4,256	1,931	6,187
1984	–	–	–	–	–	–	–	–	–
1985	49	2,482	0	0	0	0	2,482	2,324	4,806
1986	87	2,483	63	0	0	0	2,546	1,552	4,098
1987	71	1,458	81	0	0	0	1,539	1,694	3,233
1988	151	2,816	46	0	0	31	2,893	3,119	6,012
1989	218	3,799	185	0	0	0	3,984	2,176	6,160
1990	174	2,982	100	0	0	0	3,082	2,192	5,274
1991	193	3,203	44	10	0	0	3,257	2,761	6,018
1992	199	5,252	233	0	0	0	5,485	3,866	9,351
1993	349	7,749	434	0	176	0	8,359	4,202	12,561
1994	236	6,856	1,020	0	384	0	8,260	3,227	11,487
1995	82	3,582	759	0	0	0	4,341	2,446	6,787
1996	64	3,083	0	0	281	0	3,364	2,500	5,864
1997	242	4,702	0	0	351	0	5,053	4,718	9,771
1998	320	7,835	435	20	785	0	9,075	7,049	16,124
1999	146	5,893	66	0	436	0	6,395	3,800	10,195
2000	193	4,604	916	14	211	0	5,745	2,304	8,049
2001	131	5,821	115	0	480	0	6,416	2,209	8,625
2002	246	5,751	1,260	0	998	0	8,009	7,109	15,118
2003	225	4,154	504	0	1,770	0	6,428	6,789	13,217
2004	153	7,722	524	0	319	0	8,565	3,539	12,104
2005	81	5,134	60	0	672	0	5,866	4,257	10,123
2006	137	3,866	367	0	844	0	5,077	4,737	9,814
2007	188	5,673	217	7	202	0	6,099	2,567	8,666
2008	231	4,563	1,047	0	277	0	5,887	5,173	11,060
2009	156	4,604	248	0	93	0	4,945	2,181	7,126
2010	96	2,149	582	0	132	0	2,863	1,610	4,473
2011	52	2,610	6,238	0	79	0	8,927	1,908	10,835
2012	117	2,884	903	0	151	0	3,938	2,282	6,220
2013	122	3,426	2,069	0	241	0	5,736	1,573	7,309
2014	103	4,927	2,397	0	407	0	7,731	3,025	10,756
2015	71	3,078	380	0	118	0	3,576	3,281	6,857
Average		4,255	676	2	285	1	5,219	3,235	8,454

Appendix A 5.–Estimated fishery sample size (expanded CWT recoveries), harvest by gear type, escapement, and total run of coho salmon returning to Hugh Smith Lake, 1982–2019.

Year	Fishery Sampling Size	Number of fish										Total Harvest	Escapement	Total Run
		Alaska					B.C.							
		Troll	Seine	Drift Gillnet	Trap	Sport	Troll	Net	Sport					
1982	91	2,758	628	203	0	0	316	84	0	3,989	2,144	6,133		
1983	185	1,374	424	277	49	0	214	50	0	2,388	1,487	3,875		
1984	151	1,266	504	471	18	0	331	27	0	2,617	1,407	4,024		
1985	213	868	287	137	5	0	201	39	0	1,537	903	2,440		
1986	256	1,598	493	213	0	16	236	28	0	2,584	1,782	4,366		
1987	99	657	82	148	4	28	155	53	0	1,127	1,117	2,244		
1988	41	406	207	78	0	0	242	27	0	960	513	1,473		
1989	91	1,217	320	247	0	62	106	20	0	1,972	433	2,405		
1990	263	1,803	566	637	23	0	840	54	0	3,923	870	4,793		
1991	399	2,103	190	941	0	38	614	44	0	3,930	1,836	5,766		
1992	497	1,854	676	600	0	40	289	10	0	3,469	1,426	4,895		
1993	155	2,227	269	666	0	0	207	41	0	3,410	832	4,242		
1994	838	4,333	1,123	1,450	0	45	694	53	13	7,711	1,753	9,464		
1995	432	2,018	947	1,588	0	98	236	28	11	4,926	1,781	6,707		
1996	502	1,585	623	487	0	125	125	38	14	2,997	950	3,947		
1997	480	1,321	108	397	0	45	91	0	0	1,962	732	2,694		
1998	668	1,771	471	980	0	150	0	0	15	3,387	983	4,370		
1999	623	1,757	283	726	0	180	0	0	30	2,976	1,246	4,222		
2000	161	489	45	116	0	97	0	0	0	747	600	1,347		
2001	314	696	454	324	0	58	7	0	0	1,539	1,580	3,119		
2002	434	892	451	555	0	91	65	0	61	2,115	3,291	5,406		
2003	335	894	354	690	0	106	91	31	0	2,166	1,510	3,676		
2004	244	1,017	196	243	0	60	48	20	69	1,653	840	2,493		
2005	256	1,163	122	532	0	59	36	8	0	1,920	1,732	3,652		
2006	169	703	64	170	0	7	34	0	58	1,036	891	1,927		
2007	294	1,262	175	300	0	74	57	11	186	2,065	1,244	3,309		
2008	302	716	244	779	0	33	59	12	192	2,035	1,741	3,776		
2009	253	1,049	268	483	0	18	265	0	19	2,102	2,281	4,383		
2010	632	1,205	287	692	0	36	218	0	101	2,539	2,878	5,417		
2011	376	778	148	417	0	25	189	4	239	1,800	2,137	3,937		
2012	542	821	348	703	0	41	169	0	173	2,255	1,908	4,163		
2013	552	1,754	767	793	0	108	283	32	121	3,858	3,048	6,906		
2014	566	1,873	399	798	0	121	218	0	188	3,597	4,110	7,707		
2015	203	470	112	272	0	24	102	6	12	998	956	1,954		
2016	123	767	150	429	0	90	39	0	43	1,518	948	2,466		
2017	93	674	50	273	0	56	106	0	0	1,159	1,266	2,425		
2018	100	230	98	288	0	17	26	0	106	765	619	1,384		
2019	203	622	218	212	0	35	73	0	107	1,354	1,239	2,593		
Average		1,289	346	508	3	52	184	19	46	2,450	1,500	3,950		

Appendix A 6.—Estimated harvest and escapement of coho salmon bound for the Taku River above Canyon Island, 1987–2019.

Year	Number of Fish						Escapement	Total Run
	Troll	Seine	Drift Gillnet	Marine Sport	Inriver	Total Harvest		
1987	-	-	-	-	6,519	-	55,457	-
1988	-	-	-	-	3,643	-	39,450	-
1989	-	-	-	-	4,033	-	56,808	-
1990	-	-	-	-	3,685	-	72,196	-
1991	-	-	-	-	5,439	-	127,484	-
1992	41,713	2,283	79,013	431	5,629	129,069	83,729	212,798
1993	78,371	3,430	40,308	3,222	4,659	129,990	119,330	249,320
1994	97,039	26,352	86,198	19,018	14,786	243,393	96,343	339,736
1995	45,041	1,853	56,820	7,857	13,835	125,406	55,710	181,116
1996	24,779	220	17,069	2,461	5,119	49,648	44,635	94,283
1997	8,822	550	1,489	4,963	2,717	18,541	32,345	50,886
1998	28,827	742	19,371	4,427	5,176	58,543	61,382	119,925
1999	36,231	2,881	7,507	4,170	5,619	56,408	60,768	117,176
2000	21,236	2,132	11,466	4,137	5,478	44,449	64,700	109,149
2001	38,326	2,065	11,777	3,094	3,121	58,383	104,394	162,777
2002	39,053	3,456	30,894	6,642	3,870	83,915	219,360	303,275
2003	36,433	3,646	27,694	10,503	3,702	81,978	183,112	265,090
2004	62,002	5,335	30,961	14,108	9,804	122,210	129,327	251,537
2005	46,521	4,325	23,546	4,654	8,393	87,439	135,558	222,997
2006	49,394	613	37,879	4,621	11,803	104,310	122,384	226,694
2007	23,519	6,484	18,795	2,124	8,133	59,055	74,246	133,301
2008	47,997	0	25,254	1,530	4,064	78,845	95,226	174,071
2009	51,748	4,749	46,838	6,720	10,006	120,061	103,950	224,011
2010	34,554	3,988	52,497	14,287	14,666	119,992	126,830	246,822
2011	23,825	6,383	11,353	4,804	12,702	59,067	70,871	129,938
2012	14,648	0	12,108	1,212	14,204	42,171	70,775	112,946
2013	34,849	2,372	24,986	2,472	10,613	75,293	68,117	143,410
2014	12,118	773	32,145	3,656	16,792	65,484	124,171	189,655
2015	16,355	5,634	8,737	3,063	10,434	44,223	60,178	104,401
2016	9,801	326	14,757	1,210	11,720	37,814	87,704	125,518
2017	19,552	5,984	10,230	4,723	7,960	48,449	57,868	106,317
2018	4,387	1,105	15,794	1,392	9,739	32,458	51,173	83,631
2019	3,381	498	13,598	4,292	12,502	34,272	82,759	117,031
Average 1992–2019	33,947	3,506	27,467	5,207	8,830	78,960	92,391	171,350

Appendix A 7.—Estimated fishery sample size (expanded CWT recoveries), harvest by gear type, escapement, and total run of coho salmon returning to the Chilkat River, 1982–2019.

Year	Fishery Sample	Number of Fish							Total Escapement ^b	Total Run
	Size	Troll	Seine	Drift Gillnet	Marine Sport	Inriver Sport ^a	Subsistence	Total Harvest		
1987	—	—	—	—	—	—	—	—	37,432	
1988	—	—	—	—	—	—	—	—	29,495	
1989	—	—	—	—	—	—	—	—	48,833	
1990	—	—	—	—	—	—	—	—	79,807	
1991	—	—	—	—	—	—	—	—	84,517	
1992	—	—	—	—	—	—	—	—	77,588	
1993	—	—	—	—	—	—	—	—	58,217	
1994	—	—	—	—	—	—	—	—	194,425	
1995	—	—	—	—	—	—	—	—	56,737	
1996	—	—	—	—	—	—	—	—	37,331	
1997	—	—	—	—	—	—	—	—	43,519	
1998	—	—	—	—	—	—	—	—	50,758	
1999	—	—	—	—	—	—	—	—	57,140	
2000	265	19,988	876	17,055	1,529	688	199	40,335	84,843	125,178
2001	250	30,465	601	13,436	1,544	1,996	126	48,168	107,697	155,865
2002	325	61,724	719	66,541	2,159	3,342	574	135,059	204,925	339,984
2003	426	51,629	1,045	26,520	3,880	2,433	498	86,005	133,109	219,114
2004	254	82,827	1,030	35,895	5,167	2,822	455	128,196	67,053	195,249
2005	141	17,409	312	10,597	769	1,203	335	30,625	34,575	65,200
2006	200	37,077	83	24,416	2,523	1,782	353	66,234	79,050	145,284
2007	73	9,307	0	3,546	0	540	107	13,500	24,770	38,270
2008	358	20,999	0	28,908	737	738	390	51,772	56,369	108,141
2009	326	11,931	346	15,352	37	2,059	460	30,185	47,911	78,096
2010	427	29,028	379	37,732	1,501	449	344	69,433	84,909	154,342
2011	219	19,329	1,201	13,861	747	1,184	299	36,621	61,099	97,720
2012	164	11,421	0	15,426	682	397	210	28,136	36,961	65,097
2013	355	25,419	873	41,766	696	1,014	445	70,213	51,324	121,537
2014	88	10,792	0	13,737	245	958	513	26,245	130,200	156,445
2015	90	10,558	576	11,552	409	988	361	24,444	47,372	71,816
2016	56	2,412	0	10,771	237	512	310	14,242	26,280	40,522
2017	49	5,868	0	9,122	1,579	692	239	17,500	34,482	51,982
2018	20	8,813	0	9,274	885	1,385	249	20,606	66,085	86,691
2019	44	19,783	0	11,322	0	916	306	32,327	34,779	67,106
Average 2000–2019		24,339	402	20,841	1,266	1,305	339	48,492	70,690	119,182

^a The freshwater sport harvest is based on a mail-out survey; the 2018 harvest was interpolated based on the relationship between escapement and freshwater sport harvest in 2000–2017.

^b Mark–recapture estimates of escapement are shown in bold.

APPENDIX B:
SOUTHEAST ALASKA INDICATOR STOCK
HARVEST RATES

Appendix B 1.–Estimated harvest (by gear type) and escapement as a percent of the total Auke Creek coho salmon run, 1980–2019.

Year	Fishery Sample Size	Percent of Total Run						Total Run
		Troll	Seine	Drift Gillnet	Sport	Total Harvest	Escapement	
1980	15	13.5	0.0	3.3	2.8	19.6	80.4	100.0
1981	70	28.7	0.0	3.2	1.9	33.8	66.2	100.0
1982	45	20.2	15.8	3.2	0.3	39.5	60.5	100.0
1983	129	31.1	0.8	2.3	9.8	44.0	56.0	100.0
1984	124	34.0	0.7	1.2	4.7	40.5	59.5	100.0
1985	177	35.3	0.2	4.2	4.3	44.0	56.0	100.0
1986	110	43.2	0.2	6.2	3.8	53.4	46.6	100.0
1987	145	37.2	0.2	4.1	2.0	43.3	56.7	100.0
1988	145	25.5	1.0	6.0	4.6	37.1	62.9	100.0
1989	182	48.2	0.6	1.4	4.4	54.6	45.4	100.0
1990	168	42.8	1.0	3.8	5.3	53.0	47.0	100.0
1991	47	17.0	0.7	12.9	0.9	31.5	68.5	100.0
1992	53	32.2	0.5	10.5	2.5	45.6	54.4	100.0
1993	169	38.5	0.5	5.8	1.2	45.9	54.1	100.0
1994	330	34.8	7.3	7.1	3.7	53.0	47.0	100.0
1995	82	32.2	0.6	7.9	3.2	43.9	56.1	100.0
1996	160	39.1	1.0	11.7	3.2	54.9	45.1	100.0
1997	43	12.4	0.5	0.0	6.6	19.6	80.4	100.0
1998	157	30.9	1.2	3.0	3.8	39.0	61.0	100.0
1999	160	33.8	0.3	4.0	2.9	41.1	58.9	100.0
2000	103	23.5	0.6	2.4	3.0	29.5	70.5	100.0
2001	149	30.9	0.7	2.9	3.9	38.5	61.5	100.0
2002	125	18.0	0.5	4.8	3.2	26.5	73.5	100.0
2003	97	23.3	0.4	6.5	5.0	35.3	64.7	100.0
2004	62	26.6	6.3	9.5	2.0	44.4	55.6	100.0
2005	66	33.0	0.0	0.8	4.3	38.1	61.9	100.0
2006	80	22.3	0.0	8.8	3.0	34.0	66.0	100.0
2007	47	25.0	1.1	5.6	2.6	34.3	65.7	100.0
2008	105	29.9	0.0	7.8	0.9	38.6	61.4	100.0
2009	75	30.2	0.0	7.8	1.3	39.3	60.7	100.0
2010	86	25.3	0.0	17.5	2.9	45.6	54.4	100.0
2011	79	17.3	3.9	11.7	2.0	34.9	65.1	100.0
2012	65	19.7	0.4	0.6	1.6	22.3	77.7	100.0
2013	128	32.1	2.2	5.5	2.1	41.9	58.1	100.0
2014	86	13.8	0.0	5.6	1.1	20.4	79.6	100.0
2015	44	20.3	0.3	2.0	2.5	25.1	74.9	100.0
2016	22	7.3	0.0	17.9	0.0	25.3	74.7	100.0
2017	39	34.0	0.0	4.0	2.9	40.9	59.1	100.0
2018	50	19.5	0.0	31.4	5.4	56.3	43.7	100.0
2019	38	5.7	0.0	21.5	1.3	28.5	71.5	100.0
Average		27.2	1.2	6.9	3.1	38.4	61.6	100.0

Appendix B 2.—Estimated harvest (by gear type) and escapement as a percent of the total Berners River coho salmon run based on the expanded escapement survey count, 1982–2019.

Year	Fishery Sample Size	Percent of Total Run								Total Run
		Troll	Seine	Drift Gillnet	Sport	B.C. Net	Cost Recovery	Total Harvest	Escapement	
1974	157	50.1	2.2	25.1	0.0	0.0	0.0	77.4	22.6	100.0
—	—	—	—	—	—	—	—	—	—	—
1978	124	49.8	0.0	28.6	0.0	0.0	0.0	78.4	21.6	100.0
1979	84	46.0	3.9	16.7	0.9	0.0	0.0	67.5	32.5	100.0
—	—	—	—	—	—	—	—	—	—	—
1982	52	43.4	0.0	33.6	0.0	0.0	0.0	77.0	23.0	100.0
1983	125	49.9	0.0	20.3	1.2	0.0	0.0	71.4	28.6	100.0
1984	—	—	—	—	—	—	—	—	—	—
1985	93	44.6	1.2	28.8	0.0	0.0	0.0	74.7	25.3	100.0
1986	159	54.9	0.0	35.7	2.3	0.0	0.0	92.9	7.1	100.0
1987	52	51.7	0.0	23.8	1.2	0.0	0.0	76.6	23.4	100.0
1988	102	40.0	1.1	40.9	0.0	0.0	0.0	82.0	18.0	100.0
1989	58	53.6	0.0	8.4	0.0	0.0	0.0	62.0	38.0	100.0
1990	471	44.2	0.5	21.6	1.1	0.0	0.0	67.5	32.5	100.0
1991	1,025	18.4	0.8	47.6	0.2	0.0	0.0	67.0	33.0	100.0
1992	701	33.3	1.1	31.9	0.4	0.0	0.0	66.7	33.3	100.0
1993	1,498	38.9	0.3	28.8	0.4	0.0	0.0	68.4	31.6	100.0
1994	2,644	37.3	1.9	38.0	1.1	0.0	0.0	78.3	21.7	100.0
1995	1,383	30.4	0.1	51.6	0.7	0.0	0.0	82.8	17.2	100.0
1996	601	44.5	1.0	27.2	1.7	0.0	0.0	74.4	25.6	100.0
1997	312	16.0	1.5	14.7	1.8	0.0	0.1	34.2	65.8	100.0
1998	613	45.1	1.7	22.6	1.3	0.0	0.0	70.6	29.4	100.0
1999	948	38.8	0.6	28.9	1.7	0.0	0.0	70.1	29.9	100.0
2000	692	22.4	0.8	24.8	2.3	0.0	0.0	50.4	49.6	100.0
2001	747	27.4	0.6	11.0	1.1	0.0	0.0	40.0	60.0	100.0
2002	787	17.4	0.6	24.2	2.2	0.0	0.0	44.4	55.6	100.0
2003	1,328	23.4	0.9	39.1	1.9	0.0	0.0	65.3	34.7	100.0
2004	756	32.5	0.3	22.2	1.5	0.0	0.0	56.4	43.6	100.0
2005	392	36.4	1.0	20.0	1.8	0.0	0.0	59.1	40.9	100.0
2006	701	25.8	0.0	38.9	0.7	0.0	0.0	65.4	34.6	100.0
2007	293	33.7	0.5	19.1	1.8	0.0	0.0	55.1	44.9	100.0
2008	423	27.0	0.0	24.1	1.0	0.0	0.0	52.2	47.8	100.0
2009	201	30.1	0.7	21.9	1.9	0.0	0.0	54.6	45.4	100.0
2010	324	29.6	0.5	33.3	2.2	0.0	0.0	65.5	34.5	100.0
2011	174	30.9	2.1	15.8	0.9	0.0	0.0	49.7	50.3	100.0
2012	159	24.3	0.0	10.9	0.6	0.0	0.0	35.8	64.2	100.0
2013	374	35.7	1.8	29.9	2.9	0.0	0.0	70.2	29.8	100.0
2014	287	16.1	0.0	23.4	2.3	0.0	0.0	41.9	58.1	100.0
2015	306	22.6	0.8	11.9	1.1	0.0	0.0	36.5	63.5	100.0
2016	173	9.2	0.1	22.1	0.9	0.0	0.0	32.3	67.7	100.0
2017	153	31.2	6.0	11.9	1.6	0.0	0.0	50.8	49.2	100.0
2018	267	12.0	0.0	38.8	1.6	0.0	0.0	54.4	45.6	100.0
2019	131	7.0	0.0	14.9	0.5	0.0	0.0	22.4	77.6	100.0
Average		33.1	0.9	25.8	1.2	0.0	0.0	61.1	38.9	100.0

Appendix B 3.—Estimated harvest (by gear type) and escapement as a percent of the total Ford Arm Creek coho salmon run, 1982–2015.

Year	Fishery	Percent of Total Run							Total Run
	Sample Size	Alaska Troll	Seine	Drift Gillnet	Sport	Canadian Troll	Total Harvest	Escapement	
1982	38	41.1	2.3	0.0	0.0	0.0	43.4	56.6	100.0
1983	93	54.0	14.7	0.0	0.0	0.0	68.8	31.2	100.0
1984	—	—	—	—	—	—	—	—	—
1985	49	51.6	0.0	0.0	0.0	0.0	51.6	48.4	100.0
1986	87	60.6	1.5	0.0	0.0	0.0	62.1	37.9	100.0
1987	71	45.1	2.5	0.0	0.0	0.0	47.6	52.4	100.0
1988	151	46.8	0.8	0.0	0.0	0.5	48.1	51.9	100.0
1989	221	61.7	3.0	0.0	0.0	0.0	64.7	35.3	100.0
1990	174	56.5	1.9	0.0	0.0	0.0	58.4	41.6	100.0
1991	193	53.2	0.7	0.2	0.0	0.0	54.1	45.9	100.0
1992	199	56.2	2.5	0.0	0.0	0.0	58.7	41.3	100.0
1993	349	61.7	3.5	0.0	1.4	0.0	66.5	33.5	100.0
1994	236	59.7	8.9	0.0	3.3	0.0	71.9	28.1	100.0
1995	91	52.8	11.2	0.0	0.0	0.0	64.0	36.0	100.0
1996	64	52.6	0.0	0.0	4.8	0.0	57.4	42.6	100.0
1997	241	48.1	0.0	0.0	3.6	0.0	51.7	48.3	100.0
1998	315	48.6	2.7	0.1	4.9	0.0	56.3	43.7	100.0
1999	145	57.8	0.6	0.0	4.3	0.0	62.7	37.3	100.0
2000	193	57.2	11.4	0.2	2.6	0.0	71.4	28.6	100.0
2001	131	67.5	1.3	0.0	5.6	0.0	74.4	25.6	100.0
2002	246	38.0	8.3	0.0	6.6	0.0	53.0	47.0	100.0
2003	225	31.4	3.8	0.0	13.4	0.0	48.6	51.4	100.0
2004	153	63.8	4.3	0.0	2.6	0.0	70.8	29.2	100.0
2005	81	50.7	0.6	0.0	6.6	0.0	57.9	42.1	100.0
2006	137	39.4	3.7	0.0	8.6	0.0	51.7	48.3	100.0
2007	188	65.5	2.5	0.1	2.3	0.0	70.4	29.6	100.0
2008	231	41.3	9.5	0.0	2.5	0.0	53.2	46.8	100.0
2009	156	64.6	3.5	0.0	1.3	0.0	69.4	30.6	100.0
2010	96	48.0	13.0	0.0	3.0	0.0	64.0	36.0	100.0
2011	52	24.1	57.6	0.0	0.7	0.0	82.4	17.6	100.0
2012	117	46.4	14.5	0.0	2.4	0.0	63.3	36.7	100.0
2013	122	46.9	28.3	0.0	3.3	0.0	78.5	21.5	100.0
2014	103	45.8	22.3	0.0	3.8	0.0	71.9	28.1	100.0
2015	71	44.9	5.5	0.0	1.7	0.0	52.2	47.8	100.0
Average		51.0	7.5	0.0	2.7	0.0	61.2	38.8	100.0

Appendix B 4.–Estimated harvest (by gear type) and escapement as a percent of the total Hugh Smith Lake coho salmon run, 1982–2019.

Year	Fishery	Percent of Total Run										Total Run
	Sample Size	Alaska Troll	Alaska Seine	Alaska Gillnet	Alaska Trap	Alaska Sport	B.C. Troll	B.C. Net	B.C. Sport	Total Harvest	Escapement	
1982	91	45.0	10.2	3.3	0.0	0.0	5.2	1.4	0.0	65.0	35.0	100.0
1983	185	35.5	10.9	7.1	1.3	0.0	5.5	1.3	0.0	61.6	38.4	100.0
1984	151	31.5	12.5	11.7	0.5	0.0	8.2	0.7	0.0	65.0	35.0	100.0
1985	213	35.6	11.8	5.6	0.2	0.0	8.2	1.6	0.0	63.0	37.0	100.0
1986	256	36.6	11.3	4.9	0.0	0.4	5.4	0.7	0.0	59.2	40.8	100.0
1987	99	29.3	3.6	6.6	0.2	1.3	6.9	2.4	0.0	50.2	49.8	100.0
1988	41	27.6	14.0	5.3	0.0	0.0	16.4	1.8	0.0	65.2	34.8	100.0
1989	91	50.6	13.3	10.3	0.0	2.6	4.4	0.8	0.0	82.0	18.0	100.0
1990	263	37.6	11.8	13.3	0.5	0.0	17.5	1.1	0.0	81.9	18.1	100.0
1991	399	36.5	3.3	16.3	0.0	0.7	10.6	0.8	0.0	68.2	31.8	100.0
1992	497	37.9	13.8	12.3	0.0	0.8	5.9	0.2	0.0	70.9	29.1	100.0
1993	155	52.5	6.3	15.7	0.0	0.0	4.9	1.0	0.0	80.4	19.6	100.0
1994	838	45.8	11.9	15.3	0.0	0.5	7.3	0.6	0.1	81.5	18.5	100.0
1995	432	30.1	14.1	23.7	0.0	1.5	3.5	0.4	0.2	73.5	26.5	100.0
1996	502	40.2	15.8	12.3	0.0	3.2	3.2	1.0	0.4	75.9	24.1	100.0
1997	480	49.0	4.0	14.7	0.0	1.7	3.4	0.0	0.0	72.8	27.2	100.0
1998	668	40.5	10.8	22.4	0.0	3.4	0.0	0.0	0.3	77.5	22.5	100.0
1999	623	41.6	6.7	17.2	0.0	4.3	0.0	0.0	0.7	70.5	29.5	100.0
2000	161	36.3	3.4	8.6	0.0	7.2	0.0	0.0	0.0	55.4	44.6	100.0
2001	314	22.3	14.6	10.4	0.0	1.9	0.2	0.0	0.0	49.3	50.7	100.0
2002	434	16.5	8.3	10.3	0.0	1.7	1.2	0.0	1.1	39.1	60.9	100.0
2003	335	24.3	9.6	18.8	0.0	2.9	2.5	0.8	0.0	58.9	41.1	100.0
2004	244	40.8	7.9	9.7	0.0	2.4	1.9	0.8	2.8	66.3	33.7	100.0
2005	256	31.8	3.4	14.6	0.0	1.6	1.0	0.2	0.0	52.6	47.4	100.0
2006	169	36.5	3.3	8.8	0.0	0.4	1.8	0.0	3.0	53.7	46.3	100.0
2007	294	38.1	5.3	9.1	0.0	2.2	1.7	0.3	5.6	62.4	37.6	100.0
2008	302	19.0	6.5	20.6	0.0	0.9	1.6	0.3	5.1	53.9	46.1	100.0
2009	253	23.9	6.1	11.0	0.0	0.4	6.0	0.0	0.4	48.0	52.0	100.0
2010	632	22.2	5.3	12.8	0.0	0.7	4.0	0.0	1.9	46.9	53.1	100.0
2011	376	19.8	3.8	10.6	0.0	0.6	4.8	0.1	6.1	45.7	54.3	100.0
2012	542	19.7	8.4	16.9	0.0	1.0	4.1	0.0	4.2	54.2	45.8	100.0
2013	552	25.4	11.1	11.5	0.0	1.6	4.1	0.5	1.8	55.9	44.1	100.0
2014	566	24.3	5.2	10.4	0.0	1.6	2.8	0.0	2.4	46.7	53.3	100.0
2015	203	24.1	5.7	13.9	0.0	1.2	5.2	0.3	0.6	51.1	48.9	100.0
2016	123	31.1	6.1	17.4	0.0	3.6	1.6	0.0	1.7	61.6	38.4	100.0
2017	93	27.8	2.1	11.3	0.0	2.3	4.4	0.0	0.0	47.8	52.2	100.0
2018	98	16.6	7.1	20.8	0.0	1.2	1.9	0.0	7.7	55.3	44.7	100.0
2019	203	24.0	8.4	8.2	0.0	1.4	2.8	0.0	4.1	52.2	47.8	100.0
Average		32.3	8.4	12.5	0.1	1.5	4.5	0.5	1.3	61.1	38.9	100.0

Appendix B 5.–Estimated harvest (by gear type) and escapement as a percent of the total Taku River coho salmon run above Canyon Island, 1992–2019.

Year	Percent of Total Run					Total Harvest	Escapement	Total Run
	Troll	Seine	Drift Gillnet	Marine Sport	Inriver			
1992	19.6	1.1	37.1	0.2	2.6	60.7	39.3	100.0
1993	31.4	1.4	16.2	1.3	1.9	52.1	47.9	100.0
1994	28.6	7.8	25.4	5.6	4.4	71.6	28.4	100.0
1995	24.9	1.0	31.4	4.3	7.6	69.2	30.8	100.0
1996	26.3	0.2	18.1	2.6	5.4	52.7	47.3	100.0
1997	17.3	1.1	2.9	9.8	5.3	36.4	63.6	100.0
1998	24.0	0.6	16.2	3.7	4.3	48.8	51.2	100.0
1999	30.9	2.5	6.4	3.6	4.8	48.1	51.9	100.0
2000	19.5	2.0	10.5	3.8	5.0	40.7	59.3	100.0
2001	23.5	1.3	7.2	1.9	1.9	35.9	64.1	100.0
2002	12.9	1.1	10.2	2.2	1.3	27.7	72.3	100.0
2003	13.7	1.4	10.4	4.0	1.4	30.9	69.1	100.0
2004	24.6	2.1	12.3	5.6	3.9	48.6	51.4	100.0
2005	20.9	1.9	10.6	2.1	3.8	39.2	60.8	100.0
2006	21.8	0.3	16.7	2.0	5.2	46.0	54.0	100.0
2007	17.6	4.9	14.1	1.6	6.1	44.3	55.7	100.0
2008	27.6	0.0	14.5	0.9	2.3	45.3	54.7	100.0
2009	23.1	2.1	20.9	3.0	4.5	53.6	46.4	100.0
2010	14.0	1.6	21.3	5.8	5.9	48.6	51.4	100.0
2011	18.3	4.9	8.7	3.7	9.8	45.5	54.5	100.0
2012	13.0	0.0	10.7	1.1	12.6	37.3	62.7	100.0
2013	24.3	1.7	17.4	1.7	7.4	52.5	47.5	100.0
2014	6.4	0.4	16.9	1.9	8.9	34.5	65.5	100.0
2015	15.7	5.4	8.4	2.9	10.0	42.4	57.6	100.0
2016	7.8	0.3	11.8	1.0	9.3	30.1	69.9	100.0
2017	18.4	5.6	9.6	4.4	7.5	45.6	54.4	100.0
2018	5.2	1.3	18.9	1.7	11.7	38.8	61.2	100.0
2019	2.9	0.4	11.6	3.7	10.7	29.3	70.7	100.0
Average	19.1	1.9	14.9	3.1	5.9	44.9	55.1	100.0

Appendix B 6.—Estimated harvest (by gear type) and escapement as a percent of the total Chilkat River coho salmon run, 2000–2019.

Year	Fishery	Percent of Total Run							Escapement	Total Run
	Sample Size	Troll	Seine	Drift Gillnet	Marine Sport	FW Sport	Subsistence	Total Harvest		
2000	265	16.0	0.7	13.6	1.2	0.5	0.2	32.2	67.8	100.0
2001	250	19.5	0.4	8.6	1.0	1.3	0.1	30.9	69.1	100.0
2002	325	18.2	0.2	19.6	0.6	1.0	0.2	39.7	60.3	100.0
2003	426	23.6	0.5	12.1	1.8	1.1	0.2	39.3	60.7	100.0
2004	254	42.4	0.5	18.4	2.6	1.4	0.2	65.7	34.3	100.0
2005	141	26.7	0.5	16.3	1.2	1.8	0.5	47.0	53.0	100.0
2006	200	25.5	0.1	16.8	1.7	1.2	0.2	45.6	54.4	100.0
2007	73	24.3	0.0	9.3	0.0	1.4	0.3	35.3	64.7	100.0
2008	358	19.4	0.0	26.7	0.7	0.7	0.4	47.9	52.1	100.0
2009	326	15.3	0.4	19.7	0.0	2.6	0.6	38.7	61.3	100.0
2010	427	18.8	0.2	24.4	1.0	0.3	0.2	45.0	55.0	100.0
2011	219	19.8	1.2	14.2	0.8	1.2	0.3	37.5	62.5	100.0
2012	164	17.5	0.0	23.7	1.0	0.6	0.3	43.2	56.8	100.0
2013	355	20.9	0.7	34.4	0.6	0.8	0.4	57.8	42.2	100.0
2014	88	6.9	0.0	8.8	0.2	0.6	0.3	16.8	83.2	100.0
2015	90	14.7	0.8	16.1	0.6	1.4	0.5	34.0	66.0	100.0
2016	56	6.0	0.0	26.6	0.6	1.3	0.8	35.1	64.9	100.0
2017	49	11.3	0.0	17.5	3.0	1.3	0.5	33.7	66.3	100.0
2018	20	10.2	0.0	10.7	1.0	1.6	0.3	23.8	76.2	100.0
2019	44	29.5	0.0	16.9	0.0	1.4	0.5	48.2	51.8	100.0
Average		19.3	0.3	17.7	1.0	1.2	0.4	39.9	60.1	100.0