PACIFIC SALMON COMMISSION
JOINT CHINOOK TECHNICAL COMMITTEE REPORT

ANNUAL REPORT OF CATCH AND ESCAPEMENT FOR 2019

REPORT TCCHINOOK (20)-01

June 29, 2020

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List of Acronyms and Abbreviations

AABM	Aggregate Abundance Based Management
ADF&G	Alaska Department of Fish and Game
AUC	Area-Under-the-Curve
AI	Abundance Index
BEG	Biological Escapement Goal
CI	Confidence Interval
CMRE	Cumulative Mature-Run Equivalent
CNR	Chinook Nonretention
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	Catch per unit effort
CR	Chinook Retention
CRITFC	Columbia River Intertribal Fish Commission
CSAP	Canadian Centre for Science Advice Pacific
CTC	Chinook Technical Committee
CU	Canadian Conservation Units
CV	Coefficient of Variation
CWT	Coded-Wire Tag
CY	Calendar Year
CYER	Calendar Year Exploitation Rate
DFO	Canadian Department of Fisheries and Oceans
DU	Canadian Designatable Units
ESA	U.S. Endangered Species Act
EO	Economic Opportunity fishery
ERA	Exploitation Rate Analysis
FNC	First Nations Caucus
FR	Fraser River
FSC	Food, Social, and Ceremonial
GHL	Guideline Harvest Level
GMR	Genetic Mark–Recapture
GW	Gitwinksihlkw
IM	Incidental Mortality
ISBM	Individual Stock Based Management
LAT	Low Abundance Threshold
LC	Landed Catch
LIM	Legal Incidental Mortality
MEF	Mid-eye to Fork-of-Tail
MOC	Mid-Oregon Coast
MR	Mark–Recapture
MRE	Mature-Run Equivalent
MSF	Mark Selective Fishery
MSY	Maximum Sustainable Yield
NBC	Northern British Columbia (Dixon Entrance to Kitimat including Queen Charlotte Islands)
NMFS	National Marine Fisheries Service
NOC	North Oregon Coast
NOR	Natural-Origin spawner
NWIFC	Northwest Indian Fisheries Commission
ODFW	Oregon Department of Fish and Wildlife
PFMA	Pacific Fishery Management Areas
PFMC	Pacific Fishery Management Council
PSC	Pacific Salmon Commission
PST	Pacific Salmon Treaty
SARA	Canadian Species at Risk Act
SEAK	Southeast Alaska-Cape Suckling to Dixon Entrance
SIM	Sublegal Incidental Mortality
S_{MSY}	Escapement producing MSY
S-R	Spawner-Recruit relationship
SSC	Sentinel Stocks Committee
SSP	Sentinel Stocks Program
t. run	Terminal run
TBD	To Be Determined
tGMR	Transgenerational Genetic Mark Recapture
TBR	Transboundary Rivers (Alsek, Taku, Stikine)
TM	Total Mortality
UGS	Upper Strait of Georgia
UMT	Upper Management Threshold
U_{MSY}	Exploitation Rate at MSY
URB	Columbia River Upriver Brights
WCVI	West Coast Vancouver Island excluding Area 20
WDFW	Washington Department of Fish and Wildlife

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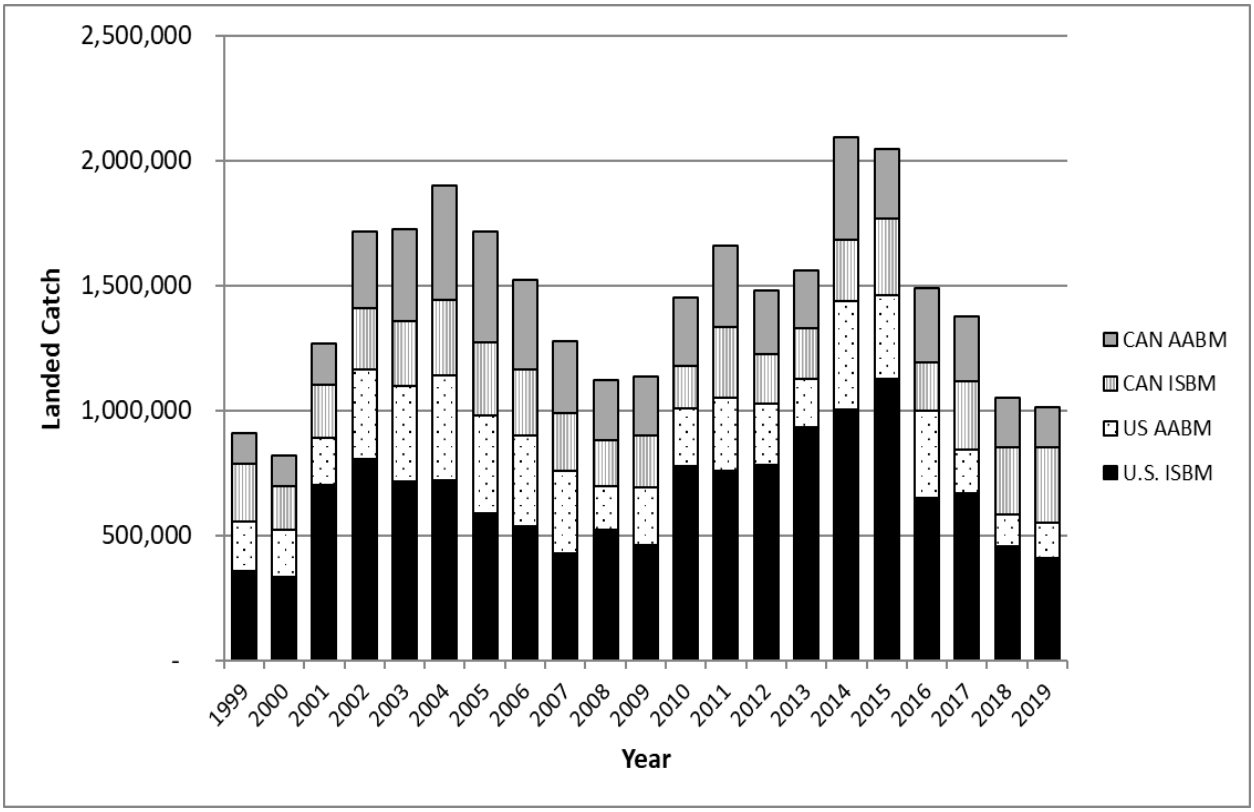
EXECUTIVE SUMMARY

The Pacific Salmon Treaty (PST) requires the Chinook Technical Committee (CTC) to provide the Pacific Salmon Commission (PSC)annual catch and escapement data for Chinook salmon stocks that are managed under the Treaty. This report contains three sections that indicate stock performance in the context of management objectives for 2019: Chinook salmon catches, escapements, and stock status.

Section 1 summarizes, for 2019, fishery catches by region and available estimates of incidental mortality (IM) by fishery, with accompanying commentary on the fisheries, management, and derivation of IM. Canada and the US compile annual catch data and estimates of IM for their respective jurisdictions within the PST area according to fishery regimes, regional locations, and gear type. Landed catch (LC) is fully reported in the appendices for each geographic area covered under the PST. A summary for all PSC Aggregate Abundance Based Management (AABM) and Individual Stock Based Management (ISBM) fisheries, from 1999 to 2019, is provided in the figure below. Time series of available IM estimates are provided in Appendix A for individual fisheries. Appendix A also includes a coastwide summary of the historical time series of LC, IM, and their sum, total mortality (TM), across all AABM and ISBM fisheries.

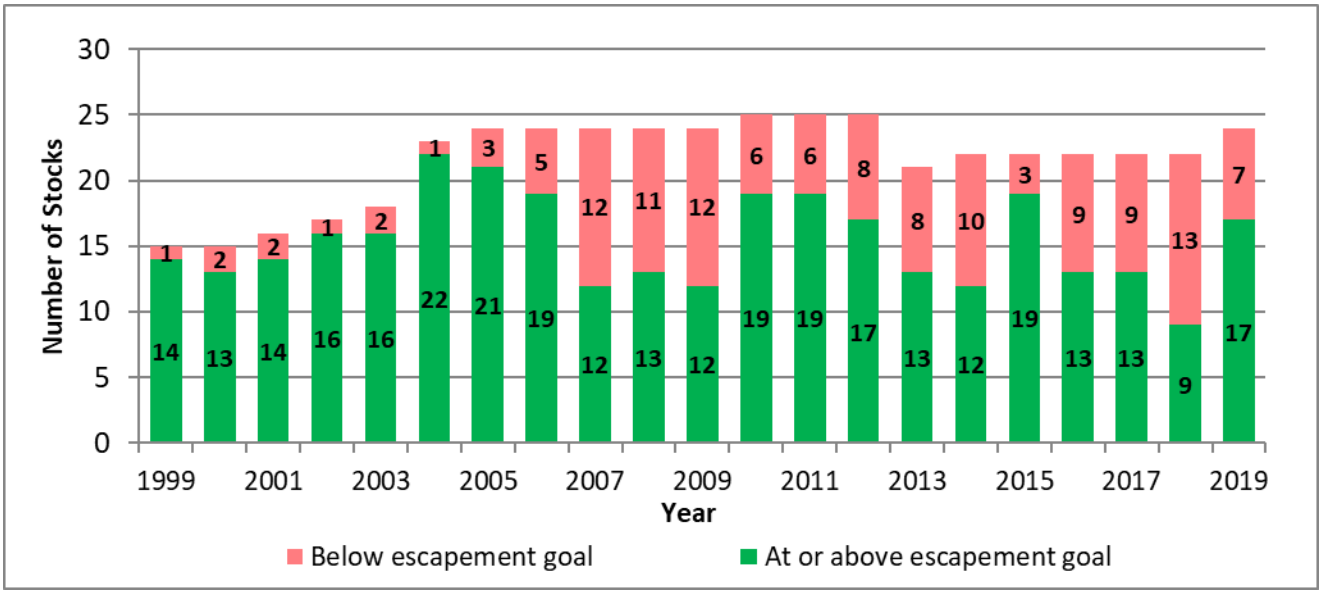


Estimates of landed catch for U.S. and Canada AABM and ISBM fisheries, 1999–2019.

The preliminary estimate of Treaty LC of Chinook salmon for all PST fisheries in 2019 is 1,015,517, of which 551,765 were taken in U.S. fisheries and 463,752 were taken in Canadian fisheries. Total estimated IM associated with this harvest is 215,587 (18% of the TM) in nominal fish. The TM for all PST fisheries in nominal fish was 1,231,104 Chinook salmon, which is approximately 8,100 less than estimated for 2018 (Table A25). Of the PSC TM estimated for 2019, 663,305 occurred in U.S. fisheries and 567,799 occurred in Canadian fisheries. For U.S. fisheries, 75% of the LC and 49% of IM occurred in ISBM fisheries; in Canada, 65% of the LC and 74% of IM occurred in ISBM fisheries. For some component sport fisheries, 2019 LC and IM estimates are not yet available. Data for calculating summary information for 2019 and previous years can be found in Table A23, Table A24, and Table A25.

Section 2 includes an assessment of escapement for 49 PST escapement indicator stocks. Some of the indicator stocks are stock aggregates. There are 24 stocks that currently have PSC-agreed biologically based goals, 6 of which have escapement goals defined as a range, and 18 having escapement goals that are the point estimate of S_{MSY} (escapement producing maximum sustained yield). Annual escapements that are more than 15% below the lower end of the range or the S_{MSY} point estimate are noted. The CTC will continue to review escapement goals for stocks as they are provided by respective agencies.

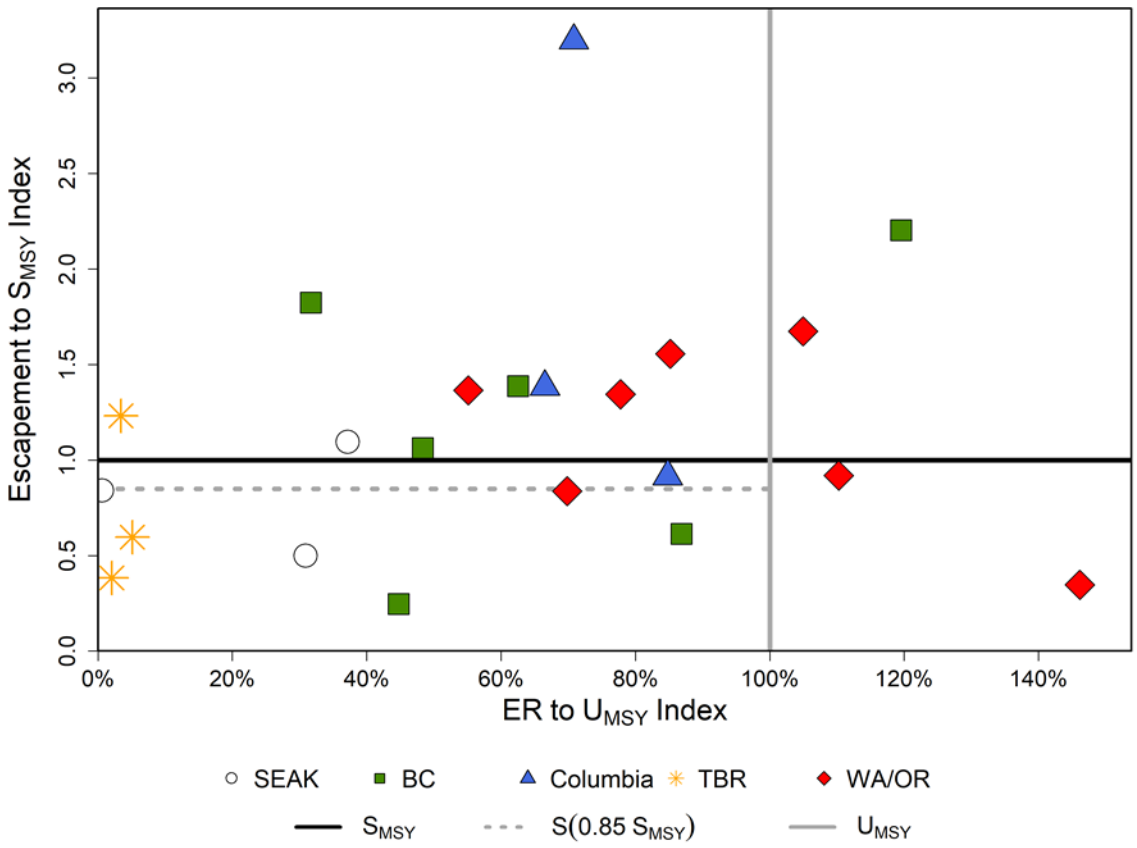
From 1999 to 2019, the percentage of stocks that met or exceeded escapement goals or goal ranges has varied from 41% to 96% (see figure below). In 2019, the percentage of stocks that met or exceeded goal was 71%. Of the 7 stocks below goal, 2 stocks (Stikine and Atnarko) were within 15% of the goal and 5 stocks were more than 15% below goal (Taku, Harrison, Queets spring/summer, Hoh spring/summer, and Siuslaw).



Number and status of stocks with PSC-agreed escapement goals, 1999–2019.

Note: The Keta, Blossom, and King Salmon rivers and Andrews Creek stocks were dropped as escapement indicator stocks in 2013 and Grays Harbor fall was added in 2014. In 2019, the Deschutes and Chickamin rivers stocks were dropped and the Atnarko, Lower Shuswap. Skagit spring, and Skagit summer/fall stocks were added bringing the total number of current indicator stocks with PSC-agreed escapement goals to 24.

Section 3 presents a synoptic evaluation of stock status that summarizes the performance of those stocks relative to established goals over time for many of the escapement indicator stocks. This evaluation draws upon catch information (Section 1), escapement information (Section 2), and exploitation rates to evaluate the status of stocks. Synoptic plots present both the current status of stocks and the history of the stocks relative to PST management objectives; this information summarizes the performance of fisheries management relative to stocks achieving established or potential goals. The synoptic summary figure below shows that, of the 22 stocks with 2018 data and biological reference points as indicated in Table 3.2, 10 of the stocks were in the safe zone (exploitation below U_{MSY} and escapement above S_{MSY}). Two stocks, Siuslaw and Nehalem, were in the high-risk zone, with the Siuslaw displaying the extreme value to the far right. One stock, Lewis, was in the buffer zone. Two stocks, Cowichan and Siletz, experienced exploitation above U_{MSY} with escapements exceeding S_{MSY}. Seven stocks were in the low escapement and low exploitation zone: Situk, Chilkat, Taku, Stikine, Nicola, Harrison, and Queets Fall.



Synoptic summary by region of stock status for stocks with escapement and exploitation rate data in 2018 (escapement and exploitation rate data for each stock was standardized to the stock-specific escapement goal and U_{MSY} reference points).

1. CATCH

The 1999 Pacific Salmon Treaty Annex and the Related Agreement (PST Agreement) substantially changed the objectives and structure of the fishery management framework by eliminating the previous ceiling and pass-through fisheries and replacing them with Aggregate Abundance Based Management (AABM) and Individual Stock Based Management (ISBM) fisheries. The 2019 PST Agreement defines catch limits based on an Abundance Index (AI) for Chinook salmon in Northern British Columbia (NBC) and West Coast Vancouver Island (WCVI) AABM fisheries, but catch limits in the Southeast Alaska (SEAK) AABM fishery are now based on a winter troll catch-per-unit-effort (CPUE) index. The 2019 Agreement also requires that ISBM fisheries be managed on a national basis to meet stock-specific agreed-to maximum sustained yield (MSY) or other biologically based escapement objectives or to limit exploitation rates (CYER) to the levels specified in Chapter 3 Attachment I if escapement goals are not met.

In response to coastwide conservation concerns, the 2009 PST Agreement called for negotiated reductions of 15% and 30%, respectively, in catches and associated harvest rates in the SEAK and WCVI AABM fisheries. The 2019 PST Agreement calls for additional sliding scale reductions in the SEAK ABBM fishery (from 7.5% in the lowest AI tiers to 1.5% in the highest AI tier) and sliding scale reductions in the WCVI AABM fishery (from 12.5% in the lowest AI tiers to 2.5% in the highest AI tier) beyond the 2009 PST Agreement levels, as well as strengthened accountability provisions for ISBM fisheries. The revised Agreement established the calendar year exploitation rate (CYER) as a metric to evaluate performance of ISBM fisheries. If escapement goals are not being met, this metric can limit the number of fish from a particular stock that can be harvested in a given year relative to how many return to the spawning grounds in that year.

In addition, it requires an evaluation of estimates of encounters, incidental mortality (IM) and total mortality (TM) in all fisheries (Appendix A 3(a)), including:

- post-season estimates of IM that include estimates from mark selective fisheries (MSF) (paragraph 4(e)(ii)),
- TM (paragraph 4(e)(ii), Appendix A 3(b)),
- causes of significant changes in rates or patterns of IM (paragraph 4(e)(iii), Appendix A 3(c)),
- whether IM exceeds 59,400 for SEAK AABM, and 38,600 for the combined aggregate of NBC and WCVI AABM (paragraph 4(f)), and
- for ISBM fisheries, annual reporting of total adult equivalent mortality for stocks that are not meeting agreed objectives (paragraph 5(a)), or for stocks without objectives (Appendix A 11).

This section addresses these requirements. It assesses landed catch (LC), IM and TM for all PST fisheries targeting Chinook salmon (Chinook Retention; CR) as well as those directed at other salmon species (Chinook Nonretention; CNR) in 2019. Historical LC, IM, and TM data are given in Appendix A.

1.1 Review of Aggregate Abundance Based Management Fisheries

AABM fisheries for Chinook salmon are managed to a treaty catch limit set annually preseason (2019 PST Agreement, Annex IV, Chapter 3, Tables 1 and 2). AABM fisheries are mixed stock salmon fisheries that intercept and catch migratory Chinook salmon from many stocks. There are three AABM fisheries (2019 PST Agreement, Annex IV, Chapter 3, paragraph 3 (a)):

(1) SEAK Troll, Net, and Sport,

(2) NBC Troll and Haida Gwaii Sport, and

(3) WCVI Troll and Outside Sport.

The 2009 PST Agreement specified that AABM fisheries would be managed to treaty catch limits based on preseason AIs, where a specific estimate of allowable treaty catch corresponds to a given AI for each fishery. The 2019 PST Agreement continues the use of preseason AIs for NBC and WCVI AABM fisheries but uses a CPUE relationship to set preseason catch limits for the SEAK AABM fishery. Table 1.1 provides the annual catch limits for all three AABM fisheries as well as an assessment of fishery performance relative to PST catch limits. Beginning in 2019, if the observed catch exceeds the preseason catch limit (overage) then the overage shall be paid back in the fishing year after the overage occurs (paragraph 6(h)(i)). In 2019, all three AABM fisheries were at or below their respective catch limits (underage).

Table 1.1.– Annual catch limits, observed catches and hatchery add-ons for AABM fisheries expressed in thousands of Chinook salmon.

Catches exceeding preseason catch limits (overages) are shown in red; catches below preseason catch limits (underages) are in green.

Year	Southeast Alaska (T, N, S)			Northern British Columbia (T), Haida Gwaii (S)		West Coast Vancouver Island (T, S)	
	Treaty Catch		Hatchery Add-on[2]	Treaty Catch		Treaty Catch	
	Limit[1,4]	Observed		Limit[1]	Observed	Limit[1]	Observed
2009	218.8	228.0	62.0	143.0	109.5	107.8	124.6
2010	221.8	230.6	53.6	152.1	136.6	143.7	139
2011	294.8	291.2	65.6	182.4	122.7	196.8	204.2
2012	266.8	242.8	51.4	173.6	120.3	133.3	135.2
2013	176.0	191.4	65.6	143.0	115.9	115.3	116.9
2014	439.4	435.2	56.6	290.3	216.9	205.4	192.7
2015	237.0	335.0	68.1	160.4	158.9	127.3	119.0
2016	355.6	350.9	35.4	248.0	190.2	133.3	103.1
2017	209.7	178.3	32.7	149.5	143.3	115.3	117.4
2018	144.5	127.8	37.0	131.3	109.0	88.3	85.3
2019[3]	140.3	140.3	34.6	124.8	88.0	79.9	73.5
2020	205.2			133.0		87.0	

Note: T = Troll, N = Net and S = Sport fisheries.

[1] Allowable treaty catch corresponds to the preseason abundance index.

[2] Treaty catch does not include hatchery add-on or exclusions (see Table A1).

[3] 2019 is the first year the 2019 Agreement is being implemented.

[4] Beginning in 2019 the SEAK preseason allowable catch is based on the CPUE method.

1.1.1 Southeast Alaska Fisheries

The SEAK Chinook salmon fishery is managed to stay within the annual all-gear PST total allowable catch limit determined by the SEAK early winter District 113 Troll fishery CPUE metric estimated from data collected in statistical weeks 41–48. Catch is allocated among troll, net, and sport fisheries through regulations established by the Alaska Board of Fisheries. The current allocation plan reserves 1,000 fish for set gillnet fisheries and 4.3% and 2.9% of the remaining all-gear catch is allocated to the purse seine and drift gillnet fisheries. After the net quotas are subtracted, 80% of the remainder is allocated to the commercial troll fishery and the other 20% to sport fisheries. The commercial troll and net fisheries are managed inseason according to procedures outlined in gear-specific management plans. The commercial fishery harvest is monitored inseason using a fish ticket reporting system. Sport fishery bag and possession limits, as well as annual limits, are established preseason to stay within the allowable sport catch. Sport fishery harvests are monitored inseason using integrated data from port sampling (creel) and charter logbook reporting programs. Sampling programs are in place for all fisheries to recover coded-wire tags (CWTs) from tagged Chinook salmon and to estimate the number of Alaska hatchery fish caught. The regulatory history and maps for each SEAK fishery are contained within annual management reports for the troll, net and sport fisheries which can be found on the Alaska Department of Fish and Game (ADF&G) website (https://www.adfg.alaska.gov/). In addition, the SEAK AABM fishery is managed for the following:

(1) Alaska hatchery add-on (CTC 1992) and exclusion of Chinook salmon catches in selected terminal areas (CTC 2004a),

(2) compliance with provisions established by the National Marine Fisheries Service (NMFS) in accordance with the U.S. Endangered Species Act (ESA), and

(3) consistency with the provisions of the PST as required by the Salmon Fishery Management Plan of the North Pacific Fishery Management Council that was established by the U.S. Magnuson-Stevens Act.

The total all-gear catch in 2019 was 175,096, with a PST catch of 140,307, an Alaska hatchery add-on of 34,578 (Table 1.2), and a terminal exclusion catch of 211 Chinook salmon. The 2019 Treaty catch of 140,307 was below the 2019 CPUE-based harvest limit of 140,323. SEAK Chinook salmon catch data from 1975 to 2019 are reported in Table A1.

Table 1.2–Harvest of Chinook salmon in Southeast Alaska by gear type in 2019.

Gear	Total Catch	Alaska Hatchery Catch[1]	Alaska Hatchery Add-on[1]	Terminal Exclusion Catch[2]	AABM Catch[3]
Troll					
Winter	12,366	1,647	1,087	0	11,279
Spring	12,536	5,398	3,814	211	8,511
Summer	84,462	1,796	1,185	0	83,277
Troll subtotal	109,364	8,841	6,087	211	103,067
Sport	29,700	6,600	5,104	0	24,596
Net					
Set Net	246	0	0	0	246
Drift gillnet	14,419	12,773	11,377	0	3,042
Seine	21,367	12,506	12,011	0	9,356
Net subtotal	36,032	25,280	23,387	0	12,644
Total	175,096	40,721	34,578	211	140,307
				CPUE-based tier catch limit =	140,323
				Underage =	16

Note: Annette Island Metlakatla Indian Community tribal harvest of 1,309 Chinook salmon are included of which 1,053 were Treaty fish. This includes a total tribal harvest of 736 troll, 385 drift gillnet, 188 purse seine fish, of which 559 troll, 306 drift gillnet, and 188 purse seine were Treaty fish.

[1] The add-on is the total estimated Alaska hatchery catch, minus 5,500 base period Alaska hatchery catch, and minus the risk adjustment (product of standard error for the total estimated Alaska hatchery catch and a risk factor of 1.282).

[2] Terminal exclusion catch is a result of the harvest sharing arrangement on the Taku and Stikine rivers.

[3] Treaty catch is the total catch minus Alaska hatchery add-on minus terminal exclusion catch. Totals may not equal the sum of the individual values due to rounding.

1.1.1.1 Troll Fisheries Catch

The accounting of Treaty Chinook salmon harvested by trollers begins with the winter fishery and ends with the summer fishery. The winter troll fishery is managed for a guideline harvest level (GHL) of 45,000 non-Alaska hatchery-produced Chinook salmon, with a guideline harvest range of 43,000−47,000 non-Alaska hatchery-produced fish, plus the number of Alaska hatchery-produced Chinook salmon harvested during the winter fishery. The 2018–2019 winter troll fishery was open from October 11, 2018 through March 15, 2019. To help reduce encounters of wild SEAK and Transboundary River (TBR) Chinook salmon, the winter season fishery was closed from March 16 through April 30, prior to reaching the GHL. A total of 12,366 Chinook salmon were harvested. Of these, 1,647 (13%) were of Alaska hatchery origin, of which 1,087 counted toward the Alaska hatchery add-on, resulting in a Treaty harvest of 11,279 (Table 1.2).

The spring troll fisheries target Alaskan hatchery-produced Chinook salmon and are conducted along hatchery migration corridors or close to hatchery release sites. Terminal area fisheries, which begin during the spring, occur directly in front of hatcheries or at remote release sites. While there is no ceiling on the number of Chinook salmon harvested in the spring fisheries, the

take of Treaty Chinook salmon is limited according to the percentage of the Alaskan hatchery fish harvested in the fishery. Non-Alaska hatchery fish are counted towards the annual Treaty catch limit of Chinook salmon, while most of the Alaska hatchery (add-on) fish are not.

The 2019 summer troll fishery included two Chinook salmon retention periods, from July 1–5 and August 13–14. Following the two traditional summer retention periods, an allocated non-competitive limited harvest fishery was conducted from September 1–10 during the second summer coho-directed fishery to harvest the remaining portion of the annual troll Treaty Chinook salmon allocation. Alaska regulations state that if the number of Chinook salmon remaining on the annual troll allocation, following the second traditional summer retention period, is insufficient to prosecute a competitive fishery, the troll fishery may reopen to the harvest of Chinook salmon in a limited harvest fishery. In 2019, a maximum of two Chinook salmon per permit could be retained over the 10-day limited harvest fishery period. A total of 84,462 Chinook salmon were harvested during summer, of which 1,796 (2%) were of Alaskan hatchery origin and 1,185 counted toward the Alaska hatchery add-on. The resulting Treaty Chinook salmon harvest was 83,277 fish.

The total harvest for all troll fisheries in the 2019 accounting year was 109,364 Chinook salmon, of which 103,067 were Treaty Chinook salmon. This includes a total harvest of 736 in the Annette Island Metlakatla Indian Community tribal troll fishery of which 559 were Treaty Chinook salmon.

1.1.1.2 Net Fisheries Catch

There are three types of commercial net fisheries conducted in SEAK: purse seine, drift gillnet, and set gillnet. A total of 14,419 Chinook salmon were harvested in the drift gillnet fisheries in 2019, of which 12,773 (89%) were of Alaska hatchery origin and 11,377 counted toward the Alaska hatchery add-on, resulting in a Treaty harvest of 3,042 fish (Table 1.2). This includes a harvest of 385 in the Metlakatla Indian Community tribal drift gillnet fishery of which 306 were Treaty Chinook salmon. A total of 21,367 Chinook salmon were harvested in the purse seine fisheries, of which 12,506 (59%) were of Alaska hatchery origin and 12,011 counted toward the Alaska hatchery add-on, resulting in a Treaty harvest of 9,356 fish. This includes a harvest of 188 in the Metlakatla Indian Community tribal purse seine fishery; all 188 were Treaty Chinook salmon. A total of 246 Chinook salmon were harvested in the set gillnet fisheries, none of which were of Alaska hatchery origin, resulting in a Treaty harvest of 246 fish (Table 1.2).

With the exception of directed gillnet harvests of Chinook salmon in SEAK terminal area regulatory Districts 108 and 111, as provided for in the Transboundary River chapter of the 2019 PST Agreement, harvests of Chinook salmon in the net fisheries are primarily incidental to harvest of other species and only constituted a small fraction (<1.0%) of the total net harvest of all species.

1.1.1.3 Sport Fishery Catch

In 2019, the management plan required a daily bag limit of one Chinook salmon 71 cm (28 inches) or greater in total length (tip of snout to tip-of-tail) for resident and nonresident anglers. The nonresident annual limit was 3 Chinook salmon between January 1 and June 30 and one Chinook salmon thereafter (July 1 – December 31); any Chinook salmon harvested by a

nonresident angler during the earlier period (January 1 – June 30) applied towards the one-fish annual limit of the later period.

Below-escapement goal preseason forecasts along with low returns in 2018 indicated that 2019 would likely be another poor return year. In March 2019, more restrictive sport regulations were enacted in Yakutat and the inside waters of Haines/Skagway, Juneau, Petersburg/Wrangell, and Ketchikan management areas to protect SEAK wild Chinook stocks, including Unuk, Chilkat, and King Salmon stocks of concern (Lum and Fair 2018a, 2018b). These more restrictive measures—effectively fishery closures—remained in place through mid-June for northern SEAK, mid-July for central SEAK, and mid-August for southern SEAK.

Inseason assessment and accounting of the sport harvest of Chinook salmon during 2019 dictated inseason management measures as directed by the *Southeast Alaska King Salmon Management Plan (*5 AAC 47.055*)*, in order to keep the sport fishery within its harvest allocation; according to the management plan, nonresident anglers will be restricted first, and the department shall only restrict resident anglers if nonresident angler restrictions are insufficient to remain within the sport harvest allocation. Based on king salmon harvest estimates accumulated through June of 2019 and the projected harvest for the remainder of the season, a period of Chinook salmon nonretention for nonresident anglers became necessary to ensure that the sport fishery remained within its harvest allocation. A period of nonresident nonretention across the region was implemented on August 1, with anticipated duration through September 15. Based on continued inseason accounting of the sport harvest of Chinook salmon, the nonresident nonretention period was rescinded on August 16; nonresident bag and annual limits identified initially for the July 1 – December 31 time period were thus reinstated, effective August 16.

The 2019 total sport Chinook salmon catch was 29,700 with an estimate of 6,600 Alaska hatchery fish. There was an Alaska hatchery add-on of 5,104 fish, resulting in a catch of 24,596 Treaty Chinook salmon (Table 1.2).

1.1.1.4 Alaska Hatchery Add-on and Treaty Catch

The yearly calculation of the Alaska hatchery add-on requires three pieces of information: the estimated total catch of Alaska hatchery-origin Chinook salmon in SEAK fisheries, a base (base level of catch) and a risk adjustment. The calculation of the add-on consists of subtracting the base and the risk adjustment from the estimated total number of Alaska hatchery Chinook salmon caught. The add-on would not be applied (assumed to be zero) if the estimated catch of Alaska hatchery produced Chinook salmon in a particular year did not exceed the sum of the risk adjustment and the base.

The total Alaska hatchery contribution estimate is the sum of multiple gear specific contribution estimates. The non-terminal Alaska hatchery contribution estimates are estimated using expanded CWT recoveries and utilize “preferred” expansion strata that vary by gear and fishery using estimation procedures contained in Bernard and Clark (1996).

The risk adjustment is a penalty that is incurred due to uncertainty in the estimation of the contribution of Chinook salmon from Alaska hatcheries which results from coded wire tagging and sampling at less than 100%. The risk adjustment is the result of a statistical calculation (the

margin of error associated with a one-sided lower confidence limit) and is inversely related to the level of coded wire tagging of Alaska hatchery produced Chinook salmon and to the level of CWT sampling that takes place in SEAK.

The base (or base level catch) consists of two components, a pre-Treaty base and a post-Treaty base. The original pre-Treaty base of 5,000 Chinook salmon was the estimated catch of Alaska hatchery produced Chinook salmon in SEAK fisheries in 1984 (just prior to the signing of the PST in 1985). A post-Treaty base of 500 Chinook salmon was added in 1996 to account for production of Chinook from SEAK hatcheries that came online in the early 1990s after the signing of the Treaty. Therefore, a current base of 5,500 Chinook salmon (the sum of the pre- and post-Treaty base) is used in the add-on calculation each year.

The 2019 preterminal Alaska hatchery contribution to the troll fishery was 8,100 Chinook and the hatchery terminal area catch was 749 Chinook. The preterminal Alaska hatchery contribution to the net fisheries was 5,565 Chinook and the hatchery terminal area catch was 20,207. Most of the commercial hatchery terminal area Chinook catch is usually taken by the seine fleet and 2019 was no exception. By the time Alaska hatchery Chinook return to hatchery terminal areas they are no longer actively feeding and are difficult to catch using troll gear. The easiest means of harvesting the fish that have made it past the preterminal fisheries is by using seine gear. The 2019 preterminal Alaska hatchery contribution to the sport fishery was 4,400 Chinook and hatchery terminal area catch was 2,200. The all-gear Alaska hatchery contribution estimate for 2019 was 41,221 Chinook and the variance of the all-gear contribution estimate was 794,839.52. The hatchery add-on was therefore calculated as:

$$Risk\ Adjustment = Risk\ Level * Standard\ Error(AK\ Hatchery\ Contribution)$$
$$= \sqrt{794{,}839.52} * 1.282 = 1{,}143$$

where

$Risk\ Level$ = 1.282 (a one-tail 90 percent normal deviation from the mean),

and

$$Hatchery\ Addon = AK\ Hatchery\ Contribution - Base\ Level\ Catch - Risk\ Adjustment$$
$$= 41{,}221 - 5{,}500 - 1{,}143 = 34{,}578$$

There were no directed terminal gillnet fisheries for Chinook near the Taku and Stikine rivers in 2019 due to record poor returns that resulted in neither stock achieving its escapement goal. Likewise, there was no directed Chinook catch in the Situk River. The only wild terminal exclusion catch consisted of 211 Chinook taken by troll gear near the Taku River. Therefore, the 2019 Treaty catch was:

$$Treaty\ Catch = Total\ Catch - Hatchery\ Addon - Terminal\ Exclusions(Situk\&TBR)$$
$$= 175{,}096 - 34{,}578 - 211 = 140{,}307$$

1.1.2 British Columbia Fisheries

The NBC AABM fishery includes NBC troll catch in Statistical Areas 1–5 and Haida Gwaii (QCI) sport catch in Statistical Areas 1 and 2. The total NBC AABM catch in 2019 was 88,026 (Table 1.3). The WCVI AABM fishery includes the WCVI commercial and First Nations troll and a portion of the WCVI sport fishery (defined below). The total WCVI AABM catch in 2019 was 73,482 (Table 1.4).

1.1.2.1 Northern British Columbia AABM

The total NBC AABM catch (troll plus sport) between October 1, 2018 and September 30, 2019 was 88,026 Chinook salmon which was below the Treaty harvest limit of 124,800 (Table 1.3).

Table 1.3–Harvest of Chinook salmon by gear for Northern British Columbia AABM fisheries in 2019.

NBC Fishery	Landed Catch	Legal Releases	Sublegal Releases
Troll			
Summer	42,801	108	4,315
CNR Troll	25	29,195	6,479
Troll subtotal	*42,826*	*29,303*	*10,794*
Sport	45,200	24,651	0
TOTAL	**88,026**	**53,954**	**10,794**

1.1.2.1.1 Northern British Columbia Troll Fishery Catch

The NBC troll fishery landed 42,826 Chinook salmon from August 20 to September 30, 2019. The entire 2019 NBC troll fishery was conducted under a system of individual transferable quotas. All landings of Chinook salmon caught in the NBC troll fishery were made at designated landing sites and catches were validated by an independent contractor. Validation of landings has occurred since 2005. A total of 221 licenses were issued, but the total catch was landed by 136 vessels due to quota transfers. Barbless hooks and revival boxes were mandatory in the troll fishery and the minimum size limit was 67 cm fork length (26.4 in). No troll test fisheries were conducted in 2019. A ribbon boundary around Langara Island and from Shag Rock to Cape Knox on Graham Island excluded the commercial troll fishery from areas within one nautical mile of the shore from August 20 to September 15, 2019. A ribbon boundary from Skonun Point to Shag Rock on Graham Island excluded the commercial troll fishery from areas within one nautical mile of the shore from August 20 to September 9, 2019.

1.1.2.1.2 Northern British Columbia Sport Fishery Catch

Sport-caught Chinook salmon from Haida Gwaii (Pacific Fishery Management Areas 1, 2, 101, 102 and 142) are included in the AABM totals. Catches in the Haida Gwaii sport fisheries have been estimated since 1995 through lodge logbook programs, creel surveys, and independent observations by Fisheries and Oceans Canada (DFO) staff. The 2019 Haida Gwaii sport catch was 45,200 Chinook salmon.

1.1.2.2 West Coast Vancouver Island AABM

Under the 2019 PST Agreement, the WCVI AABM fishery includes the WCVI troll and the

outside WCVI sport fishery (defined below). The total AABM LC in the commercial troll, outside tidal sport, and First Nations troll in 2019 was 73,482 Chinook salmon which was below the Treaty harvest limit of 79,900 (Table 1.4).

Table 1.4–Harvest of Chinook salmon by gear for West Coast Vancouver Island AABM fisheries in 2019.

WCVI Fishery	Landed Catch	Legal Releases	Sublegal Releases
Troll			
Winter	0	0	0
Spring	0	0	0
Summer	23,195	0	555
Food, social, and ceremonial	5,000	N/A	N/A
Maa-nulth	1,184	N/A	N/A
T'aaq-wiihak	7,123	277	0
Brooks Test Fishery	339	48	0
Troll subtotal	*36,841*	*325*	*557*
Sport	36,641	12,781	26,631
TOTAL	**73,482**	**13,106**	**27,188**

1.1.2.2.1 West Coast Vancouver Island Troll Fishery Catch

The West Coast of Vancouver Island (WCVI) troll fishery is conducted in Areas 23-27, and Pacific Fishery Management Areas (PFMA) 123-127. The PST accounting year begins October 1 and ends September 30 which covers two domestic management planning years: June 1, 2018 to May 31, 2019 and June 1, 2019 to May 31, 2020.

The Area G Troll annual management plan is designed to maintain conservative exploitation rates on stocks of concern within established limits through the use of fishing time and area closures in conjunction with fishing effort limits. Fishery openings are planned to distribute harvests proportionately over all fishery periods subject to constraints to protect stocks of concern.

Due to domestic constraints for stocks of concern, the 2019 WCVI troll fishery was constrained to August 1to August 8 and August 29 to September 15. The August and September fisheries utilized plug gear only and troll fisheries were monitored to determine encounter rates of other species and estimate numbers of released Chinook. Biological sampling was conducted for size distributions and stock compositions (CWT, DNA and otolith samples).

From May 25 to June 24 and July 15 to August 19, 2019, the Five Nations rights-based sale fishery (T'aaq-wiihak fishery) occurred in portions of PFMAs 24 and 26, and 124–126. The catch for 2019 commercial Area G troll fisheries was 23,195 Chinook salmon (Table 1.4). The WCVI First Nations caught an estimated 5,000 Chinook salmon in food, social, and ceremonial fisheries, 1,184 Maa-nulth and 7,123 in the Five Nations rights-based sale fisheries. The Brooks Test Fishery project harvested 339 Chinook salmon for samples. Therefore, the total WCVI AABM troll catch for 2019 was 36,841 with 325 legal and 557 sublegal Chinook salmon releases.

1.1.2.2.2 West Coast Vancouver Island Sport Fishery Catch

The AABM sport fishery includes northwest WCVI (Areas 25–27, 125–127) from October 16 to June 30, and outside of the surf line (about one nautical mile offshore) from July 1 to October 15, plus southwest WCVI (Areas 21, 23, 24, 121, 123, and 124) from October 16 through July 31, and outside one nautical mile offshore from August 1 to October 15. Areas inside the surf line and outside these AABM periods are included in ISBM fishery catch.

The WCVI AABM sport fishery occurs primarily in the Barkley Sound, outer Clayoquot Sound, and Nootka Sound areas. Most fishing effort occurs from mid-July through August in northwest Vancouver Island and August through mid-September in Southwest Vancouver Island. Creel surveys were conducted from early June to mid-September. The Chinook salmon daily bag limit was two fish greater than 45 cm fork length (17.7 in). Barbless hooks were mandatory. The 2019 WCVI AABM sport LC estimate during the creel period was 35,868 with an additional 773 Chinook reportedly caught in the non-creel periods through an electronic reporting system (iREC) (Table 1.4).

1.2 Estimates of Incidental Mortalities in AABM Fisheries

1.2.1 Southeast Alaska Fisheries

Estimates of encounters and IM in SEAK fisheries are presented for 2019 in Table 1.5 and in Appendix A for prior years. Estimates were converted from total IM into Treaty IM by multiplying the total encounters by the ratio of Treaty catch to LC for each respective fishery. The 2019 troll encounters were estimated from regressions of historical encounter estimates and troll effort. The regression predicts encounters from troll effort using encounter estimates obtained from direct fishery observation programs conducted during a series of years. The CR and CNR sublegal regressions use a data series from 1998 to 2006, while the CNR legal regression uses a data series from 1985 to 1988 and 1998 to 2006 (CTC 2011). Sport fishery releases were computed from the number of Chinook salmon caught and released as recorded on the annual Statewide Catch Survey (mail-in survey) forms. Legal and sublegal CNR purse seine encounters were calculated using a modified catch per landing approach that uses the relationship between the yearly catch and the magnitudes of legal and sublegal CNR encounters for years for which direct observational data are available (CTC 2011). For the gillnet fishery, drop-off mortality was estimated as a percentage of the LC using the region-specific drop-off rate for SEAK (CTC 2004b). Encounter estimates are multiplied by the respective IM rate from CTC (1997) to obtain estimates of IM. The estimated TM in 2019 was 196,973 nominal Treaty fish, including 140,307 LC, and 56,666 IM (Table 1.5).

Chapter 3, Paragraph 4(f) of the 2019 PST Agreement established a 59,400 limit for the level of Treaty IM in the SEAK AABM fishery. The 2019 Treaty IM for SEAK AABM fishery was 56,666, which is below the limit.

Table 1.5–Estimates of treaty and total (includes total treaty, terminal exclusion, and hatchery add-on catch and estimates of incidental mortality) landed catch (LC), incidental mortality (IM; in nominal numbers of fish), and total mortality (TM) in SEAK AABM fishery, 2019.

SEAK Fishery	LC	Legal Encounters	Sublegal Encounters	Total LIM[1]	Total SIM[1]	Total IM	Total Mortality
Treaty							
Troll CR	103,067	103,067	15,774	825	4,149	4,973	108,040
Troll CNR	0	46,384	30,719	10,158	8,079	18,237	18,237
Troll Total	103,067	149,451	46,493	10,983	12,228	23,210	126,277
Sport Total[2]	24,596	37,503	34,268	2,938	5,449	8,386	32,982
Gillnet	3,288	3,288	0	66	0	66	3,354
Seine CR	9,356	9,356	2,887	0	2,477	2,477	11,834
Seine CNR	0	9,150	24,299	4,667	17,860	22,526	22,526
Net Total	12,644	21,794	27,187	4,732	20,337	25,070	37,714
Treaty Total	140,307	208,748	107,947	18,653	38,013	56,666	196,973
Total SEAK							
Troll CR	109,364	109,364	16,738	875	4,402	5,277	114,641
Troll CNR	0	47,045	31,156	10,303	8,194	18,497	18,497
Troll Total	109,364	156,409	47,894	11,178	12,596	23,774	133,138
Sport Total[2]	29,700	45,285	41,379	3,547	6,579	10,126	39,826
Gillnet	14,665	14,665	0	293	0	293	14,958
Seine CR	21,367	21,367	6,594	0	5,658	5,658	27,025
Seine CNR	0	10,991	29,187	5,605	21,453	27,058	27,058
Net Total	36,032	47,023	35,781	5,899	27,110	33,009	69,041
SEAK Total	175,096	248,716	125,054	20,624	46,286	66,909	242,005

[1] Includes dropoff mortality. LIM = Legal Incidental Mortality, SIM = Sublegal Incidental Mortality.

[2] Catch data are preliminary estimates from creel survey expansions; IM for the SEAK sport fishery is estimated from the preliminary LC and the previous year IM to LC ratios. Final estimates are available from mail-out surveys in October one year post fishing season and will be reported in Table A2 and Table A3 of the next annual Catch and Escapement Report.

1.2.2 British Columbia Fisheries

Chapter 3, Paragraph 4(f) of the 2019 PST Agreement established a 38,600 limit for Treaty IM for the combined NBC and WCVI AABM fisheries. The 2019 IM for the NBC and WCVI AABM fisheries was 27,473, which is below the limit.

1.2.2.1 Northern British Columbia Fisheries

Table 1.6 summarizes estimates of LC, encounters, and associated IM by size class during CR and CNR fishing periods for the 2019 NBC AABM fishery. Releases of Chinook salmon from the NBC troll fishery are based on logbook data. Encounters from the QCI sport fishery are based on creel survey and logbook programs. IM estimates were derived using gear- and size-specific rates from the CTC (1997). The estimated TM for 2019 was 104,492 nominal fish, which included 88,026 LC, and 16,466 IM (Table 1.6).

1.2.2.2 West Coast Vancouver Island Fisheries

The estimated TM of Chinook salmon for the 2019 WCVI AABM fishery was 84,489 nominal fish, which included 73,482 LC and 11,007 IM (Table 1.6). The estimated IM included 5,674 legal and 5,333 sublegal nominal Chinook salmon. Table 1.6 also summarizes encounters for these fisheries by size class during CR and CNR fisheries.

Table 1.6–Estimates of total landed catch (LC), incidental mortality (IM; in nominal numbers of fish), and total mortality (TM) in NBC and WCVI AABM fisheries, 2019.

Fishery	LC	Legal Releases	Sublegal Releases	Total LIM[1]	Total SIM[1]	Total IM	Total Mortality
NBC							
Troll CR	42,801	108	4,315	749	1,708	2,457	45,258
Troll CNR	25	29,195	6,479	5,898	2,564	8,462	8,487
Troll Total	42,826	29,303	10,794	6,647	4,272	10,919	53,745
Sport Total	45,200	24,651	0	5,547	0	5,547	50,747
NBC Total	88,026	53,954	10,794	12,194	4,272	16,466	104,492
WCVI							
Troll CR[2]	36,841	325	557	692	220	912	37,753
Troll CNR	0	0	0	0	0	0	0
Troll Total	36,841	325	557	692	220	912	37,753
Sport Total	36,641	12,781	26,631	4,982	5,113	10,095	46,736
WCVI Total	73,482	13,106	27,188	5,674	5,333	11,007	84,489

[1] LIM = Legal Incidental Mortality, SIM = Sublegal Incidental Mortality.
[2] Includes commercial, First Nations troll food, social, and ceremonial and Maa-nulth and T'aaq-wiihak catch and Brooks test fishery.

1.3 Review of Individual Stock Based Management Fisheries

ISBM fisheries include all British Columbia Chinook salmon fisheries that are not included in the NBC and WCVI AABM fisheries, and all marine and freshwater Chinook salmon fisheries in Washington and Oregon. ISBM fisheries are managed with the intent of meeting management objectives for individual stocks listed in Attachment I in Chapter 3, Annex IV, of the 2019 PST Agreement.

1.3.1 Canadian Individual Stock Based Management Fisheries

The Canadian ISBM fisheries include all fisheries that catch or release Chinook salmon in British Columbia that are not AABM fisheries. Catches of Taku River and Stikine River Chinook salmon occurring in Canada are also provided, although provisions for catch sharing arrangements between Canada and the US for these two Transboundary River stocks are described in Chapter 1 of the 2019 Agreement. ISBM obligations are not applicable to these stocks since they are not identified in the Attachments to Chapter 3. In 2019, a total of 302,244 nominal fish were caught in Canadian ISBM fisheries in British Columbia and Canadian sections of the Transboundary Rivers. Total estimated IM in 2019 was 76,574 Chinook salmon. The distribution

of LC and estimated IM are presented in Table 1.7. Historical catches in these fisheries are provided in Appendix Table A4, Table A7, Table A8, and Table A11 through Table A15.

Table 1.7–Landed catch and incidental mortalities in Canadian ISBM fisheries for 2019.

Fishery	Gear	Landed Catch	Releases	IM	Total Mortality
Transboundary Rivers	Net	0	783	741	741
	Freshwater Sport	5	0	0	5
	First Nations-FSC[1]	607	0	28	635
	Total	**612**	**783**	**769**	**1,381**
Northern British Columbia	Net	0	1,010	896	896
	Tidal Sport	15,152	11,129	2,315	17,467
	Freshwater Sport	0	0	0	0
	First Nations-FSC	9,260	N/A	426	9,686
	Tyee Test Fishery	462	11	32	494
	Total	**24,874**	**12,150**	**3,669**	**28,543**
Central British Columbia	Net	6,092	576	707	6,799
	Tidal Sport	10,750	153	411	11,161
	Freshwater Sport	1,895	N/A	131	2,026
	First Nations-FSC	2,045	N/A	94	2,139
	Troll[2]	0	1,878	419	419
	Total	**20,782**	**2,607**	**1,762**	**22,544**
West Coast Vancouver Island	Net	45,505	402	6,810	52,315
	Tidal Sport	42,876	25,353	7,826	50,702
	First Nations-EO[3] and FSC	33,498	10	1,550	35,048
	Total	**121,879**	**25,765**	**16,186**	**138,065**
Johnstone Strait	Commercial & Test Net	60	560	415	475
	Tidal Sport	11,226	14,904	3,636	14,862
	First Nations-FSC	356	3	19	375
	Total	**11,642**	**15,467**	**4,070**	**15,712**
Georgia Strait	Net	0	0	0	0
	Tidal Sport	50,868	156,093	33,480	84,348
	Freshwater Sport	2	2,157	414	416
	First Nations-FSC	1,016	4	51	1,067
	Troll	0	0	0	0
	Total	**51,886**	**158,254**	**33,945**	**85,831**
Juan de Fuca	Commercial & Test Net	155	2,039	1,537	1,692
	Tidal Sport	25,778	44,133	10,252	36,030
	Total	**25,933**	**46,172**	**11,789**	**37,722**
Fraser River	Commercial & Test Net, FN-EO	4,129	1,051	1,181	5,310
	First Nations-FSC Net	29,057	149	1,478	30,535
	Mainstem Catch & Trib Sport	11,450	4,867	1,725	13,175
	Total	**44,636**	**6,067**	**4,384**	**49,020**
Grand Total		**302,244**	**267,265**	**76,574**	**378,818**

[1] FSC = food, social, and ceremonial.

[2] CBC troll releases are expanded (actual releases = 1,427).

[3] EO = economic opportunity.

1.3.2 Southern US Individual Stock Based Management Fisheries

Southern U.S. fisheries in the Treaty area south of the U.S./Canada border are managed in accordance with legal obligations under the PST, several treaties between Native American tribes and the U.S., and conservation constraints of the ESA. Two court cases in the 1970s, *U.S. v. Washington* and *U.S. v. Oregon*, litigated treaty fishing rights and set forth harvest sharing obligations. Catches herein are termed *treaty Indian* if harvested under these Native American Treaty fishing rights cases and *non-treaty* otherwise. Tribal catches not harvested under these court cases are included in non-treaty catch. Currently, all southern U.S. fisheries are ISBM fisheries (Table 1.8). Historical catches in these fisheries are provided in Table A16 through Table A22.

Table 1.8–Landed catch and incidental mortality in Southern U.S. troll, net, and sport fisheries, 2017–2019.

		2019[1]			2018			2017		
Fishery	**Gear**	**LC**	**Release**	**IM**	**LC**	**Release**	**IM**	**LC**	**Release**	**IM**
	Net	41	NA	3	1,830	NA	146	50	NA	4
Juan de Fuca	Sport	11,284	27,358	8,968	14,308	34,688	11,371	9,894	47,535	14,174
	Troll	1,520	NA	38	1,772	NA	44	1,703	NA	43
Total		**12,845**	**27,358**	**9,009**	**17,910**	**34,688**	**11,562**	**11,647**	**47,535**	**14,221**
San Juans	Net	3,661	757	898	3,429	783	901	2,630	46	247
	Sport	8,266	7,957	3,331	7,303	7,030	2,943	11,321	19,295	6,813
Total		**11,927**	**8,714**	**4,229**	**10,732**	**7,813**	**3,844**	**13,951**	**19,341**	**7,060**
Puget Sound	Net	110,114	NA	8,809	112,261	NA	8,981	135,907	NA	10,873
	Sport	35,844	46,093	17,550	43,237	55,600	21,170	41,352	142,624	44,219
Total		**145,958**	**46,093**	**26,360**	**155,498**	**55,600**	**30,151**	**177,259**	**142,624**	**55,092**
Wash. Inside	Net	17,478	NA	350	15,337	NA	307	20,491	NA	410
Coastal	Sport	12,717	NA	877	10,522	NA	726	13,626	NA	940
Total		**30,195**	**-**	**1,227**	**25,859**	**-**	**1,033**	**34,117**	**-**	**1,350**
Columbia	Net	8,692	0	261	24,902	0	747	30,406	0	912
River- Spring	Sport	13,484	612	1,056	23,912	1,938	2,036	33,852	978	2,543
Summer	Net	6,284	0	189	10,858	0	326	18,111	0	543
	Sport	6,982	2,093	739	5,560	2,033	634	9,495	5,011	1,271
Fall	Net	77,750	0	2,333	69,893	0	2,097	139,608	0	4,188
	Sport	29,846	20,784	6,050	32,778	5,689	3,354	77,917	8,768	7,060
Total		**143,038**	**23,489**	**10,627**	**167,903**	**9,660**	**9,193**	**309,388**	**14,757**	**16,518**
WA/OR	Sport	10,714	6,988	1,337	10,603	10,321	1,834	21,945	18,604	3,383
North Falcon	Troll	41,665	NA	1,042	47,792	NA	1,195	59,974	NA	1,499
Total		**52,379**	**6,988**	**2,379**	**58,395**	**10,321**	**3,029**	**81,919**	**18,604**	**4,882**
Oregon	Sport[2]	15,115	NA	1,043	19,469	NA	1,343	40,880	NA	2,821
Inside	Troll[3]	-	NA	-	322	NA	8	70	NA	2
Total		**15,115**	-	**1,043**	**19,791**	-	**1,351**	**40,950**	-	**2,822**
GRAND TOTAL		**411,458**	**112,642**	**54,874**	**456,089**	**118,083**	**60,163**	**669,232**	**242,861**	**101,945**

[1] WDFW Catch Record Card estimates of LC were not yet available; LC for 2019 was computed using 2016–2018 mean values. Releases for 2019 were computed using the ratio of releases to landed catch from 2018.

[2] Values for 2019 LC and IM are estimates based on averages, not actual observed values. These will become available after the timeframe required for this report.

[3] The value represented by Troll is the concentrated fishery off of the mouth of the Elk River which is designed to specifically exploit returning Elk River Chinook salmon.

1.3.2.1 Strait of Juan de Fuca and the San Juan Islands

The preliminary estimate of the 2019 Chinook salmon catch in Strait of Juan de Fuca (Area 4B, 5, 6, and 6C) net fisheries was 41 fish. There were 3,661 Chinook salmon harvested in the San Juan Islands net fisheries (Area 6A, 7, and 7A). The preliminary estimate of the 2019 Strait of Juan de Fuca treaty Indian troll fishery catch (through December 2019) is 1,520 Chinook salmon. The catch estimate does not include catches from Area 4B during the May to September Pacific Fisheries Management Council management period; those are included in North of Cape Falcon ocean fishery catches (see section 1.3.2.4 below). Estimates for sport fisheries in 2019 are not yet available from the Washington Department of Fish and Wildlife (WDFW) Catch Record Card accounting system; thus, the preliminary estimates of sport catches and incidental mortalities in 2019 are approximated by averages of the three preceding years. Historic catch estimates are provided for the Strait of Juan de Fuca (Table A16) and San Juan areas (Table A17).

1.3.2.2 Puget Sound

The preliminary estimate of the net fishery harvest of Chinook salmon in Puget Sound marine and freshwater areas (excluding Strait of Juan de Fuca and the San Juan Islands) in 2019 is 110,114 (100,605 treaty Indian, 9,509 non-Indian). The harvests in treaty Indian fisheries include a preliminary estimate of 38,382 Chinook salmon in inriver fisheries. Estimates of the sport catch in 2019 are not yet available from the Washington Department of Fish and Wildlife (WDFW) Catch Record Card accounting system; thus, the preliminary estimate of sport catch reported here for 2019 is an average of the previous three years (35,844). Historic catch tables for Puget Sound (exclusive of the Strait of Juan de Fuca and San Juan Islands) are provided in Table A18.

1.3.2.3 Washington Coast Terminal

The preliminary 2019 estimate of harvest in Washington coastal net fisheries was 17,478 Chinook salmon. Harvest in treaty Indian fisheries include 13,526 harvested in north coastal rivers (Quinault, Queets, Hoh, and Quillayute rivers) and 2,374 in Grays Harbor and the Humptulips and Chehalis rivers within the basin. The 2019 non-Indian commercial net harvest was 32 Chinook salmon in Grays Harbor and 1,546 from Willapa Bay.

From Grays Harbor north, sport fisheries were implemented based upon preseason state–tribal agreements and were subject to inseason adjustment. Estimates of sport fishery catches for Washington coastal terminal fishing areas in 2019 are not yet available from the Catch Record Card accounting system, but are approximated here based on the average catch from the previous three years (12,717). Historic catch estimates for Washington Coastal inside fisheries are shown in Table A19.

1.3.2.4 North of Cape Falcon

Ocean fisheries off the coasts of Washington, Oregon, and California are managed under regulations recommended by the Pacific Fishery Management Council. The fisheries north of Cape Falcon also fall under the jurisdiction of the PST. For 2019, the estimated catch of Chinook salmon in commercial troll fisheries from Cape Falcon, Oregon, to the U.S.-Canada border was 41,665 for non-treaty and treaty Indian fisheries combined. Estimated catch in the ocean sport

fishery north of Cape Falcon in 2019 was 10,714 Chinook salmon. Historic catch estimates for U.S. ocean fisheries north of Cape Falcon are shown in Table A20.

1.3.2.5 Columbia River

Chinook salmon from the Columbia River are divided into eight stock groups for management purposes. These groups are delineated by run timing and area of origin: (1) spring run originating below Bonneville Dam, (2) spring run originating above Bonneville Dam, (3) summer run originating above Bonneville Dam, (4) fall run returning to Spring Creek Hatchery, (5) fall run originating in hatchery complexes below Bonneville Dam, (6) wild fall run originating below Bonneville Dam, (7) Upriver Bright fall run, and (8) Mid-Columbia Bright fall hatchery fish.

When comparing the IM estimates in Table 1.8 and Table A21 with IM from *U.S. v. Oregon* Technical Advisory Committee, WDFW, Oregon Department of Fish and Wildlife (ODFW), and Columbia River Intertribal Fish Commission (CRITFC) reports, readers should keep the following in mind.

(1) The Columbia River fishery management agencies include release mortality in some of their catch estimates whereas the tables in this report show LC in terms of retained fish only.

(2) Release mortality rates used by Columbia River fishery management agencies differ from those used by the CTC for this report.

(3) The tables in this report include estimates of IM from net dropout and hook and line drop-off, whereas the Columbia River fishery management agencies do not estimate this type of mortality. In 2019, the total annual harvest for all fisheries (spring, summer, and fall, both hatchery and wild) in the Columbia River basin was 143,038 Chinook salmon. This included non-treaty commercial net plus Wanapum and Colville tribal harvest of 15,949; sport harvest of 50,312; and treaty Indian commercial, ceremonial, and subsistence harvest of 76,777 (Table A21). The 2019 total annual Columbia River combined net and sport harvest consisted of 22,176 spring Chinook, 13,266 summer Chinook and 107,596 fall Chinook salmon (Table 1.8).

1.3.2.6 Oregon Coast Terminal

Most harvest in ocean fisheries off Oregon's coast is comprised of a mixture of southern Oregon and California Chinook salmon stocks not included in the PST agreement. These stocks usually do not migrate north into the PST fisheries to any great extent. Chinook salmon originating from Oregon streams north of Cape Blanco migrate north, and most of these populations are included in the North Oregon Coast (NOC) aggregate in the CTC Chinook model. From the mid-Oregon coast to north of Cape Blanco is a smaller population group designated as the Mid-Oregon Coastal (MOC) aggregate population. Based on CWT distribution data, NOC stocks are harvested only incidentally in Oregon ocean fisheries, while the contribution of MOC stocks to Oregon and Washington ocean fisheries is greater. Commercial catch statistics for the MOC are readily available for only one terminal ocean area troll fishery on a hatchery supplemented stock at the mouth of the Elk River. The late season (October to December) troll fishery in the Elk River terminal troll area was closed in 2019.

Sport catch of these two stock groups occurs primarily in estuary and freshwater areas as

mature fish return to spawn, and catch is reported through a punch card accounting system. These estimates become available more than two years after the current season. Therefore, in-river and estuary sport catch punch card estimates are only provided through 2018. The 2018 punch card estimate of estuary and freshwater catch for both groups is 19,469 Chinook salmon. However, catch projections have been made for 2019 using correlations between escapement and punch card catch estimates from past years; these preliminary estimates of terminal sport catch for 2019 are presented in Table 1.8. Historical catch estimates for the troll fishery targeting Elk River and the estuary and freshwater sport fisheries targeting on NOC stocks are shown in Table A22.

1.3.3 Estimates of Incidental Mortality for Southern U.S. Fisheries

Table 1.8 shows estimates of IMs for southern U.S. fisheries in marine and river fisheries in Puget Sound, on the Washington and Oregon coast north of Cape Falcon, Oregon coast terminal fisheries, and in the Columbia River fisheries. IM was calculated using the release mortality, drop-out, and drop-off mortality rates assigned for areas and gears in CTC (1997). Numbers of fish released were derived from creel interviews, voluntary trip reports, fishery monitoring, or extrapolated from similarly structured fisheries with known release information.

1.4 Summary of Coastwide Landed Catch, Incidental Mortality, and Total Mortality in PSC Fisheries

Table 1.9 provides a coastwide summary of Chinook salmon catches and estimates of IM and TM in PST fisheries for 2019. It should be noted, for some component fisheries, that current 2019 LC and IM are not yet available; the preliminary estimates of LC and IM will be updated in future reports as observed data become available.

The preliminary estimate of Treaty LC of Chinook salmon for all PST fisheries in 2019 is 1,015,517, of which 551,765 were taken in U.S. fisheries and 463,752 were taken in Canadian fisheries (Table 1.9). Total estimated IM associated with this harvest is 215,587 (18% of the TM) in nominal fish. The TM for all PST fisheries in nominal fish was 1,231,104 Chinook salmon, which is approximately 8,100 less than recorded for 2018 (Table A25). Of the total PSC TM estimated for 2019, 663,305 occurred in U.S. fisheries and 567,799 occurred in Canadian fisheries. For U.S. fisheries, 75% of the LC and 49% of IM occurred in ISBM fisheries; in Canada, 65% of the LC and 74% of IM occurred in ISBM fisheries. For some component sport fisheries, 2019 LC and IM estimates are not yet available. Data for calculating summary information contained in Table 1.9 for 2019 and previous years can be found in Table A23, Table A24, and Table A25.

Table 1.9–Summary in nominal fish of preliminary estimates for landed catch (LC), incidental mortality (IM), and total mortality (TM) for U.S. and Canada AABM and ISBM fisheries in 2019.

Fishery	2019		
	Landed Catch	Incidental Mortality	Total Mortality
SEAK AABM	140,307	56,666	196,973
SEAK hatchery add-on and terminal exclusion	34,789	34,629	69,417
U.S. ISBM	411,458	54,874	466,332
U.S. Total[1]	551,765	111,540	663,305
NBC AABM	88,026	16,466	104,492
WCVI AABM	73,482	11,007	84,489
Canada ISBM	302,244	76,574	378,818
Canada Total	463,752	104,047	567,799
PST Fisheries Total[1]	1,015,517	215,587	1,231,104

[1] Does not include SEAK AABM fishery nontreaty catch from hatchery add-on and terminal exclusion.

Total mortality in PST fisheries since 1999 is summarized over the four broad categories of AABM and ISBM fisheries for both parties in Figure 1.1. The total mortality across all four fishery groups averaged 1,572,900 Chinook during the 1999 PST Agreement (1999–2008) and averaged 1,743,800 during the 2009 PST Agreement (2009–2018). The ISBM total mortality averages increased for both U.S. and Canadian fisheries between the two PST Agreements by approximately 205,100 fish and 12,500 fish respectively; the averages for the U.S. and Canadian AABM fishery groups decreased by approximately 41,200 in the U.S. and 5,500 in Canada. During the 1999 PST Agreement, 22% of the average total PST-related fishery mortality occurred in U.S. AABM fisheries, 20% in Canadian AABM fisheries, 17% in Canadian ISBM fisheries, and 41% in U.S. ISBM fisheries. During the 2009 PST Agreement the distribution shifted slightly such that 18% of total mortality occurred in U.S. AABM fisheries, 18% in Canadian AABM fisheries, 16% in Canadian ISBM fisheries, and 49% in U.S. ISBM fisheries.

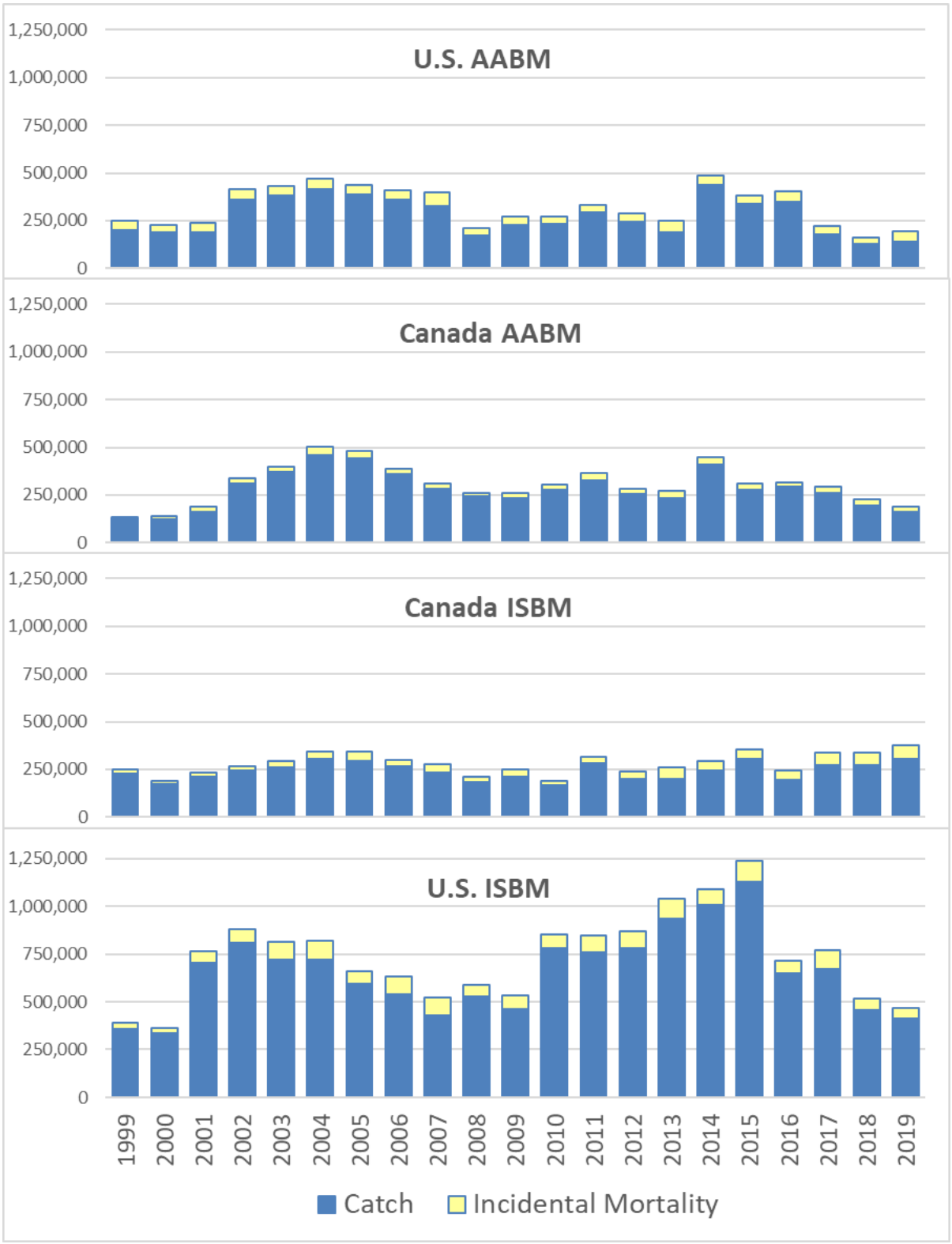


Figure 1.1– Estimates of landed catch, incidental mortality and total mortality for U.S. and Canada AABM and ISBM fisheries, 1999–2019.

2. CHINOOK SALMON ESCAPEMENTS

The 2019 PST Agreement (Annex IV, Chapter 3, Paragraph 2(a)) establishes a comprehensive and coordinated Chinook salmon fishery management program that:

> *"(iii) uses harvest regimes based on annual indices of abundance that are responsive to changes in production, that take into account all fishery induced mortalities, and that are designed to meet maximum sustainable yield (MSY) or other agreed biologically-based numeric escapement or exploitation rate objectives, including those set out in Attachment I,*
>
> *(iv) contributes to the improvement in trends in spawning escapements of depressed Chinook salmon stocks and is consistent with improved Chinook salmon production"*,

Paragraph 2(b)(iii) and Appendix A (1)(c) direct the CTC to report annually on 1) naturally spawning Chinook stocks in relation to the agreed MSY or other agreed biologically-based escapement objectives, 2) rebuilding exploitation rate objectives, or other metrics, and 3) trends in the status of stocks and progress in rebuilding naturally spawning Chinook stocks.

In addition, paragraph 7(a)(iv) directs the CTC to annually provide the Commission with:

> *the status concerning the achievement of stock-specific management objectives; specifically, a table of agreed-to management objectives for each stock included in Attachment I and the annual stock-specific metrics, if available, with the identification of stocks that achieved less than 85% of the point estimate (or lower end range) of the management objective for three consecutive years beginning in 2019*;

Attachment I of Chapter 3 of the 2019 PST Agreement lists 37 escapement indicator stocks, including 22 stocks with escapement goals and 15 stocks with escapement goals to be determined. In addition, the Canadian Okanagan stock is being evaluated, per paragraph 5(b), for future inclusion as an indicator stock.

In this section of the report, the CTC provides information on escapement, escapement performance relative to PSC accepted management objectives, and escapement trends consistent with tasks described in Chapter 3, Appendix A.

2.1 ESCAPEMENT GOAL ASSESSMENTS

This section includes an assessment of escapement for 49 PST escapement indicator stocks, some of which are stock aggregates. There are currently 22 stocks in Attachment I that have management objectives; 18 of these have CTC agreed escapement goals or escapement goal ranges[1] and 4 have agency escapement goals that have been accepted by the PSC but have not undergone CTC review (Atnarko, Lower Shuswap, Skagit Spring, Skagit Summer/Fall). The status and number of stocks in Attachment I with agreed management objectives for return years 2017 through 2019 are shown in (Table 2.1). In 2019, 5 of the 22 stocks were below their escapement goals; of these 3 stocks (Taku, Harrison, Siuslaw) were more than 85% below and 2 stocks (Stikine, Atnarko) were within 85% of their escapement goals.

[1] Escapement goals reviewed by the CTC are based on analyses that follow the guidelines developed in CTC (1999).

Paragraph 7(a)(iv) directs the CTC to identify stocks that achieved less than 85% of the point estimate (or lower end range) of the management objective for three consecutive years. For the 2017 to 2019 there were 3 stocks that failed to achieve 85% of their respective escapement goals in all three consecutive years: Taku, Harrison, and Siuslaw.

Table 2.1.– *Attachment I escapement indicator stocks, management objectives, and escapement performance, 2017–2019.*

For stocks with PSC agreed management objectives, escapements above the goal or lower bound escapement range are in green, escapements within 85% of the goal or lower bound of the escapement range are in yellow, and escapements below the 85% threshold are in red.

Stock group	Run	Escapement Indicator	Management Objective[1]	2017	2018	2019	3 Yrs < 85%?
Southeast Alaska							
Yakutat	Spr	Situk[2]	500-1,000	1,187	420	623	No
Northern Inside	Spr	Chilkat[2]	1,750-3,500	1,173	873	2,028	No
Southern Inside	Spr	Unuk[2]	1,800-3,800	1,203	1,971	3,115	No
Transboundary Rivers							
Transboundary Rivers	Spr	Alsek[2,3]	3,500-5,300	1,718	4,312	6,356	No
		Taku[2,3]	19,000-36,000	8,754	7,271	11,558	Yes
		Stikine[2,3]	14,000-28,000	7,206	8,355	13,817	No
Northern British Columbia							
Northern British Columbia	Sum	Skeena	TBD	18,480	35,005	23,248	
Central British Columbia	Sum	Atnarko[4]	5,009	5,464	5,328	4,587	No
Vancouver Island							
North East Vancouver Island	Fall	TBD	TBD				
West Coast Vancouver Island	Fall	NWVI Natural[5]	TBD	3,233	2,163	2,200	
	Fall	SWVI Natural[6]	TBD	993	750	411	
Fraser River							
Spring-Run 1.2	Spr	Nicola	TBD	1,702	1,627	3,859	
Spring-Run 1.3	Spr	Chilcotin	TBD	493	936	437	
Summer-Run 1.3	Sum	Chilko	TBD	3,591	2,191	2,486	
Summer-Run 0.3	Sum	Lower Shuswap[4]	12,300	13,430	17,120	29,649	No
Fraser Fall 0.3	Fall	Harrison	75,100	29,799	46,094	45,186	Yes
Strait of Georgia							
Lower Strait of Georgia	Fall	Cowichan	6,500	10,590	14,353	14,943	No
Upper Strait of Georgia	Fall	Phillips	TBD	2,468	1,242	2,531	
Puget Sound							
North Puget Sound Natural Springs	Spr	Nooksack Spring	TBD	2,926	NA	NA	
		Skagit Spring[4]	690	2,851	2,376	1,131	No
Puget Sound Natural	Sum/	Skagit Sum/Fall[4]	9,202	12,784	10,903	11,810	No

Summer/Falls	Fall	Stillaguamish	TBD	1,075	562	440	
		Snohomish	TBD	6,119	4,210	1,644	
Washington Coast							
Washington Coastal Fall Natural	Fall	Hoko	TBD	695	2,115	1,779	
		Quillayute Fall	3,000	3,604	4,031	7,256	No
		Hoh Fall	1,200	1,405	1,638	1,552	No
		Queets Fall	2,500	2,721	2,095	2,504	No
		Grays Harbor Fall	13,326	17,145	20,741	14,880	No
Columbia River							
Columbia River Summers	Sum	CAN Okanagan[7]	TBD	NA	NA	NA	
		Mid-Col Summers	12,143	56,265	38,816	41,090	No
Columbia River Falls	Fall	Upriver Brights	40,000	120,582	55,349	96,268	No
		Lewis	5,700	6,058	5,299	14,307	No
		Coweeman	TBD	921	230	374	
Oregon Coast							
North Oregon Coastal	Fall	Nehalem	6,989	6,473	6,420	9,746	No
		Siletz	2,944	7,364	4,929	3,521	No
		Siuslaw	12,925	10,957	4,481	4,797	Yes
Mid Oregon Coastal	Fall	South Umpqua	TBD	5,514	3,692	824	
		Coquille	TBD	6,470	498	265	

[1] Management objective of "TBD" is "to be determined" after CTC review (Paragraph 2(b)(iv)).

[2] Identified for management of SEAK fisheries in paragraph 6(b)(iv).

[3] Stock specific harvest limits identified in Chapter 1 of this Treaty.

[4] Agency escapement goal has the same status as CTC agreed escapement goal.

[5] NWVI Natural Aggregate consists of Colonial-Cayeagle, Tashish, Artlish, and Kaouk.

[6] SWVI Natural Aggregate consists of Bedwell-Ursus, Megin, and Moyeha.

[7] Pending the review specified in paragraph 5(b) of Chapter 3 and a subsequent Commission decision.

The status and number of stocks with agreed goals for return years 1999 through 2019 is shown in Figure 2.1. The percentage of stocks that met or exceeded escapement objectives (at or above point estimate or lower end of range) has varied between 41% and 96%. In 2019, the percentage of stocks that met or exceeded goal was 71%. Of the 7 stocks below goal, 2 stocks (Stikine and Atnarko) were within 15% of the goal and 5 stocks were more than 15% below goal (Taku, Harrison, Queets spring/summer, Hoh spring/summer, and Siuslaw).

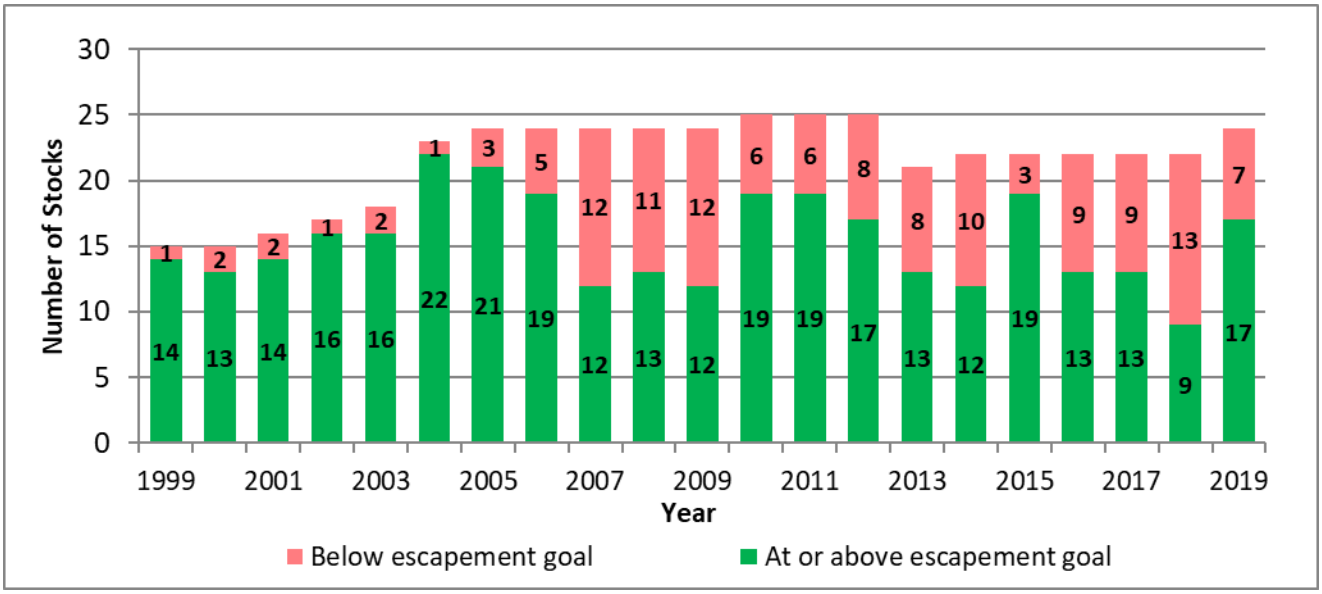


Figure 2.1–Number and status of stocks with PSC-agreed escapement goals, 1999–2019.

Note: The Keta, Blossom, and King Salmon rivers and Andrews Creek stocks were dropped as escapement indicator stocks in 2013 and Grays Harbor fall was added in 2014. In 2019, the Deschutes and Chickamin rivers stocks were dropped and the Atnarko, Lower Shuswap. Skagit spring, and Skagit summer/fall stocks were added bringing the total number of current indicator stocks with PSC-agreed escapement goals to 24.

2.2 Trends for Escapement Indicator Stocks

In this evaluation of escapement trends the socks are grouped into five regions: Southeast Alaska, Transboundary, British Columbia, Washington, and Columbia River/Oregon. The first year in the time series, 1999, corresponds with the start of the 1999 Agreement, except that the Lower Shuswap stock begins in 2000. The time series run through 2019, except that 2018 and 2019 data were not available for the Nooksack Spring stock.

The evaluation uses a state-space exponential growth model (Dennis et al. 2006) parameterized through restricted maximum likelihood (Humbert et al. 2009). Estimates of rates of change produced by this model are generally superior to those produced through maximum likelihood analysis alone (Staples et al. 2004). Assuming the true population size is generated by stochastic exponential growth, this method separates observation error and process noise and it produces variances and confidence intervals (CIs) that fully represent the annual variability associated with environmental stochasticity, along with sampling error (Humbert et al. 2009). Stock-specific escapement trends are characterized by the long-term mean rate of change (μ) and corresponding 80% CIs, where μ = 0.00 represents equilibrium, indicating that escapement has been stable on average for the selected time period. Hence the mean rate of change μ quantifies the mean tendency of escapement over the selected time period. If the ratio of process noise and observation error is constant, the CI represents the inter-annual variability in escapement rates of change (Humbert et al. 2009). A longer time series generally improves (reduces) CIs, and the greater the inter-annual variability, the wider the CI; a CI that straddles 0.00 indicates that the estimated μ is not a significant rate of change.

2.2.1 Escapement Trends for Southeast Alaska Stocks

Escapement trends for 2 of 3 SEAK Chinook salmon stocks (Situk, Unuk) were highly variable and not significantly different from 0.00 (Figure 2.2). However, escapement has declined significantly for the Chilkat stock. Poor productivity associated with low marine survival of SEAK Chinook salmon beginning with the 2008 brood year has resulted in below-goal escapements in some years for the Chilkat stock.

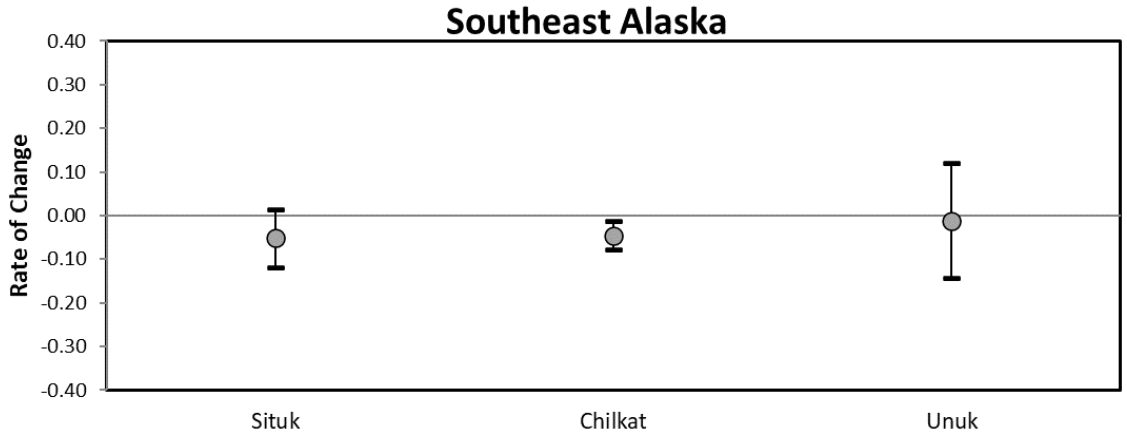


Figure 2.2.–Long-term annual rates of change in escapements for SEAK Chinook salmon stocks.

Note: Circles represent mean rate of change and bars represent 80% CIs.

2.2.2 Escapement Trends for Transboundary Stocks

All three TBR stocks of Chinook salmon (Alsek, Taku, and Stikine) had highly variable escapement with no significant trends (Figure 2.3).

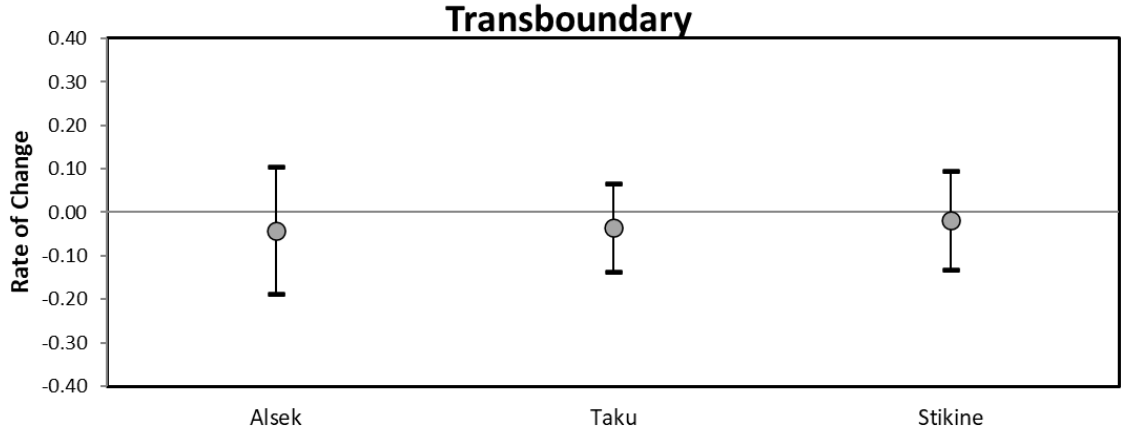


Figure 2.3–Long-term annual rates of change in escapements for Transboundary River Chinook salmon stocks.

Note: Circles represent mean rate of change and bars represent 80% CIs.

2.2.3 Escapement Trends for Canadian Stocks

Long-term rates of change in escapement for Canadian stocks were based on 1999–2019 time series for 18 of the 19 stocks evaluated. The time series started in 2000 for Lower Shuswap due to changes in escapement estimation methodologies. Few Canadian stocks exhibited clearly positive or negative tendencies in long-term rates of change in escapement, generally due to large variability in annual rates of change (as indicated by the 80% CIs; Figure 2.4). Twelve stocks exhibited negative mean rates of change in escapement, but these were clearly negative only for Nass (-4.2%), Skeena (-3.8%), Harrison (-5.2%), and Lower Shuswap (-3.5%). Seven stocks had positive mean rates of change, but only WCVI-14 (3.2%), Nanaimo (1.8%), and Fraser Summer 0.3 (1.7%) showed a clearly positive trend. Chinook salmon of Nass, Skeena, Kitsumkalum, WCVI-14, Nanaimo, Fraser Summer 0.3, Harrison, and Lower Shuswap exhibited the lowest variability in annual rates of change in escapement, whereas Chinook salmon of Phillips, Cowichan, Fraser Spring 1.2, Fraser Spring 1.3, and Fraser Summer 1.3 exhibited the largest variability. Regional patterns in rates of change are noticeable with declines in escapement for Northern BC and a subset of Fraser stocks. Similarly, increased escapements have generally been observed for Georgia Strait stocks.

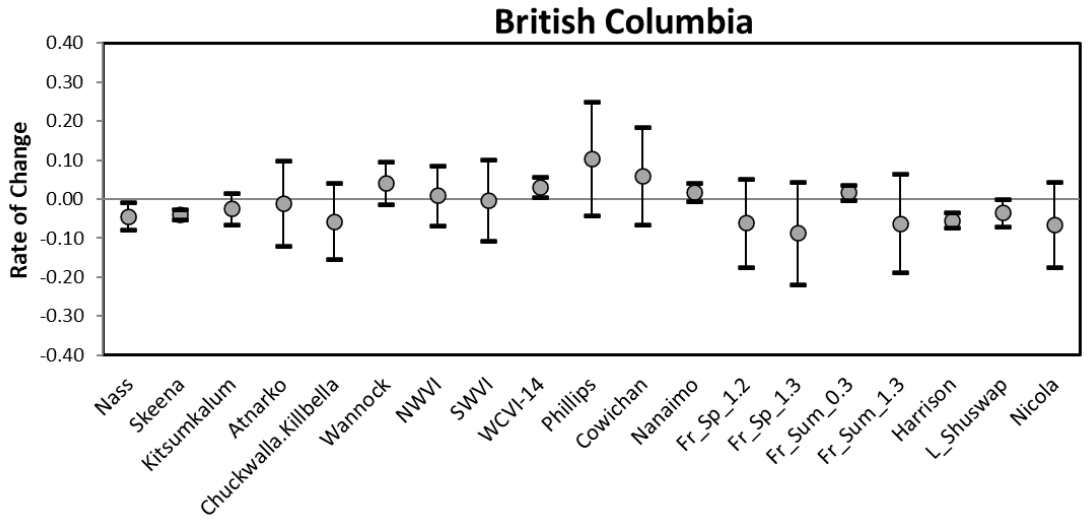


Figure 2.4.–Long-term annual rates of change in escapements for Canadian Chinook salmon stocks.

Note: Circles represent mean rate of change and bars represent 80% CIs. Escapement time series for Lower Shuswap started in 2000.

2.2.4 Escapement Trends for Washington Stocks

Escapement trends revealed several noteworthy patterns for Puget Sound and Washington Coastal escapement indicator stocks (Figure 2.5). Of the seven Puget Sound indicator stocks, rates of change in escapement declined significantly for Stillaguamish (-4.5%) and Snohomish (-3.9%) and increased significantly for Skagit Spring (4.2%) and Lake Washington (2.2%). Confidence intervals around the rates of change, as well as point estimates, for the remaining three Puget Sound indicator stocks had no significant trends. However, due to widely varying

escapements, there is considerable uncertainty around rate of change estimates for the Nooksack spring, Skagit River summer/fall, and Green River stocks. Puget Sound indicator stocks have largely met their agency management objectives (i.e., exploitation rate ceilings) for the 1999–2018 time period, although these objectives have not been reviewed by the CTC. Of the 9 Washington Coast indicator stocks,3 showed significant trends in escapement for 1999–2018. Rates of change in escapement decreased significantly for the Grays Harbor spring (–4.7%) and Hoh fall (-2.2%) stocks, whereas the rate increased significantly for the Queets spring/summer stock (2.1%). Six of the coastal indicator stocks have CTC-approved goals, which have usually been met by summer/fall (Quillayute, Hoh, Queets, Grays Harbor), but not met by spring/summer (Hoh, Queets) run timing groups. Five of the stocks—Hoko, Quillayute summer, Quillayute fall, Hoh spring/summer, and Grays Harbor fall—have wide CIs relative to other coastal indicator stocks. In the case of the Hoh and Queets spring/summer Chinook, despite regularly missing goals and returning at levels consistently lower than observed historically, there is a positive significant rate of change in escapement for Queets, while the rate of change for Hoh is not significant.

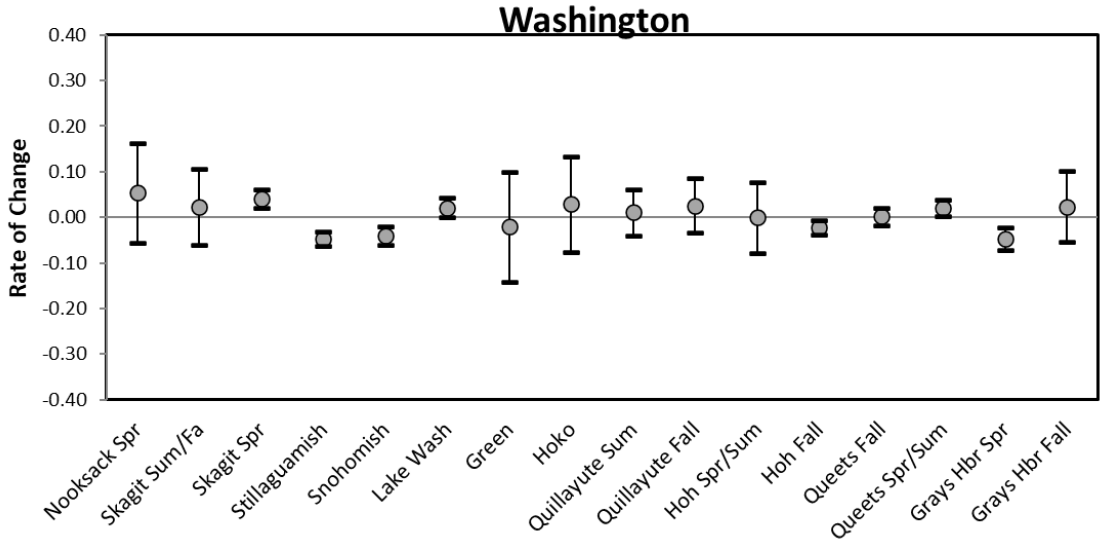


Figure 2.5.–Long-term annual rates of change in escapements for Washington Chinook salmon stocks.

Note: Circles represent mean rate of change and bars represent 80% CIs. The 2018 and 2019 Nooksack spring escapement estimates were not available to be included in this analysis.

2.2.5 Escapement Trends for Columbia River/Oregon Stocks

None of the Columbia River/Oregon stocks showed rates of change in escapement significantly different from 0.00, although the mean rate was positive for Columbia River stocks and negative for 4 of the 5 Oregon stocks (Figure 2.6). The historically low escapements observed in the Coquille in 2018 and 2019 have spurred an investigation of potential causes and of expectations for this stock into the future.

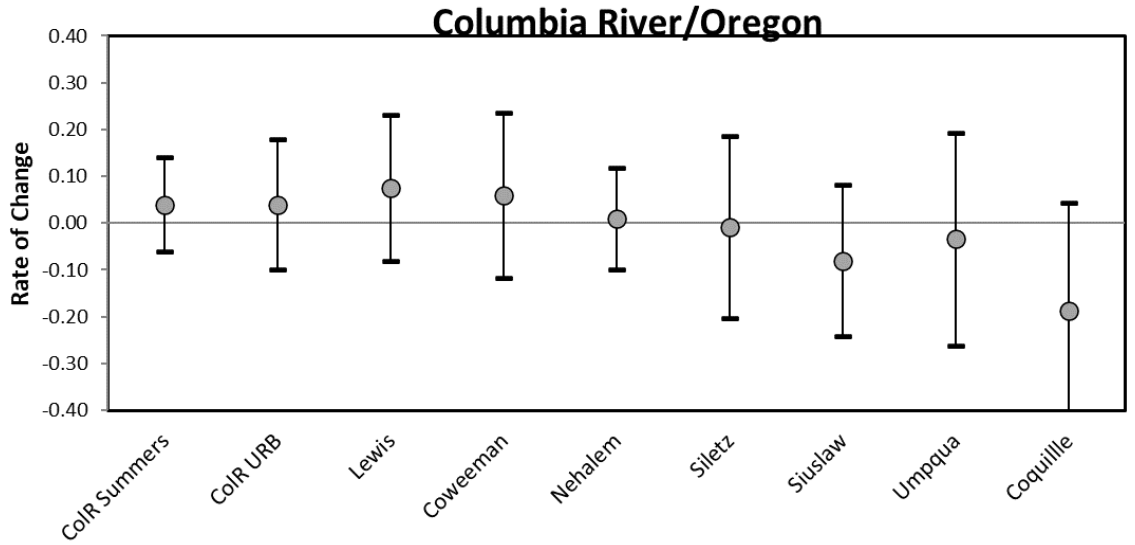


Figure 2.6.–Long-term annual rates of change in escapements for Columbia River/Oregon Chinook salmon stocks.

Note: Circles represent mean rate of change and bars represent 80% CIs.

2.3 PROFILES FOR ESCAPEMENT INDICATOR STOCKS

Escapements are graphed for stocks from Alaska, Canada, Puget Sound, Coastal Washington, Columbia River, and Oregon Coast regions. For each stock a commentary describes escapement methodology, escapement goal basis, escapement evaluation and agency comments. Escapement is usually reported as adult number by calendar year (CY). Escapement goals accepted by the CTC are shown as horizontal reference lines. Historical escapement and terminal run data are provided in Appendix B.

2.3.1 Southeast Alaska Stocks

Estimates for the four SEAK escapement indicator stocks are germane to large fish, defined as Chinook salmon $\geq$ 660 mm length mid-eye to tail fork for the Situk and Unuk rivers or as fish $\geq$ age 1.3 for the Chilkat stock. Estimates of large fish include mostly ocean-age-3, -4, and -5 fish, and almost 100% of the females in the population, while excluding ocean-age-1 and -2 males. All SEAK indicator stocks produce primarily yearling smolt (freshwater-age-1) except the Situk River, which produces around 90% subyearling (freshwater-age-0) smolt. Survey methods have been standardized since 1975 except for the Chilkat River, which was standardized in 1991 concurrent with the initiation of mark-recapture (MR) escapement estimation. Escapement estimates for the Unuk River are expanded aerial counts of large spawners. Biological escapement goals (BEGs) for each of these stocks consist of an S_{MSY} point estimate and an escapement goal range.

Based on CWT recoveries, SEAK stocks are classified into two categories of ocean migration patterns: inside rearing and outside rearing. Inside-rearing stocks include those vulnerable to SEAK fisheries as immature fish, as well as mature, migrating fish, and include stocks returning to the Chilkat and Unuk rivers. Outside-rearing stocks, sometimes referred to as “far north

migrating stocks," have limited marine rearing time in SEAK and are harvested primarily during their spawning migrations through marine waters in the spring; this includes the stock returning to the Situk River.

In 1981, ADF&G established a 15-year rebuilding program which included developing interim point escapement goals for all the SEAK stocks based on the highest observed escapement count prior to 1981. Since then, more rigorous escapement goal analyses by ADF&G have been reviewed and accepted by the CTC. The ADF&G uses escapement goal ranges for management, based on the State of Alaska *Policy for Statewide Salmon Escapement Goals and Policy for the Management of Sustainable Salmon Fisheries* (Title 5 of the Alaska Administrative Code, Chapter 39, sections 222 and 223: 5 AAC 39.222 and 39.223).

2.3.1.1 Situk River

The Situk River is a non-glacial system near Yakutat, Alaska that supports an outside-rearing stock. Most harvest of Situk-origin Chinook salmon occurs in a commercial fishery, which operates in the estuary and nearby marine waters, and in sport and subsistence fisheries located inriver, in the estuary, and in nearby marine waters. These fisheries are prosecuted under a State of Alaska management plan (Situk-Ahrnklin Inlet and Lost River King Salmon Management Plan (5 AAC 30.365)) to achieve escapements within the escapement goal range.

Escapement Methodology: The escapement is enumerated using a weir in the lower river, minus sport harvest above the weir which is estimated by a creel survey and a postseason mail-out survey. The weir was operated from 1928 to 1955 and continuously since 1976 including escapement enumeration. Escapement estimates meet U.S. and bilateral CTC data standards.

Escapement Goal Basis: In 1991, ADF&G revised the escapement goal to 600 large spawners (McPherson and Weiland 1991)[2], and in 1997, the goal was revised to a range of 500 to 1,000 large spawners to conform to ADF&G's escapement goal policy. The CTC reviewed and accepted this range in 1998. The analysis was updated by ADF&G in 2003, leading to a proposed goal range of 450 to 1,050, but this was not accepted by the CTC.

Escapement Evaluation: Productivity of the Situk River stock has declined significantly over the last decade. Annual escapements less than 85% of the lower bound of the goal have occurred in six of the last ten years After a 2018 escapement of 420, the 2019 estimated escapement was 623 large Chinook salmon, above the lower bound of the BEG. Similar to 2015 through 2018, all terminal fisheries were closed in 2019 to pass as many fish to escapement as possible. There was also no harvest above the weir in 2019 and therefore an exact count of escapement was obtained (Figure 2.7).

Agency Comments: Total calendar year exploitation rates (all harvests within the PST area) averaged about 53% from 1990 to 2003. Because this stock has experienced poor marine survival and declining production, exploitation rates have been substantially curtailed since 2004.

[2] Scott A. McPherson, ADF&G, to Keith Weiland, ADF&G. 1991 memorandum. Available from author, Douglas Island Center Building, 802 3rd Street, P. O. Box 240020, Douglas, AK 99824-0020.

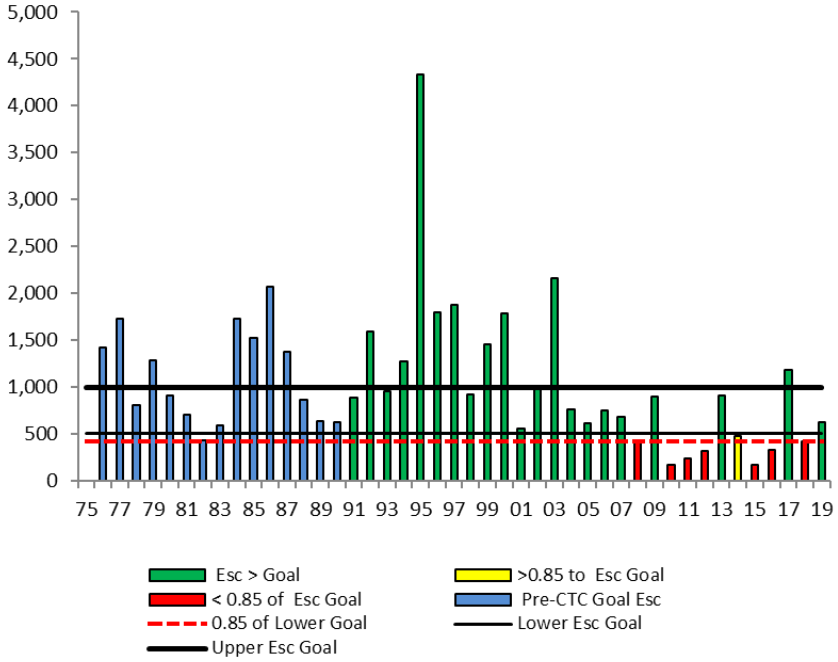


Figure 2.7.–Situk River escapements of Chinook salmon, 1976–2019.

2.3.1.2 Chilkat River

The Chilkat River is a moderate-sized glacial system near Haines, Alaska, which supports an inside-rearing stock. Escapement estimates are germane to spawners that are ocean age-3 and older. Coded-wire tags have been applied to wild smolt at relatively high rates (8–10%) beginning with the 1999 brood year; additional wild stock tagging occurred for three broods prior to that time. Relatively small terminal marine sport and subsistence fisheries target this stock. This stock is also caught in SEAK commercial troll, drift gillnet, and sport fisheries. Calendar year exploitation rates averaged 15% with a range of 3% to 28% since 2009.

Escapement Methodology: Escapements of large spawners have been estimated with a MR program annually since 1991 (Ericksen and McPherson 2004). Annual escapement estimates have an average coefficient of variation (CV) of about 14% since 1991, meeting the CTC bilateral data standard of CV<=15%. From 1975 to 1992, aerial survey counts were conducted on two small tributaries with relatively clear water and results from these estimates were inconsistent with radio-telemetry studies conducted in 1991 and 1992. The studies found that these two tributaries represented less than 5% of the total escapement. Therefore, aerial surveys were discontinued.

Escapement Goal Basis: An initial 1981 escapement goal was 2,000 large fish, based on an assumed fraction of the total escapement represented by aerial survey counts. A revised escapement goal range of 1,750 to 3,500 large spawners, based on MR estimates of escapement and limited CWT information, (Ericksen and McPherson 2004) was reviewed and accepted by the CTC in 2004.

Escapement Evaluation: Escapements to the Chilkat River were $\geq$ 85% of the goal in all years except 2007 and from 2016 to 2018. The 2019 escapement estimate of 2,028 large fish

(CV=12%) rebounded from an all-time low estimate in 2018 (873 fish) and was above the lower bound of the escapement goal range (Figure 2.8).

Agency Comments: Like other Chinook stocks in Alaska, the Chilkat stock has recently experienced a decline in productivity. Despite restrictive management in recent years, the Chilkat stock failed to meet management objectives during return years 2016 to 2018.

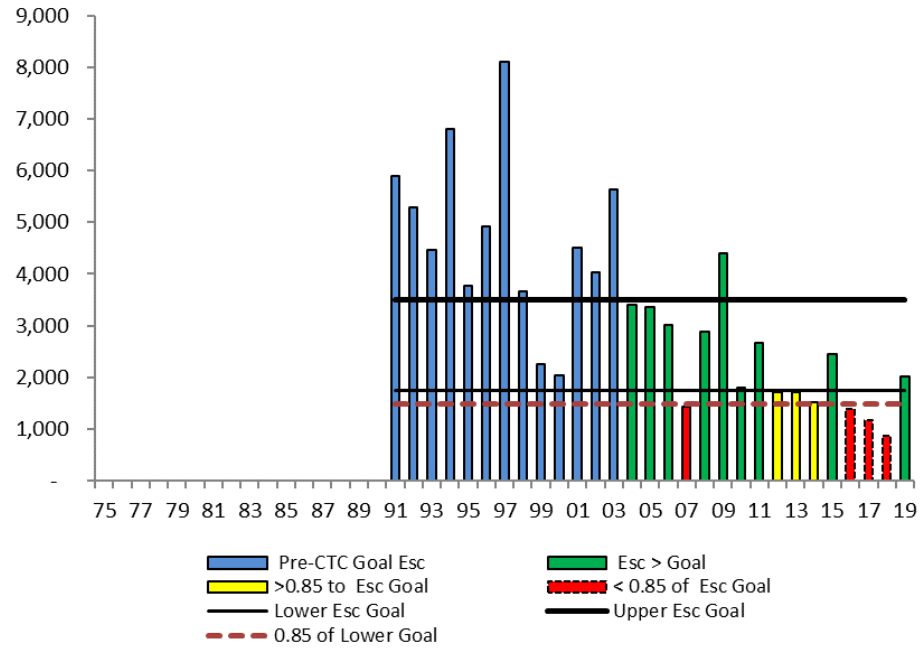


Figure 2.8.–Chilkat River escapements of Chinook salmon, 1991–2019.

2.3.1.3 Unuk River

The Unuk River is a moderate-sized glacial system that flows into Behm Canal northeast of Ketchikan, Alaska. This river supports an inside-rearing stock of Chinook salmon and escapement estimates are germane to large spawners (greater than 659 mm mid-eye to fork-of-tail (MEF) in length). Coded-wire tags have been applied to wild smolt at relatively high rates (7–10%) beginning with the 1992 brood year. Harvest of immature and mature fish occurs predominately in SEAK commercial and sport fisheries although some fish are also caught in NBC commercial net and troll fisheries**.**

Escapement Methodology: Escapements of large spawners were derived from MR estimates of total escapement from 1997 to 2011, and from expanded survey counts from 1977 to 1996 and 2012 to present. Radio telemetry studies in 1994 and 2007 demonstrated that the surveys are conducted where approximately 80% of the spawning occurs; the expansion factor for survey counts is 4.83 (Hendrich et al. 2008). From 1997 to 2011, CVs of the MR escapement estimates averaged 11% and were less than 15% in all but one year (2011). The average CV for expanded survey counts performed since 2012 is 12%; these estimates meet bilateral CTC data standards.

Escapement Goal Basis: In 1994, ADF&G revised the Unuk River escapement goal to 875 large spawners observed during survey (index) counts (unpublished work), which the CTC reviewed

and accepted. In 1997, ADF&G revised the goal to a range of 650 to 1,400 large spawners observed during index counts (McPherson and Carlile 1997), which the CTC reviewed and accepted in 1998. Since the expansion factor for surveys was unknown at that time, the goal was expressed as an index peak survey count. In 2008, a more extensive analysis was completed using the 1982 to 2001 brood years with spawners, recruitment, and fishing mortality expressed in total numbers of fish (Hendrich et al. 2008). In 2009, the CTC accepted a BEG range of 1,800 to 3,800 large spawners, with a point estimate of 2,764 fish.

Escapement Evaluation: The Unuk River stock had annual escapements from 1977 to 2011 that were within or above the escapement goal range. However, productivity of the stock has recently declined, and escapements were below the 85% threshold of the lower bound of the escapement goal range in 2012, 2013, 2016, and 2017. The 2019 escapement estimate is 3,115 large Chinook salmon (CV = 12%) which met the lower bound of the BEG of 1,800 fish. Despite this slight upturn in 2018 and 2019, the Unuk River stock, similar to other SEAK stocks, is experiencing a period of low productivity (Figure 2.9).

Agency Comments: The large reduction in run strength of the Unuk River stock in recent years was unexpected given its history of consistent production. There are no directed fisheries that target this stock; sport fishing in freshwater is closed, marine sport fishing in East Behm Canal is closed during the spring and summer, and commercial fishing in nearby marine waters is closed. Additional management measures to reduce exploitation of this stock in the SEAK fishery were implemented from 2014 to 2019 and restrictions will continue in 2020.

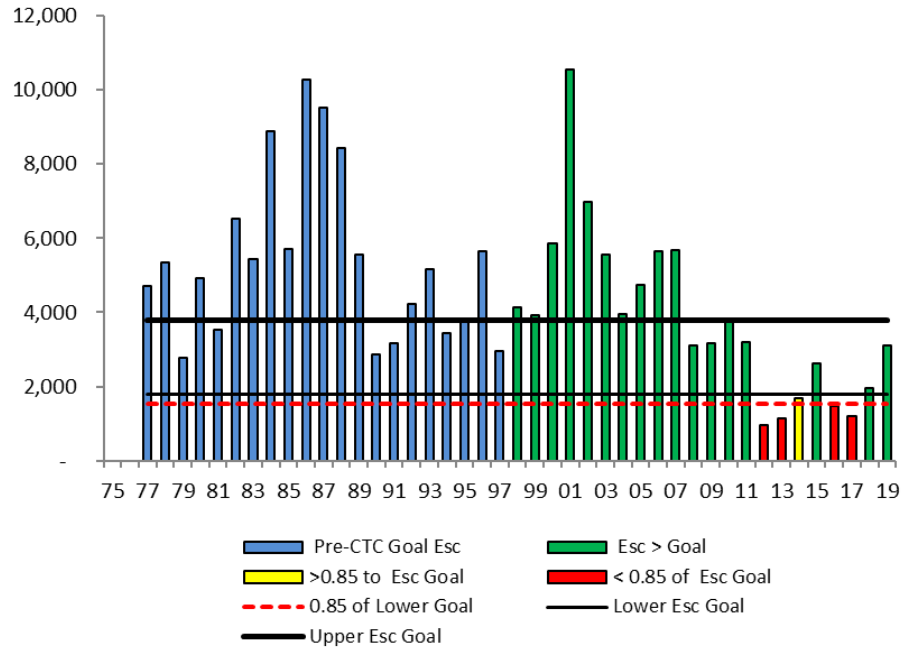


Figure 2.9.–Unuk River escapements of Chinook salmon, 1977–2019.

2.3.2 Transboundary River Stocks

The transboundary (TBR) stocks include Chinook salmon returning to the Alsek, Taku, and Stikine rivers. Escapement estimates in the Alsek River are for ocean age-2 fish and older. Escapement estimates in the Taku and Stikine rivers are for large fish only, defined as Chinook salmon $\geq$ 660 mm length mid-eye to tail fork, and include ocean age-3 through age-5 fish, which contain almost 100% of the females in the population. Survey methods have been standardized since 1973 in the Taku River, since 1975 in the Alsek and Stikine rivers, and BEGs exist for each of these stocks.

All three TBR stocks are classified as outside rearing based on marine CWT recovery patterns. These stocks emigrate as yearling smolt and have limited marine rearing in SEAK waters; therefore, they are harvested primarily during their spawning migrations each spring.

In response to low abundance, a 15-year rebuilding program was established in 1981 (ADF&G 1981). Concurrently, ADF&G established interim escapement goals for all three systems, based on the highest observed escapement count prior to 1981. Escapement goals for all three TBR stocks have subsequently been revised by ADF&G and DFO, and have been reviewed and accepted by the CTC, Canadian Centre for Science Advice Pacific (CSAP), and the TBR Panel. Escapement goal ranges are used by ADF&G for domestic management, as described in the State of Alaska *Policy for Statewide Salmon Escapement Goals* and *Policy for the Management of Sustainable Salmon Fisheries*. Escapement goal ranges are also used by the U.S. and Canada for implementation of Annex IV, Chapter 1 of the PST.

2.3.2.1 Alsek River

The Alsek River is a large glacial system that originates in Southwest Yukon Territory and Northwest British Columbia, Canada, and flows into the Gulf of Alaska about 50 miles east of Yakutat, Alaska. This river supports a run of outside-rearing Chinook salmon.

Escapement Methodology: Since 1976, escapements have been monitored using a weir on the Klukshu River, one of 51 tributaries of the Tatshenshini River, the principal salmon-producing tributary of the Alsek River. Counts of returning ocean age-2 and older Chinook have been collected from 1976 to present. Concurrent with the weir counts, Alsek River drainage-wide MR escapement estimates were generated from 1998 to 2004 through a cooperative effort among the Champagne and Aishihik First Nations, DFO, and ADF&G. An expansion factor of 4.0 is used to convert the Klukshu River weir counts to Alsek River drainage-wide inriver run estimates. Canadian inriver harvest is subtracted from the estimated inriver abundance to yield the estimate of drainage-wide escapement. The associated CV of 35% for the expansion factor fails to meet bilateral CTC data standards of 15%.

Escapement Goal Basis: A drainage-wide revised goal of 3,500 to 5,300 ocean age-2 and older fish was accepted by the CTC, ADF&G, and CSAP in 2010 based on Bernard and Jones (2010). The previous goal was based solely on the Klukshu River return (McPherson et al. 1998).

Escapement Evaluation: Annual escapements of less than 85% of the lower bound of the current goal range have been observed four times since 1976, and all have occurred in the last 15 years (2006, 2008, 2016 and 2017). Calendar year exploitation rates exerted on the stock have averaged 10% since 1999. Even in the absence of exploitation from 2006 to 2008 and

from 2016 to 2017, the stock would still have failed to achieve the lower bound of the escapement goal range. The 2019 escapement estimate is 6,356 (CV = 0.36) ocean age-2 and older Chinook salmon, which is above the upper bound of the BEG range (Figure 2.10).

Agency Comments: Directed sport and Aboriginal fisheries occur in Canada in various upriver sections of the Alsek River and mostly in the Yukon Territory. Some Chinook salmon are caught incidentally in U.S. subsistence and U.S. directed sockeye salmon fisheries that operate in the lower river. Overall, calendar year exploitation rates have averaged only 10% since 1999.

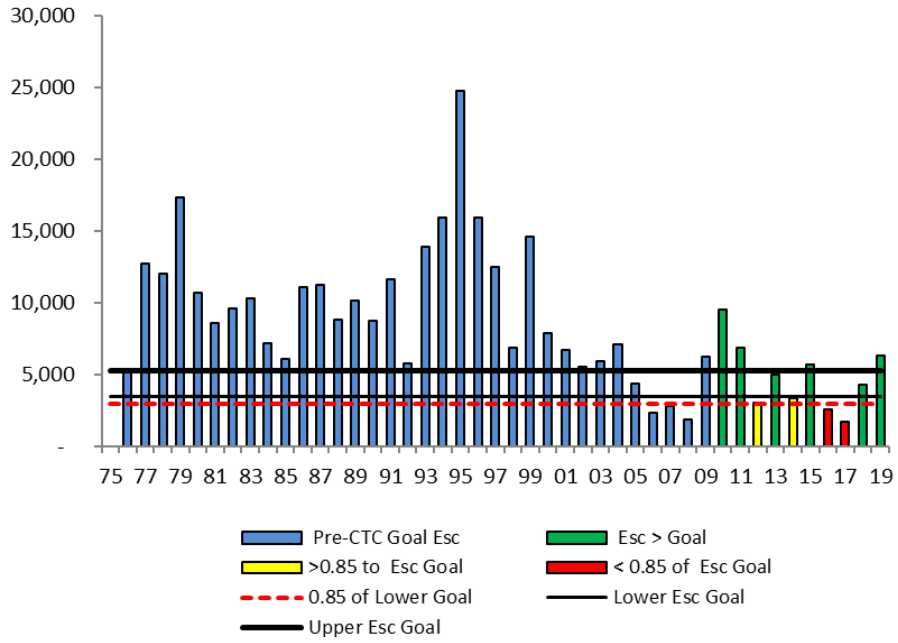


Figure 2.10.–Alsek River escapements of Chinook salmon, 1976–2019.

2.3.2.2 Taku River

The Taku River is a large glacial system that originates in Northwest British Columbia, flows into marine waters of SEAK near Juneau, Alaska, and supports a run of outside-rearing Chinook salmon. Most Taku River Chinook salmon are caught in the terminal area of District 111 and in the Canadian portion of the lower Taku River. Directed gillnet fisheries take place in terminal U.S. (District 111 of SEAK) and Canadian inriver fisheries when forecasted abundance or inseason assessments exceed predetermined levels as described in the 2019 PST Agreement under Annex IV, Chapter 1, Transboundary Rivers 3(b)(3). Taku River Chinook are incidentally harvested in terminal directed sockeye salmon gillnet fisheries, sport fisheries near Juneau, Alaska, and inriver Aboriginal and sport fisheries in Canada. Taku Chinook salmon are also harvested outside of the terminal area in SEAK sport and troll fisheries.

Escapement Methodology: Escapement estimates of large Chinook salmon have been generated using MR experiments in 1989, 1990, 1995 to 1997, 1999 to 2010, and 2014 to 2019. The MR estimates are from cooperative stock assessment efforts among the Taku River Tlingit First Nation, DFO, and ADF&G. The MR escapement estimates have an average CV of

15% and since 1995, CVs have ranged from 9% to 38%; most assessments meet bilateral CTC data standards. Standardized aerial survey counts have been performed by ADF&G since 1973. Counts prior to 1989, from 1991 to 1994, 1998, and 2011 to 2013 were expanded by a factor of 5.2, which is the average of the ratio of the MR estimates to aerial survey counts. Escapement estimates based upon expanded aerial survey counts are assumed to be unbiased and have a CV of about 30%.

Escapement Goal Basis: Prior to 1999, several drainage-wide or index goals were developed by the U.S. and Canada using limited data. A BEG based upon maximizing smolt production was accepted by the CTC and used for management from 1999 to 2009 (McPherson et al. 2000). The current BEG range of 19,000 to 36,000 large Chinook salmon was based on stock-recruit analysis and accepted by the CTC in 2009 (McPherson et al. 2010).

Escapement Evaluation: Escapements of less than 85% of the lower bound of the current goal range occurred seven times since 1975 and most notably in the last 4 years (1975, 1983, 2007, 2016–2019). The 2019 escapement estimate is 11,558 (CV = 12%) large Chinook salmon, which is below the 85% threshold of the lower bound of the escapement goal range and less than half of the S_{MSY} point goal of 25,500 (Figure 2.11).

Agency Comments: Like the Stikine River stock of Chinook salmon and other SEAK stocks, the Taku River stock has shown declining productivity in recent years, largely related to reduced marine survival. Until marine survival improves, it is unlikely that directed fisheries will occur.

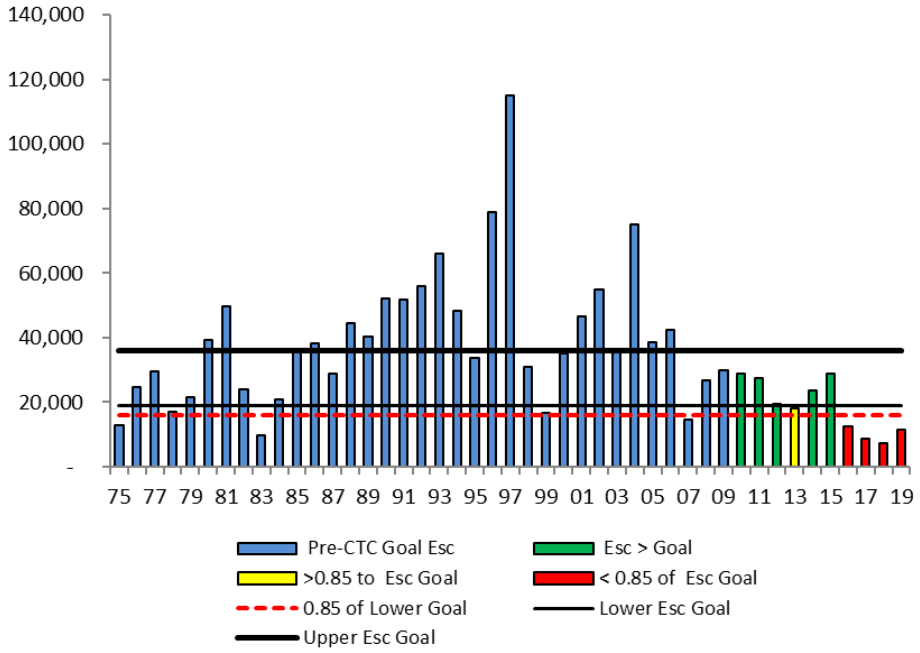


Figure 2.11.–Taku River escapements of Chinook salmon, 1975–2019.

2.3.2.3 Stikine River

The Stikine River drainage is the largest in SEAK, originating in British Columbia, Canada, and flowing into the marine waters in central SEAK near the towns of Petersburg and Wrangell.

The Stikine River supports a run of outside-rearing Chinook salmon and most harvest occurs in terminal areas, including U.S. commercial gillnet and sport fisheries in District 108 near Petersburg and Wrangell. There are also commercial gillnet, Aboriginal, and recreational fisheries in the Canadian portion of the drainage. Stikine Chinook salmon are also harvested outside of the terminal areas in SEAK sport and troll fisheries. Starting in 2005, during years of surplus production to the Stikine River, directed Chinook salmon fisheries were allowed in District 108 marine waters and inriver in Canada.

Escapement Methodology: From 1975 to 1984, index escapement estimates were generated using survey counts performed by ADF&G, and since 1985, counts were made through a weir on the Little Tahltan River operated by DFO and the Tahltan First Nation. Since 1996, MR studies were conducted annually to estimate total escapement. The MR estimates are cooperative stock assessment efforts among the Tahltan First Nation, DFO, and ADF&G. Combined, these efforts indicated weir counts represented 17% to 20% of the total escapement (Pahlke and Etherton 1999). Since 1996, 52% of the escapement estimates have had CVs that meet bilateral CTC data standards, and overall CVs ranged from 7% to 35%.

Escapement Goal Basis: In 1999, a BEG of 14,000 to 28,000 large Chinook salmon was reviewed and accepted by the CTC, ADF&G, TBR Panel, and CSAP, based on the analysis in Bernard et al. (2000). Previously, several drainage-wide or index goals were developed by the U.S. and Canada and were based on limited data.

Escapement Evaluation: The Stikine River stock had annual escapements of less than 85% of the lower bound occur eight times since 1975 and only three times in the past 30 years (2009, 2017, and 2018). The 2019 escapement estimate is 13,817 (CV = 25%) large Chinook salmon, which is above the 85% threshold of the lower bound of the escapement goal range (Figure 2.12).

Agency Comments: Despite exceeding the lower bound of the goal range in most years since 1999, the lower bound has not been attained in the last four years. Similar to Taku River Chinook salmon and other SEAK stocks, the Stikine River stock has demonstrated declining productivity in recent years due to poor marine survival. Until production improves, it is unlikely that directed terminal fisheries will occur.

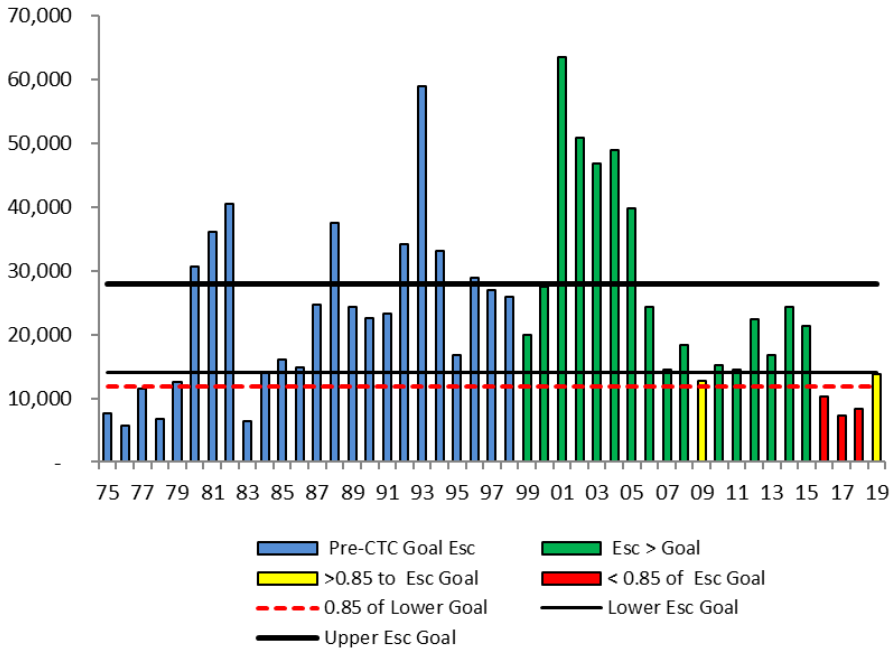


Figure 2.12.–Stikine River escapements of Chinook salmon, 1975–2019.

2.3.3 Canadian Stocks

Since the beginning of the Chinook salmon rebuilding program of the 1985 PST, escapement goals for Canadian Chinook salmon stocks were generally based on doubling the average escapements recorded from 1979 to 1982. The doubling was based on the premise that Canadian Chinook salmon stocks were overfished and that doubling the escapement would still be less than the optimal escapement estimated for the aggregate of all Canadian Chinook salmon populations (PSC 1991). Doubling was also expected to be a large enough change in escapements to allow detection of the change in numbers of spawners and the subsequent production. The escapement goals of most Canadian stocks are currently being reviewed; two stocks (Harrison and Cowichan) have PSC-agreed escapement goals.

2.3.3.1 Northern British Columbia

2.3.3.1.1 Nass River

The Nass River is the largest river in Area 3, representing a group of approximately 25 streams. It flows southwest from the interior of British Columbia into Portland Inlet and the estuary is located 30 km south of the Alaska/British Columbia border. The Nass River drains an area of approximately 18,000 km^2 and is constrained by a canyon at Gitwinksihlkw (GW). The canyon was formed by the Tseax Volcano in 1775 and is approximately 40 km upstream from the estuary. The mainstem of the Nass River is extremely turbid with visibility near zero for most of the year. Among the major Chinook salmon producing tributaries, the Bell Irving River is glacially turbid while the Meziadin, Cranberry/Kiteen, Kwinageese and Damdochax rivers are relatively clear. Nass River Chinook salmon are primarily (97%) stream-type and are thought to be far north migrating.

Escapement Methodology: Prior to 1992, DFO observations of Nass River Chinook salmon escapement were based on visual counts. Programs using MR have been conducted since 1992 by Nisga'a Fisheries to estimate total spawning escapement in the Nass River. The Nass MR program uses two fish wheels at GW in the Lower Nass River canyon and occasionally two fish wheels at Grease Harbor further upstream to capture fish for tag application. The Meziadin River fishway, a weir across the Kwinageese River, and a dead pitch program on the Damdochax River are used for tag recovery. Tags were also recovered in upriver fisheries and on the spawning grounds. A modified Petersen model was used to estimate the total population of Chinook salmon past the tagging location. Spawning escapements were calculated as the estimated population past Gitwinksihlkw from the MR studies, minus upriver catches in sport and First Nations fisheries. Three tributaries with Chinook salmon populations—the Kincolith, Ishkeenickh and the Iknouk—enter the Nass River below GW. Visual estimates of these systems were augmented using fence counts of the Kincolith River in 2001, 2002, 2005, and 2007 to estimate escapements below the fish wheels.

Escapement Goal Basis: There is no PSC-agreed escapement goal for the Nass River aggregate of Chinook salmon. The Fisheries Operational Guidelines define two goals for managing Chinook salmon fisheries: an operational escapement target of 20,000 fish and a minimum escapement target of 10,000 fish. If escapements are projected to be below 10,000 fish, then no fishing on Nass River Chinook salmon would be recommended. The median estimate of S_{MSY} upstream of GW using the habitat model was 16,422 (CV = 23%) Chinook salmon based on a watershed area of 15,244 km^2 (Parken et al. 2006; Figure 2.13). The 2019 escapement estimate for the Nass River above GW was 10,493 (Appendix Table B3; Figure 2.13).

Agency Comments: Chinook salmon escapement estimates produced before 1992 have been calibrated to the MR estimates. The Sentinel Stocks Program (SSP) and Northern Endowment Fund have funded projects on the Kwinageese River and Damdochax Creek designed to increase recoveries and improve the escapement estimates for the Nass River aggregate of Chinook salmon.

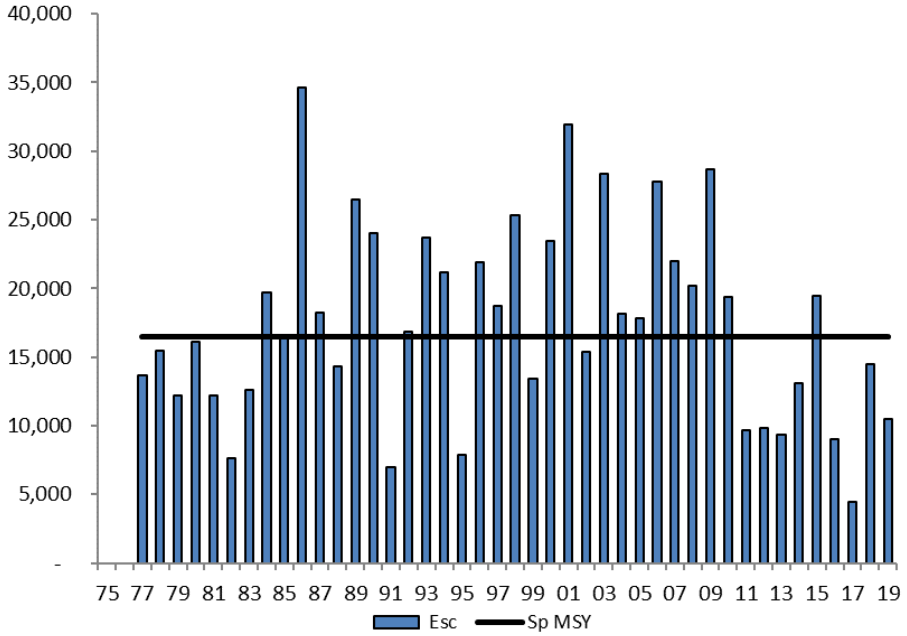


Figure 2.13.–Nass River escapements of Chinook salmon, 1977–2019.

2.3.3.1.2 Skeena River

The Skeena River is the second largest river in British Columbia and drains an area of approximately 54,400 km^2. It supports the second largest aggregate of Chinook salmon stocks in British Columbia with over 75 separate spawning populations. There are four large lake-stabilized tributaries, Kitsumkalum, Morice, Babine and Bear rivers, and genetics studies show these populations typically account for 63% of the total abundance in the Skeena River. The Kitsumkalum River is glacially turbid and visual methods for enumerating salmon are not possible. In contrast, the Morice, Bear, Babine, and Kispiox tributaries are relatively clear, especially in late summer when most of the Chinook salmon spawning occurs, allowing for visual counts. Skeena River Chinook salmon are primarily stream-type salmon (97%) and are far north migrating. Most of the Skeena River Chinook salmon populations are summer run but spring run fish occur in the Cedar and Upper Bulkley rivers.

Escapement Methodology: Most of the escapement estimates are based on visual observations from helicopter, fixed-wing aircraft and/or from stream walking surveys, but fish counting weirs are present across the Babine, Sustut, and Kitwanga rivers. The Kitsumkalum River is the exploitation rate indicator stock for Northern British Columbia, and the spawning population has been estimated using a MR program since 1984. The Skeena escapement index is the sum of Chinook salmon enumerated using various methods on each system. The Kitsumkalum stock represents approximately 30% of the spawners measured by the Skeena escapement index. The Bear and Morice river populations have contributed 20% and 26%, respectively, to the escapement index since 1984. The Bear and Morice populations account for 46% of the total Skeena escapement index which overestimates their actual contribution when compared to genetic-based estimates.

Chinook salmon returns to the Skeena River have also been estimated using the proportion of

Kitsumkalum River fish measured from genetic samples collected at the Tyee test fishery and from Kitsumkalum River Chinook salmon escapement estimates from independent MR programs (Figure 2.14, checkered bars). Preliminary estimates are available from 1984 to 2019 as a result of SSP and Northern Endowment Fund projects. The genetic-based estimates represent an improvement over the historic indices because they include estimates of variance. Also, comparisons between years are valid since the method is consistent across the time series, whereas methods used for the historic indices varied through time.

The genetic studies found that the Kitsumkalum River conservation unit contributes, on average, 18% to the Skeena River aggregate. The Morice, Bear and Babine populations make up the Skeena Large Lake conservation unit and contribute 31%, 7% and 7% to the aggregate, respectively. An average contribution of 45% makes the Skeena Large Lake conservation unit the largest in the watershed. The estimated 2019 escapement for the Skeena River aggregate was 24,536 using the historic index and 23,248 using the genetic-based estimate (Appendix Table B3; Figure 2.14).

Escapement Goal Basis: There is no PSC-agreed escapement goal for the Skeena River aggregate of Chinook salmon. The estimate of S_{MSY} for the Kitsumkalum indicator stock is 8,621 Chinook salmon based on stock–recruitment analyses (McNicol 1999; updated in Parken et al. 2006). Habitat-based estimates of S_{MSY} and other reference points are available for stocks within the Skeena River, but estimates of total escapement (or calibration of the visual indices) are needed to make them effective (Parken et al. 2006). Future assessments will partition this large aggregate into stocks by run timing, life history and geographic areas.

Agency Comments: Terminal fisheries in the Skeena River include commercial gillnet in the terminal exclusion area (River Gap Slough, Area 4), inriver sport and Aboriginal fisheries. Estimates of inriver sport catch were only included in the total terminal run estimates when data were available from creel surveys. Creel surveys were conducted on the Lower Skeena River below Terrace in 2003 and from 2010 to 2017. The inriver sport fishery was closed in 2018 and was limited in 2019 by management actions to protect sockeye salmon. Spawning escapements to the Kitsumkalum River exceeded S_{MSY} in every year except 1998 and 2017 (Figure 2.15).

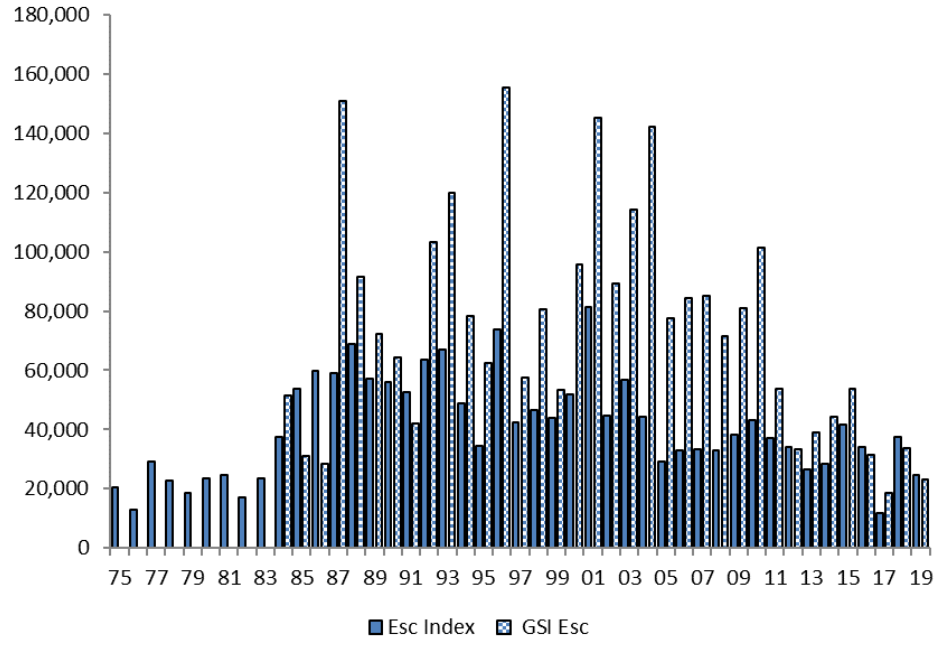


Figure 2.14.–Skeena River escapements of Chinook salmon, 1975–2019.

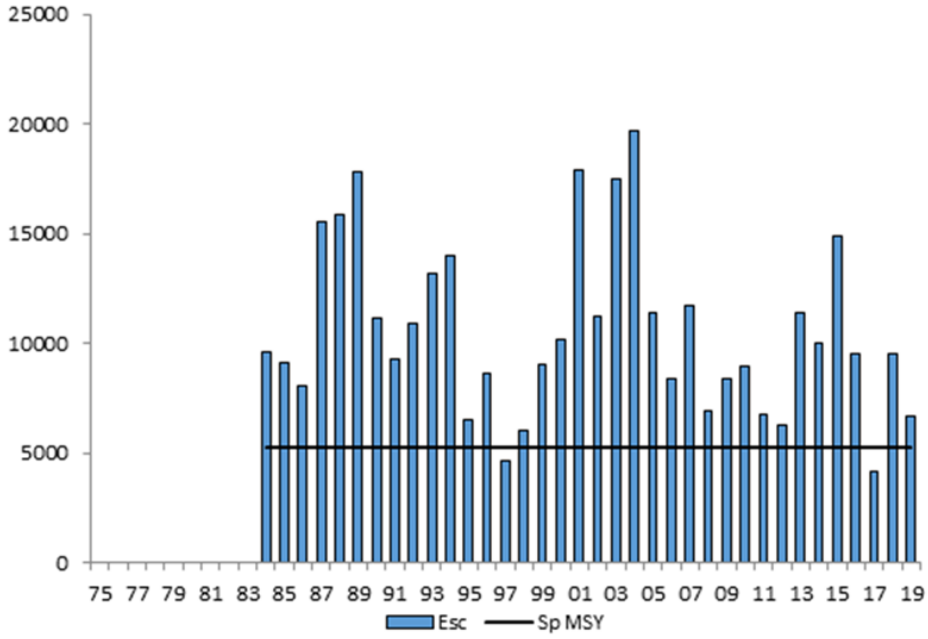


Figure 2.15.–Kitsumkalum River escapements of Chinook salmon, 1984–2019.

2.3.3.2 Central British Columbia

2.3.3.2.1 Rivers Inlet

The Rivers Inlet aggregate of Chinook salmon is monitored using an index of escapements to the Wannock, Kilbella and Chuckwalla rivers. The Wannock River drains Owikeno Lake into the

head of Rivers Inlet. It is about 6 km long, over 100 m wide, and is glacially turbid. Wannock Chinook salmon are genetically distinct from other Chinook salmon populations from the central coast of British Columbia. This ocean-type stock exhibits fall run timing and is renowned for its large body size, due to high proportions of ocean age-4 and age-5 year components in the return. The Kilbella and Chuckwalla river systems share an estuary on the north shore of Rivers Inlet. These systems are relatively small and run clear, but the degree of turbidity fluctuates with seasonal precipitation. The Chinook salmon populations in the Chuckwalla and Kilbella rivers have summer run timing and are stream-type salmon. The largest contributor to the index is the Wannock River, which represents an average of 76% of the production for this index over the past decade, and over 95% since 2010. Since 2016, environmental conditions and limited resources have precluded direct estimates of escapement to the Wannock, Kilbella and Chuckwalla rivers. Covariation analysis and regressions involving robust escapement estimates for Atnarko Chinook salmon have been used to infill escapement estimates in the Wannock River, 2016 to 2019, and Chuckwalla and Kilbella rivers, 2018 to 2019 (Appendix Table B3; Figure 2.16). Indirect Chinook escapement estimates were 3,061 for Wannock and 795 for Chuckwalla and Kilbella rivers.

Escapement Methodology: Chinook salmon escapement estimates for the Wannock River are produced from an annual carcass recovery program. Estimates are derived by expanding the number of carcasses pitched using historical recovery rates. Expansion factors are somewhat subjective and take into consideration water clarity, river height, and recovery effort. Programs to calibrate carcass recoveries with population estimates from MR experiments were conducted from 1991 to 1994 and again in 2000. Results suggest the estimates based on the subjective expansions of carcass recoveries may underestimate the Wannock Chinook salmon population. Inherent biases typical in carcass recovery programs as well as imprecision in the MR estimates leads to uncertainty in calibration of the carcass estimates.

Chinook salmon escapements in the Chuckwalla and Kilbella rivers are estimated using Area Under the Curve (AUC) methods applied to visual counts from helicopter surveys. Typically four flights are made during the spawning period.

Escapement Goal Basis: There are no PSC-agreed escapement goals for the Rivers Inlet aggregate of Chinook salmon. Habitat-based estimates of S_{MSY} and other stock–recruitment reference points are available but estimates of total escapement are needed to apply them. Habitat-based escapement goals may overestimate S_{MSY} for the Wannock stock because the river has a relatively small amount of available spawning area (Parken et al. 2006).

Agency Comments: A small hatchery enhancement program occurs on the Wannock River but the contribution to the total population is unknown. Production from enhancement of the Kilbella and Chuckwalla rivers from 1990 to 1998 is thought to have had significant influence on escapements from 1994 to 2003, but estimates of the enhanced component are not available. However, estimated returns to the Kilbella and Chuckwalla rivers averaged 1,300 Chinook salmon during the period of enhancement. Recent returns have averaged less than 500 Chinook salmon for both rivers combined. It is unclear if these populations have returned to pre-enhancement levels or are simply experiencing a period of poor production, similar to SEAK stocks just to the north.

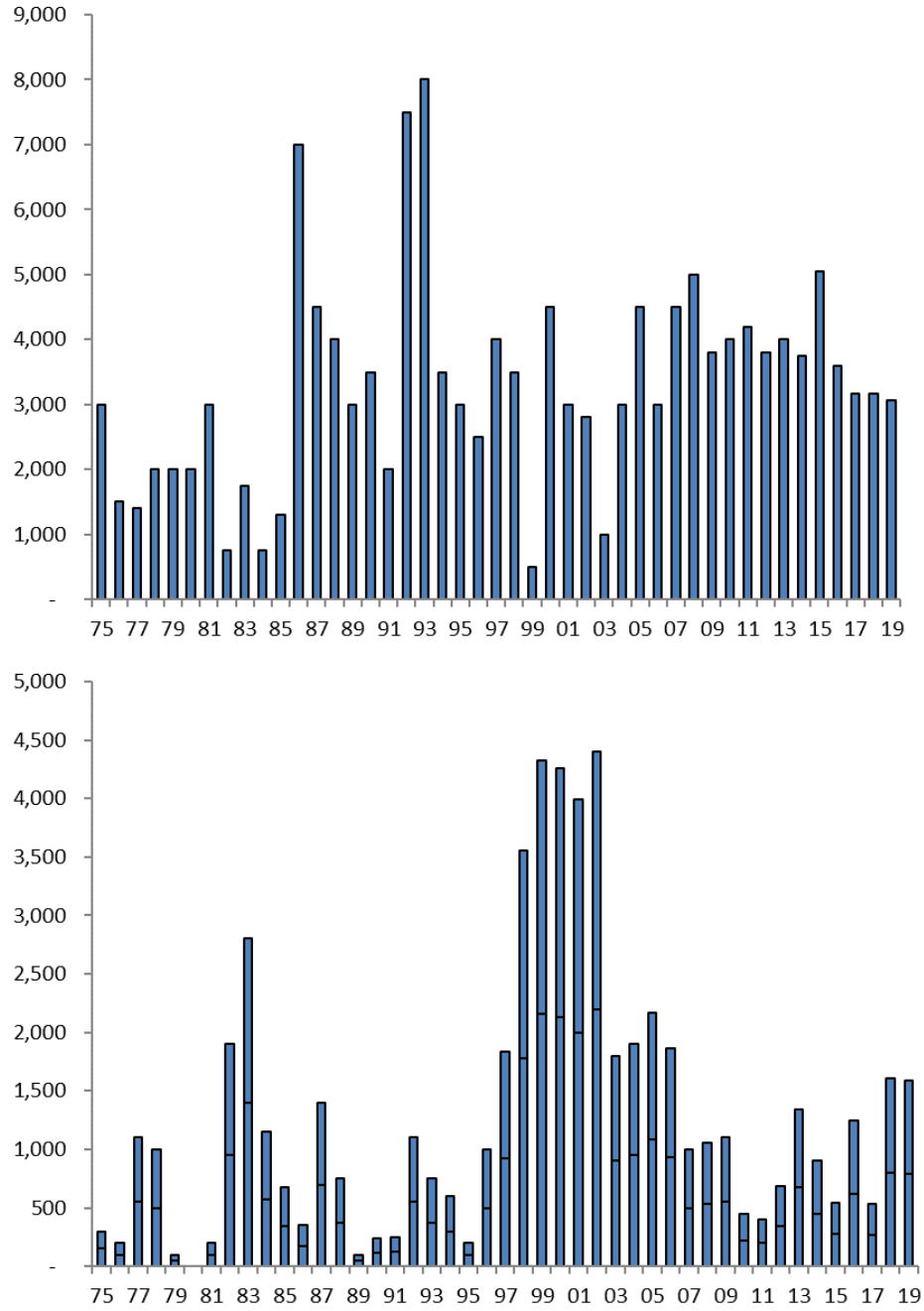


Figure 2.16.–Rivers Inlet escapement index of Chinook salmon, 1975–2019, including Wannock River (upper) and Kilbella and Chuckwalla rivers (lower).

Escapement estimates are not available for 2018 because high water levels precluded surveys.

2.3.3.2.2 Atnarko River

The Atnarko River feeds the Bella Coola River and is situated in Statistical Area 8 on the Central Coast of British Columbia. Chinook salmon spawning in this river are predominantly ocean-type but stream-type Chinook are also observed. This constitutes the largest complex of Chinook

salmon in Central British Columbia. Hatchery releases of Atnarko Chinook salmon have averaged around 2 million annually with recent CWT releases in excess of 400,000. Atnarko CWT recoveries occur in both U.S. and Canadian AABM fisheries as well as coastal British Columbia ISBM fisheries.

Following the 2009 PST Agreement, the CWT Improvement Program highlighted the lack of a Chinook salmon indicator in the Central British Columbia region. In order to convert the existing Atnarko Chinook Assessment program into an exploitation rate indicator, a series of objectives were identified including the application of 250,000 additional CWTs, sampling of the terminal commercial, sport, and First Nations fisheries, and reintroduction of an MR program to improve escapement estimates (Vélez -Espino et al. 2011). Implementation of these changes began in 2009 (Vélez -Espino et al. 2010) and subsequent MR programs have yielded escapement estimates with corresponding CVs of less than 15% for all years (Vélez -Espino et al. 2014). The estimated total escapement in the Atnarko River in 2019 (excluding jacks) was 11,675 fish with a wild escapement of 4,587 fish (Appendix Table B3; Figure 2.17). The wild escapement for 2019 was below the agency escapement goal of 5,009 fish.

Escapement Methodology: Three methods have been used since 1990 to generate independent estimates of Chinook salmon escapement in the Atnarko River. These methods are based on (1) CPUE during broodstock collection, (2) carcass counts during dead pitching, and (3) the number of spawners observed during drift boat surveys. The simplicity and low cost of these three methods has allowed the continuous monitoring of Atnarko River escapement, and the average of these three population estimates (3MA method) has been used as escapement estimates in years without MR studies. A serious flood event in the fall of 2010 impacted the Atnarko River by altering flow dynamics and creating a sequence of obstructive log jams. As a result, the use of rafts to obtain drift counts was no longer feasible. Robust maximum likelihood estimates within a model selection framework have been developed for escapement of total and wild Atnarko Chinook salmon, based on MR data for years 2001 to 2003 and 2009 to 2019. Escapement estimates for years without MR studies were calibrated using Generalized Linear Models based on these high-quality MR escapement estimates and data routinely collected for the 3MA method (Vélez-Espino et al. 2014). The estimation model used for time series calibration also serves as a tool to generate reliable escapement estimates based on broodstock CPUE and carcass counts. The calibrated escapement estimates have yielded escapement estimates with corresponding CVs of less than 15% for all years, except 1995 (17.9%) and 2006 (15.6%; Velez-Espino et al. 2014).

Escapement Goal Basis: An agency goal of 5,009 wild fish was developed using a habitat-based approach (Parken et al. 2006; Vélez-Espino et al. 2014) and this escapement goal is in Attachment I of Chapter 3 of the 2019 PST Agreement (Figure 2.17).

Agency Comments: The Atnarko River has been developed as an exploitation rate indicator stock (Vélez-Espino et al. 2011) and MR estimates with corresponding CVs less than 15% have been attained in all years (2001–2003 and 2009–2019). The estimation model used for the 1990 to 2013 time series calibration can also generate reliable escapement estimates based on broodstock CPUE and carcass counts. In future years when MR data are absent, carcass counts used with a calibrated time series of escapement provide a method to produce escapement estimates. Future calibrations would be required for years without MR data and will include

new data derived from subsequent MR studies. This was not necessary for 2019 because MR studies took place for Atnarko Chinook salmon.

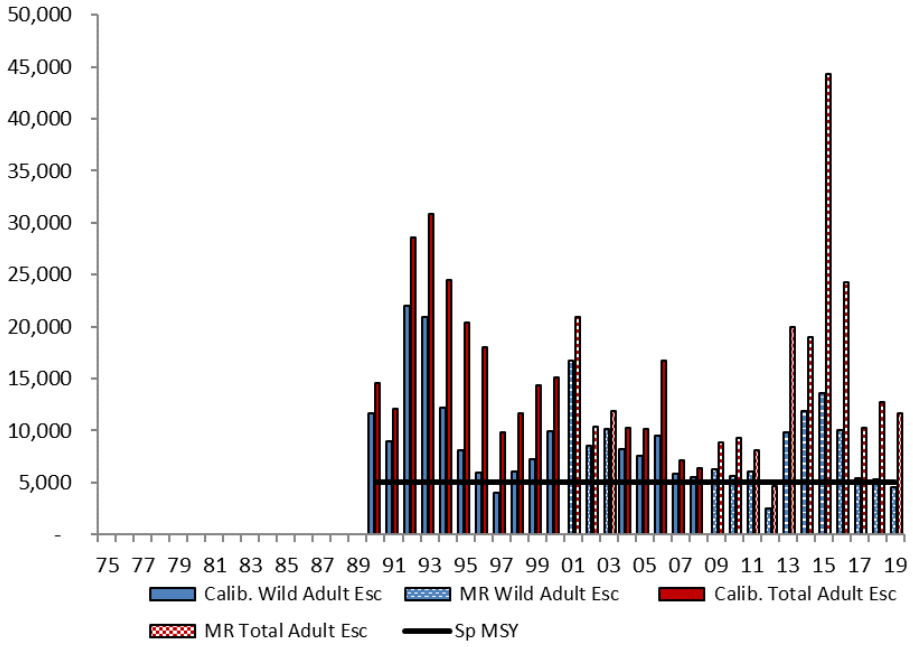


Figure 2.17.–Atnarko River escapements of wild adult (excluding jacks) and total adult (hatchery and wild, excluding jacks) Chinook salmon, 1990–2019.

2.3.3.3 West Coast Vancouver Island and Georgia Strait

2.3.3.3.1 West Coast Vancouver Island

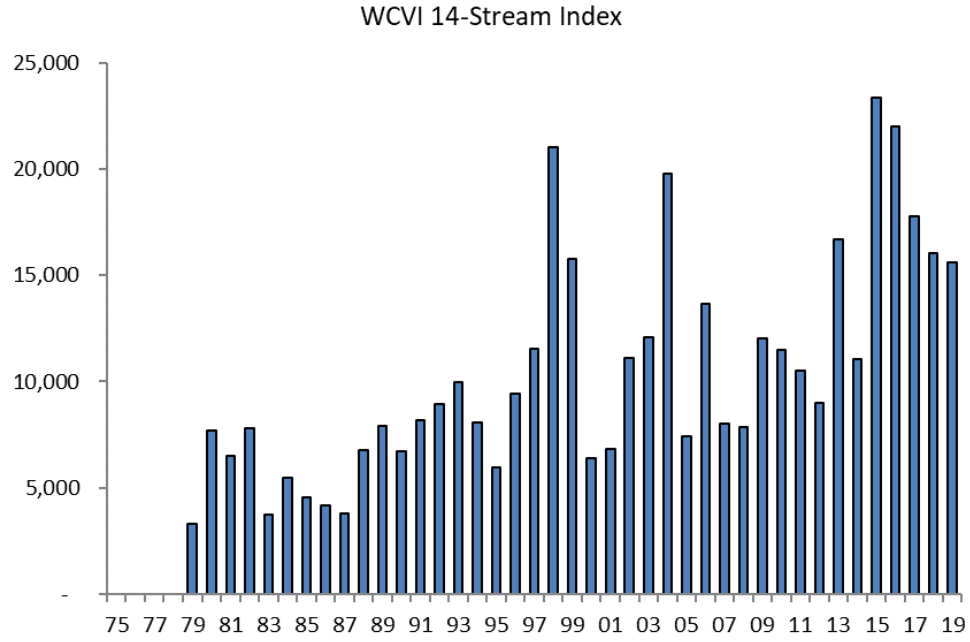
Escapement Methodology: Under the 2019 agreement, two escapement indices are reported to represent escapement to systems with little or no hatchery influence in Northwest Vancouver Island (NWVI) and Southwest Vancouver Island (SWVI) areas. The NWVI aggregate represents the sum of the total escapements for four rivers (Colonial-Cayeagle, Artlish, Kaouk, and Tahsish), and the SWVI aggregate represents the sum of the total escapement for three rivers (Bedwell-Ursus, Megin, Moyeha). These systems were chosen to provide an index of escapement for wild WCVI stocks in general based on historical consistency of data quality. However, the escapement methodology changed in 1995 and earlier estimates have not been calibrated to the new methodology. DFO also developed a 14-stream expanded index (Figure 2.18), which includes escapements to the NWVI and SWVI indices plus the following WCVI streams: Marble (Area 27); Leiner, Burman and Tashsis (Area 25); Sarita, Nahmint (Area 23); and San Juan (Area 21). An MR program in the Burman River was conducted from 2006 to 2018 in addition to the regular Area Under the Curve (AUC) methodology based on swim and foot surveys. Robust estimation of escapement using open-population models within a model selection framework (see Vélez -Espino et al. 2016) started in 2009. In 2019, discounted survey life (DSL) was used. DSL is drawn from the relationship established from 2009-2018 between raw AUC fish-days divided by the mark-recapture population size to provide an index of

spawning area residence time and timing of the first freshet. The annual DSL is now drawn from the relationship by the date of the freshet to divide the raw AUC. A comparison of these escapement estimates with those produced by the AUC method is shown in Figure 2.19 For consistency between aggregate components, the Burman River escapement estimate used for the 14-stream index is based on the swim and foot survey method instead of the MR estimates. The escapement indices in 2019 were 2,200 Chinook salmon for NWVI index, 411 Chinook salmon for the SWVI index and 15,624 for the 14-stream index (Appendix Table B5).

Over the last decade, the PSC Sentinel Stocks Program (SSP) and Endowment Fund programs conducted several studies aimed at producing high quality escapement estimates that are consistent with the CTC data quality standards (CTC 2013). In 2013 and 2014, Canadian Science Advisory Process workshops were held with the objective of evaluating the escapement estimation methodology used to assess the abundance of WCVI indicator stocks. The reviews produced several recommendations for further work and potential improvements. It is anticipated that this work may eventually result in revised escapement data, with measures of precision, which are better quality than the estimates presented in Figure 2.19.

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock group.

Agency Comments: Habitat-based estimates of S_{MSY} and other stock–recruitment reference points are available for these stocks (Parken et al. 2006), but estimates of total escapement are needed to make them effective. Escapements have remained low in non-enhanced streams since 1999 despite terminal fishing restrictions in effect in Areas 24–26 from July to September each year. Escapement indices to all non-enhanced Clayoquot Sound and Kyuquot Sound Chinook salmon streams remain below 500 fish.



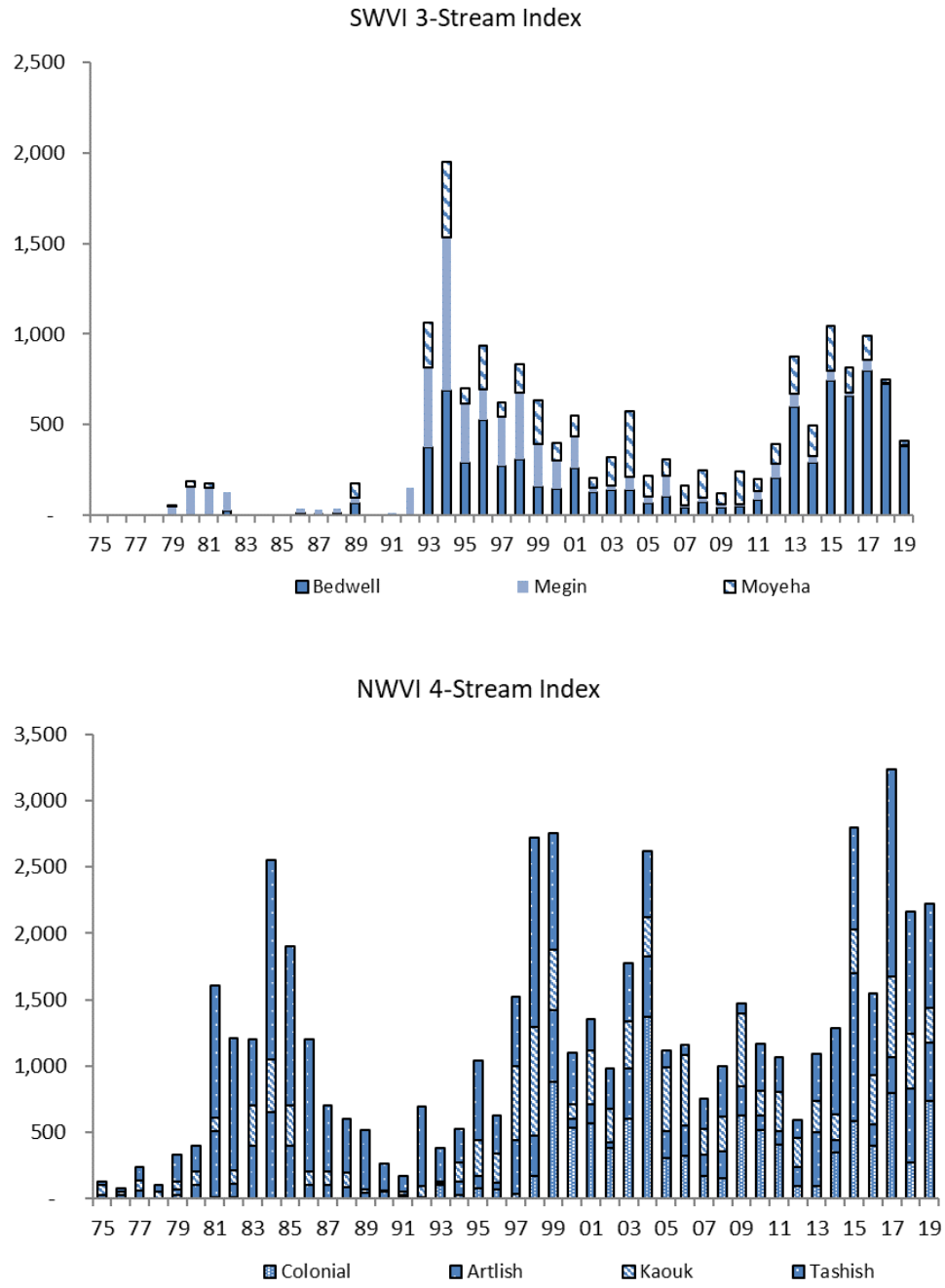


Figure 2.18.– WCVI 14-stream, SWVI 3-stream and NWVI 4-stream indices of escapement of Chinook salmon, 1975–2019.

Note: The escapement methodology changed for all WCVI index streams in 1995 and prior estimates have not been calibrated to the new methodology.

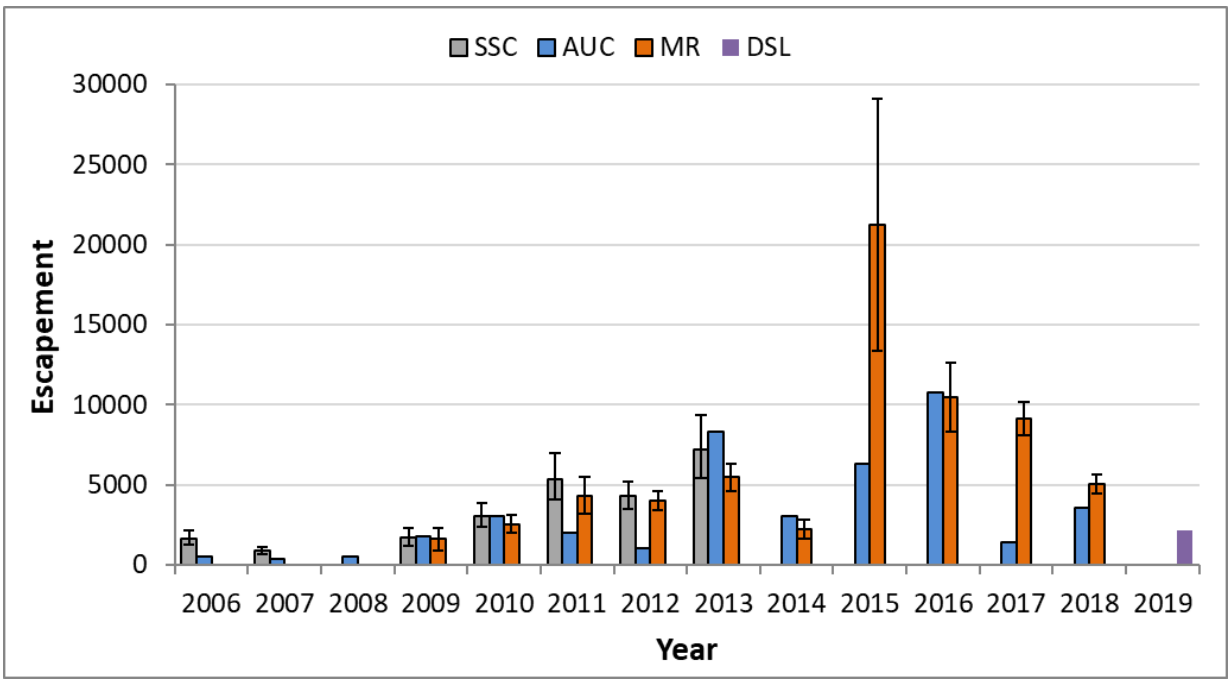


Figure 2.19.– Burman River Chinook escapement based on Petersen estimates from the Sentinel Stock Committee (SSC; 2006–2013), AUC-based agency estimates (2006–2018), open-population mark–recapture estimates (MR; 2009–2018), and discounted survey life (DSL; 2019). Bars are 95% CIs.

2.3.3.3.2 Upper Strait of Georgia

Under the 2019 PST Agreement, two escapement indicators are identified within the Upper Strait of Georgia. Phillips River fall Chinook is an enhanced escapement indicator for the mainland inlets area, and a yet to be determined system will represent the North East Vancouver Island (NEVI) area. Work is ongoing to identify the most suitable escapement indicator for the NEVI area, which is not reported on this year.

The estimated escapement for Phillips River, representing the mainland inlets portion of the Upper Strait of Georgia stock group in 2019 was 2,531 (Appendix Table B4; Figure 2.20).

Escapement Methodology: The accuracy of most escapement estimates in the mainland inlet systems is poor, likely due to low visibility of glacial systems, remote access, and timing of surveys. Furthermore, these escapement estimates have primarily been based on aerial counts targeting other salmon species, which may not coincide with the main spawning period for Chinook salmon. Escapement estimates for these systems have been reported since 1975.

In 2009, an MR program (Live Tag/Deadpitch) was initiated; historically, Phillips Chinook were assessed by helicopter, bank walks and swim surveys. Between 2001–2011, estimation methods utilized were AUC or Peak Live + Dead. Since 2012, escapement estimates have been based on MR results, derived by a modified Petersen estimator (Chapman formula). Over the 2012–2019 period, program precision (CV) has averaged 18.5%. Broodstock and other removals are also included in the total return as Phillips Chinook have been enhanced since 1988. Over that time juvenile releases have been coded-wire tagged to varying degrees. The 2019 brood will be the final enhanced release of Phillips Chinook; MR assessment will continue.

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock group.

Agency Comments: Assessment of stock status is highly uncertain and the escapement time series requires standardization to better represent this stock group in the PSC Chinook model. Differences in ocean distributions, run timing, and life history indicate that future assessments should separate the stock group into conservation units to better represent differences in population dynamics and both freshwater and smolt survival.

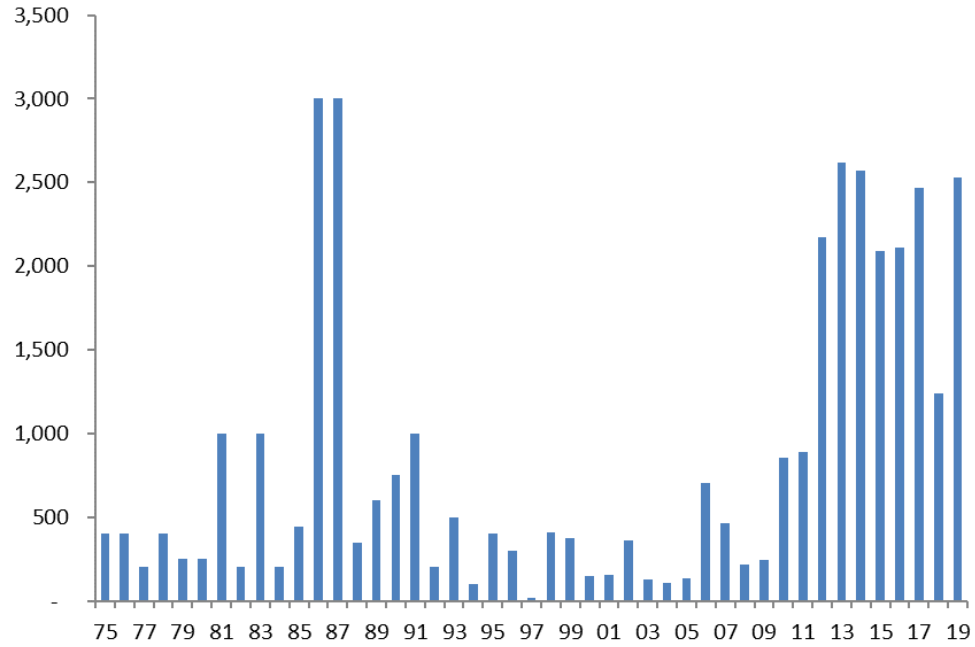


Figure 2.20.– Phillips River escapements of Chinook salmon, 1975-2019.

Note: Since 2012, the escapement estimates have been derived through an intensive MR program. Prior to that, escapement estimates were based on a variety of visual surveys. No calibration between the pre- and post-2012 methods have been made.

2.3.3.3.3 Lower Strait of Georgia

The Lower Strait of Georgia rivers monitored for naturally spawning fall Chinook salmon escapement are the Cowichan and Nanaimo rivers (Figure 2.21 and Figure 2.22). The estimated escapement in 2019 was 18,099 adult Chinook salmon for the Cowichan River (14,943 natural spawners) and 2,572 for the Nanaimo River (Appendix Table B4).

Escapement Methodology: Total Chinook salmon returns have been estimated since 1975. Prior to 1988, escapement estimates from the Cowichan River were derived from swim and aerial surveys. This approach was also used for the Nanaimo River prior to 1995. Since 1988, a counting fence has been operated on the lower Cowichan River. Between 1995 and 2003, a counting fence and carcass MR surveys were used in the Nanaimo River, and since 2004, AUC snorkel survey methods have been used. Survey life utilized in AUC estimate methodology is based on a tagging study completed in 2006.

Cowichan River fence operations rarely span the entirety of the fall Chinook migration due to rainfall driven flow increases exceeding operational limits. As a result, a variable proportion of

the natural spawning population is enumerated at the fence between years. Expansion methods to achieve a population estimate have included snorkel surveys, carcass mark-recapture and generalized run timing curves. A PIT tag-based method has been used since 2017 to produce a Peterson estimate.

Escapement Goal Basis: An escapement goal of 6,500 (CV = 33%) for the Cowichan River was accepted by the CTC in 2005 (Tompkins et al. 2005). There is currently no PSC-agreed escapement goal for the Nanaimo River; however, there is a habitat-based estimate for S_{MSY} of 3,000 spawners (median; CV = 14%; Parken et al. 2006).

Agency Comments: The Cowichan River stock showed considerable increases in escapement in 1995 and 1996, followed by a rapid decline to conservation concern levels of more than 15% below the escapement goal. Significant Canadian fishery management actions were used to reduce exploitation levels on the Lower Strait of Georgia natural stock group. Following a low point in 2009, the population has shown a strong rebuilding trend driven mainly by natural origin Chinook prompting relaxation of several area specific marine closures Hatchery production has been reduced from a peak of 3M to 650K smolts while hatchery-origin fish currently contribute approximately 10% of the natural spawning population. A large scale habitat restoration project conducted in 2006 at Stoltz Bluff significantly reduced fine sediment inputs to the lower 25 km. Considerable focus has also been put on water management in recent years.

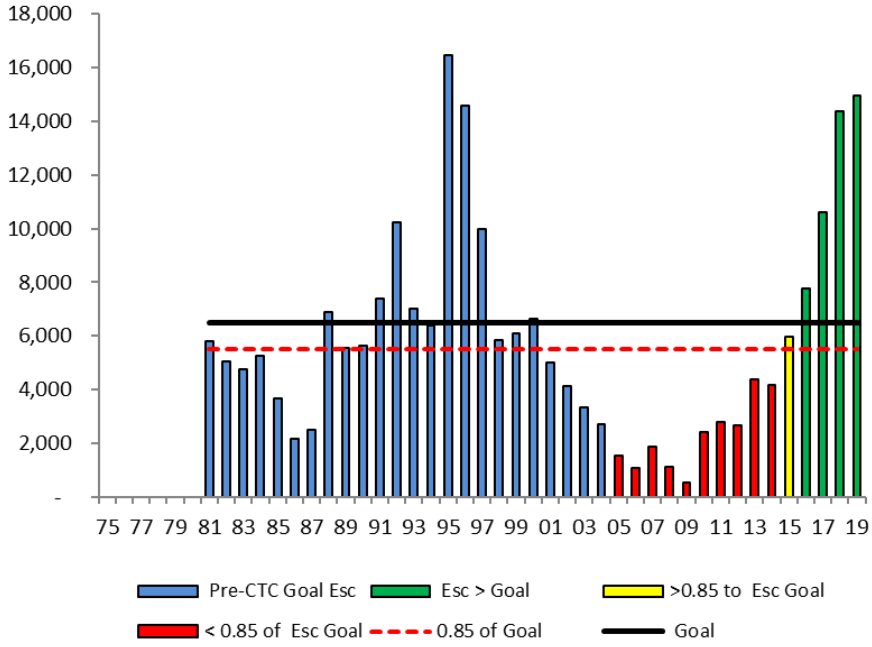


Figure 2.21.–Cowichan River escapements of Chinook salmon, 1981–2019.

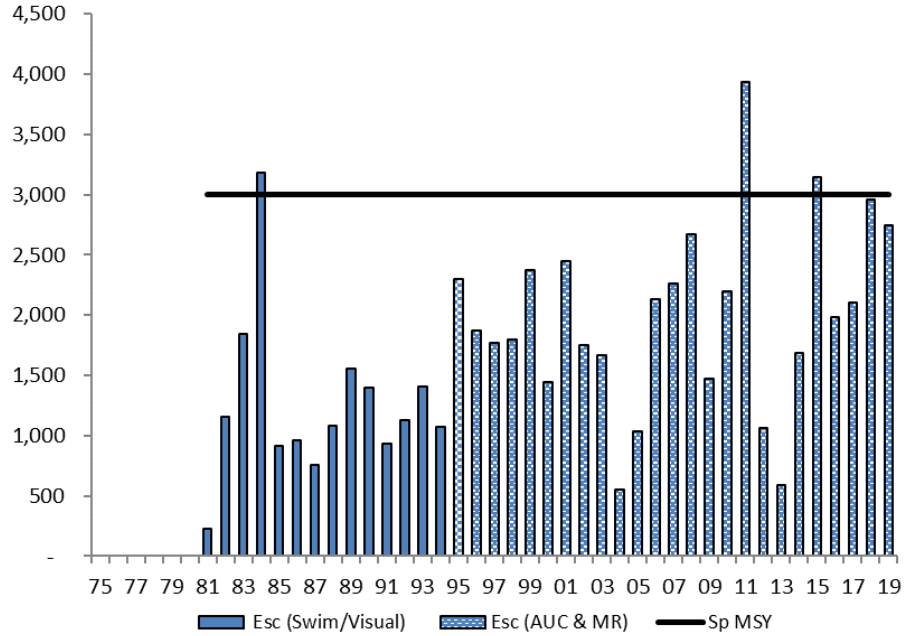


Figure 2.22.–Nanaimo River escapements of Chinook salmon, 1981–2019.

2.3.3.4 Fraser River Stocks

Much of the knowledge about the status of Fraser Chinook salmon is based on escapement data. Most of these data are from visual surveys, and are generally biased low, although considered precise (Parken et al. 2003). Escapement estimates determined from visual survey data are usually obtained by dividing the peak count of spawners, holders and carcasses by 0.65 (Farwell et al. 1999; Bailey et al. 2000). The DFO continues to evaluate accuracy and regularly updates estimates based on the peak count method through calibration studies on Middle Shuswap, Lower Chilcotin, Chilko and periodically on Lower Shuswap. Escapement has also been estimated at several locations using MR methods and direct counts at fences, or from electronic files collected using sonar and resistivity counter technology. Occasionally, escapement estimates cannot be determined for reasons including forest fires and extreme weather events that cause power outages at electronic counters or cancellation of visual surveys. When this occurs, missing estimates are infilled using the English method (English et al. 2007).

Fraser River Chinook are assessed as five naturally spawning stock groups for PSC management including Fraser Spring-Run 1.2, Fraser Spring-Run 1.3, Fraser Summer-Run 1.3, Fraser Summer-Run 0.3, and the Harrison River (Fall-Run 0.3; Appendix Table B.6). Historically, they were only represented by two stocks in the CTC Model (Fraser Early and Fraser Late). As part of the CTC Model Improvements program and the 2019 PST Agreement, the Fraser Early model stock has been separated into four model stocks to better represent population dynamics, ocean fishery distribution and maturation patterns, whereas the Fraser Late (Fraser Fall 0.3) model stock has been separated into two stocks, Harrison (natural) and Chilliwack (hatchery), to represent differences in production dynamics and maturation.

The terminal run estimates in Appendix B6 include catch estimates derived from the Fraser run reconstruction model for CTC stocks only (English et al. 2007).

Within the Fraser, prior to 2019 there were five CWT-indicator stocks; Nicola River (Fraser Spring-Run 1.2), Lower Shuswap (Fraser Summer-Run 0.3), Harrison River and Chilliwack River (Fraser Fall 0.3), and Dome Creek (Fraser Spring-Run 1.3), which was discontinued in 2005. Two new CWT-indicator stocks are under development: Lower Chilcotin (Fraser Spring 1.3) to replace Dome Creek, and Chilko River (Fraser Summer 1.3). The Lower Chilcotin River Chinook salmon population spawns within the Chilcotin system between the confluence with the Chilko River and Chilcotin Lake (30 km). CWTs are also applied and recovered at Middle Shuswap and analyzed as part of the CTC Exploitation Rate Analysis (ERA) to increase recoveries in the Fraser Summer-Run 0.3 stock group as part of the escapement estimation for all Fraser Summer-Run 0.3 Chinook spawning in the Thompson River, with most in the South Thompson tributary (PSC 2018).

Lower Shuswap and Harrison Rivers have PSC management goals identified in the 2019 Agreement. For the spring and summer stock groups, habitat-based models have been developed to estimate spawning capacity and the spawner abundance required to produce maximum sustainable yield, S_{MSY} (Parken et al. 2006). In 2014, a Canadian Centre for Science Advice Pacific meeting examined the status and benchmarks for Southern BC Chinook conservation units (CUs), including Fraser. Benchmarks and status were accepted for non-enhanced CUs, but further work on enhanced CUs is required to evaluate status.

In 2019, the Big Bar Landslide on the Fraser Mainstem obstructed migration of some populations in the Fraser Spring-Run 1.3 and Fraser Summer-Run 1.3 stock groups. For Chinook returning to rivers upstream of the landslide, an estimated 13% of the Spring run and 48% of the Summer run were able to pass the landslide and return to their spawning grounds in 2019. Since there are populations within these stock groups that are downstream of the slide, the overall mortality rates relative to the terminal runs were 81.4% for the Spring-Run 1.3 stock group and 38.6% for the Summer-Run stock group.

There have been four consecutive years of low escapements to the three Fraser stock groups with yearling smolt life history (Spring 1.2, Spring 1.3; and Summer 1.3) and the Harrison (Fall 0.3). The Nicola River escapement estimate has only met the agency approved management goal once in the past 15 years and was low again in 2019. The Harrison River has only met the CTC-agreed escapement goal once in the past 8 years and was well below the escapement goal in 2019 (Figure 2.31). These four stock groups are of continuing conservation concern. The Fraser Summer-Run 0.3 increased during the 1990s and remained abundant until 2012; were lower from 2016–2018; and higher again in 2019. Lower Shuswap exceeded the CTC-agreed escapement goal in 2019.

2.3.3.4.1 Fraser River Spring Run: Age 1.3

The Fraser River Spring-Run age-1.3 stock group includes spring-run populations of the Lower, Middle and Upper Fraser, North Thompson, and South Thompson, but excludes the Lower Thompson tributaries (CTC 2002). The 2019 Fraser Spring 1.3 escapement estimate (3,140) was the lowest since 1975 and is 13% of the 1975–2019 average escapement (Figure 2.23).

Escapement Methodology: Escapements are typically estimated by expanded peak counts of spawners, holders and carcasses, surveyed from helicopters or on foot. The Lower Chilcotin River is a new escapement indicator, with escapement estimated by conducting electronic counts and recovering carcasses, and it is being developed as a CWT exploitation rate indicator stock (Figure 2.24). The collection of hatchery brood stock for the CWT program did not occur in 2019 because of uncertainties associated with the Big Bar landslide mortality, and concerns about too few fish returning to make brood stock collection practical.

The Lower Chilcotin River estimated escapement of 437 in 2019 was 18% of the time series average (2,401; Figure 2.24).

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock group. Habitat-based estimates of S_{MSY} and other stock-recruitment reference points are available, but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements by developing factors that calibrate the visual survey indices to total escapements estimated by electronic counter methods. The Lower Chilcotin is the indicator for the Spring-Run 1.3 stock group identified in Attachment I of the 2019 Agreement. Since 2015, the Lower Chilcotin River escapements have been less than the median habitat-based estimate of S_{MSY} (4,400).

Agency Comments: The Fraser Spring 1.3 stock group is of high conservation concern as escapement estimates have declined substantially over the last decade. There have been four consecutive years of very low returns and 2019 had the lowest escapement estimate in 44 years, largely due to the substantial mortality from the Big Bar Landslide obstruction. In this stock group there are six Conservation Units, used for the DFO Wild Salmon Policy, and six Designatable Units (DUs), assessed by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) as part of Canada's Species at Risk Act (SARA). Four of the DUs were identified as Endangered, one as Threatened, one as Special Concern and one has not yet been assessed by the COSEWIC.

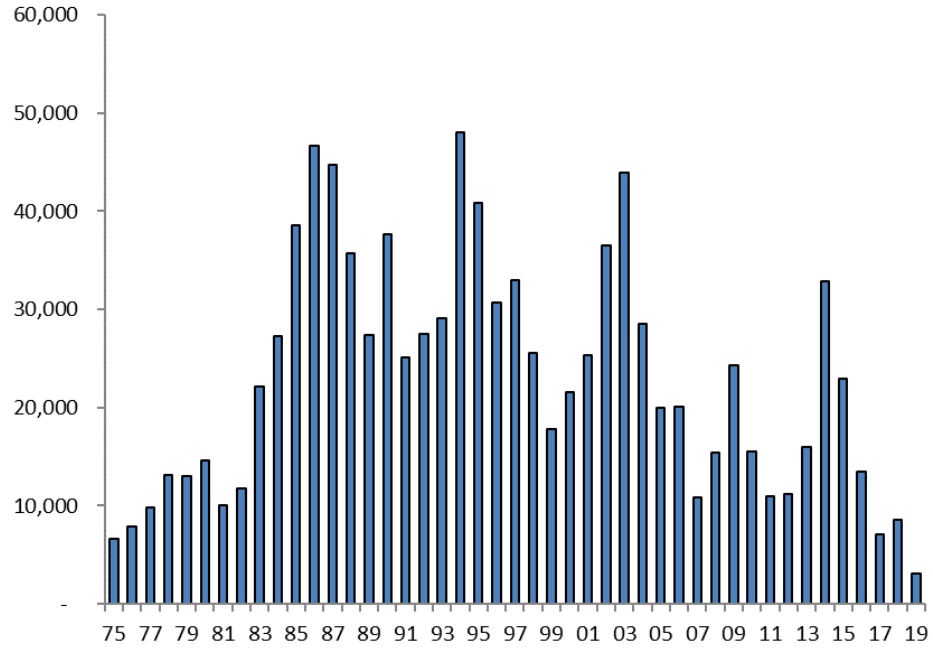


Figure 2.23.–Fraser River spring run age-1.3 stock group escapements of Chinook salmon, 1975–2019.

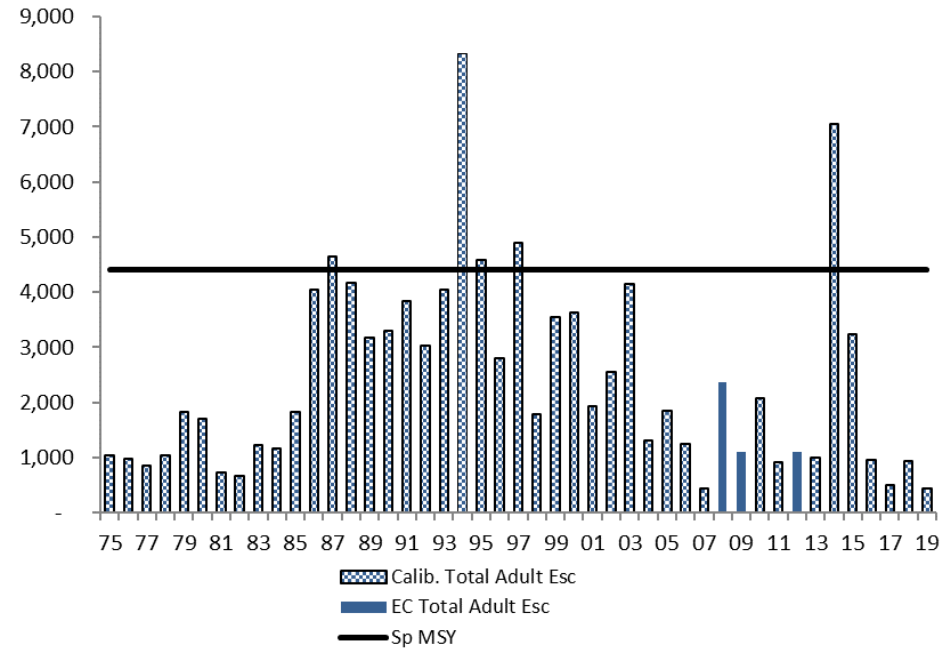


Figure 2.24.–Lower Chilcotin River escapements of Chinook salmon, 1975–2019.

2.3.3.4.2 Fraser River Spring Run: Age 1.2

The Fraser spring run age-1.2 stock group includes six populations that spawn in the Lower Thompson River tributaries, Louis Creek of the North Thompson and the spring-run fish of Bessette Creek in the South Thompson (CTC 2002). This stock group has an early maturation schedule for a stream-type life history, with an average generation time of 4.1 years (brood

years 1985–1986), which results in smaller body size and lower fecundity compared to other stock groups. The 2019 Fraser 1.2 stock group escapement estimate was 5,848, which is 56% of the 1975-2019 average escapement (Figure 2.25).

Escapement Methodology: For the CTC time series, escapements are estimated using expanded visual peak counts of spawners, holders and carcasses in Spius Creek, Coldwater River, and Louis Creek. Escapements to the Deadman and Bonaparte rivers are estimated by resistivity counter. Mark-recapture and calibrated visual surveys are used to estimate escapement to the Nicola River.

In 2018, the Bonaparte River fish way suffered a catastrophic failure due to extremely high runoff, and passage of Chinook salmon above the fish way was extremely limited. The passage was restored in 2019.

The Nicola River is the indicator for the Fraser Spring 1.2 stock group in Attachment I of the 2019 Agreement and it is also the exploitation rate indicator stock. Since 1995, high precision escapement estimates (by age and sex) have been generated using an MR program where Petersen disk tags are applied by angling and post-spawned carcasses are examined for the presence of marks. Estimates of escapement have been generated using pooled Petersen and stratified Darroch methods. The expanded peak count time series for the Nicola River is generally less than the MR estimates (Parken et al. 2003); therefore, the Nicola peak count series has been calibrated to the mark-recapture data and is used prior to 1995 in the Fraser Spring-run Age 1.2 aggregate time series (Figure 2.25 and Figure 2.26).

The Nicola River MR estimated escapement of 3,859 in 2019 was 69% of the time series average (5,554). Since 1995, hatchery-origin fish have averaged 28% of the spawning escapement; however, they represented 60% of the spawning escapement in 2019.

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this aggregate. Habitat-based estimates of S_{MSY} and other stock-recruitment reference points are available for this stock group (Parken et al. 2006), but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements by developing factors that calibrate the visual survey indices to total escapements estimated by MR and electronic resistivity counter methods. In 2019, the habitat-based S_{MSY} for the Nicola was updated to 6,600 by removing unsuitable habitat upstream of Nicola Lake and adjusting for the lower than average fecundity to account for the females having a small body size and maturing at age 1.2. Since 2014, the Nicola River escapements have been less than the median habitat-based estimate of S_{MSY} (6,600).

Agency Comments: The stock group has declined substantially over the last decade and is a stock of conservation concern. In this stock group there are two Conservation Units, used for the DFO Wild Salmon Policy, and 2 DUs assessed by the COSEWIC as part of SARA. Only one of the DUs has been assessed by COSEWIC (Endangered), and the assessment for the other DU is expected over the next year.

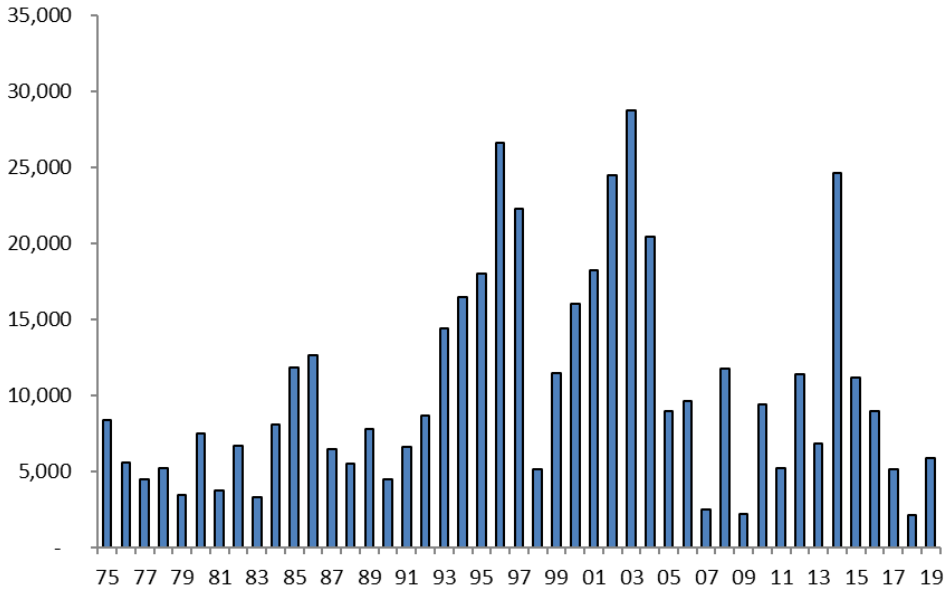


Figure 2.25.–Fraser River spring run age-1.2 stock group escapements of Chinook salmon, 1975–2019.

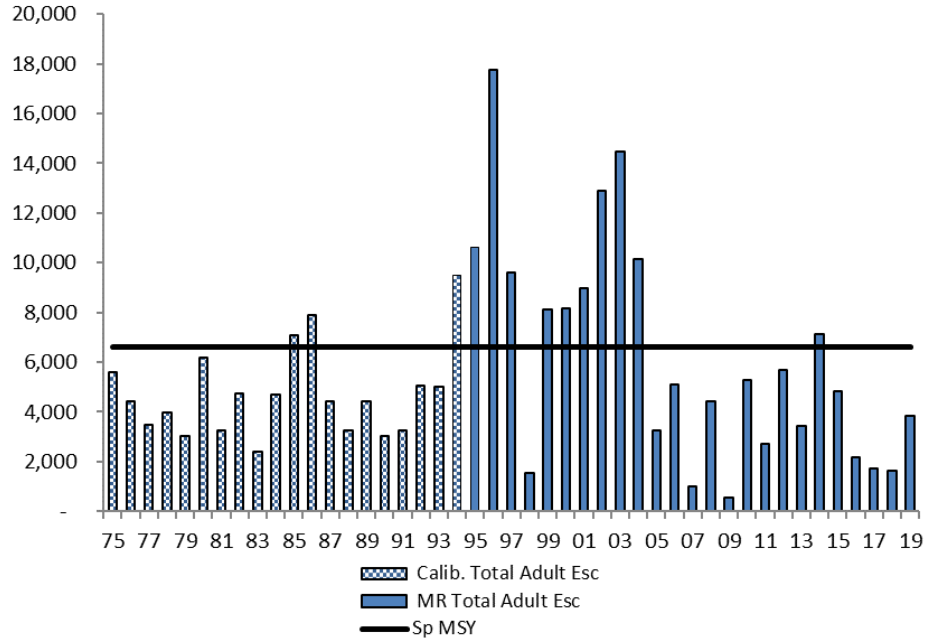


Figure 2.26.–Nicola River escapements of Chinook salmon, 1975–2019.

2.3.3.4.3 Fraser River Summer Run: Age 1.3

The Fraser River summer run age-1.3 aggregate includes 10 populations spawning in large rivers, mostly below the outlets of large lakes. These include the Chilko, Nechako and Quesnel rivers in the Mid-Fraser and the Clearwater River in the North Thompson watershed (CTC 2002).

The 2019 Fraser Summer 1.3 escapement estimate (5,506) was the second lowest since 1975 and only 28% of the 1975–2019 average escapement (Figure 2.27).

Escapement Methodology: Escapements are estimated by expanded peak counts of spawners, holders and carcasses surveyed from helicopters. Surveys of the Stuart River and North Thompson River were discontinued and removed from the data series in 2004 due to unreliable counting conditions. MR and calibrated visual surveys are used to estimate escapement to the Chilko River. From 2010 to 2018, MR methods were used at Chilko River with tags being applied to live fish captured by seining and salmon carcasses being examined later for the presence of marks. Estimates of escapement have been generated using pooled Petersen and stratified Darroch methods.

As there were concerns of very low returns and poor fish health in 2019 due to the Big Bar landslide, adults were not captured for MR tagging at Chilko River. Escapement was estimated using the calibrated peak count method and carcass surveys occurred to collect age, sex, length and CWT recovery data. The Chilko River estimated escapement of 2,486 in 2019 was 30% of the time series average (8,392; Figure 2.28).

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for the aggregate. Habitat-based estimates of S_{MSY} and other stock–recruitment reference points are available for this stock group, but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements by developing factors that calibrate the visual survey indices to total escapements estimated by MR and AUC methods. The Chilko River is the indicator stock for the Summer-Run 1.3 stock group and since 2016, the escapements have been less than the median habitat-based estimate of S_{MSY} (4,500).

Agency Comments: The Fraser Summer 1.3 stock group is of high conservation concern as escapement estimates have declined substantially over the last decade, there have been four consecutive years of very low returns, and 2018 and 2019 are the 2 lowest escapement estimates in 44 years. This stock group has five Conservation Units, used for the DFO Wild Salmon Policy, and five Designatable Units, assessed by COSEWIC as part of SARA. Two of the DUs were identified as Endangered, two as Threatened and one has not yet been assessed by the COSEWIC.

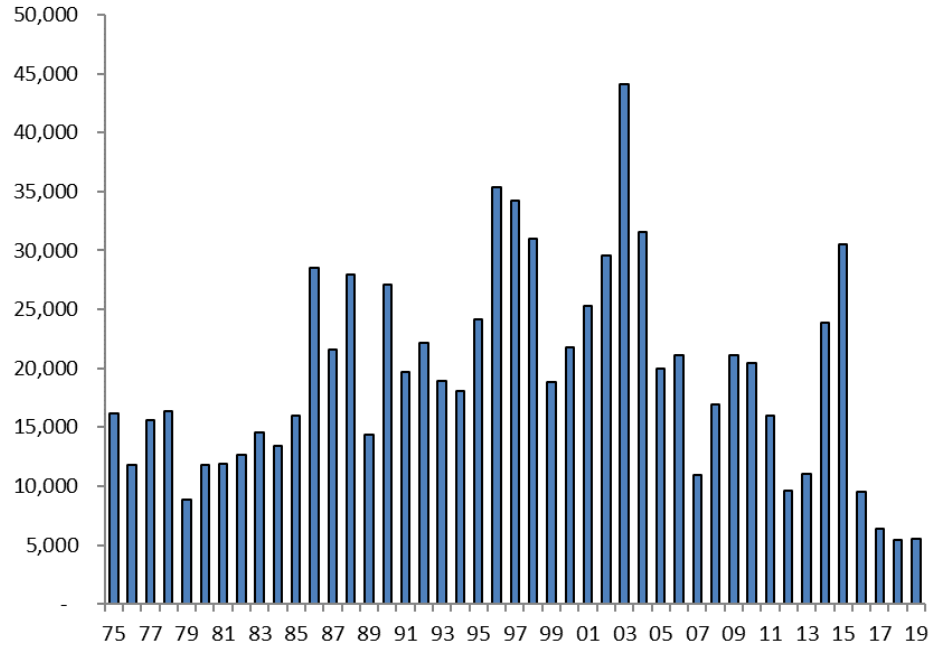


Figure 2.27.–Fraser River summer run age-1.3 stock group escapements of Chinook salmon, 1975–2019.

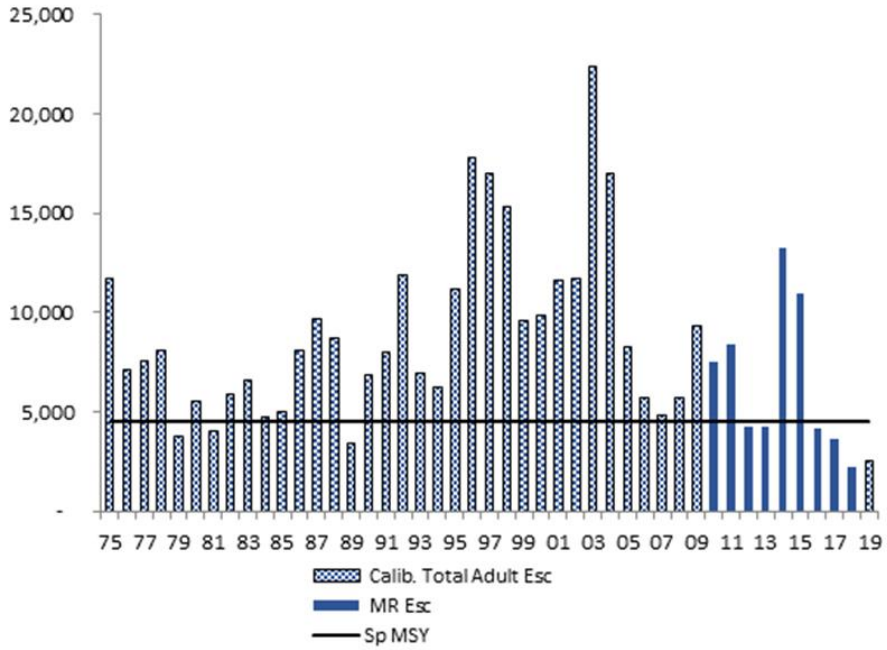


Figure 2.28.–Chilko River escapements of Chinook salmon, 1975–2019.

2.3.3.4.4 Fraser River Summer Run: Age 0.3

The Fraser summer run age-0.3 aggregate includes six populations spawning in the South Thompson watershed and one in the lower Fraser. These include the Middle Shuswap, Lower Shuswap, Lower Adams, Little River, and the South Thompson River mainstem, in the BC interior, and Maria Slough in the lower Fraser (CTC 2002). The 2019 escapement estimate of

169,234 is high for this stock group and is 94% of the 2015 parental brood escapement and well above the 1975–2019 average (Figure 2.29).

Escapement Methodology: Escapements are estimated using peak count visual survey and MR methods. The Lower Shuswap River is the indicator stock identified in Attachment I of the 2019 Agreement and it is the exploitation rate indicator stock. Since 2000 (with the exception of 2003), an MR program provides high precision estimates of escapement by age and sex at the Lower Shuswap River. Tags have been applied to live fish by seining and salmon carcasses were examined later for the presence of marks. Estimates of escapement have been generated using pooled Petersen and stratified Darroch methods. In addition, there are multiple years of MR and CWT data for the Middle Shuswap River.

Since 2000, hatchery-origin fish averaged 9% of the escapement (range: 3%-19%); and they were 4% of the escapement in 2019.

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for the aggregate. Habitat-based estimates of S_{MSY} and other stock-recruitment reference points are available for this stock group (Parken et al. 2006), but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements by developing factors that calibrate the visual survey indices to total escapements estimated by MR methods and novel methods developed during the Sentinel Stocks Program. Peak count estimates for the Lower Shuswap River from 1975 to 1999, and for 2003 have been calibrated to MR equivalents. In the past two decades, with the exception of 2012 and 2016, Lower Shuswap River escapement estimates have exceeded the PSC management objective of 12,300 escapement, which is the median habitat-based estimate of S_{MSY} (Figure 2.30).

Agency Comments: Escapements had been increasing for this stock group over the last decade and the stock group has been healthy and abundant, with the exception of the 2012 and 2016 escapement (largely the progeny of the 2012 brood year escapement). There are three Conservation Units, used for the DFO Wild Salmon Policy, and two Designatable Units, assessed by the COSEWIC as part of Canada's SARA. One DU was identified as not being at risk of extinction and one has not yet been assessed by the COSEWIC.

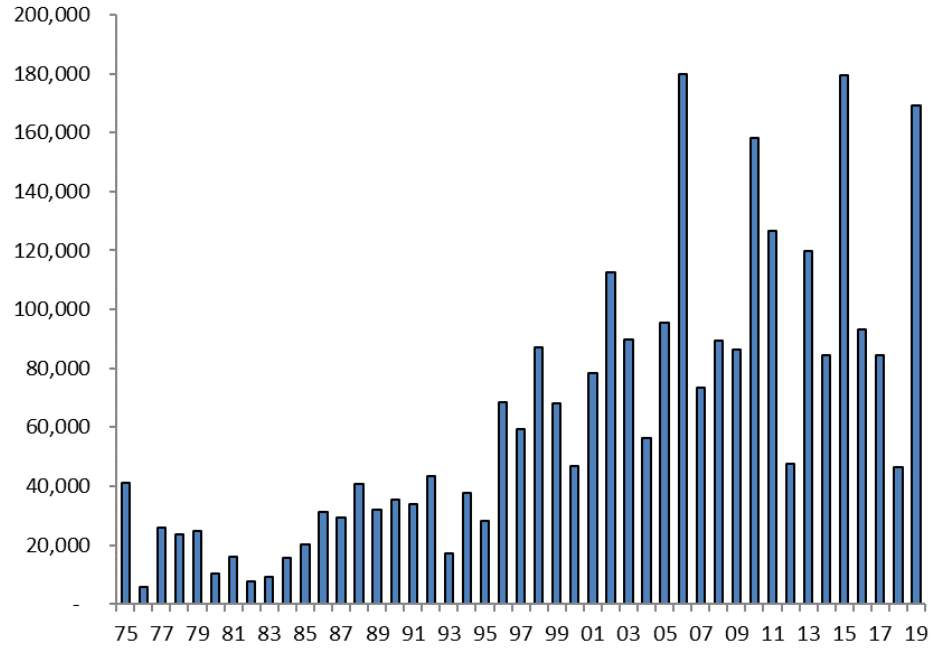


Figure 2.29.–Fraser River summer run age-0.3 stock group escapements of Chinook salmon, 1975–2019.

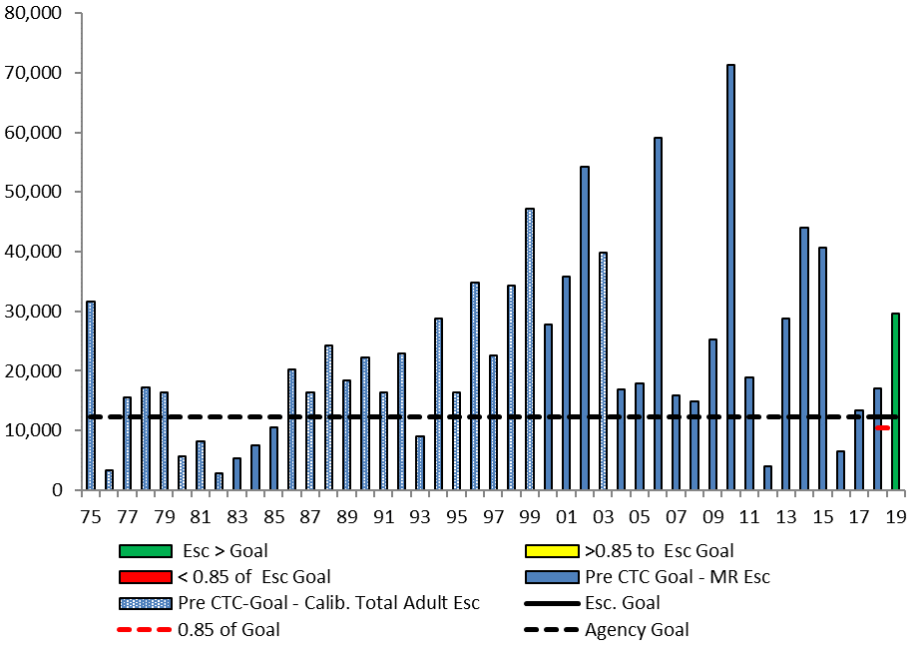


Figure 2.30.–Lower Shuswap River escapements of Chinook salmon, 1975–2019.
The visual escapement estimates have been calibrated with the mark–recapture estimates.

2.3.3.4.5 Fraser River Late Run (Harrison River)

The Fraser River fall run age-0.3 is Harrison River Chinook salmon, which are white-fleshed fish that return to spawn during the fall. These Chinook salmon are unusual in that the fry migrate

into the lower Fraser River and estuary shortly after emergence. This stock spends 2-4 years in the coastal marine environment before returning to spawn. When healthy, the Harrison River stock is one of the largest naturally spawning Chinook salmon populations in the world and makes important contributions to fisheries in southern BC, and Washington State. Spawning escapements to the Harrison River have varied widely from a low of 28,616 adults in 1995 to a high of 246,986 adults in 2003 (Figure 2.31). Escapements have been more than 15% below the lower bound of the escapement goal since 2012 (excluding 2015), the estimated escapement in 2019 was 45,186 adult Chinook salmon.

Escapement Methodology: Since 1984, MR studies have been conducted annually on the Harrison River to obtain reliable estimates of spawning escapements by age and sex. Tags have been applied to live fish by seining and salmon carcasses are examined later for the presence of marks. Since 1984, hatchery-origin fish averaged 4% of the escapement (range: 0.3%-16.8%) and were estimated to be 5% of the escapement in 2019.

Escapement Goal Basis: Due to their natural abundance and importance in numerous British Columbia and Washington State fisheries, Harrison River Chinook salmon were designated as an escapement indicator stock (i.e., 'key stream' indicator) to aid in fulfilling commitments under the 1985 Pacific Salmon Treaty. In 1986, an interim escapement goal for Harrison River Chinook salmon was established at 241,700 fish, based on doubling of the escapement estimate obtained from a MR program in 1984. In 2001, an escapement goal range was developed for Harrison Chinook salmon using a Ricker stock-recruit approach (CTC 2002). The escapement goal range that was proposed was 75,100–98,500 (CV=15%) with the upper bound equal to the upper 75% confidence limit derived from a bootstrap procedure. This range was reviewed and accepted by the CTC. The 2019 Agreement identifies a management objective of 75,100. Escapements have fluctuated substantially with no apparent trend in the time series, until the recent period of poor returns.

Agency Comments: The Fraser Fall 0.3 stock group is a conservation concern due to very low escapement estimates relative to the escapement goal for the past eight years, excluding 2015. In this stock group there is one Conservation Unit, used for the DFO Wild Salmon Policy, and one Designatable Unit, assessed by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) as part of Canada's Species at Risk Act. The Harrison DU was identified as Threatened by the COSEWIC.

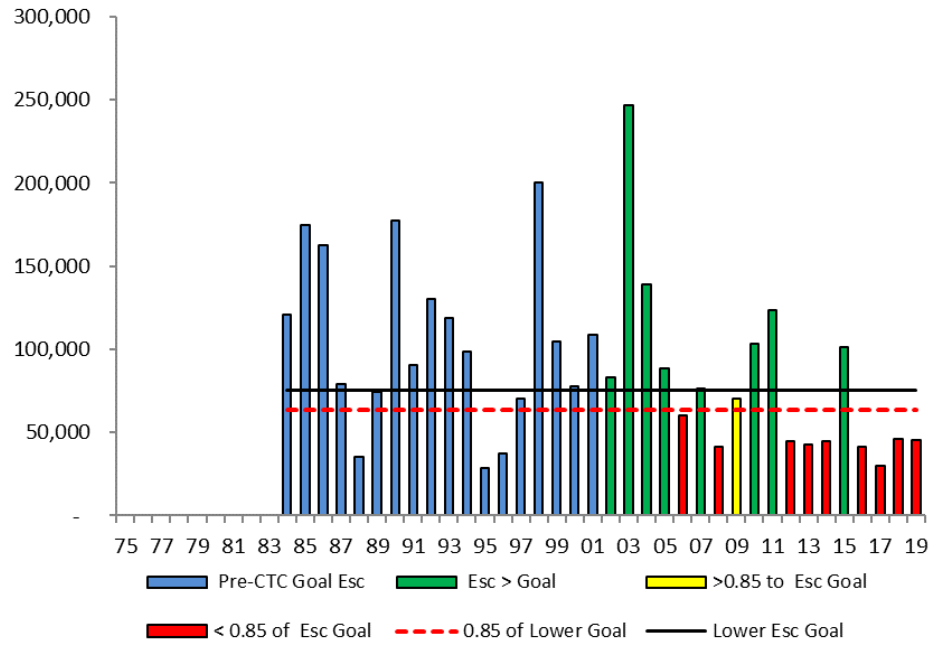


Figure 2.31.–Harrison River escapements of Chinook salmon, 1984–2019.

2.3.4 Puget Sound, Coastal Washington, Columbia River, and Coastal Oregon Stocks

The PSC escapement indicator stocks in Washington and Oregon are currently separated into four regional groups: Puget Sound, Washington Coastal, Columbia River, and North Oregon Coastal. Far north migrating Chinook salmon from the mid-Oregon Coast are currently being incorporated in the PSC Chinook model in this year's base period recalibration. There are currently no CTC-agreed escapement indicator stocks for the Mid-Oregon Coastal group, although the South Umpqua and Coquille have been proposed. The indicator stocks include a variety of run timings and ocean distributions.

Biologically based escapement goals have been reviewed and accepted by the CTC for four fall stocks (Queets, Quillayute, Hoh, and Grays Harbor) and two spring/summer stocks (Queets and Hoh) in coastal Washington, four Columbia River stocks (Lewis, Upriver Brights, Deschutes, and Mid-Columbia Summers), and three far north migrating Oregon coastal stocks (Nehalem, Siletz, and Siuslaw).). Deschutes fall Chinook, as part of the Upriver Bright management group, are no longer included as a separate escapement indicator.

2.3.4.1 Puget Sound

Puget Sound escapement indicator stocks include spring, summer/fall and fall Chinook salmon stocks from the Nooksack, Skagit, Stillaguamish, Snohomish, Lake Washington, and Green river systems. They tend to have a more local marine distribution than most coastal and Columbia River stocks and are caught primarily in WCVI AABM fisheries and Canadian and US ISBM fisheries. Escapement for these stocks is defined as the total number of natural- and hatchery-origin fish observed on the spawning grounds.

2.3.4.1.1 Nooksack River

The Nooksack River drains into Puget Sound just north of Bellingham. The Nooksack spring Chinook stock includes early-timed populations returning to the North and South forks.

Escapement Methodology: Prior to 1999, estimates of the spring run type escapement in the South Fork were based on the number of redds observed prior to the first of October, expanded by 2.5 spawners per redd. Since 1999, this estimate has been refined using CWTs, adipose fin clips, and thermal otolith marks to estimate the number of hatchery- and natural-origin fish in the spawning population. Beginning in 2008 and applied retroactively back to 1999, micro-satellite DNA has been used to assign fish sampled through the first week of October to geographic and run type origin, i.e., North and Middle Fork, South Fork, or hatchery-origin, and spring or fall run type. Most of the escapement is composed of hatchery-origin returns from two supplementation programs. Estimates of escapement in the North and Middle Fork are based on a combination of field methods, dictated by the influence of glacial runoff; methods include redd and carcass counts in clear tributaries as well as in mainstem (turbid) reaches during clear/low-flow conditions. North and Middle Fork escapement estimates are comprised of spring Chinook, but the South Fork spring Chinook have a slightly later run timing than the North and Middle Fork and may spawn concurrently with fall hatchery-origin Chinook. Proportions of hatchery-origin fish are calculated from the number of fish identifiable to hatchery origin out of the total observed during carcass sampling. The 2017 estimate of total spawners is 2,926, with 317 total natural-origin spawners (Figure 2.32). Escapement estimates from 2018 and 2019 are not yet available for either stock.

Since the 2008 return year, WDFW has been investigating the use of transgenerational genetic mark-recapture (tGMR) methods to estimate spawning escapement of spring Chinook. One finding of the tGMR study (Seamons and Rawding, 2017) was that escapement estimates using the tGMR techniques ranged from 1.2 to 3.1 times higher than escapement estimates obtained from carcass and redd count data (Figure 2.33). These tGMR results include fish from the entire river basin, rather than potentially incomplete expansions of sampled reaches. The co-managers are currently reviewing results of the tGMR studies, including investigating analytical techniques that would adjust estimates calculated from field sampling data to a tGMR equivalent estimate that would more appropriately incorporate un-sampled areas.

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock.

Agency Comments: The state–tribal escapement goal established for this Chinook management unit is an upper management threshold (UMT) of 1,000 combined North Fork and Middle Fork natural-origin spawners and a UMT of 500 South Fork natural-origin spawners. The low abundance threshold (LAT) is 400 combined North and Middle Fork natural-origin spawners and 200 South Fork natural-origin spawners. The UMT established by the state–tribal managers is generally considered as the adult (age 3+) escapement level associated with maximum sustained harvest. The LAT is the escapement level below which dramatic declines in long-term productivity could occur. Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has operated under a ceiling ER rather than for a UMT or LAT escapement.

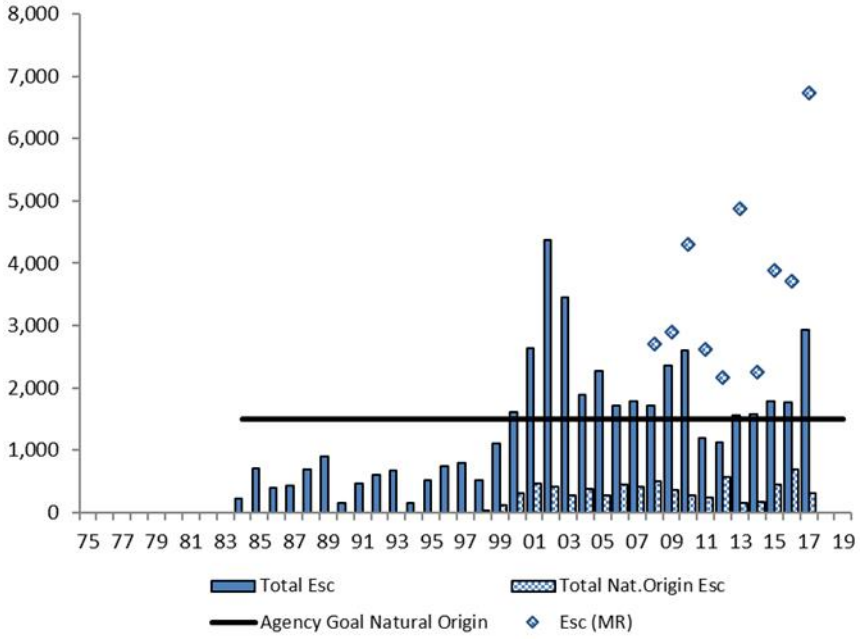


Figure 2.32.– Nooksack River escapement of total (natural- and hatchery-origin) spring Chinook salmon, 1984–2017. The transgenerational genetic mark-recapture (tGMR) estimates are represented by the points with legend label: Esc (MR).

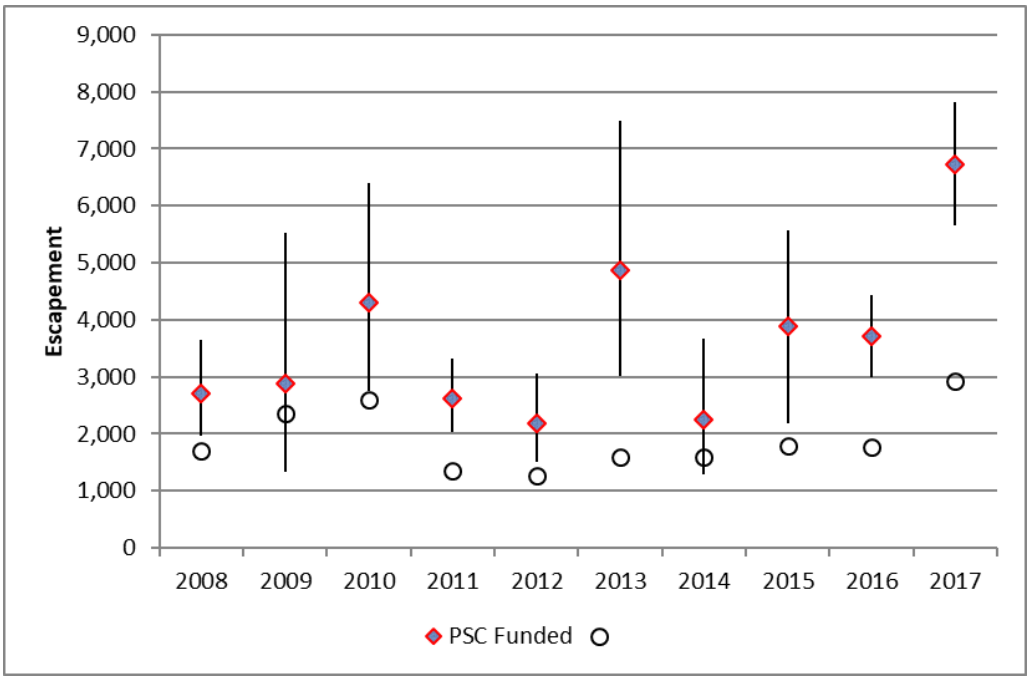


Figure 2.33.–Nooksack River escapements of Chinook salmon to the spawning grounds in years when both agency expanded redd counts were used (circles) and when transgenerational genetic mark–recapture estimates were conducted with Treaty-related funding (diamonds are point estimates and the bars are 95% CIs).

2.3.4.1.2 Skagit River Spring

The Skagit River drains into northern Puget Sound near Mount Vernon and is the largest drainage basin in Puget Sound. The Skagit River spring Chinook salmon stock includes early-timed populations returning to the Upper Sauk, Cascade, and Suiattle rivers.

Escapement Methodology: Due to changes in spawning index areas, beginning in 1992 for the Cascade stock and 1994 for the Sauk and Suiattle stocks, escapements are not directly comparable to previous numbers. In the Upper Sauk, cumulative redd counts are conducted from river mile (rm) 31.0 to 39.7 (Cascade below White Chuck river mouth to the confluence of the North and South Fork Sauk), in the North Fork Sauk from the mouth to the falls, and in the South Fork Sauk (rm 0 to 5.0). This method replaced the peak live and dead count approach used in prior years. In the Cascade River, cumulative redds are counted in the mainstem upstream of rm 8.1 to the forks at 18.6 encompassing the lower north fork and south fork, and in Found, Kindy, and Marble creeks. In the Suiattle basin, cumulative redds are counted in mainstem Suiattle, and in Big, Tenas, Straight, Circle, Buck, Lime, Downey, Sulphur, and Milk creeks. Prior to 1994, peak live and dead fish counts in Big, Tenas, Buck, and Sulphur creeks were used. Escapement may include very small numbers of hatchery strays in these natural production areas. Past PSC-funded studies on straying of Marblemount Hatchery spring Chinook salmon focused on the area immediately adjacent to the hatchery, which is outside the survey reach for natural production. The 2019 escapement estimate is 1,131 natural spawners (Figure 2.34).

Escapement Goal Basis: Attachment I of the 2019 PST Agreement lists an escapement goal of 690 for the Skagit Spring Chinook stock. The escapement goal is the median estimate of escapement that would produce the S_{MSY}. The estimate of S_{MSY} was calculated using a Bayesian state-space model with two major components: a process model describing the production of age-specific recruits, and observation models to account for errors in the estimates of spawning escapement and age composition. The stock-recruit relationship used to estimate S_{MSY} was a Ricker curve, which was chosen instead of a Hockey Stick or Beverton-Holt model as these models tended to overestimate recruitment at low abundances for the Skagit Spring population.

Agency Comments: State–tribal co-managers and NOAA Fisheries are in the process of establishing new domestic management objectives and escapement goals for the Skagit Spring stock. In 2018, the co-managers implemented a UMT of 2,000 natural-origin spawners and an LAT of 690 natural-origin spawners. These objectives are currently being reviewed and may be updated in the future following additional technical analysis. Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has been operated under a total exploitation rate ceiling rather than for a UMT or LAT escapement.

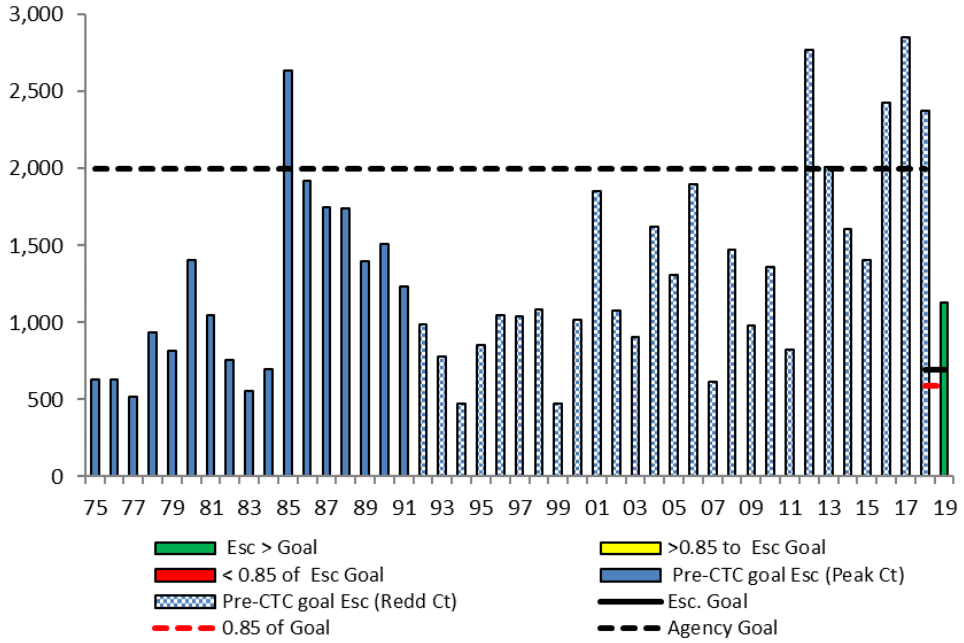


Figure 2.34.–Skagit River escapement of spring Chinook salmon to the spawning grounds, 1975–2019.

Note: This includes early-timed populations returning to the Upper Sauk, Cascade, and Suiattle rivers.

2.3.4.1.3 Skagit River Summer/Fall

The Skagit River summer/fall Chinook salmon stock includes the Upper Skagit River summer, Sauk summer, and Lower Skagit River fall run populations.

Escapement Methodology: Escapement of Skagit River summer/fall Chinook salmon was estimated using expansion of redd counts from helicopter surveys of mainstem areas and foot surveys of smaller tributaries. The counts are expanded by the AUC method (Smith and Castle 1994). This method assumes a 21-day redd life and 2.5 adult spawners per redd. Natural escapement is predominantly offspring from natural-origin spawners; the remainder are hatchery-origin fish from the wild stock tagging program that started in 1994. Natural escapement does not include the brood stock collected for this program. The preliminary 2019 escapement estimate is 11,810 natural spawners (Figure 2.35).

Escapement Goal Basis: Attachment I of the Pacific Salmon Treaty lists an escapement goal of 9,202 for Skagit River Summer/Fall Chinook. The escapement goal is the median estimate of escapement that would produce the S_{MSY}. The estimate of S_{MSY} was calculated using a Bayesian state-space model with two major components: a process model describing the production of age-specific recruits, and observation models to account for errors in the estimates of spawning escapement and age composition. The stock-recruit relationship utilized to estimate S_{MSY} was a Ricker curve, which was chosen instead of a Hockey Stick or Beverton-Holt model as these models tended to overestimate recruitment at low abundances for the Skagit Fall population.

Agency Comments: The UMT used by the state–tribal comanagers for the Skagit River summer/fall Chinook salmon management unit is 14,500, based on a recent assessment of

freshwater productivity and accounting for variability and biases in management error (CCMP 2010). The LAT is 9,100 spawners. Since its listing as threatened under the ESA in 1999, annual fishery management for this stock has been operated under a total exploitation rate ceiling rather than for a UMT or LAT escapement. In years when the UMT is expected to be exceeded, terminal fisheries can be expanded subject to the overall total ceiling exploitation rate.

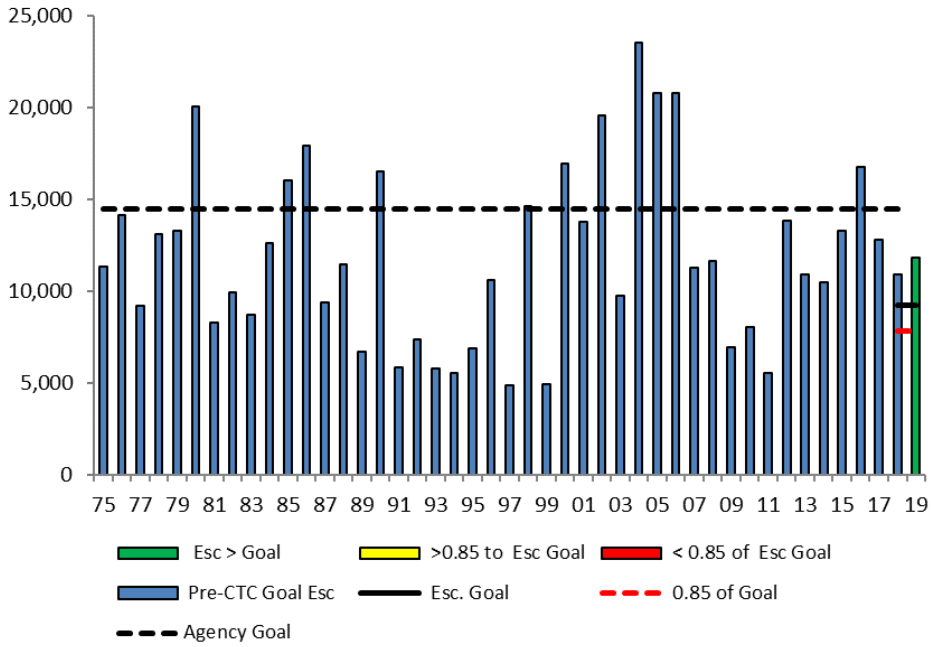


Figure 2.35.–Skagit River escapement of summer/fall Chinook salmon to the spawning grounds, 1975–2019.

2.3.4.1.4 Stillaguamish River

The Stillaguamish River drains into northern Puget Sound between Everett and Mount Vernon. The Stillaguamish River has two populations of Chinook salmon distinguished by genetic characteristics—a summer-timed run and a fall-timed run. These two populations overlap in spawn timing and distribution with both populations spawning in both forks of the river. The summer-timed run is a composite of natural- and hatchery-origin supplemental production, with most spawning occurring in the North Fork and its major tributaries, including Boulder River, and Deer, Grant, French, and Squire creeks. A much smaller, natural-origin fall stock spawns primarily in the mainstem and South Fork Stillaguamish, in Pilchuck, Jim, and Canyon creeks, and the North Fork Stillaguamish River. Escapement is currently estimated as South Fork and North Fork Stillaguamish rather than summer and fall populations of Chinook salmon.

Escapement Methodology: Escapement estimates for Stillaguamish Chinook salmon were based on redd count expansions, assuming a 21-day redd life. Between 1988 and 2007, the North Fork of the Stillaguamish River was surveyed with one to three aerial surveys and redd estimates were expanded by AUC methods (Smith and Castle 1994). Starting in 2008, field methods to obtain redd counts in the North Fork changed to ground based surveys.

Escapement estimates for the south fork of the Stillaguamish River use a peak redd count and assumes 2.5 fish per redd. Boulder and Squire Creeks on the North Fork Stillaguamish River and

Jim Creek on the South Fork Stillaguamish River are also surveyed. Spawning escapement estimates of fall Chinook salmon are biased low due to incomplete redd counts using visual sampling methods (Figure 2.36). Evidence of this is supported by results of tGMR studies that have occurred in recent years, funded by Treaty-related sources (Small et al. 2020). Escapement estimates based on these studies were 1.0 to 1.6 times higher than those calculated from redd count data (Figure 2.37). Natural escapement excludes brood stock taken for the wild stock indicator program after 1987, but does include spawning hatchery fish from this production. Total natural spawning escapement in 2019 is estimated at 440. An additional 152 fish were collected for broodstock from the spawning grounds.

Recently, the co-managers agreed to revise escapement estimates from 1988 to 2007 to a tGMR equivalent estimate. First, aerial survey-based escapement estimates from the North Fork are adjusted to a ground survey-based equivalent using data collected in 2008, 2009, 2016, and 2017 when aerial and ground surveys were conducted concurrently. South Fork escapements are then added to the new North Fork escapements to arrive at a total escapement for historic aerial surveys. The new total ground count escapements are converted to a tGMR equivalent using a regression relationship derived from ground based and tGMR escapements from the period 2008 to 2016 when both methods were used concurrently.

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock group.

Agency Comments: State–tribal co-managers and NOAA Fisheries are in the process of establishing new domestic management objectives and escapement goals for the Stillaguamish stock. In 2018, the co-managers implemented a UMT of 1,500 natural spawners, an LAT of 1,200 natural spawners, and a Lower Bound Threshold of 900 natural spawners. The summer Chinook salmon supplementation program, which collects brood stock from the North Fork of the Stillaguamish River return, was initiated in 1986 as a PST indicator stock program, and its current objective is to release 200,000 tagged fingerling smolts per year. Since 2000, an average of approximately 140 adults have been collected annually from the spawning population for this program. Most releases into the North Fork are from acclimation sites. Relatively small numbers of smolts have been released into the South Fork of the Stillaguamish River. Since listing as threatened under the ESA in 1999, annual fishery management for this stock has been operated under a ceiling exploitation rate rather than for a UMT or LAT escapement.

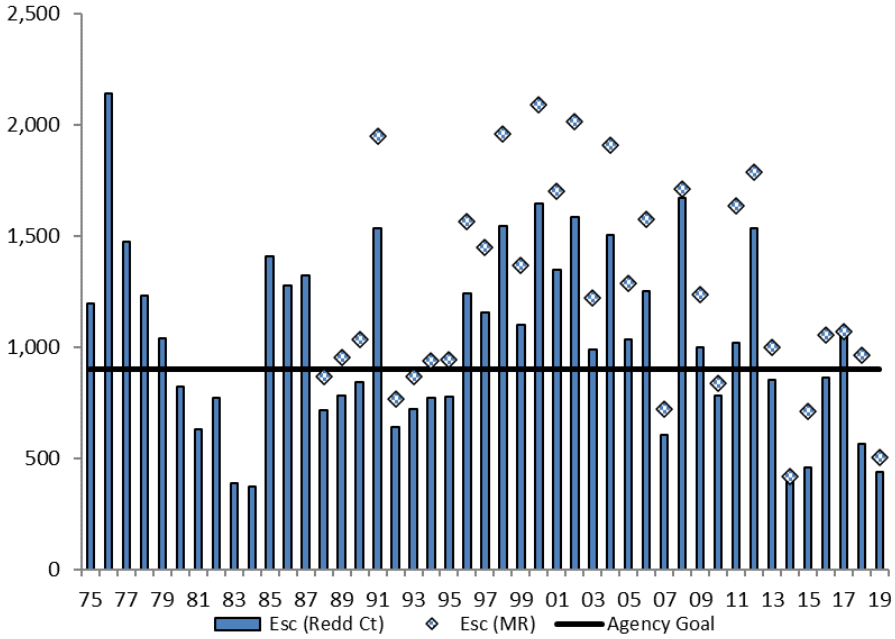


Figure 2.36.–Stillaguamish River escapement of Chinook salmon to the spawning grounds, 1975–2019.

The points labeled Esc (MR) represent new estimates based on recent surveys applying transgenerational genetic mark-recapture (tGMR) estimates.

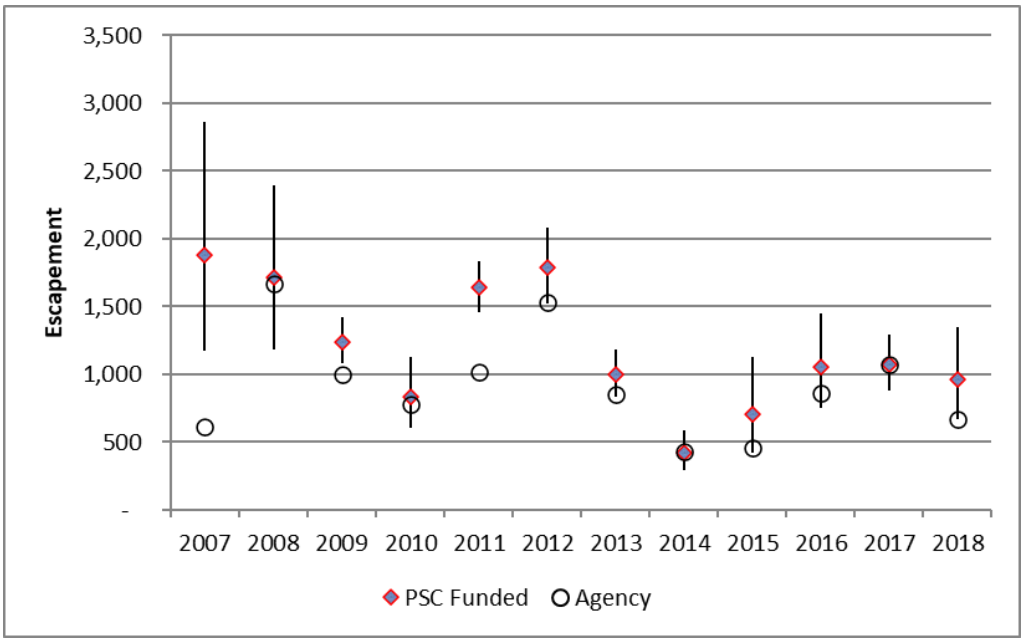


Figure 2.37.–Stillaguamish River escapements of Chinook salmon to the spawning grounds in years when both agency expanded redd counts were used (circles) and when transgenerational genetic mark–recapture estimates were conducted with Treaty-related funding (diamonds are point estimates and the bars are 95% CIs).

2.3.4.1.5 Snohomish River

The Snohomish River is in northern Puget Sound near Everett. The Snohomish Chinook salmon stock includes the Skykomish and Snoqualmie summer/fall run populations. Skykomish Chinook salmon spawn in the mainstem of the Skykomish River and its tributaries—including the Wallace and Sultan rivers, Bridal Veil Creek, the south fork of the Skykomish River between river mile 49.6 and river mile 51.1, above Sunset Falls (fish have been transported around the falls since 1958), and the North Fork of the Skykomish River up to Bear Creek Falls (rm 13.1). Snoqualmie Chinook salmon spawn in the Snoqualmie River and its tributaries, including the Tolt River, Raging River, and Tokul Creek.

Escapement Methodology: Escapement was estimated using expanded redd counts obtained by a combination of helicopter, float, and foot surveys, and from fish counts at the Sunset Falls fishway. The natural spawning escapement estimate includes a significant contribution of hatchery strays from the Wallace and Bernie Kai-Kai Gobin (Tulalip Tribes) facilities. Annual tGMR studies funded under the SSP were conducted from 2011–2015 (Figure 2.38 and Figure 2.39). The 2019 escapement is estimated at 1,644 natural spawners.

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock.

Agency Comments: The state–tribal co-managers have a UMT for this stock of 4,900 natural-origin spawners. The LAT for Snohomish River summer/fall Chinook salmon is 3,250. Since listed as threatened under the ESA in 1999, annual fishery management for this stock has been for a ceiling exploitation rate rather than for a UMT or LAT escapement. In 2014, WDFW and the Tulalip Tribes reviewed, reconciled, and updated the historic escapement time series for the Snohomish Basin; this resulted in minor changes to the data series.

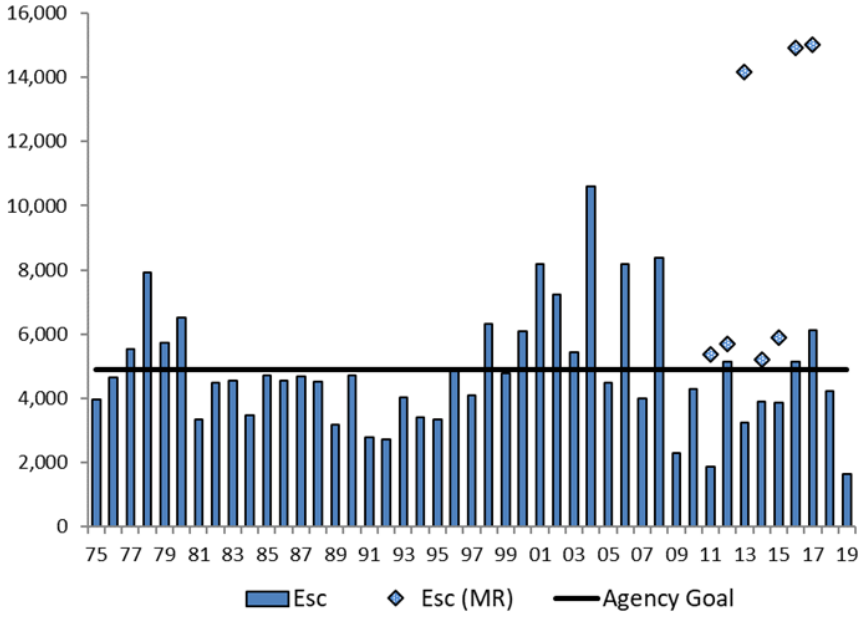


Figure 2.38.–Snohomish River escapement of Chinook salmon to the spawning grounds, 1975–2019.

The transgenerational genetic mark-recapture estimates are represented by the points with legend label: Esc (MR).

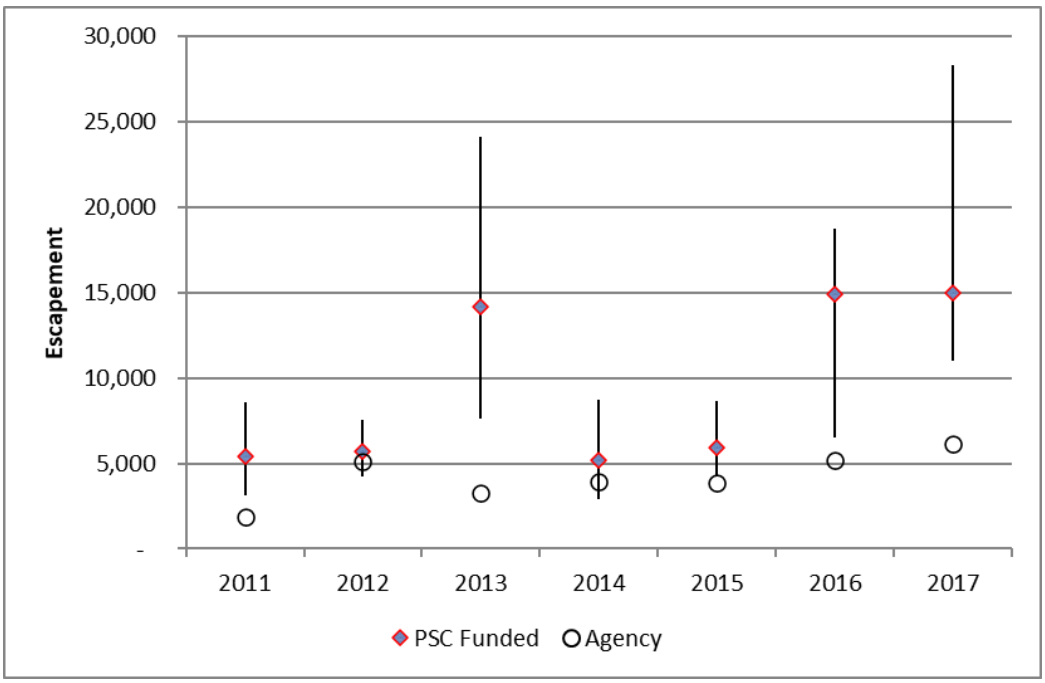


Figure 2.39.–Snohomish River escapements of Chinook salmon to the spawning grounds in years when both agency expanded redd counts were used (circles) and when transgenerational genetic mark–recapture estimates were conducted with Treaty-related funding (diamonds are point estimates and the bars are 95% CIs).

2.3.4.1.6 Lake Washington

The Lake Washington Chinook salmon stock includes the fall run populations in the Cedar River and in the Sammamish River tributaries of Bear, Cottage, and Issaquah creeks. A hatchery is located on Issaquah Creek, and Chinook salmon at the hatchery rack are not included in the natural escapement for Lake Washington.

Escapement Methodology: Escapement in the mainstem Cedar River is estimated using expansion of total redd counts. Prior to 1999, live counts and AUC methods were used to estimate spawning abundance in the Cedar River. Past AUC estimates have been converted to redd-based estimates using simple linear regression. Escapement estimates are considered a complete census because redd surveys encompass the entire Chinook production area of the Cedar River. It should be noted that although there are no hatchery fish released into the Cedar River, an average of 24% of the spawners from 2003 to 2019 were adipose clipped from mass-marked hatchery production, originating primarily from Issaquah Hatchery (J. Schaffler, Senior Quantitative Scientist, Muckleshoot Indian Tribe, 2020, pers. comm.). Escapement to the Sammamish River tributaries is estimated using live counts and AUC methods in Bear and Cottage Lake creeks. Index surveys in Bear Creek began in 1981; index surveys in lower Cottage Lake Creek began in 1983 and were expanded in 1997 to include upper Cottage Lake Creek (considered a non-index area). Spawning escapement based on AUC methods in Issaquah Creek below the Issaquah Creek Hatchery rack and East Fork Issaquah Creek were initiated in 1999. Past AUC estimates of index areas have been converted to AUC estimates of both index and non-index areas using simple linear regression. The majority of natural spawners in the

Sammamish River tributaries are hatchery-origin, likely strays from the Issaquah hatchery. The 2019 naturally spawning escapement estimate for Lake Washington is 1,220 of which 855 were attributed to the Cedar River and 365 (of which 101 were natural-origin fish) to the Sammamish River tributaries (Figure 2.40).

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock.

Agency Comments: State–tribal co-managers and NOAA Fisheries are in the process of establishing new domestic management objectives and escapement goals for the Lake Washington stock. In 2018, the co-managers developed an MSY based escapement goal (282) for the Cedar River population and implemented a UMT of 500 natural spawners and an LAT of 200 natural spawners for the Cedar River population. Since listed in 1999 as threatened under the ESA, annual fishery management for this stock has operated under a ceiling exploitation rate rather than for a UMT or LAT escapement in the Cedar River; however, when the UMT is expected to be exceeded, some additional fishing in Lake Washington may be considered.

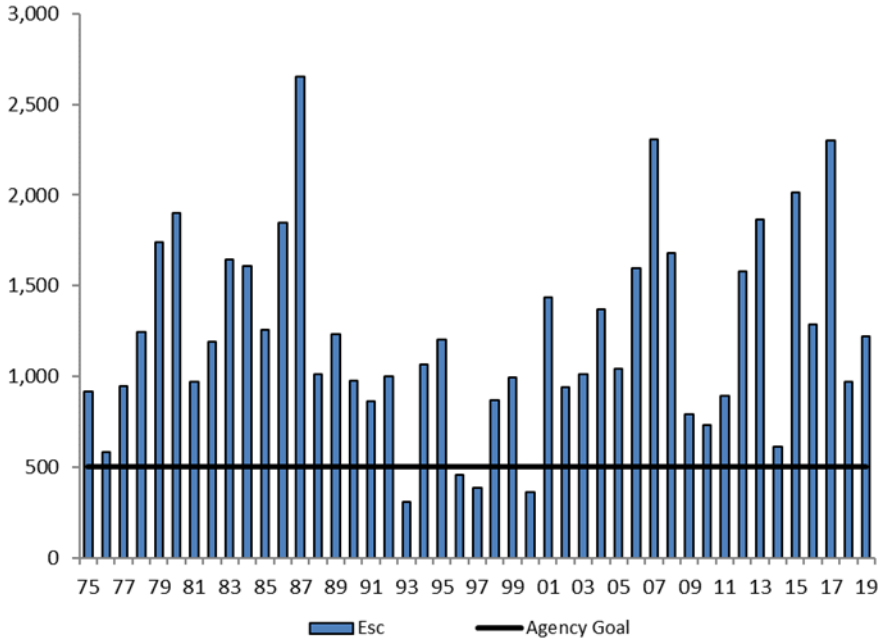


Figure 2.40.–Escapement of Chinook salmon to the spawning grounds in the tributaries of Lake Washington (Cedar River and Bear and Cottage Lake Creeks), 1975–2019.

2.3.4.1.7 Green River

The Green River fall Chinook salmon stock consists of a single population spawning in the mainstem Green River and two of its major tributaries, Newaukum and Soos creeks.

Escapement Methodology: Escapement is estimated from a redd count expansion method that has varied over the time series by the extent of spawning survey coverage. The method used until about 1996 involved an index area redd count multiplied by 2.6 to estimate total redds, then multiplied by 2.5 fish per redd to produce estimated escapement. The 2.6 index to total redd expansion factor was based on a 1976 to 1977 US Fish and Wildlife Service MR study

(Ames and Phinney 1977). Since 1996, the survey areas have been broadened and the associated expansion factor of 2.6 has been reduced to the point where redd count surveys in 2009 have complete spawning reach coverage. The method used in recent years provides natural escapement estimates for the mainstem Green River and Newaukum Creek. Newaukum Creek redds are counted during foot surveys. The mainstem Green River is surveyed by boat and by air. Some parts of the river (i.e., the gorge) are only surveyed by air. Boat surveys are generally conducted once a week, or twice a week in years with large numbers of pink salmon. One aerial survey is made during the peak of spawning, with more surveys if budgets permit. Certain index reaches of the river are surveyed every week by boat to develop a cumulative redd count total for those reaches. These index reaches are distributed throughout the river. Visible redds are counted for the entire floatable part of the river by boat each week and for the entire river by helicopter during the peak. The ratio of visible redds seen by boat to those seen by air (boat surveys assumed to be best) is used to estimate how many redds would be seen by boat in the reaches not surveyed. This provides an estimate of how many visible redds exist during the peak of spawning. To get from peak redds to cumulative total redds, the visible redds in the index reaches during the peak are compared to the season total for those index reaches. Different areas of the river have different ratios of peak visible redds to season totals. Expansion of visible redds outside index areas to season total redds uses the ratio from nearby index reaches of the same general character. The CTC considers these estimates from redd counts as index values rather than estimates of total escapement. Estimates of total escapement from MR studies in 2000, 2001, and 2002 funded through the US Letter of Agreement were about 2.5 times higher than the escapement estimate from redd count expansion. In 2010, 2011 and 2012, tGMR-based escapements from studies funded under the SSP were once again more than twice as high as the redd count expansion estimates (Figure 2.41 and Figure 2.42). There is a large hatchery program in this basin and these fish comprise a large portion of the return. Hatchery contribution to the natural escapement in the Green River averaged 58% from 2004-2019 and ranged from 27% to 75%. The 2019 redd-based estimate of naturally spawning escapement is 2,976 mixed hatchery- and natural-origin Chinook salmon.

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock.

Agency Comments: State–tribal co-managers and NOAA Fisheries are in the process of establishing new domestic management objectives and escapement goals for the Green River stock. In 2018, the co-managers developed an MSY-based escapement goal of 2,003 and implemented a multi-tiered natural spawning escapement threshold of 3,800 (UMT1) and 6,000 (UMT2) natural spawners and a LAT of 802 natural spawners that regulated exploitation rates for this stock. Since listed as threatened under the ESA in 1999, annual fishery management for this stock has used a ceiling exploitation rate in the southern U.S. preterminal fisheries, and a UMT in the terminal fisheries.

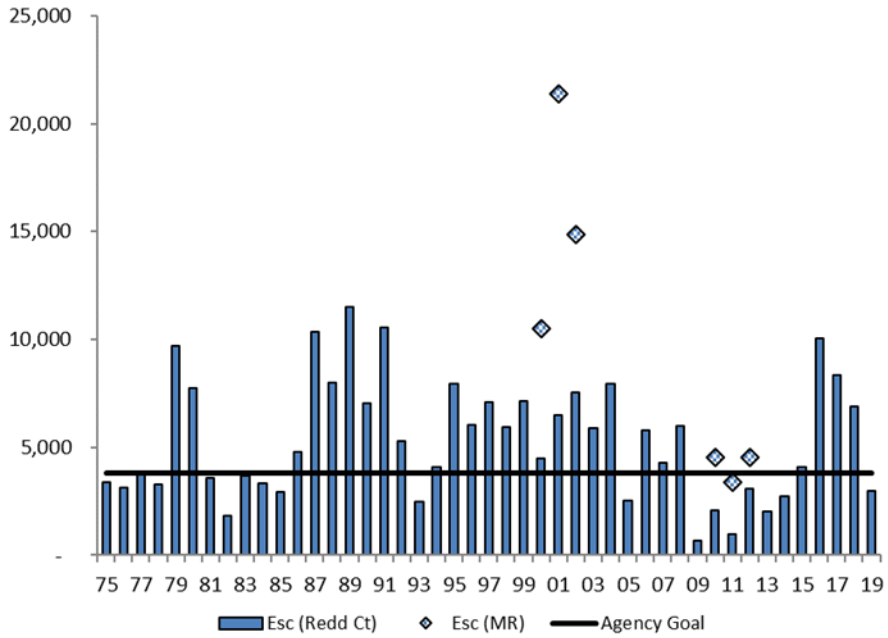


Figure 2.41.–Green River escapement of Chinook salmon to the spawning grounds, 1975–2019.

The transgenerational genetic mark-recapture (tGMR) estimates are represented by the points with legend label: Esc (MR).

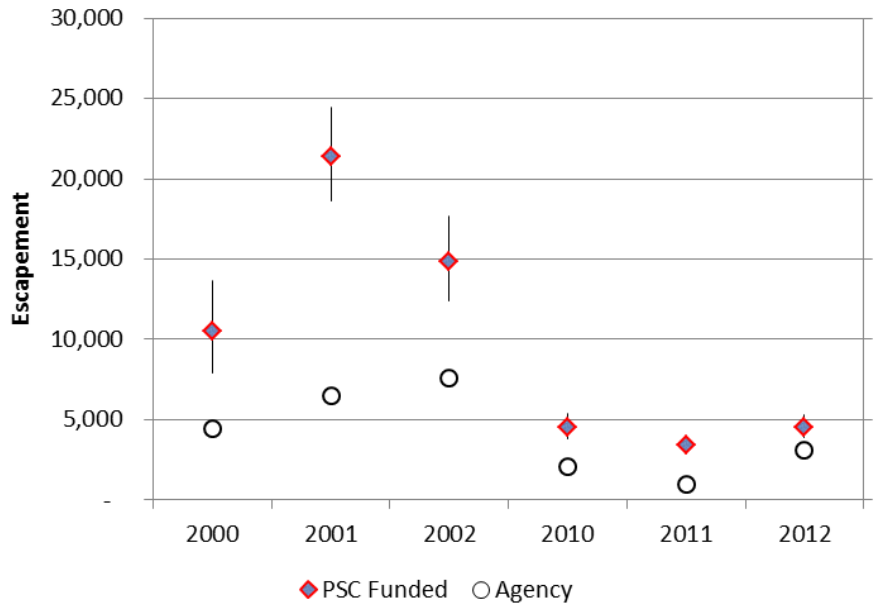


Figure 2.42.– Green River escapements of Chinook salmon to the spawning grounds in years when both agency expanded redd counts were used (circles) and when conventional (2000–2002) and genetic (2010–2012) mark–recapture estimates were conducted with Letter of Agreement or SSP funding (diamonds are point estimates and the bars are 95% CIs).

2.3.4.2 Coastal Washington

Coastal Washington stocks include spring, summer, and fall Chinook salmon from the Hoko, Quillayute, Hoh, and Queets Rivers, and from Grays Harbor including the Chehalis and Humptulips rivers. Coastal Washington stocks have a northerly distribution and are primarily caught in SEAK and NBC AABM fisheries. They are also caught in southern U.S. terminal net fisheries, primarily as mature fish during their spawning migrations.

2.3.4.2.1 Hoko River

The Hoko River is located at the extreme western end of the Strait of Juan de Fuca and is not listed as part of the Puget Sound Chinook Salmon Endangered Species Unit under the ESA. Hoko River Chinook salmon spawn primarily in the mainstem of the Hoko River, with limited spawning in larger tributaries.

Escapement Methodology: The Makah Tribe and WDFW conduct ground surveys using cumulative redd counts for the Hoko River mainstem and tributaries found between rm 1.5 and 21.7, which represents the entire range of spawning habitat utilized by Chinook salmon. Redd counts are multiplied by 2.5 adults per redd. There are 10 mainstem reaches plus 13 tributary reaches, including Little Hoko, Browne's, Herman, North Fork Herman, Ellis, Bear, and Cub rivers, which are all upper mainstem tributaries. The tribe also surveys the mainstem Sekiu River, and Carpenter, South Fork Carpenter, Sunnybrook, and three unnamed creeks (numbered 19.0215, 19.0216, and 19.0218). Escapement excludes fish used as broodstock to support the supplementation program, which started in 1988 and targets 200 fish each year. In 2019, 264 fish were retained for the supplementation program leaving a total natural spawning escapement estimate of 1,779 mixed natural-and hatchery-origin returns from the supplementation program (Figure 2.43).

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock.

Agency Comments: The UMT escapement goal established by state and tribal co-managers is 850 naturally spawning adults. Instead of a stock–recruitment analysis, the escapement goal was derived using a habitat-based approach where estimates of available spawning habitat were expanded by assumed optimal redds per mile and fish per redd values (Ames and Phinney 1977).

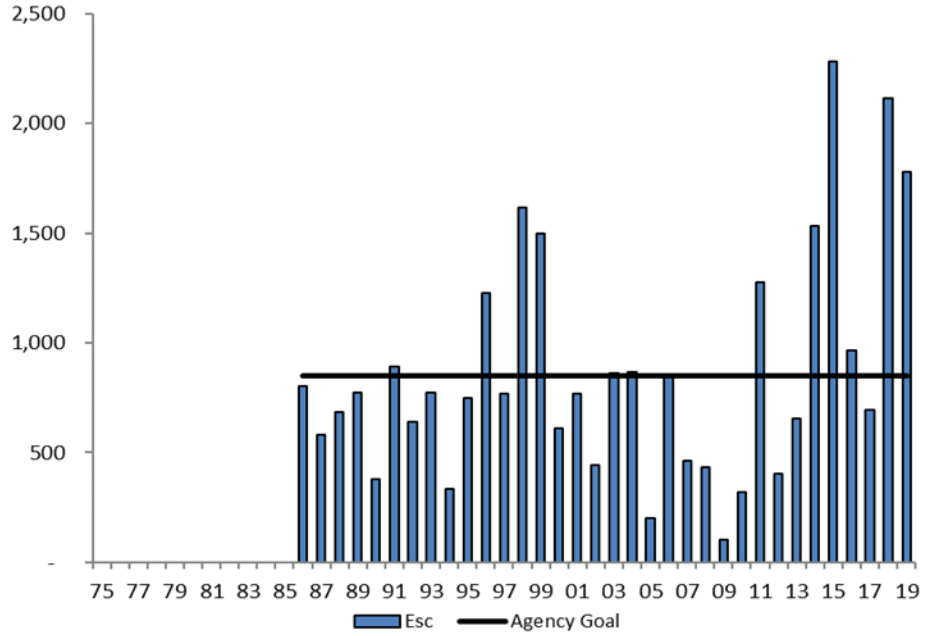


Figure 2.43.–Hoko River escapement of Chinook salmon to the spawning grounds, 1986–2019.

2.3.4.2.2 Quillayute River Summer

The Quillayute River drains from the northwest side of the Olympic Mountains into the Pacific Ocean, south of Cape Alava on the north Washington coast.

Escapement Methodology: Escapement estimates are based on redd counts in index areas and from supplemental surveys on the Bogachiel, mainstem Calawah, North Fork Calawah, and Sitkum rivers. This has been used consistently in the Quillayute River system since the 1970s. Surveys are conducted by foot, raft, drift boat, and helicopter. Index areas are surveyed either weekly or biweekly as conditions allow. Supplemental surveys are done once a season during the peak spawning period. Redd counts from these supplemental surveys are then expanded by the index surveys to estimate redds within the supplemental survey areas for the entire season. Using an appropriate redds-per-mile assignment, the information from index and supplemental surveys is then applied to other unsurveyed streams and segments with historical fish presence. These areas comprise the Quillayute River system stream mileage base that is consistently calculated by multiplying the number of redds by 2.5 to estimate escapement. The 2019 escapement estimate was 991 summer Chinook (Figure 2.44).

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock.

Agency Comments: The state–tribal management goal for this stock is 1,200 adults and jacks combined (PFMC 2016).

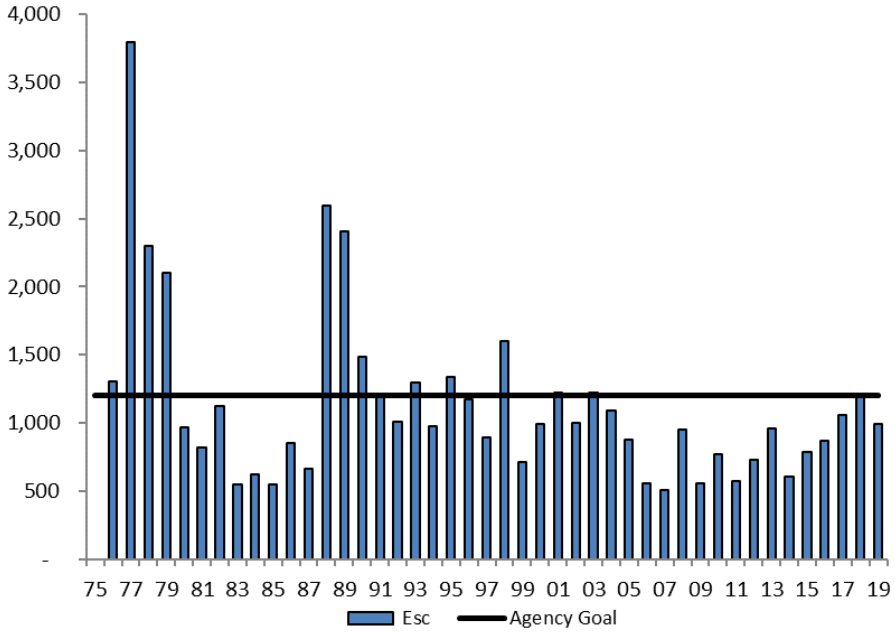


Figure 2.44.–Quillayute River escapement of summer Chinook salmon to the spawning grounds, 1976–2019.

2.3.4.2.3 Quillayute River Fall

The Quillayute River is one of four Washington coast river systems that contain fall Chinook salmon with PSC-agreed escapement goals.

Escapement Methodology: Escapement estimates are based on redd counts in index areas and from supplemental surveys on the Bogachiel, Sol Duc, Dickey, and Calawah rivers and several other smaller tributaries in the basin. Methods have been consistent in the Quillayute River system since the 1970s. Surveys are conducted by foot, raft, drift boat, and helicopter. Index areas are surveyed either weekly or biweekly as conditions allow. Supplemental surveys are done once a season during the peak spawning period. Redd counts from these supplemental surveys are then expanded by the index surveys to estimate redds within the supplemental survey areas for the entire season. Using an appropriate redds-per mile, the information from index and supplemental surveys is then applied to other streams and segments that historically had fish presence, but were not surveyed. These areas comprise the Quillayute River system stream mileage base that is consistently calculated by multiplying the number of redds by 2.5 to estimate escapement. The 2019 escapement estimate was 7,256 fall Chinook (Figure 2.45).

Escapement Goal Basis: In 2004, the PSC agreed upon an escapement goal of 3,000 natural spawners for Quillayute fall Chinook salmon based on a spawner–recruit analysis developed by Quinault Department of Natural Resources (QDNR 1982) and Cooney (1984).

Agency Comments: Terminal fisheries are managed for a harvest rate of 40%, with an escapement floor of 3,000 fish. This objective was designed to allow a wide range of escapements from which to eventually develop an MSY objective or proxy while protecting the long-term productivity of the stock.

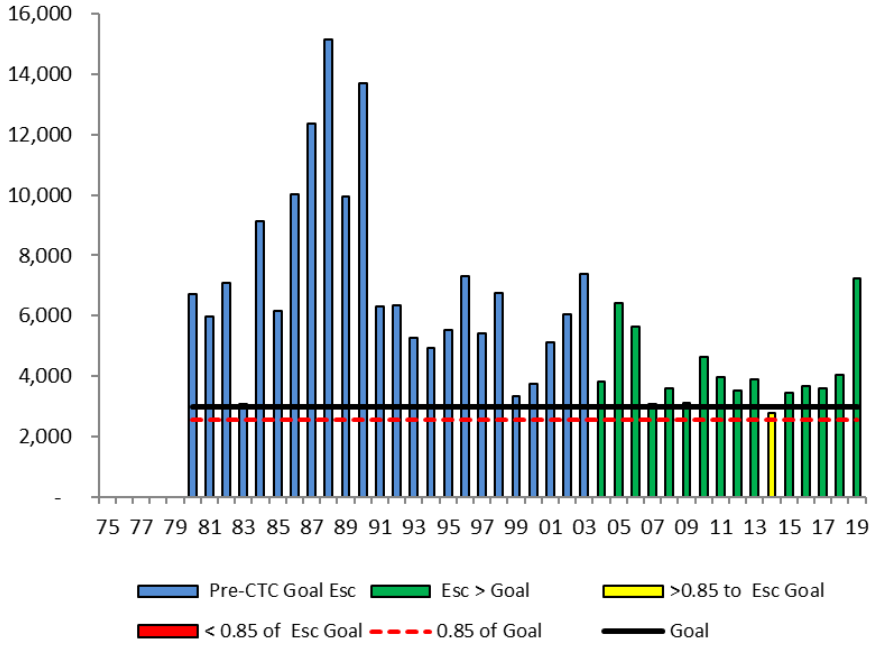


Figure 2.45.–Quillayute River escapement of fall Chinook salmon to the spawning grounds, 1980–2019.

2.3.4.2.4 Hoh River Spring/Summer

The Hoh River drains from the western side of the Olympic Mountains on the north Washington coast between the Quillayute River to the north and the Queets River to the south.

Escapement Methodology: Escapement is estimated from redd counts in index areas, supplemental surveys in the mainstem and south fork of the Hoh River, and in tributaries with spawning habitat. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed weekly to record new and visible redds. Cumulative redd counts for each index reach represent the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate spawning timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Surveys are also conducted in reaches too large or remote to intensively monitor throughout the season. These surveys are timed as close as possible to peak spawning activity, and spawner abundance estimates are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement for these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. There is no hatchery program in this system. The 2019 natural escapement estimate was 766 fish (Figure 2.46).

Escapement Goal Basis: In 2004, the CTC accepted an escapement floor goal of 900 for the Hoh spring/summer Chinook salmon, that was developed by QDNR (1982) and Cooney (1984) based on spawner–recruit analyses for brood years 1969 to 1976.

Agency Comments: Like many of the other Washington coastal stocks, Hoh River spring/summer escapements have been relatively stable except for much larger returns in 1988, 1989, and 1990. The terminal return for this stock declined from 1997 to 2000 and rebounded in 2001 before declining again from 2006 to 2014. Terminal fisheries are managed to catch 31% of the river run, with an escapement floor of 900 fish. This objective was designed to allow a wide range of spawner escapements from which to eventually develop an MSY objective or proxy while protecting the long-term productivity of the stock.

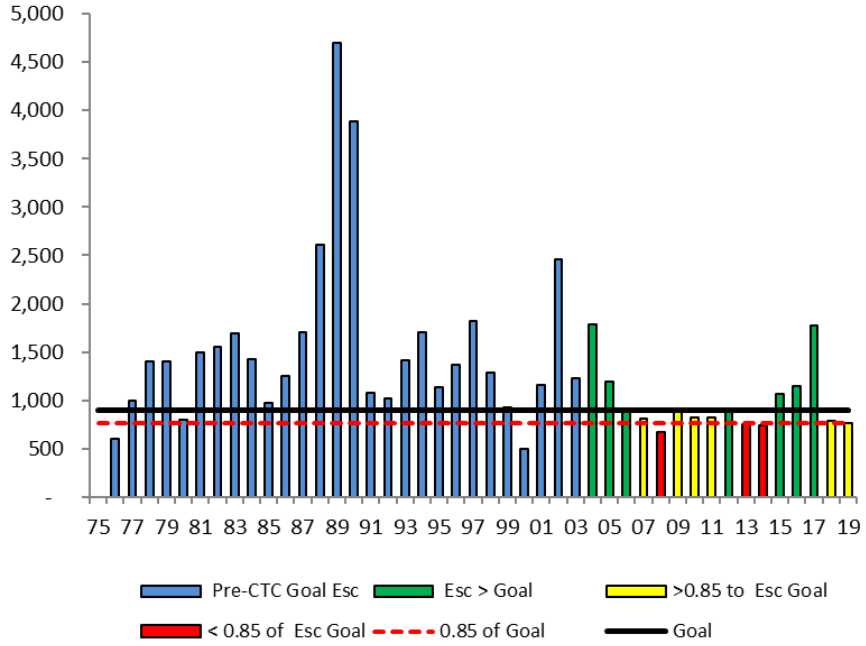


Figure 2.46.–Hoh River escapement of spring/summer Chinook salmon to the spawning grounds, 1976–2019.

2.3.4.2.5 Hoh River Fall

The Hoh River is one of four Washington coast river systems that contain fall Chinook salmon with PSC-agreed escapement goals.

Escapement Methodology: Escapement is estimated from redd counts in index areas, supplemental surveys in the mainstem and south fork Hoh River, and in tributaries with spawning habitat. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed weekly to record total new and visible redds observed each week. Cumulative redd counts for each index reach represent the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive but infrequent surveys are also conducted in additional monitored Chinook spawning areas. These reaches encompass areas too large or remote to intensively monitor throughout the season. Surveys are timed as close as possible to peak spawning activity. Spawner abundance estimates from the extensive surveys are derived using

index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement for these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The natural escapement estimates for Hoh River fall Chinook include a small number of fish taken for an experimental hatchery program from 1983 to 1986, but otherwise should be considered natural-origin fish. The 2019 escapement estimate is 1,552 fish (Figure 2.47).

Escapement Goal Basis: In 2004, the CTC accepted an escapement floor goal of 1,200 for Hoh fall Chinook salmon, developed by QDNR (1982) and Cooney (1984) based on spawner–recruit analyses of data from 1968 to 1982.

Agency Comments: The state–tribal management plan for this stock includes a harvest rate of 40% on the terminal run, with an escapement floor of 1,200 spawners. This objective was designed to allow a wide range of spawner escapements from which to eventually develop an MSY objective or proxy while protecting the long-term productivity of the stock.

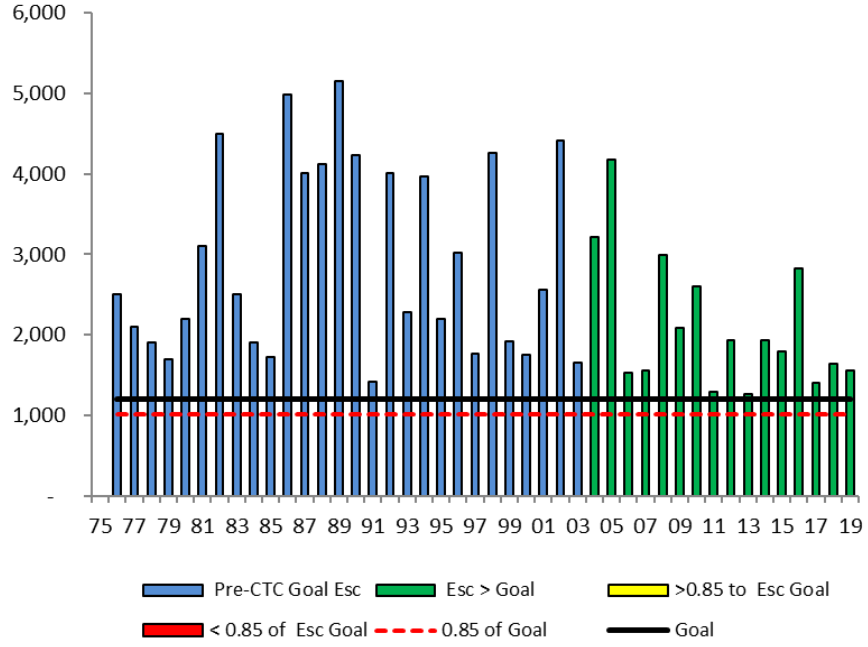


Figure 2.47.–Hoh River escapement of fall Chinook salmon to the spawning grounds, 1976–2019.

2.3.4.2.6 Queets River Spring/Summer

The Queets River drains from the western side of the Olympic Mountains on the north Washington coast and is south of the Hoh River.

Escapement Methodology: Escapement is estimated from redd counts from August 15 to October 15 for spring/summer Chinook salmon. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed weekly to record total new and visible redds observed each week. Cumulative redd counts for each index reach represent the total spawner abundance for that particular spawning area. Weekly visible redd counts in index

reaches are used to estimate timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive but infrequent surveys are also conducted in additional spawning areas. These reaches encompass areas too large or remote to intensively monitor throughout the season and the surveys are timed as close as possible to peak spawning activity. Spawner abundance estimates from the extensive surveys are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The 2019 estimate of natural escapement was 322 fish (Figure 2.48).

Escapement Goal Basis: In 2004, the CTC accepted an escapement floor goal of 700 for Queets spring/summer Chinook salmon, developed by QDNR (1982) and Cooney (1984) based on spawner–recruit analyses for brood years 1969 to 1976.

Agency Comments: Terminal fisheries are managed by the state and tribes to catch 30% of the terminal run, with an escapement floor of 700 fish. This objective was designed to allow a wide range of spawner escapements from which to eventually develop an MSY objective or proxy while protecting the long-term productivity of the stock. Since 1990, terminal fisheries on this stock have been limited, as returns to the river have rarely exceeded the escapement floor. Since 2000, sport anglers have been required to release all Chinook salmon during the summer, and tribal fisheries have been limited to one tribal netting day for ceremonial and subsistence purposes.

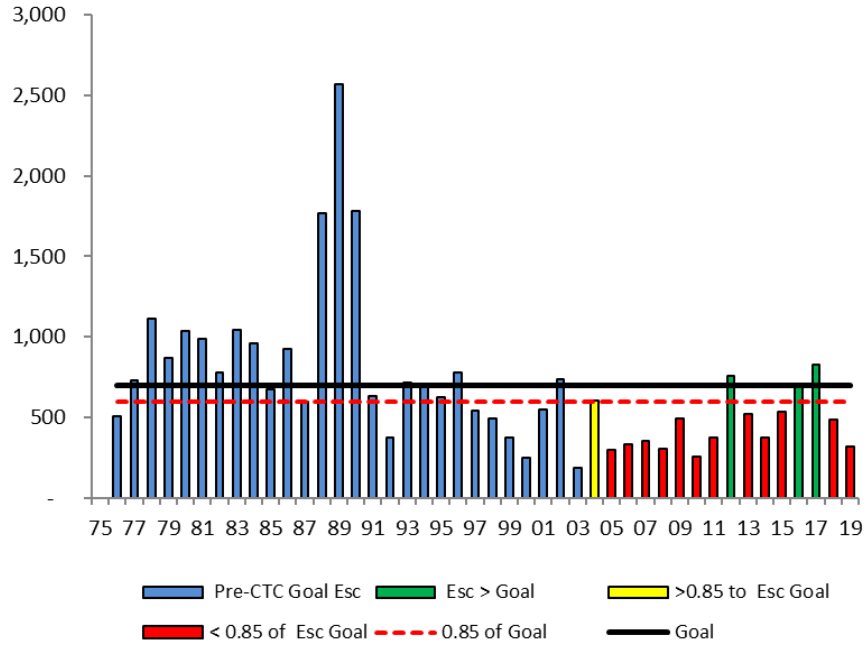


Figure 2.48.–Queets River escapement of spring/summer Chinook salmon to the spawning grounds, 1976–2019.

2.3.4.2.7 Queets River Fall

The Queets River drains from the western side of the Olympic Mountains on the north Washington coast and is south of the Hoh River. It is one of four Washington coast river systems that contain fall Chinook salmon with PSC-agreed escapement goals.

Escapement Methodology: Escapement is estimated from redd counts from October 15 to December 1 for fall Chinook salmon. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed weekly to record total new and visible redds observed. Cumulative redd counts for each index reach represent the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive but infrequent surveys are also conducted in additional monitored spawning areas that are too large or remote to intensively monitor throughout the season. These surveys are timed as close as possible to peak spawning activity. Spawner abundance estimates from these larger areas are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The 2019 estimate of Queets River fall Chinook salmon natural escapement was 2,504 fish (Figure 2.49).

Escapement Goal Basis: In 2004, the CTC accepted an escapement floor goal of 2,500 for the Queets fall Chinook salmon, developed by QDNR (1982) and Cooney (1984) based on spawner–recruit analyses of data from 1967 to 1982.

Agency Comments: Terminal fisheries are managed by the state and tribes to catch 40% of the terminal run, with an escapement floor of 2,500 spawners. This objective was designed to allow a wide range of spawner escapements from which to eventually develop an MSY objective or proxy while protecting the long-term productivity of the stock.

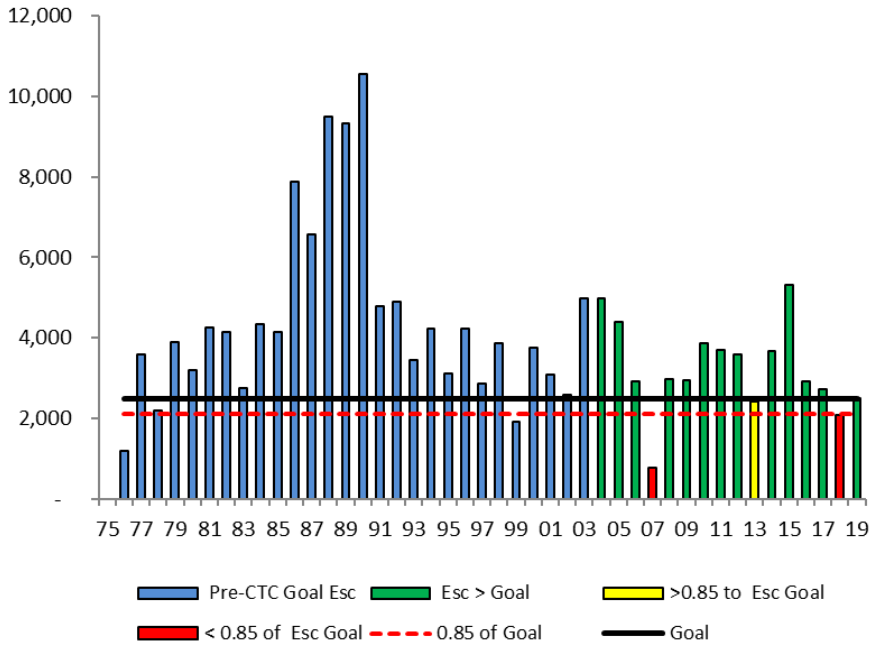


Figure 2.49.–Queets River escapement of fall Chinook salmon to the spawning grounds, 1976–2019.

2.3.4.2.8 Grays Harbor Spring

Grays Harbor spring Chinook salmon spawn primarily in the upper reaches of the mainstem Chehalis River and its tributaries.

Escapement Methodology: Escapement is estimated from redd counts from August 15 to October 15 for spring/summer Chinook salmon. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed weekly to record total new and visible redds observed. Cumulative redd counts for each index reach represent the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Infrequent surveys are also conducted in additional spawning areas that are outside of the index reaches and are too large or remote to intensively monitor throughout the season. These surveys are timed as close as possible to peak spawning activity. Spawner abundance estimates from these larger areas are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The 2019 escapement was 983 Chinook salmon (Figure 2.50).

Escapement Goal Basis: There is currently no PSC-agreed escapement goal for this stock group.

Agency Comments: The natural spawning escapement goal established by the state–tribal co-managers for Grays Harbor spring Chinook salmon is 1,400 adult fish (PFMC 2016). This goal was developed as an MSY proxy, derived from actual spawning data from the mid- to late 1970s, and expanded to include additional habitat not covered by spawner surveys.

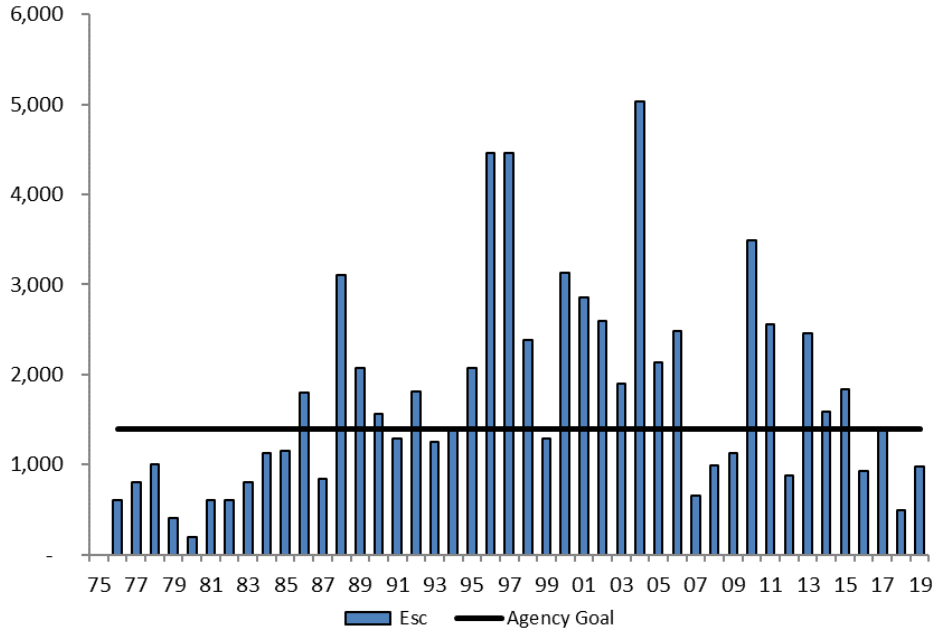


Figure 2.50.–Grays Harbor escapement of spring Chinook salmon to the spawning grounds, 1976–2019.

2.3.4.2.9 Grays Harbor Fall

Grays Harbor fall Chinook salmon spawn primarily in the mainstem Chehalis River, in the Humptulips and Satsop rivers where fall Chinook salmon hatchery facilities are located, and in smaller tributaries such as the Wishkah and Hoquiam rivers that flow directly into the harbor. The Grays Harbor fall Chinook stock is one of four Coastal Washington fall Chinook stocks that have PSC-agreed escapement goals.

Escapement Methodology: Escapement is estimated from redd counts from October 15 to December 1 for fall Chinook salmon. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed weekly to record total new and visible redds observed. Cumulative redd counts for each index reach represent the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive but infrequent surveys are also conducted in additional spawning areas that are too large or remote to intensively monitor throughout the season. These surveys are timed as close as possible to peak spawning activity. Spawner abundance estimates from these larger areas are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The 2019 escapement was 14,880 spawners (Figure 2.51).

Escapement Goal Basis: In 2014, the CTC accepted an escapement goal for Grays Harbor fall Chinook salmon of 13,326 natural spawners based on a spawner-recruit analysis developed by QDNR and WDFW (2014)**.**

Agency Comments: The Grays Harbor fall Chinook salmon escapement goal will be applied in CTC stock-performance evaluations on a stock aggregate basis. This goal, however, is the sum of tributary-specific goals that were derived separately for the Chehalis and Humptulips rivers.

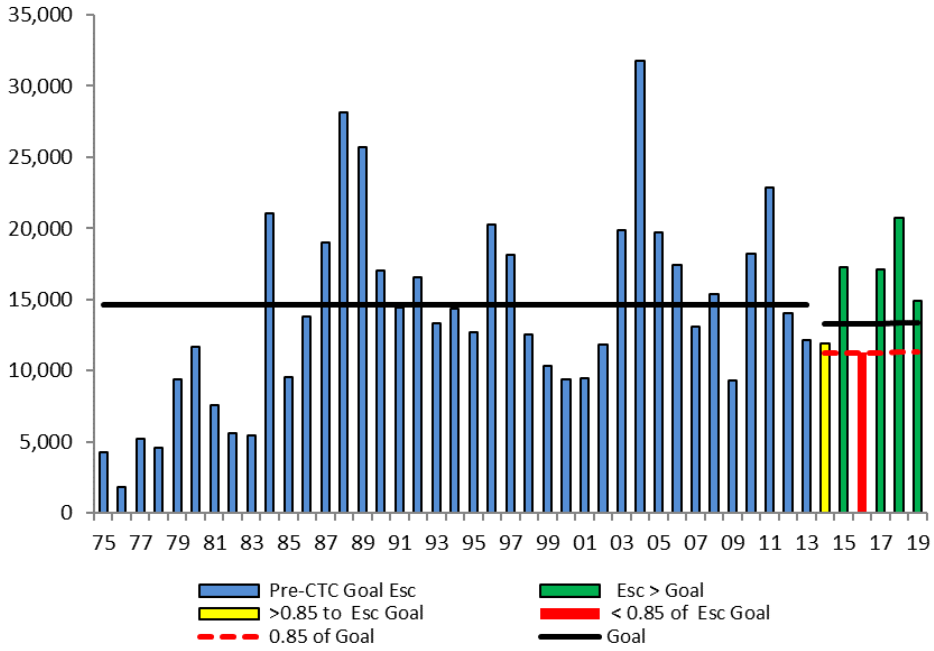


Figure 2.51.–Grays Harbor escapement of fall Chinook salmon to the spawning grounds, 1976–2019.

Note: The displayed agency goal line (14,600) relates to the agency goal in effect through 2013; the recently PSC-agreed escapement goal (13,326) will be used in assessments from 2014 onward.

2.3.4.3 Columbia River

Columbia River fisheries are managed under the 2018–2027 *U.S. v. Oregon Management Agreement*, using six harvest indicators, and eleven abundance indicators.

Harvest indicators are used to directly manage fisheries during three fishing periods, based on the number of adults returning to the river mouth:

Run (Fishing Period)	Harvest Indicator
Spring 1 January – 15 June	Upriver spring and Snake River spring/summer Chinook
	Natural-origin Snake River spring/summer Chinook
	Natural-origin Upper Columbia spring Chinook
Summer 16 June – 31 July	Upper Columbia Summer Chinook
Fall 1 August – 31 December	Upriver Bright fall Chinook
	Snake River natural-origin fall Chinook

Columbia Upriver Spring Chinook are comprised of all spring Chinook above Bonneville Dam and summer Chinook from the Snake River and are predominantly hatchery fish from the Snake

River. These fish have stream-type life histories, migrate quickly offshore, and have fishery impacts that are predominantly terminal. Since they are not listed in Attachment I, they are not addressed in this report.

Upper Columbia Summer Chinook have a northern coastal distribution, demonstrate both ocean- and stream-type life histories, are defined as all summer Chinook above Bonneville Dam during the summer period, and are represented by the Mid-Columbia Summer Chinook PSC indicator stock.

Columbia River Fall Chinook have ocean-type life histories and coastal distributions, but there are two distinctive races. Lower Columbia River "tule" Chinook return below Bonneville Dam, mature quickly, are caught mainly in the WCVI AABM and U.S. ISBM fisheries, and are represented by the Coweeman Tule Fall Chinook PSC escapement indicator. In addition, PSC monitors Lewis River Wild fall Chinook production below Bonneville Dam. Upriver Bright Fall Chinook, which have more prolonged maturation, are comprised of production above McNary Dam, and in the Deschutes and Snake rivers. Upriver Bright Fall Chinook above McNary Dam have a northerly distribution, and comprise substantial proportions of catch in SEAK, WCVI, and U.S. ISBM fisheries, while Snake and Deschutes river production is predominantly impacted in WCVI and U.S. ISBM fisheries.

Abundance indicator stocks are defined by the *U.S. v. Oregon Management Agreement* to further monitor status of natural-origin populations that may limit Columbia River fisheries:

Abundance Indicator Stocks	
Stock	**Performance Measure**
Upriver spring/summer Chinook	
Snake R natural-origin spring/ summer Chinook	Snake R natural-origin spring/ summer Chinook
Upper Columbia R natural-origin spring Chinook	Upper Columbia R natural-origin spring Chinook
Upriver Columbia R natural-origin spring Chinook (Wenatchee, Entiat, Methow)	Upriver Columbia R natural-origin spring Chinook (Wenatchee, Entiat, Methow)
Snake R spring/summer Chinook index stocks (Bear Valley, Marsh, Sulphur, Minam, Catherine Cr., Imnaha, Poverty Flats, Johnson)	Snake R spring/summer Chinook index stocks (Bear Valley, Marsh, Sulphur, Minam, Catherine Cr., Imnaha, Poverty Flats, Johnson)
John Day natural-origin spring Chinook	John Day natural-origin spring Chinook
Warm Springs natural-origin spring Chinook	Warm Springs natural-origin spring Chinook
Upper Columbia Summer Chinook	
Upper Columbia R summer Chinook	Upper Columbia R summer Chinook
Fall Chinook	
Hanford natural-origin adult fall Chinook	Hanford natural-origin adult fall Chinook
Snake River adult fall Chinook	Snake River adult fall Chinook
Snake River adult fall Chinook	Snake River adult fall Chinook
Deschutes River natural- origin adult fall Chinook	Deschutes River natural- origin adult fall Chinook

2.3.4.3.1 Mid-Columbia Summer

Escapement Methodology: Figure 2.52 displays adult Chinook salmon passing Rock Island Dam between June 18 and August 17; these counts include hatchery fish but are more consistent with the PSC Chinook Model data (hatchery and natural-origin combined) used to develop the interim escapement goal.

Escapement Goal Basis: The CTC (1999) developed an interim escapement goal of 12,143 adult summer Chinook salmon past Rock Island Dam, using PSC Chinook model predictions of escapement and recruitment. A 2008 analysis of actual escapement data resulted in a higher estimate, but the CTC requested addition years of data, so the interim goal remains. The *2018–2027 U.S. v. Oregon Management Agreement* calls for reviewing goals.

Agency Comments: Upper Columbia Summer Chinook are managed for 29,000 adults at the river mouth, based on a spawning escapement goal of 20,000 adults at Priest Rapids Dam. Although management is not constrained by individual components, sub-basin objectives are 13,500 Wenatchee/Entiat/Chelan naturally spawning fish, 3,500 Methow/Okanogan natural fish and 3,000 hatchery brood stock. Catches are based on an abundance-based harvest rate schedule (2018–2027 *U.S. v. Oregon Management Agreement*, Table A2). Harvest rates are near 5% for run sizes up to 16,000, and 15% to 17% for run sizes up to 36,250 (125% of 29,000). Between 36,250 and 50,000, harvestable surplus is run size less 29,000, and above 50,000, 75% of the additional run becomes harvestable surplus, while the other 25% is foregone to escapement. Rock Island Dam counts have shown a steep decline of over 50% since 2015, but are still well above goal.

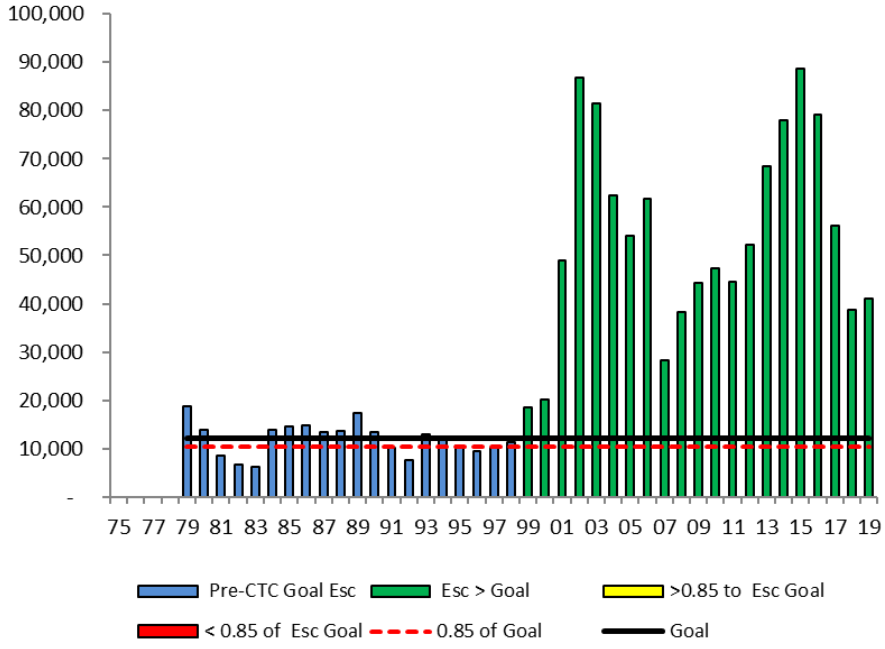


Figure 2.52.–Adult passage of Mid-Columbia Summer Chinook salmon at Rock Island Dam, 1979–2019.

2.3.4.3.2 Columbia Upriver Brights

Escapement Methodology: Figure 2.53 displays the McNary Dam count minus adult Hanford Reach sport catch, Wanapum tribal catches, and broodstock taken at Priest Rapids, Ringold and Snake River hatcheries.

Escapement Goal Basis: The PSC-agreed escapement goal for Columbia Upriver Brights is 40,000 naturally spawning fish past McNary Dam based on stock–recruitment analyses.

Agency Comments: Upriver Brights are managed according to an abundance-based harvest rate schedule (2018–2027 *U.S. v. Oregon Management Agreement*, Table A3), and a minimum management goal of 60,000 adult fall Chinook salmon at McNary Dam, which includes Snake River production. The *U.S. v. Oregon* Parties also agreed to a minimum goal of 43,500 Upriver Bright escapement to provide spawning in the Hanford Reach, Lower Yakima River, and mainstem Columbia River above Priest Rapids Dam, as well as Priest Rapids Hatchery production. Fall Chinook salmon fisheries are managed according to a harvest rate schedule ranging from 21.5% to 45%, depending on either (1) the expected river mouth run size of the aggregate fall Chinook salmon run, or (2) the Snake River natural-origin Chinook salmon run—if that run size is associated with a lower harvest rate. Constraints on Upriver Bright fisheries include the 15% harvest rate limit on commingled ESA-listed B-run summer steelhead (>78 cm) for forecast runs of less than 20,000, ESA-listed Snake River wild fall Chinook salmon impacts, and the need for 7,000 tule fall Chinook salmon for brood stock at Spring Creek Hatchery. Almost identical to Mid-Columbia Summer Chinook, Upriver Bright escapement has shown a steep decline since 2015, but is still well above the escapement goal.

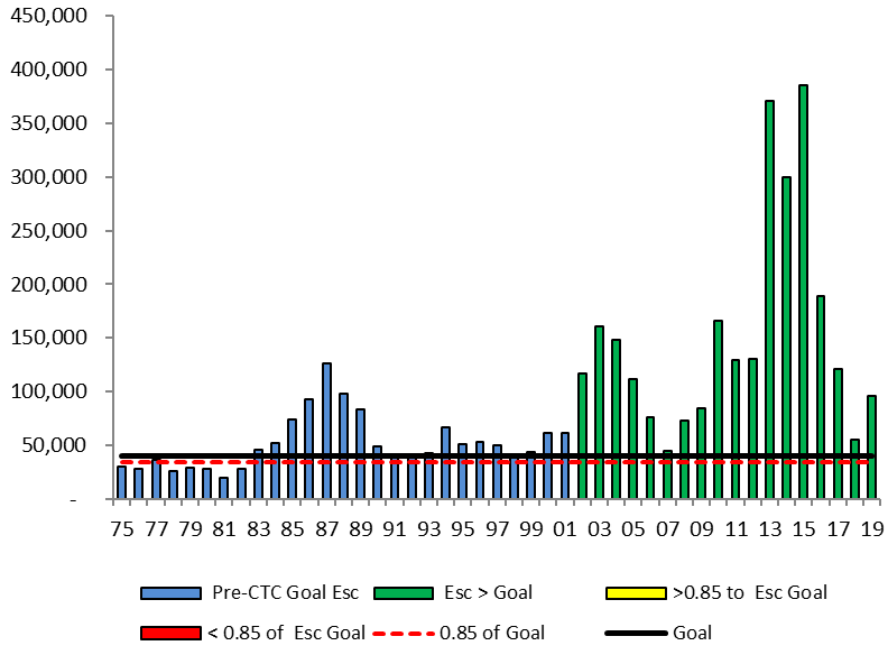


Figure 2.53.– Upriver Bright Chinook salmon escapements, 1975–2019.

2.3.4.3.3 Coweeman River Tules

The Coweeman River is a 3rd order tributary to the Cowlitz River located in Cowlitz County, Washington and drains approximately 329 km^2. This watershed supports a small population of mostly natural-origin 3 and 4-year-old tule fall Chinook salmon. The Coweeman escapement indicator stock represents ESA-listed natural tule fall Chinook salmon production from the Lower Columbia River.

Escapement Methodology: From 2002 to 2011, PSC funding was used to conduct intensive studies to estimate Chinook escapement (fish > 59 cm) for the entire basin using a variety of methods. These estimates were on average 23% higher than the traditional estimates based on expanding peak fish counts, but study estimates for 2005 and 2007 were nearly double the traditional estimates. Escapement was estimated using MR methodologies from 2002 to 2004, and in 2011; live-count AUC methodologies in 2005 and 2006; redd-based methodologies in 2007 and 2008; and genetic mark–recapture (GMR) methodologies in 2009 and 2010. Since 2011, a combination of physical MR of fish above the weir and redd count expansion for fish spawning below the weir have been used. A time series of expanded escapement estimates and further details for each year is now available on WDFW's Salmon Stock Inventory (SaSI) system (https://data.wa.gov/Natural-Resources-Environment/WDFW-Salmonid-Stock-Inventory-Population-Escapemen/fgyz-n3uk/data). The data graphed are total naturally spawning fish expanded from redd counts from the mouth of Mulholland Creek (RM 18.4) downstream to the Jeep Club Bridge (RM13.1). Escapement in 2019 was less than half of the agency goal (Figure 2.54).

Escapement Goal Basis: The Coweeman stock has no CTC-agreed goal. It is managed according to an abundance-based exploitation rate ceiling schedule for Lower Columbia River Tule Chinook salmon under ESA fishery consultation standards. The agency recovery goal is 3,600 with a maximum recovery exploitation rate determined by NOAA, and an interim minimum natural escapement goal of 1,000.

Agency Comments: Coweeman Tule stock is listed as threatened under the U.S. ESA.

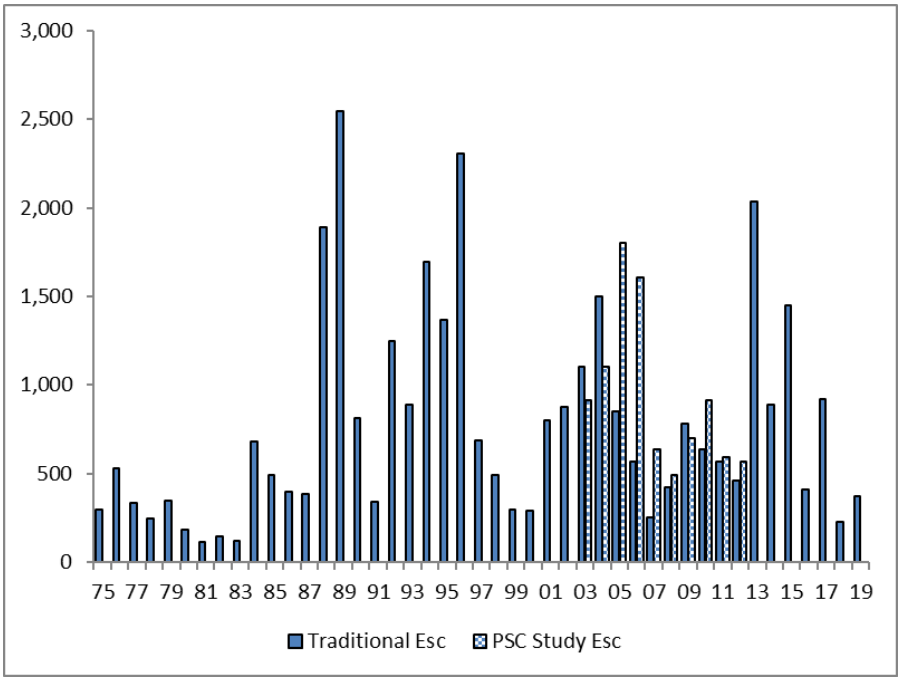


Figure 2.54.–Coweeman River tule fall Chinook salmon escapements, 1975–2019.

2.3.4.3.4 Lewis River Fall

Escapement Methodology: Most natural bright fall Chinook salmon production below Bonneville Dam occurs in the North Fork Lewis River. The Lewis River Wild stock is the main component of the Lower River Wild management unit for fall Chinook salmon, which also includes small amounts of wild production from the Cowlitz and Sandy river basins. In this report, the escapements and goal are for the Lewis River component. Peak weekly counts of live and dead fish in the 6.4 km area below Merwin Dam (river km 31.4) are expanded by a factor of 5.29 to estimate total spawning escapement (hatchery and wild). This expansion factor was derived from a carcass tagging and recapture study in 1976 (McIsaac 1990) and was verified by studies from 1999 to 2001. Wild smolts have been coded-wire tagged since 1977.

Escapement Goal Basis: The escapement goal of 5,700 fall Chinook in the Lewis River was developed by McIsaac (1990) based on spawner–recruit analysis of the 1964 to 1982 broods and CWT recoveries from the 1977 to 1979 broods. This analysis was updated by the CTC (1999) using brood years 1964 to 1991 and 5,700 was accepted as a biologically based goal.

Agency Comments: Until 2018, Lewis River escapements were above the escapement goal since 1979, except for 1999, and 2007–2009 and 2018. In 2019, escapement improved to over twice the goal (Figure 2.55).

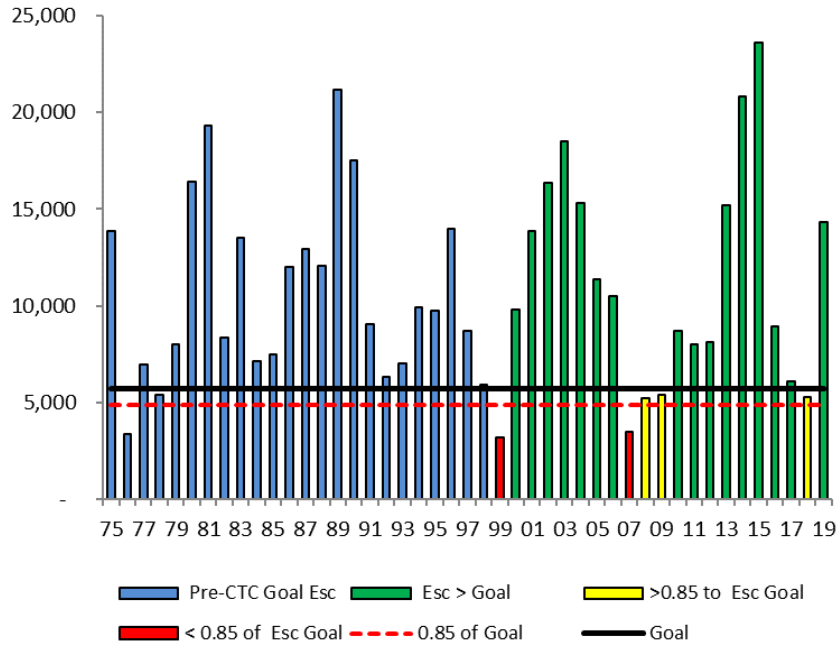


Figure 2.55.–Lewis River fall Chinook salmon escapements, 1975–2019.

2.3.4.4 Coastal Oregon

The North Oregon Coast (NOC) and Mid-Oregon Coast (MOC) Chinook salmon are aggregates with stocks migrating to SEAK and NBC AABM fisheries. With the adoption of the Chinook model (the "new model") with updated base period information, both NOC and MOC aggregates are now being accounted for in PSC management for the first time.

2.3.4.4.1 North Oregon Coast

The NOC Chinook salmon production consists mostly of naturally spawned, fall-returning, with ocean-type life history. Adult spawning escapement is dominated by 4- and 5-year-old fish with smaller proportions of 3- and 6-year-old fish. These Chinook salmon from the NOC aggregate are caught primarily in SEAK, NBC and in terminal fisheries.

Forecasts for the NOC aggregate are based on forecast models developed for each discrete stock, both indicator and non-indicator stocks. The aggregate forecast for NOC is the sum of the forecasts for the individual basins within the geographic range. Forecasting methods were developed in 2008 and are continually refined with each year's additional information. Prior to 2008, the aggregate forecast (and each of the indicator stock forecasts) was based on a running 3-year average.

Stocks in the NOC aggregate are those salmon spawning from the Necanicum River in the north through the Siuslaw Basin in the south. Three escapement indicator stocks represent the production of NOC Chinook salmon: the Nehalem, Siletz, and Siuslaw stocks. Other stocks in the NOC aggregate include the Nestucca, Yaquina, Alsea, and Tillamook stocks. The Tillamook stock includes several substocks from the Kilchis, Miami, Trask, Tillamook and Wilson rivers.

This past year's escapement has shown a dichotomy of run performance ranging from improving escapement in the Nehalem basin to dismal returns observed in the Tillamook, Alsea and Siuslaw basins. While the majority of escapement indicators for the NOC aggregate have met their escapement goal this past year (Nehalem and Siletz), other basins within the aggregate (Tillamook, Alsea, Siuslaw) are displaying continued poor performance, in spite of terminal fishery restrictions imposed during the last two years. It is likely that the Siletz basin would not have met escapement goal had it not been for 2019 terminal fishery reductions. The Siuslaw basin did not meet its goal despite 2018 and 2019 terminal fishery restrictions

2.3.4.4.1.1 Nehalem River

Escapement Methodology: Both historically conducted surveys and MR based calibrations, which are expanded to represent available habitat (the normative agency methods), were used to estimate escapement in the Nehalem during the 2019 return year. Standard estimates were generated from peak abundance observed during surveys of historically walked standard index areas of known spawning habitat within the basin. These observations were then adjusted by estimates of the total available habitat, estimated observer bias, the total run encountered during the peak count, and the bias observed between these predefined surveys and other survey areas that were randomly selected. Figure 2.56 represents escapement estimates generated using normative agency methodologies, which are directly comparable to the established escapement goal. Comparison between those standard estimates and MR estimates of adult spawning escapement funded by the PSC indicates that in most years (6 out of 9) standard agency escapement estimates fall within the CIs around the comparable MR point estimates for the Nehalem stock (Figure 2.57).

Escapement Goal Basis: The current point goal of 6,989 spawners was derived by Zhou and Williams (1999) and was based on assessments of escapement made through standard survey methodology.

Agency Comments: Methods of escapement estimation comparable to those used to generate the agreed-to escapement goal for the Nehalem indicate a 2019 escapement of 9,746 adult spawners. This is 139% of the current escapement goal. Based on multiple forecasting models, the Nehalem stock is forecasted to meet the escapement goal in 2020. ODFW is currently engaged in analysis from recent MR experiments to reconstruct historic estimates from peak survey counts, and to apply those estimates towards an updated escapement goal.

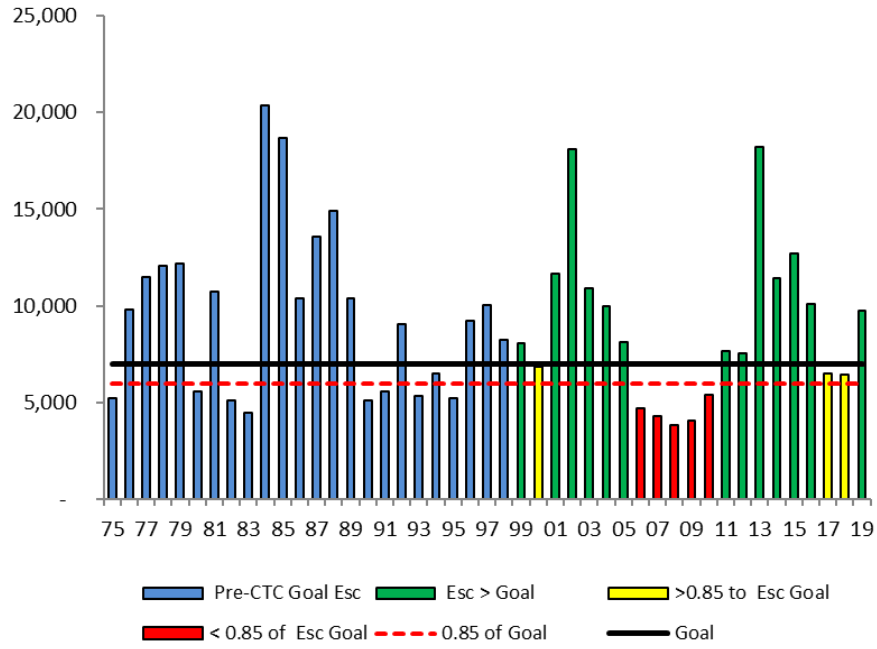


Figure 2.56.–Nehalem River escapements of Chinook salmon, 1975–2019.

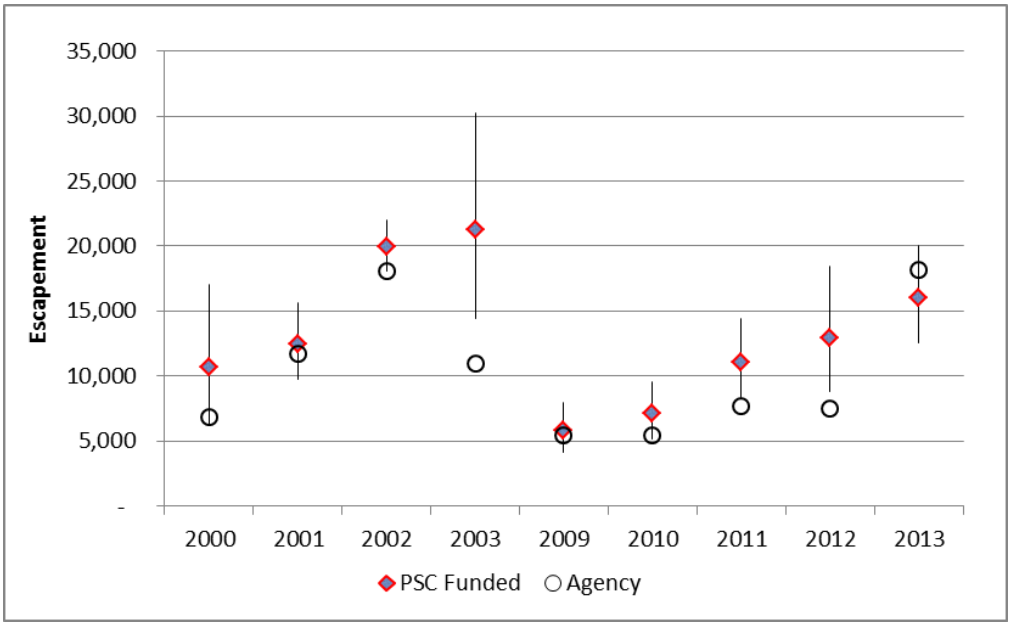


Figure 2.57.–Nehalem River escapements of Chinook salmon in years when both agency historical expanded surveys were used (circles) and when mark–recapture estimates (diamonds are point estimates and the bars are 95% CIs) were conducted with Letter of Agreement or SSP funding from the PST.

2.3.4.4.1.2 Siletz River Fall

Escapement Methodology: Standard estimates were generated from peak abundance observed in historically walked, predefined areas of known spawning habitat within the basin. These observations were then adjusted by estimates of the total available habitat, estimated observer bias, the total run encountered during the peak, and the bias observed between these predefined surveys and other survey areas that are randomly selected. Escapement estimates generated using standard agency methodologies were used to develop the current escapement goal and are presented for comparison with that goal (Figure 2.58).

Escapement Goal Basis: The current point goal of 2,944 spawners is from Zhou and Williams (2000) and was based on assessments of escapement made through standard survey methodology. Comparison between standard estimates and estimates from MR studies funded by the PSC reveals that for those MR-based estimates with CVs less than 30%, two standard estimates are within the CI around the MR-based estimate; in 2008 and 2009, the two sets of estimates were nearly identical (Figure 2.59).

Agency Comments: This stock has been studied with funds from the SSP to improve escapement estimation using MR methods. However, traditional methods of escapement estimation remain in place until MR -based estimates and a goal based on MR calibrated surveys is complete. The estimate derived from standard methods was 3,521 fall Chinook salmon (120% of goal) in 2019. Following a period of failing to meet escapement goals between 2007 through 2009, this stock has met its escapement goal each year since 2010. The forecast for 2019 indicated a downturn in stock performance, but terminal fishery restrictions were deployed to ensure that the Siletz return met its goal. This stock is forecasted to exceed its escapement goal in 2020.

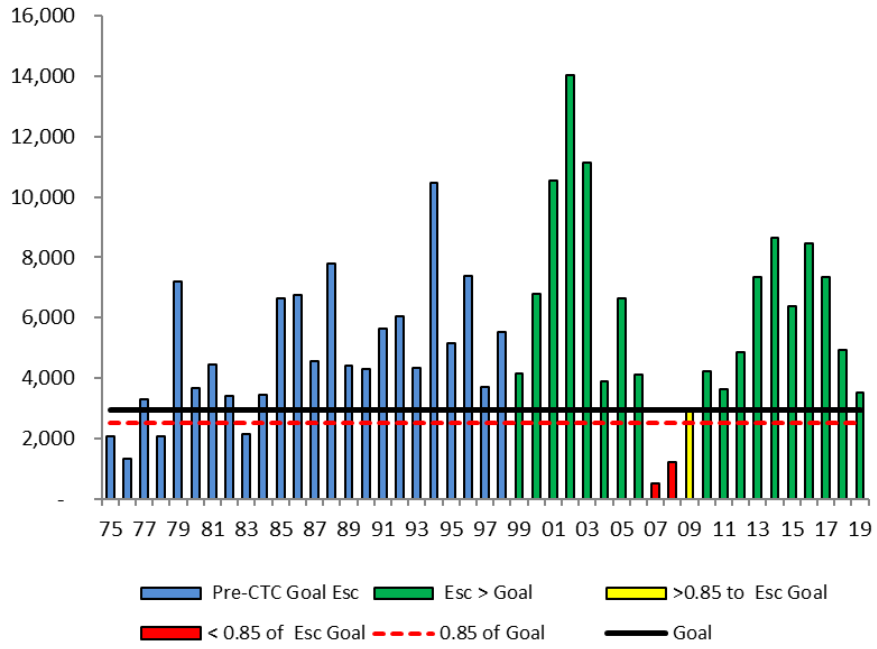


Figure 2.58.–Siletz River fall escapements of Chinook salmon, 1975–2019.

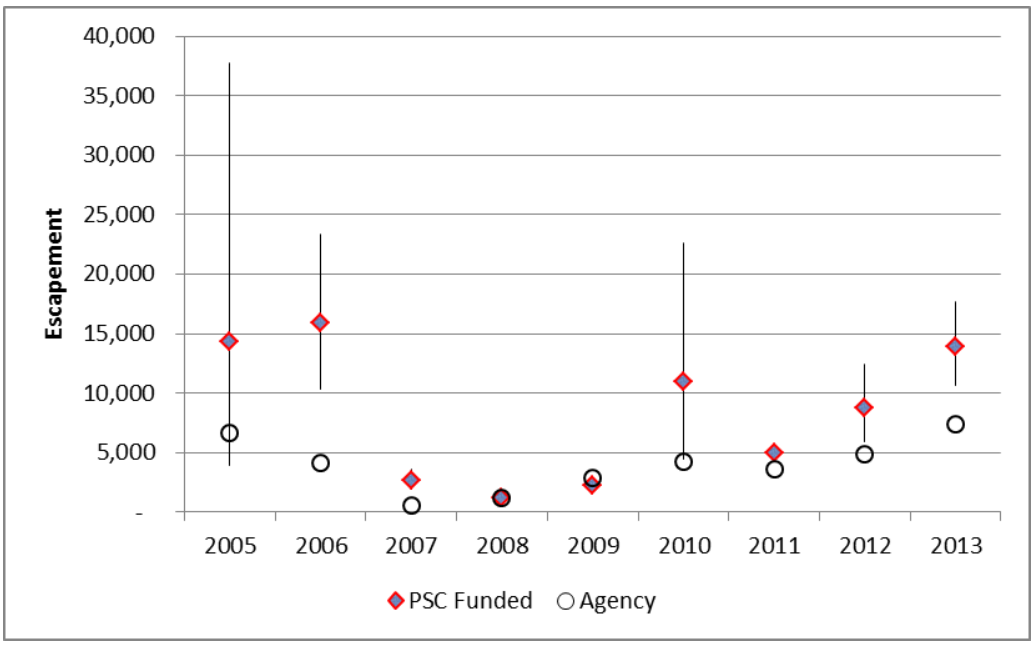


Figure 2.59.–Siletz River escapements of Chinook salmon in years when both agency historical expanded surveys were used (circles) and when mark–recapture estimates (diamonds are point estimates and the bars are 95% CIs) were conducted with Letter of Agreement or SSP funding from the PST.

2.3.4.4.1.3 Siuslaw River Fall

Escapement Methodology: Historically, standard surveys and updated estimates based on MR calibration factors were used to measure escapement in the Siuslaw basin during 2019. Standard estimates were generated from observation of peak abundance in historically walked, predefined areas of known spawning habitat within the basin. These observations were then adjusted by estimates of the total available habitat, estimated observer bias, the total run encountered during the peak, and the bias observed between these predefined surveys and those that are randomly selected. These standard estimates were used to derive the current escapement goal and are used for comparison with that goal (Figure 2.60). Comparison of the standard agency escapement estimates with PSC-funded MR estimates reveals a clear pattern with the standard estimates being consistently higher than the MR estimates (Figure 2.61). This bias in the agency-based estimate will need to be addressed in upcoming revisions of the escapement goal for the Siuslaw River.

Escapement Goal Basis: The current point goal of 12,925 spawners was derived in 2000 by Zhou and Williams (2000) and was based on assessments of escapement made through standard survey methodology.

Agency Comments: Escapement in 2019 for the Siuslaw stock, estimated based on standard habitat expansion methods, was 4,797 adult spawners (37% of the escapement goal). The MR-calibrated estimate was 1,691 adult spawners. This is the second lowest estimated escapement for this basin using MR-calibrated methods during the entire time series since 1975, with only 1983 lower. Despite terminal fisheries restrictions within the Siuslaw basin during the past two return years, this stock continues to display poor escapement. The current escapement goal

estimate was based on the standard escapement estimates, like other basins on the Oregon coast. Ultimately, a new goal should be developed from a calibrated historical data series. This stock is not forecast to meet the current escapement goal in 2020.

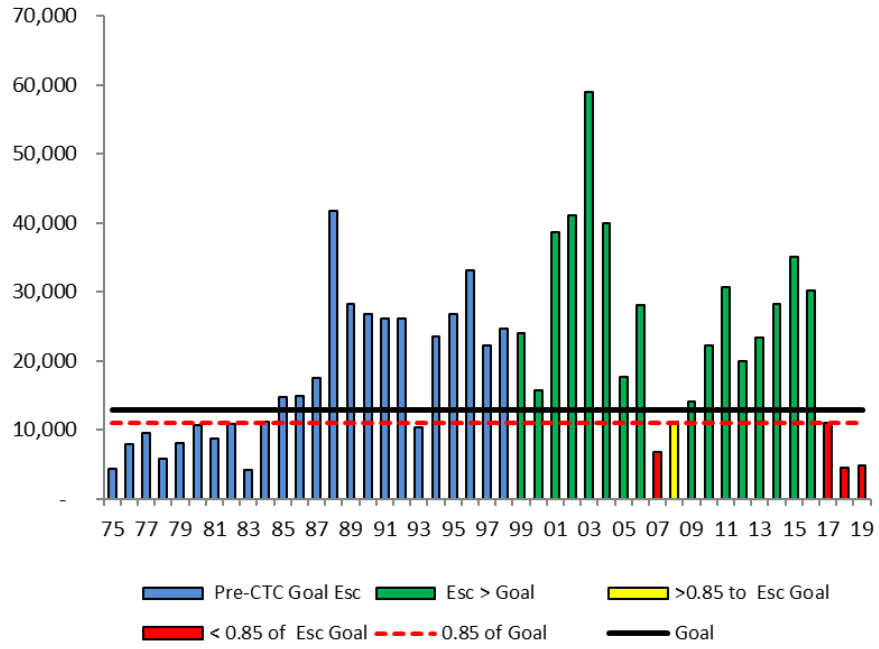


Figure 2.60.–Siuslaw River fall escapements of Chinook salmon, 1975–2019.

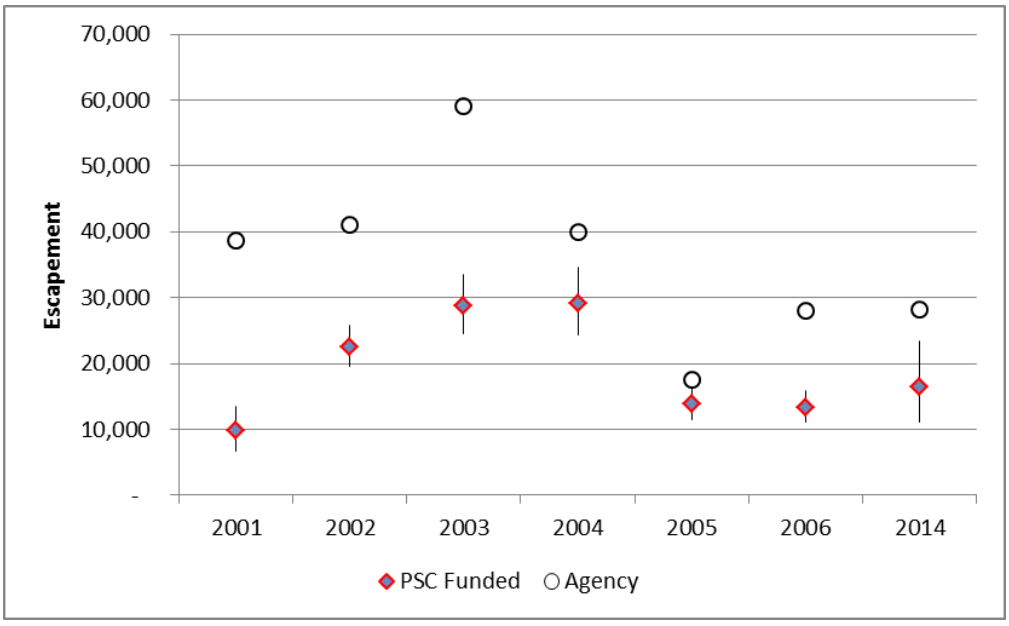


Figure 2.61.–Siuslaw River escapements of Chinook salmon in years when both agency expanded surveys were used (circles) and when mark–recapture estimates (diamonds are point estimates and bars are 95% CIs) were conducted with Letter of Agreement funding from the PST.

2.3.4.4.2 Mid-Oregon Coast

The South Umpqua and the Coquille stocks are the two escapement indicator stocks for the MOC aggregate as per the 2019 PST Agreement. This area is bounded by the Umpqua River on the north and the Elk River Basin on the south, and includes two additional major basins, the Coos and Coquille, and two small basins, Floras Creek and the Sixes River.

The MOC consists of a mixture of natural and hatchery-produced salmon, both of which return in the fall and follow an ocean-type life history. The largest age class proportions which normally contribute to spawning escapement are 3- and 4-year-old fish with smaller proportions of 5- and 6-year-old fish. These Chinook salmon are caught primarily in SEAK, NBC, Pacific Fishery Management Council (PFMC) fisheries and in terminal fisheries.

Forecasts for MOC stocks, except for the Elk River stock, are based on multiple forecasting models which are updated and re-assessed annually. Forecasts for the Elk River stock are based on projected survival rates of hatchery releases and recent proportions of wild adults in the aggregate return.

2.3.4.4.2.1 South Umpqua River Fall

Escapement Methodology: Until 2013, aerial spawning surveys for fall Chinook salmon had been conducted by the ODFW on both the South Umpqua River and Cow Creek since 1978; the surveys were started as part of Douglas County's mitigation plan for the construction and operation of Galesville Dam on upper Cow Creek.

However, following a 2013 crash that injured two ODFW employees and the pilot, ODFW aerial surveys were discontinued and methods changed. The new method involves a visual index of abundance that serves as an alternative to aerial survey counts. The visual index includes a sum of dead count from two spawning ground surveys within the South Umpqua drainage. Results from a calibration assessment of dead Chinook salmon to MR estimates indicated a strong correlation from two reaches in the basin. This strong relationship to the MR estimates allows for both the long-term redd count data and more contemporary sum of dead counts to correlate to known fish abundance. Figure 2.62 shows South Umpqua River escapement of fall Chinook salmon, 1978–2019.

Escapement Goal Basis: ODFW is currently engaged in analysis which will produce an escapement goal for this stock.

Agency Comments: Recoveries of CWTs from fall run Chinook salmon from the Umpqua River indicate that they are caught in PST fisheries. Budget constraints precluded the field work required for 2016 estimates. Funding for sampling in 2019 was secured, and the agency was able to generate an estimate for the 2019 return year. The 2019 escapement estimate is 824 adult Chinook salmon, which is the lowest observed escapement since normalized survey areas have been counted in this basin.

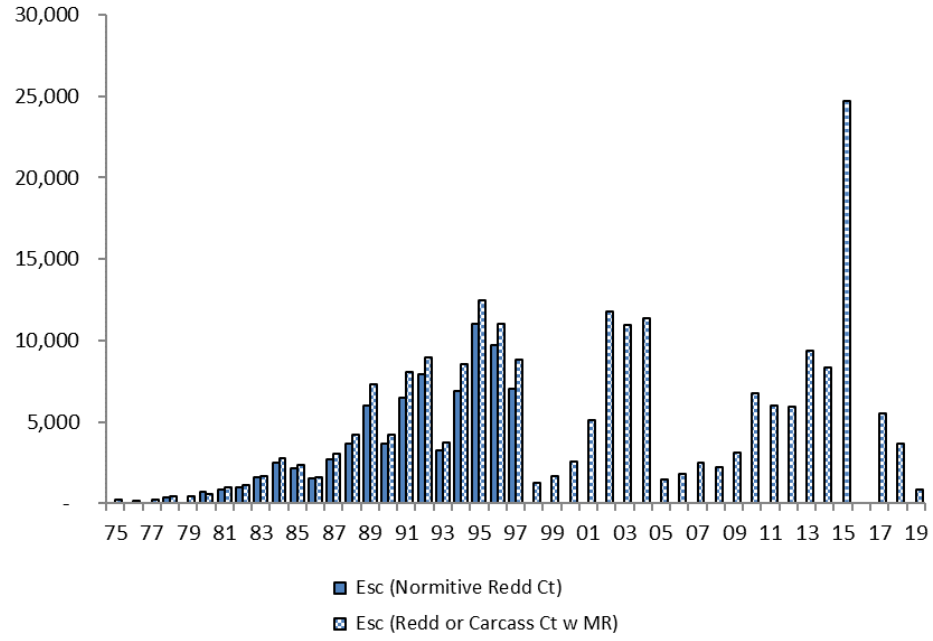


Figure 2.62.–South Umpqua River escapement of fall Chinook salmon, 1978–2019.

2.3.4.4.2.2 Coquille River Fall

Escapement Methodology: Both MR-calibrated and historically conducted surveys were used to measure escapement in 2019. Standard survey methods are identical to those described in the Siuslaw, Siletz and Nehalem basins. Values presented in Figure 2.63 are based on standard habitat surveys along with values calibrated to MR estimates. Both standard and MR-calibrated estimates may be found in the appendix tables (Appendix Table B12).

Escapement Goal Basis: ODFW is currently engaged in analysis which will produce an escapement goal for this stock.

Agency Comments: Methods based on MR-calibrated analysis yield a historically low adult escapement estimate of 275 Coquille Basin spawners in 2019. Standard surveys dating back to the 1950s indicate that this is the lowest escapement ever recorded since these surveys began.

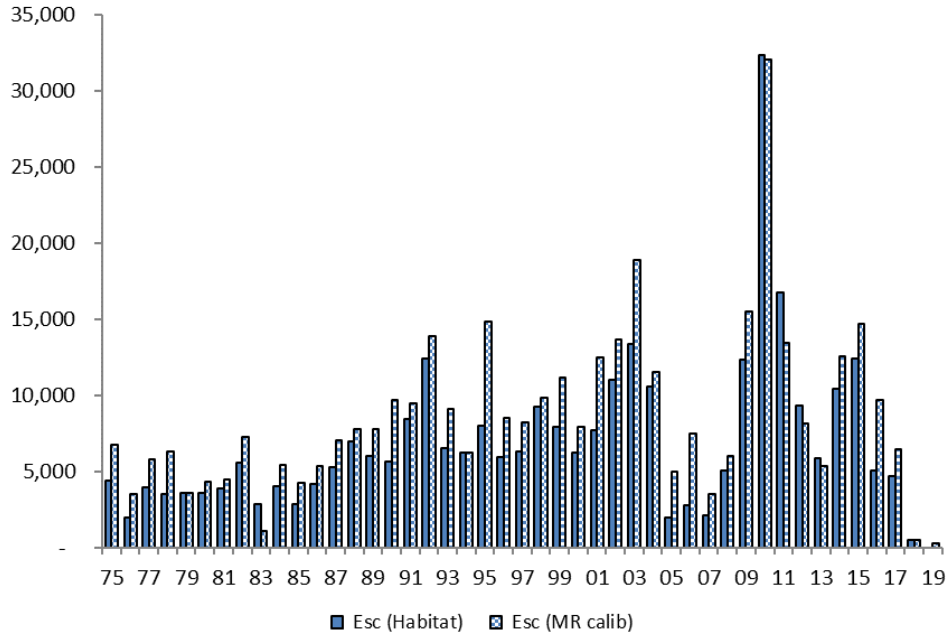


Figure 2.63.–Coquille River escapement of fall Chinook salmon, 1975–2018.

3. STOCK STATUS

3.1 SYNOPTIC EVALUATION OF STOCK STATUS

The following sections include graphics to display stock status information with spawning escapement on one axis and exploitation rate on the other. These synoptic plots display summary information for individual escapement indicator stocks. The figures present both the current status of stocks and the history of the stocks relative to PST management objectives. Information used in these figures includes (1) escapement data; (2) PSC-agreed MSY management objectives (or, in some cases, habitat model or agency escapement objectives that have yet to be agreed upon by the CTC); and (3) exploitation rates from related CWT indicator stocks to clearly summarize the performance of the stocks and fisheries management relative to established or potential goals.

The plots resemble those presented for groundfish in Garcia and De Leiva Moreno (2005). A general depiction of the plots with three reference lines is provided in Figure 3.1. The plots show the exploitation rate (x-axis) and escapement abundance (y-axis) of each stock for available years of data. There are three reference lines, a vertical one for fishing mortality (U_{MSY}) and two horizontal ones for escapement abundance. The definition of reference points for PST Chinook salmon stocks is based on the management objectives (escapement and exploitation rate) identified in the 2019 Agreement. For stocks with point escapement goals, the upper reference line is S_{MSY}, and the lower reference line is $0.85*S_{MSY}$. For stocks with escapement objectives defined as ranges (SEAK, TBR, and the Harrison River), the upper reference line) is the lower bound of the escapement range and the lower reference line is 85% of the lower bound. The exploitation rate reference line (U_{SMSY}) is the exploitation rate at S_{MSY} for stocks with escapement objectives.

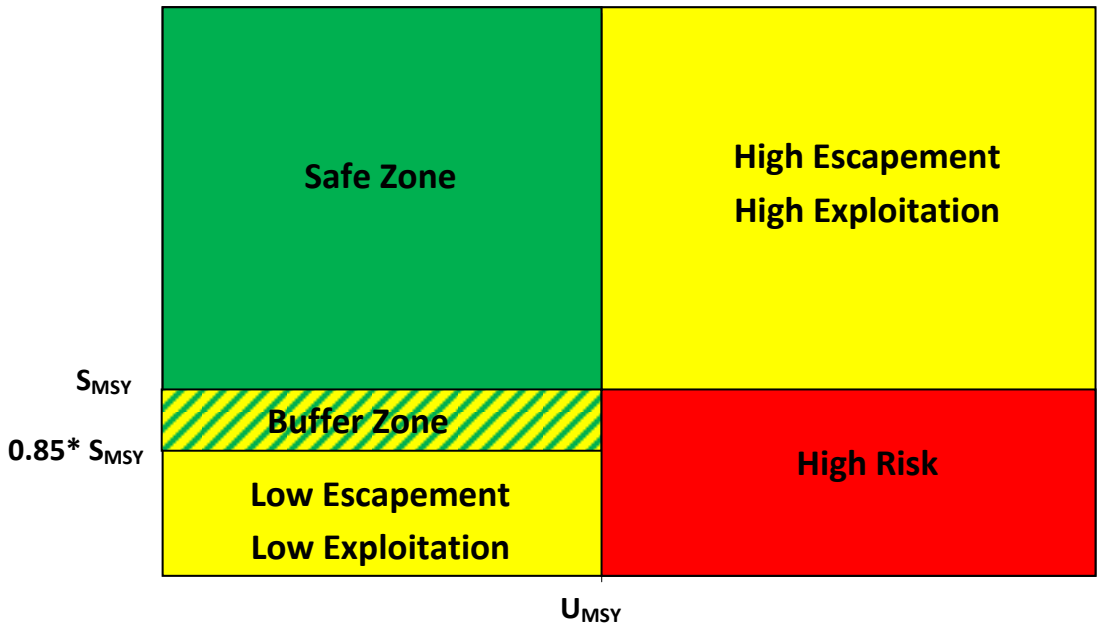


Figure 3.1–Precautionary plot for synoptic evaluations of PST Chinook salmon stocks.

The three reference lines produce five zones in the synoptic plots. The green area (Safe Zone) in Figure 3.1 represents a healthy stock status where fishing is below U_{MSY} and the concurrent stock spawning abundance is above the escapement goal. The red area (High Risk) represents a stock in which fishing mortality is above U_{MSY} and escapement abundance is below the escapement goal. The two yellow zones (High Escapement High Exploitation, Low Escapement Low Exploitation) represent situations in which the stock could be in danger of falling into an area of conservation concern; in the upper right (High Escapement High Exploitation), escapement is at a healthy level, but fishing mortality is above the U_{MSY} limit, and in the lower left (Low Escapement Low Exploitation), fishing is occurring below the U_{MSY} limit but the population failed to attain a desired minimum escapement. The cross-hatched region is the escapement buffer zone, where fishing mortality is below U_{MSY} but escapement is also slightly low.

Exploitation rates used in the synoptic plots are one of the following: calendar year exploitation rates, preterminal cumulative mature-run equivalent (MRE) exploitation rates, or total (preterminal and terminal) cumulative MRE exploitation rates. Total cumulative MRE exploitation rates are not used when there is a terminal fishery targeting a hatchery indicator stock because the terminal exploitation will differ from that on the wild stock being represented. The ages used in the escapement and exploitation rate calculations are not the same for each stock and typically exclude age 2 for ocean-type stocks and age 3 for stream-type stocks. See Table 3.1 for parameter definitions.

Calendar year exploitation rates are computed as

$$CYER_{CY} = \frac{OceanMorts_{CY} + TermMorts_{CY}}{(OceanMorts_{CY} + TermMorts_{CY} + OESC_{CY})}$$

Cumulative MRE (CMRE) exploitation rates are computed as

$$CMREER_{CY} = 1 - \left(\frac{OESC_{CY}}{PESC_{CY}}\right)$$

where

$$OESC_{CY} = \sum_{a=startage}^{maxage} OESC_{CY,a},$$

$$PESC_{CY} = \sum_{a=startage}^{maxage} PESC_{CY,a},$$

and

$$PESC_{CY,a} = \frac{OESC_{CY,a}}{CumSurvRte_{CY-a,a}}.$$

When computing total (preterminal and terminal) MRE exploitation rates, the cumulative survival rate is computed for each age in a brood year as

$$CumSurvRte_{BY,a} = TermSurvRte_{BY,a} * \prod_{i=startage}^{a} PreTermSurvRte_{BY,i}.$$

When computing preterminal MRE exploitation rates, the cumulative survival rate is computed for each age in a brood year as

$$CumSurvRte_{BY,a} = \prod_{i=startage}^{a} PreTermSurvRte_{BY,i}.$$

The preterminal harvest rates for each age in a brood year are computed as

$$PreTermHR_{BY,a} = \frac{OceanMorts_{BY,a}}{CohortSizeANM_{BY,a}}.$$

The preterminal survival rates for each age in a brood year are computed as

$$PreTermSurvRte_{BY,a} = 1 - PreTermHR_{BY,a}.$$

Table 3.1–Parameter definitions for all equations used to estimate CY exploitation rates and cumulative mature-run exploitation rates.

Parameter	Description
a	age
BY	Brood year
CY	Calendar year
$CMREER_{CY}$	Cumulative MRE exploitation rate for calendar year *CY*
$CohortSizeANM_{BY,a}$	Cohort size after natural mortality for brood year *BY* and age *a*
$CumSurvRte_{BY,a}$	Cumulative survival rate for brood year *BY* and age *a*
$CYER_{CY}$	Calendar year exploitation rate for calendar year *CY*
$OceanMorts_{BY,a}$	Ocean mortalities for brood year *BY* and age *a*
$OESC_{CY}$	Observed escapement for calendar year *CY*
$OESC_{CY,a}$	Observed escapement for calendar year *CY* and age *a*
$PESC_{CY}$	Potential escapement for calendar year *CY*
$PESC_{CY,a}$	Potential escapement for calendar year *CY* and age *a*
$PreTermHR_{BY,a}$	Pre-terminal harvest rate for brood year *BY* and age *a*
$PreTermSurvRte_{BY,a}$	Pre-terminal survival rate for brood year *BY* and age *a*
$TermMorts_{CY}$	Terminal mortalities for calendar year *CY*
$TermSurvRte_{BY,a}$	Terminal survival rate for brood year *BY* and age *a*

Data necessary to plot the stock trajectories are available for most escapement indicator stocks (Table 3.2). Most escapement indicator stocks have companion exploitation rate indicator stocks that are assumed to reflect the exploitation rates in pre-terminal areas. Exploitation rate data may not be available for some stocks in the period 1975 to 1984, so plots may show a different start year. Similarly, there are some stocks for which data are unavailable in the most recent year, particularly in the Southern U.S., because sport fishery catches that are needed for CWT expansions are generally lagged by one year. With suitable assumptions about terminal area fisheries, the total exploitation rates on stocks can be estimated. Most areas along the coast have escapement indicator stocks. Notable exceptions are the Upper Georgia Strait (UGS) area the WCVI area and the Fraser River early stocks (spring and summer). Region-specific synoptic evaluations of Chinook salmon stocks are presented in Section 3.2. The stock-specific synoptic plots presented in this section are grouped by relevant Treaty periods: pre-Treaty, 1985–2008, 1999–2008, 2009–2018, and 2019–2028.

Table 3.2–Summary of information available for synoptic stock evaluations.

Note: Shaded rows indicate stocks that cannot be evaluated because of data gaps.

Stock Region[1]	Escapement Indicator	Management Obj[2]	S_{MSY}[3]	85% of S_{MSY}[3]	U_{MSY}[3]	Exploitation Rate Indicator[3]	Exp. Rate Type[4]
SEAK	Situk	500-1,000	600	425[5]	0.81	TBD	CY
SEAK	Chilkat	1,750-3,500	2,200	1,488[5]	0.40	CHK	CY
SEAK	Unuk	1,800-3,800	2,764	1,530[5]	0.60	UNU	CY
TBR	Alsek	3,500-5,300	4,677	2,975[5]	0.58	TBD	CY
TBR	Taku	19,000-36,000	25,500	16,150[5]	0.59	TAK	CY
TBR	Stikine	14,000-28,000	17,400	11,900[5]	0.42	STI	CY
NBC	Kitsumkalum[6]	TBD	5,235	4,450	0.63	KLM	CMRE
BC	Skeena	TBD	TBD	TBD	TBD	KLM	CMRE
BC	Atnarko	5,009[7,8]	5,009	4,258	0.77	ATN	CMRE
BC	NWVI Natural Aggregate	TBD	TBD	TBD	TBD	RBT adjusted (TBD)[9]	CMRE
BC	SWVI Natural Aggregate	TBD	TBD	TBD	TBD	RBT adjusted (TBD)[9]	CMRE
BC	East Coast Vancouver Island North	TBD	TBD	TBD	TBD	QUI adjusted (TBD)[9]	CMRE
BC	Phillips	TBD	TBD	TBD	TBD	PHI	CMRE
BC	Cowichan	6,500	6,514	5,537	0.69	COW	CMRE
BC	Nicola	TBD	6,600[10]	5,600[10]	0.60[10]	NIC	CMRE
BC	Chilcotin	TBD	TBD	TBD	TBD	TBD	CMRE
BC	Chilko	TBD	TBD	TBD	TBD	CKO(TBD)[9]	CMRE
BC	Lower Shuswap	12,300[7]	12,339	10,488	0.73	SHU	CMRE
BC	Harrison	75,100	75,072	63,811	0.57	HAR	CMRE
WA/OR	Nooksack Spring	TBD	TBD	TBD	TBD	NSF	CMRE
WA/OR	Skagit Spring	690[7]	TBD	TBD	TBD	SKF	CMRE
WA/OR	Skagit Summer/Fall	9,202[7]	TBD	TBD	TBD	SSF	CMRE
WA/OR	Stillaguamish	TBD	TBD	TBD	TBD	STL	CMRE
WA/OR	Snohomish	TBD	TBD	TBD	TBD	SKY	CMRE
WA/OR	Hoko	TBD	TBD	TBD	TBD	HOK	CMRE
WA/OR	Grays Harbor Fall	13,326	13,326	11,327	0.67	QUE adjusted[9]	CMRE
WA/OR	Queets Fall	2,500	2,500	2,125	0.87	QUE	CMRE
WA/OR	Quillayute Fall	3,000	3,000	2,550	0.87	QUE adjusted[9]	CMRE
WA/OR	Hoh Fall	1,200	1,200	1,020	0.90	Hoh	CMRE
Columbia	Upriver Brights	40,000	40,000	34,000	0.56	URB	CMRE
Columbia	Lewis River Fall	5,700	5,791	4,922	0.79	LRW	CMRE
Columbia	Coweeman	TBD	TBD	TBD	TBD	CWF	CMRE
Columbia	Mid-Columbia Summers	12,143	12,143	10,322	0.75	SUM	CMRE
WA/OR	Nehalem	6,989	6,989	5,941	0.69	SRH adjusted[9]	CMRE
WA/OR	Siletz	2,944	2,944	2,502	0.81	SRH adjusted[9]	CMRE
WA/OR	Siuslaw	12,925	12,925	10,986	0.61	SRH adjusted[9]	CMRE
WA/OR	South Umpqua	TBD	TBD	TBD	TBD	ELK adjusted[9]	CMRE
WA/OR	Coquille	TBD	TBD	TBD	TBD	ELK adjusted[9]	CMRE
Columbia	Lewis River Fall	5,700	5,791	4,922	0.79	LRW	CMRE

[1] See List of Acronyms for region definitions.

[2] TBD = to be determined after review specified in paragraph 2(b)(iv) of Chapter 3 of 2019 Pacific Salmon Treaty.

[3] TBD = to be determined because the requisite data are not available.

[4] Two types of exploitation rates were used: cumulative mature-run equivalents (CMRE) which are based on CWT recovery data and calendar year (CY) which are based on actual stock assessment data gathered annually.

[5] Stocks with an escapement goal range use 85% of the lower bound.

[6] Kitsumkalum is not an attachment I stock.
[7] Agency escapement goal has the same status as CTC agreed escapement goal for implementation of Chapter 3.
[8] Natural origin spawners.
[9] CWT indicator stocks and fishery adjustments described in CTC (2016), CTC (2019; ISBM Subgroup Technical Note) and CTC (2020 *in prep)*.
[10] Revised habitat-based values that also include an adjustment for the lower than average fecundity of this stock.

A synoptic summary plot for 22 stocks with 2018 data shows that most stocks were in the safe zone (exploitation below U_{MSY} and escapement above S_{MSY}; Figure 3.2). Two stocks, Siuslaw and Nehalem, were in the high-risk zone, with the Siuslaw displaying the extreme value to the far right. One stock, Lewis, was in the buffer zone. Two stocks, Cowichan and Siletz, experienced exploitation above U_{MSY} with escapements exceeding S_{MSY}. Seven stocks were in the low escapement and low exploitation zone: Situk, Chilkat, Taku, Stikine, Nicola, Harrison, and Queets Fall.

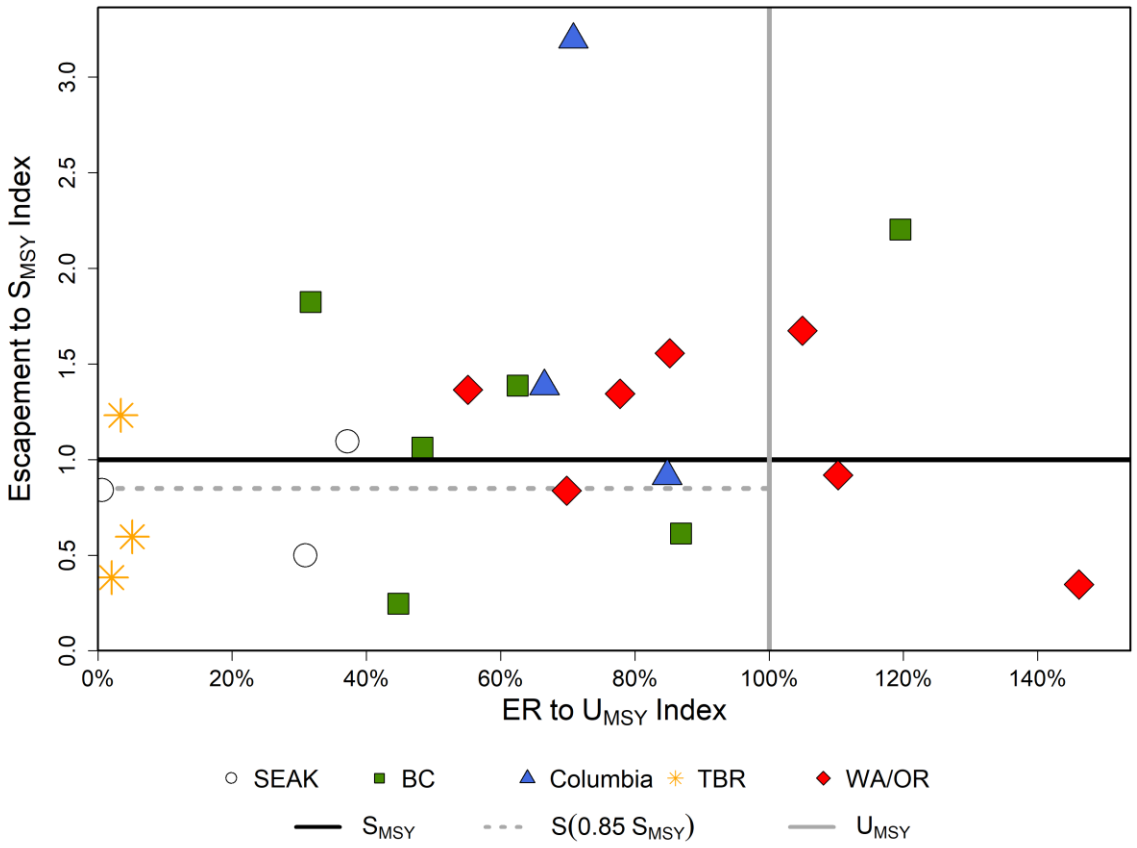


Figure 3.2–A synoptic summary by region of stock status for stocks with escapement and exploitation rate data in 2018.

Note: Escapement and exploitation rate data were standardized to the stock-specific escapement goal and U_{MSY} reference points.

3.2 REGIONAL TRENDS AND PROFILES

3.2.1 Southeast Alaska: Situk, Chilkat, Unuk, and Chickamin Rivers

Recent declines in Chinook salmon productivity and abundance are widespread and persistent throughout Alaska. Available run abundance data indicate significant declines were first fully detected in 2007 from a persistent decline in productivity that began with returns from brood year 2001. Run abundance data available from 27 stocks in Alaska show substantial variability and moderate to no coherence among stocks prior to 2004 (Figure 3.3). This is consistent with downward trends in productivity and similar declines of SEAK Chinook salmon stocks.

The SEAK stocks exhibit two consistent rearing behaviors. Outside-rearing behavior includes rearing in the Gulf of Alaska and Bering Sea after leaving the freshwater environment. Inside-rearing behavior involves rearing in the nearshore environment of SEAK for a significant amount of time. The Situk stock is an outside-rearing stock and the Chilkat and Unuk stocks are inside-rearing. However, CWT recovery data suggests at least a small proportion of the inside-rearing fish exhibit some outside-rearing behavior. The decline in productivity is far reaching, extends beyond SEAK, and has affected most Alaska Chinook stocks.

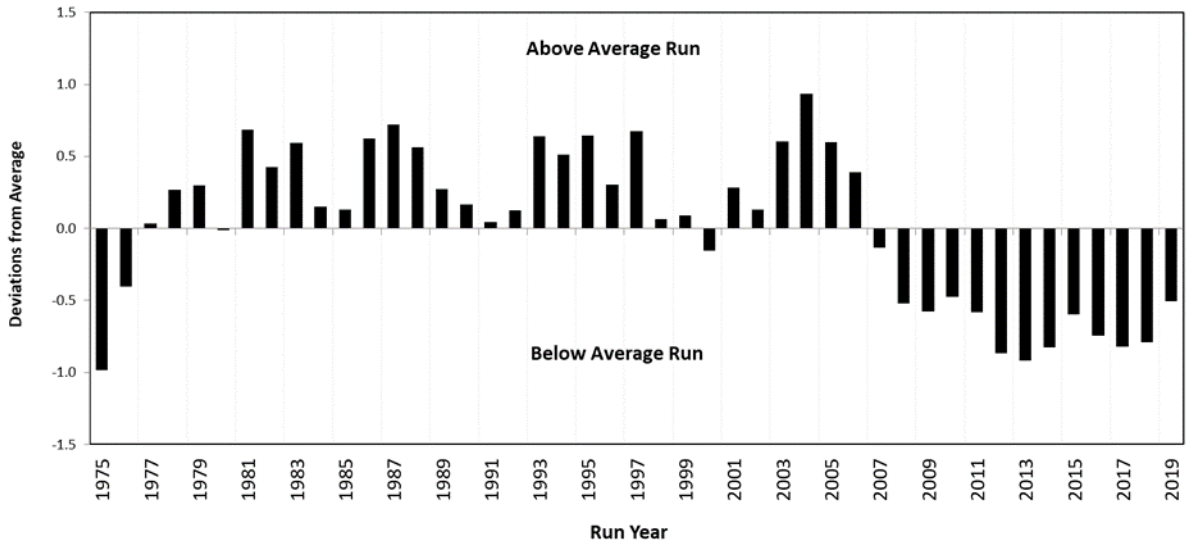


Figure 3.3– Average of standardized deviations from average run abundance for 27 stocks of Chinook salmon in Alaska

Includes: the Unalakleet, Goodnews, Kuskokwim and Nushagak in western Alaska; the Chena and Salcha tributaries to the Yukon River; the Canadian Yukon, the Chignik and Nelson on the Alaska Peninsula; the Karluk and Ayakulik on Kodiak Island; the Deshka, Anchor, Kenai Early and Kenai Late in Cook Inlet, the Copper in the northeastern Gulf of Alaska, and the Situk, Alsek, Chilkat, Taku, King Salmon, Andrews, Stikine, Unuk, Chickamin, Blossom and Keta in Southeastern Alaska.

The Situk stock has failed to meet the escapement goal seven times since 2009. Over the recent decade, this stock has demonstrated the poorest performance among the four SEAK

escapement indicator stocks. This failure cannot be explained by fishery impacts; they have been extremely low, with a recent 10-year average exploitation rate of 13%. Harvests mostly occur in-river or in the estuary and detailed catch accounting programs enumerate most harvest, yielding CY estimates of exploitation. This stock is outside rearing and is not exposed to SEAK harvest before maturation. Calendar year exploitation rates for the Situk stock have never exceeded the U_{MSY} threshold of 81% (Figure 3.4). Generally, poor runs and escapement result primarily from decreased productivity, and mirror the very low productivity of other Alaskan stocks. Conservation measures have been in place to reduce harvests in the effort to pass as much of the run to escapement as possible and these efforts will continue in 2020.

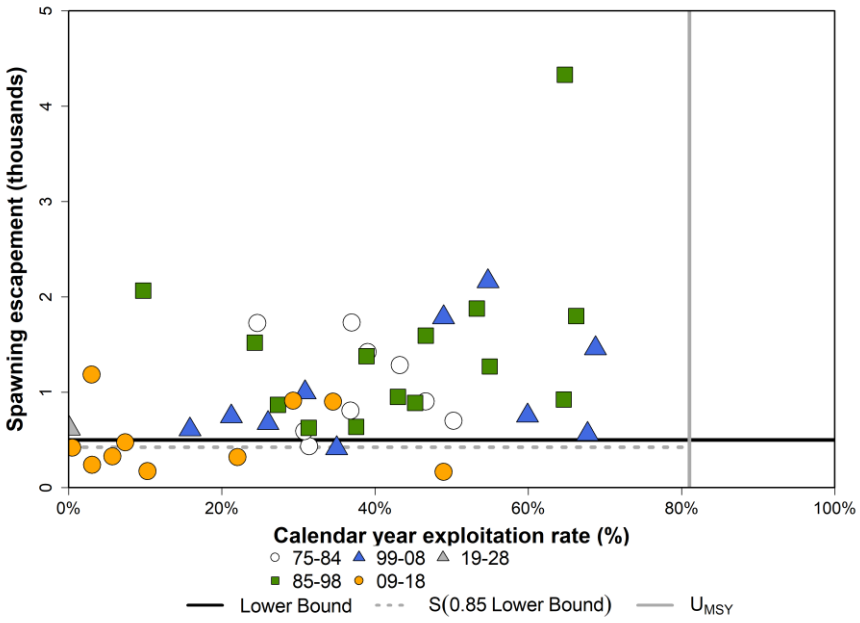


Figure 3.4– Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement for large (greater than 659 mm MEF in length) Situk River Chinook salmon, 1976–2019.

Chilkat River Chinook salmon return to northern SEAK and are mostly inside rearing. The Chilkat River stock failed to achieve its escapement goal six times since 2009. The Chilkat River is located at the northern end of Lynn Canal; gillnet and sport fisheries in the region are managed to conserve this stock.

A CWT program has been in place since the 1999 brood year to estimate the harvest of Chilkat Chinook salmon. Recoveries of CWTs indicate some age-4 Chilkat fish are harvested while rearing in SEAK, primarily in the net fisheries. Most of the harvest is mature fish from sport and commercial troll and drift gillnet fisheries in SEAK. In general, exploitation rates on the Chilkat stock are some of the lowest observed in the region, with a recent 10-year average exploitation rate of 21%, well below the U_{MSY} threshold reference value of 40% (Figure 3.5).

Smolt abundance and survival have been estimated for the Chilkat stock since the 1999 brood year. Since the 2008 brood year, there has been no apparent trend in freshwater survival; however, marine survival has generally been below average for recent broods (Figure 3.6).

Below average marine survival has negatively affected abundance; continued low exploitation rates are needed to achieve the escapement goal until productivity improves.

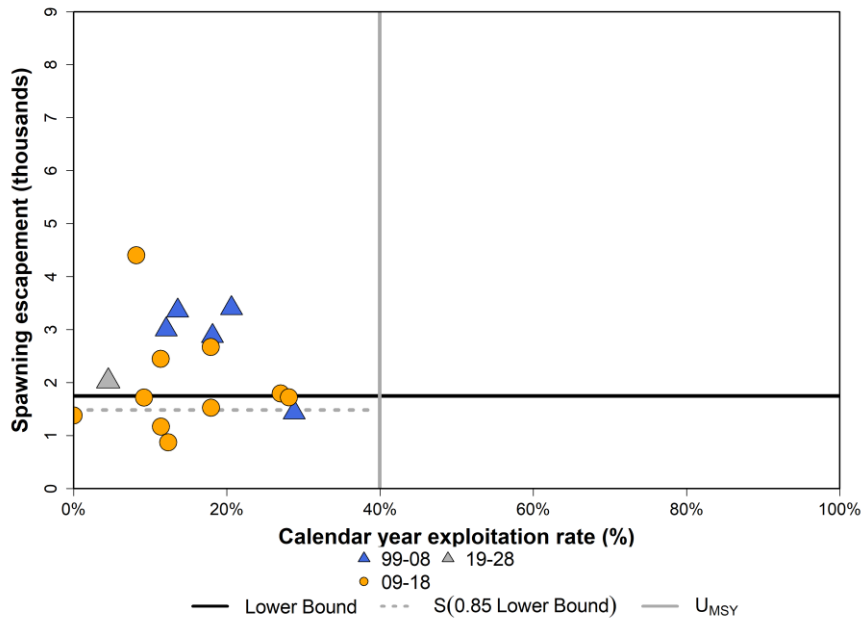


Figure 3.5–Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement for ≥ocean age-3 Chilkat River Chinook salmon, 2004–2019.

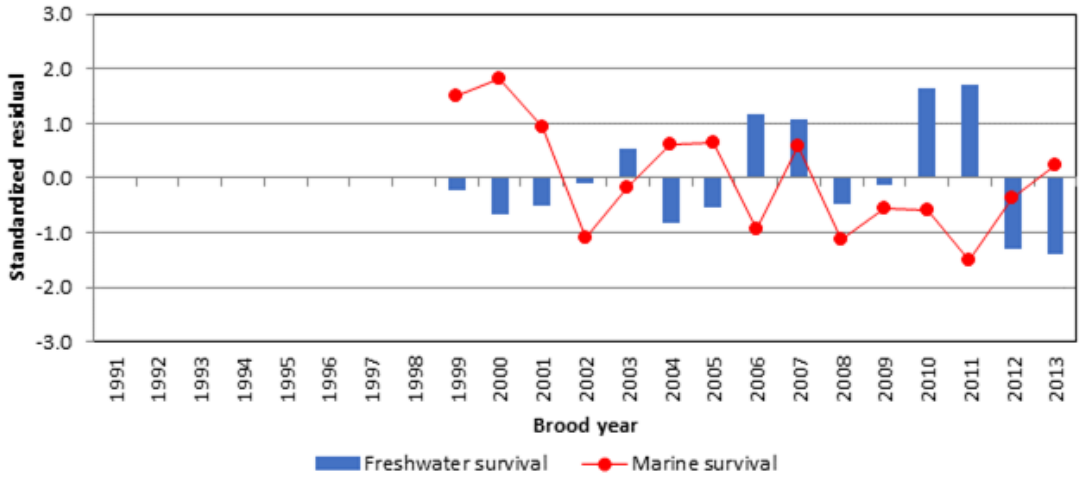


Figure 3.6–Freshwater and marine survival indices (standardized to a mean of zero) for the Chilkat River stock of Chinook salmon, 1999–2013 brood years.

The Unuk River flows into Behm Canal in southern SEAK and Chinook salmon from the Unuk River are mostly inside-rearing. Escapements to the Unuk River were below the escapement goal from 2012 to 2014, and again in 2016 and 2017, the only 5 years when the escapement goal was missed in the past 40 years. There are no Chinook salmon fisheries in freshwater or in most marine waters of the adjacent Behm Canal. Most southern SEAK stocks are harvested at

below threshold rates while rearing and maturing, and they are not harvested in terminal areas due to management closures.

A CWT program was implemented beginning with the 1992 brood year to estimate harvest in mixed-stock fisheries. In sharp contrast to other SEAK stocks, exploitation rates for the Unuk stock have been high in recent years. Some Unuk Chinook salmon are caught while rearing in SEAK, but most of the harvest is mature fish. Exploitation rates on this stock have historically averaged about one-half of the threshold reference value. However, during the recent period of poor production, rates have been the highest on record, including an over the U_{MSY} threshold exploitation rate of 72% in 2012 (Figure 3.7). As a result, additional domestic management measures have been imposed to reduce exploitation rates and pass more fish to escapement.

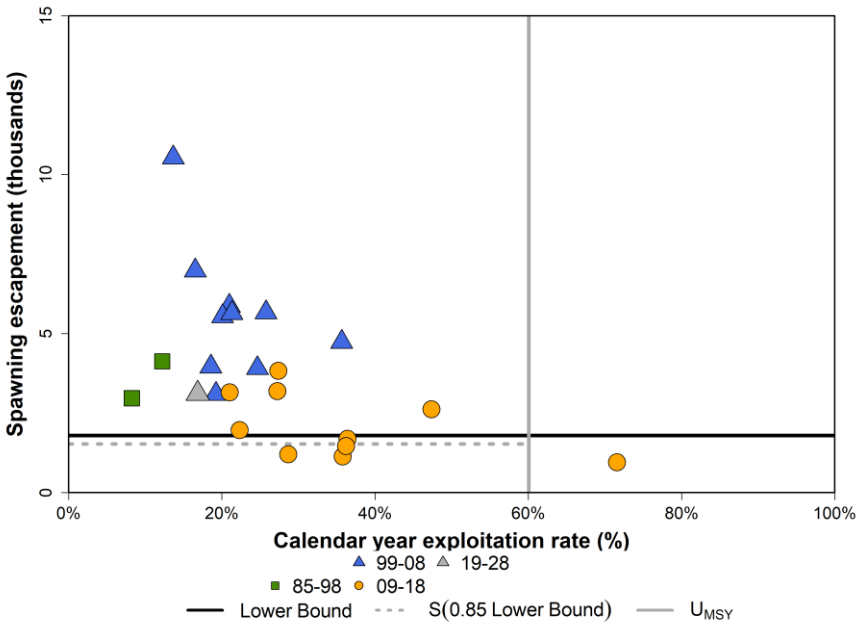


Figure 3.7– Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement of large (greater than 659 mm MEF in length) Unuk River Chinook salmon, 1997–2019.

Estimates of smolt abundance and survival are available beginning with the 1992 brood year. Freshwater survival has, for the most part, shown no apparent pattern. The 2003 and 2005 brood year freshwater survival estimates were some of the lowest on record. However, high freshwater survival occurred in 2006 and in 2012. Unfortunately, freshwater and marine survival have shown an inverse relationship in the time series. The highest freshwater survival for the 2012 brood year coincided with the lowest marine survival, while the highest marine survival for the 2005 brood year coincided with the lowest freshwater survival. Marine survival was near-average and showed high inter-annual variability over the 1991 to 2005 brood years. However, the 2006 to 2013 brood years exhibited some of the lowest marine survivals over the range of data (Figure 3.8).

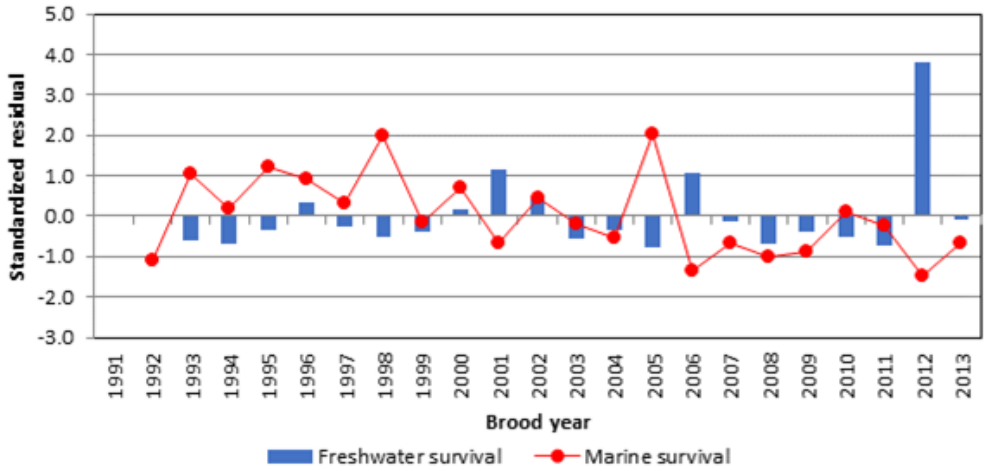


Figure 3.8–Freshwater and marine survival indices (standardized to a mean of zero) for the Unuk River stock of Chinook salmon, 1992–2013 brood years.

3.2.2 Transboundary Rivers: Alsek, Taku, and Stikine Rivers

Transboundary stocks include Chinook salmon originating from the Alsek, Taku, and Stikine rivers. The Alsek River stock has failed to achieve the lower bound of the escapement goal 4 times since 2009, and the Taku and Stikine stocks have missed the goal 5 times in the same time period, including the most recent 4 years. The recent failure of the Alsek stock cannot be solely explained by over-harvest, as the Alsek River stock has one of the lowest exploitation rates for a Chinook salmon stock on the entire Pacific Coast, averaging 12% since 2011 All known harvests occur inriver in the U.S. and Canada and detailed catch accounting and age, sex, length, and genetic sampling programs are in place for U.S. harvests and for sport and Aboriginal harvests in Canada. Most samples are taken at a weir across the Klukshu River, an index tributary of the Alsek River. Similar to Situk River Chinook salmon, the Alsek stock is outside rearing and is not exposed to SEAK fisheries while rearing. Exploitation rates have never approached the U_{MSY} threshold of 58% (Figure 3.9). Poor runs and escapement are apparently the result of decreased productivity and mirror other Alaskan stocks that rear in the Gulf of Alaska and Bering Sea. During this period of poor production, management measures have been in place to reduce harvests in both countries in the effort to pass as much of the run to escapement as possible.

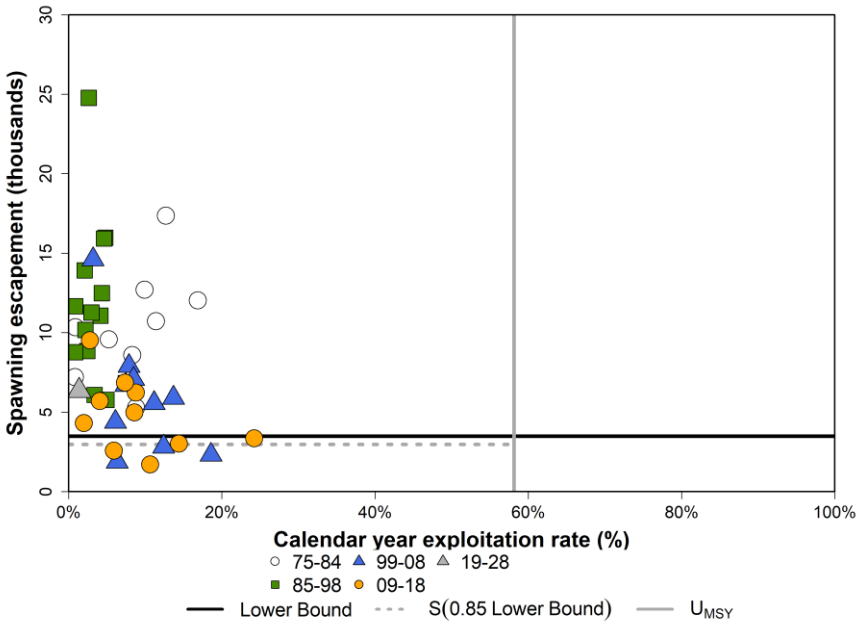


Figure 3.9–Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement ≥ocean age-2 Alsek River Chinook salmon, 1976–2019.

The Taku and Stikine river stocks have also recently experienced reduced productivity and changing age composition, which has affected forecasting accuracy. Preseason forecasts are developed for each of these stocks by December 1 per obligations specified in Chapter 1 of Annex IV. The preseason forecasts trigger directed Chinook salmon fisheries in the U.S. and Canada during years of surplus production, and in-season estimates are used to refine fishery management. In recent years, forecasts have overestimated the run size, and to account for this, forecasts have been adjusted by the five-year average percentage error; this method has performed well. Since 2009, the escapement goals for these two stocks have been missed five times and in all years since 2016.

These stocks rear in the Gulf of Alaska and Bering Sea and have essentially no exposure to SEAK fisheries as immature fish; almost all harvest is of mature fish. Both stocks are harvested in terminal marine sport fisheries and incidentally in U.S. marine and Canadian inriver traditional sockeye salmon gillnet fisheries, that take place near the end of the Chinook salmon runs. Both stocks are also caught outside of the terminal districts in commercial spring troll and net fisheries, along with outside sport fisheries. Most harvest takes place inriver and in terminal areas, and detailed genetic stock identification programs are in place to identify Taku and Stikine Chinook salmon in mixed stock marine waters. These programs, when coupled with the assessment methods described in McPherson et al. (2010) for CYs 1977 to 2007 for the Taku River stock and in Bernard et al. (2000) for CYs 1981 to 1997 for the Stikine River stock, have been used to provide CY harvest estimates since 2005.

Exploitation rates for the Taku River have never exceeded the U_{MSY} threshold of 59%. Since

2009, CY exploitation rates averaged 19%; and escapements failed to meet the escapement goal in 6 of 11 years (2013 and from 2016 to 2019). Between 1975 and 2008, the average exploitation rate was 14%, and escapements were below the goal for 5 years (Figure 3.10).

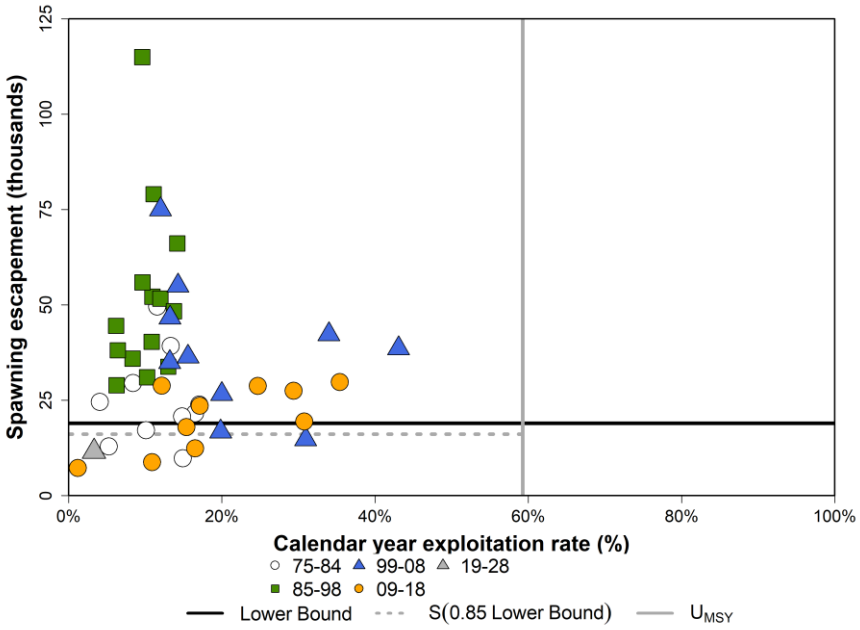


Figure 3.10– Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement for large (greater than 659 mm MEF in length) Taku River Chinook salmon, 1975–2019.

Since 2009, Stikine River Chinook CY exploitation rates averaged 26%, and escapements failed to meet the escapement goal in 2009 and from 2016 to 2019. Substantial directed fishing occurred from 2005 to 2008 with exploitation rates averaging 47%, which was over the U_{MSY} threshold value of 42%; however, the escapement goal was achieved in each of those years. Prior to 2005, the average exploitation rate was 20%, and escapements were above the goal in all but seven years (Figure 3.11).

Exploitation rates on Alsek, Taku, and Stikine river stocks will need to remain low until production improves.

Chinook salmon smolt abundance and survival have been monitored for the Taku River stock since the 1991 brood year. Freshwater survival has been above the long term average 6 out of the recent 10 brood years. However, marine survival has undergone cycles throughout this period and the most recent ten brood years have all been below average (Figure 3.12).

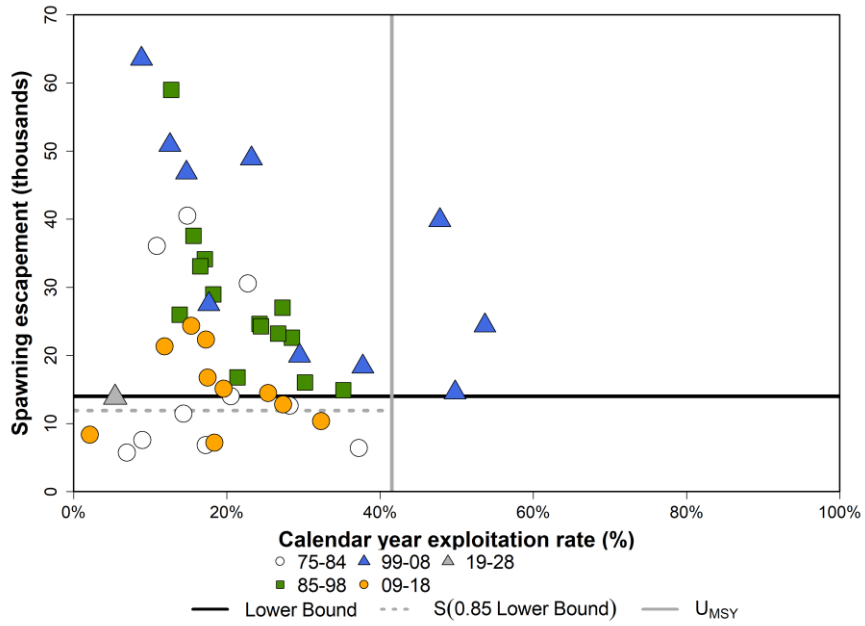


Figure 3.11– Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement for large (greater than 659 mm MEF in length) Stikine River Chinook salmon, 1975–2019.

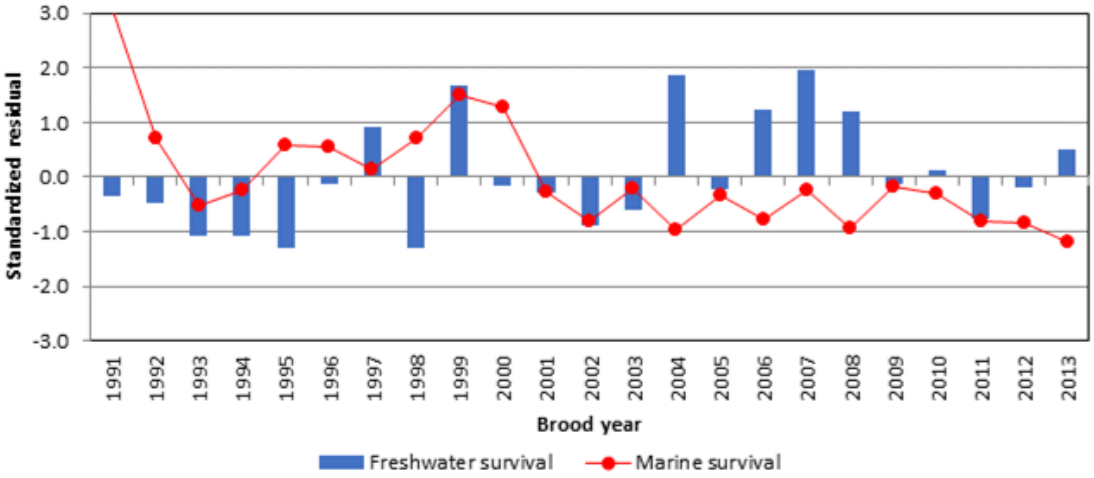


Figure 3.12–Freshwater and marine survival indices (standardized to a mean of zero) for the Taku River stock of Chinook salmon, 1991–2013 brood years.

Smolt abundance and survival have been monitored for Stikine River Chinook salmon since the 1998 brood year. Freshwater survival over this time period is declining and marine survival has also been below the long term average 6 out of the recent 10 brood years (Figure 3.13).

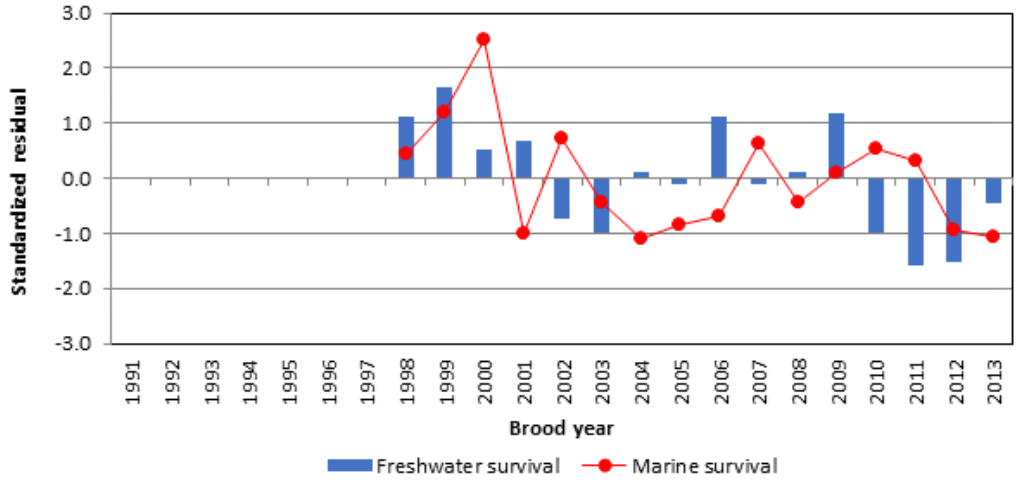


Figure 3.13–Freshwater and marine survival indices (standardized to a mean of zero) for the Stikine River stock of Chinook salmon, 1998–2013 brood years.

3.2.3 Canadian Stocks

3.2.3.1 Northern British Columbia: Kitsumkalum River

The Skeena River is an escapement indicator stock in NBC and it does not have a CTC-agreed escapement goal. The Kitsumkalum River is a tributary of the Skeena River and is the CWT indicator stock for the Skeena River. High quality MR escapement data have been collected for Kitsumkalum River Chinook salmon annually since 1984. The method for determining escapement estimates was revised in 2019 to use open population models (Winther et.al. *In prep*.). Revised escapement estimates from the open population models were lower in most years than previous estimates, as were the stock-recruit parameters (e.g. preliminary S_{MSY} = 5,235). Prior to 2019 the MR escapement estimates were produced using the Petersen method. Under this closed population model, McNicol (1999) estimated the stock–recruit relationship (S_{MSY} = 8,876), that was updated by Parken et al. (2006) (S_{MSY} = 8,621). Spawning escapements have exceeded S_{MSY} reference line in all years but two. In 1997 the stock was in the buffer zone and in 2017 the stock was in the low escapement and low exploitation zone.

This stock has had very low levels of enhancement relative to the CWT indicator stock targets (mean enhanced contribution = 4.5%, range = 0.4–13.9%, run years 1985–2019).

Marine survival was below average for 2007 to 2010, 2012 and 2013 brood years and above average for the 2011 brood year (Figure 3.14). The mature-run equivalent exploitation rates have been below the threshold reference line (U_{MSY} = 0.626) in all years (Figure 3.15).

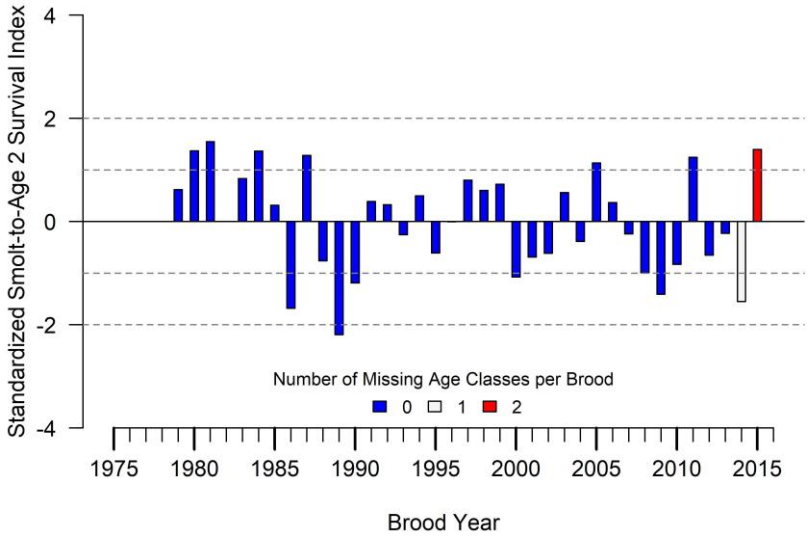


Figure 3.14–Marine survival index (standardized to a mean of zero) for the Kitsumkalum River stock of Chinook salmon, 1979–2015 brood years.

Note: Brood year 1982 was not represented by CWTs; thus no datum is available.

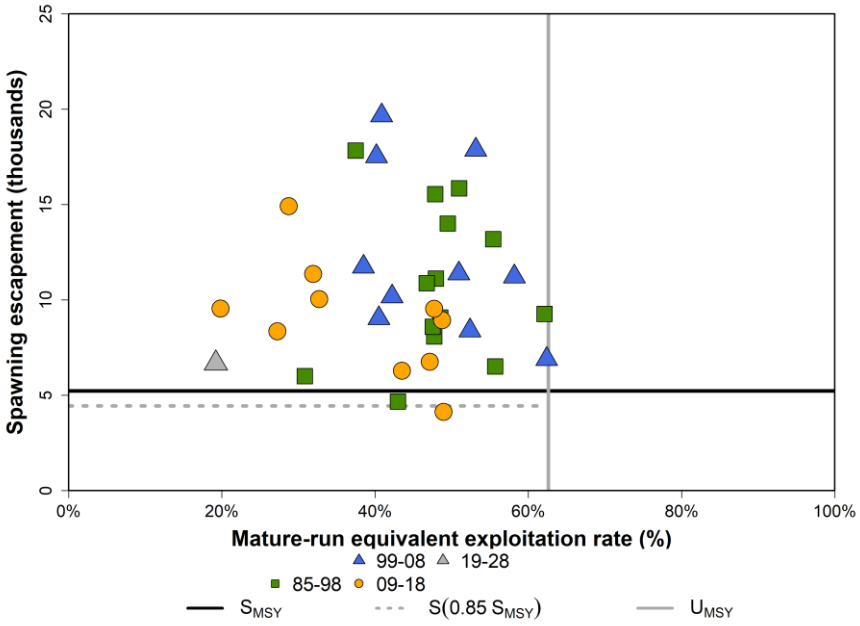


Figure 3.15–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Kitsumkalum River stock of Chinook salmon, 1985–2019.

3.2.3.2 Central British Columbia: Atnarko River

The North/Central BC model stock group includes the Dean, Wannock, Chuckwalla-Kilbella and Atnarko escapement indicators in Central BC. Currently, only the Atnarko has an escapement goal recognized in the new Agreement. The Atnarko River was added as an exploitation rate

indicator stock in Area 8 in 2012 (Vélez-Espino et al. 2011) with MR escapement estimates produced annually (Vélez-Espino et al. 2010). These estimates were used to calibrate the time series of existing carcass count based escapement estimates and broodstock CPUE back to 1990 based on a GLM approach (Vélez-Espino et al. 2014).

This stock has had a moderate level of enhancement relative to the CWT indicator stock targets (mean enhanced contribution = 39%, range: 13–69%, run years 1990–2019). The largest hatchery contributions occurred in the mid-1990s, reaching 67% and 69% in 1996 and 2015, respectively, whereas the lowest (13%) took place in 2008. Recent increases in hatchery contribution are partly due to the implementation of a yearling-release strategy in addition to the customary subyearling releases. Adjustments are made to escapement estimates to remove hatchery fish in order to make inferences for non-enhanced stocks in Central BC (Vélez-Espino et al. 2014). A stock–recruitment relationship has not yet been generated; however, a habitat-based estimate of S_{MSY} (Parken et al. 2006) of 5,009 large wild adults has been developed for Atnarko Chinook salmon (Vélez-Espino et al. 2014).

The average marine survival (i.e., age-2 cohort survival) of Atnarko Chinook salmon is 4.8% (for brood years 1986–2016), with an increasing survival index from brood year 1986 to brood year 1991, and remaining below average for most years from brood year 1992 up to brood year 2008 (Figure 3.16). For brood years 2009–2012, marine survival increased to a level comparable to that achieved for brood year 1990 and reached the highest recorded level (6.1%) for brood year 2011. Survival rates have been mostly below average since 2013.

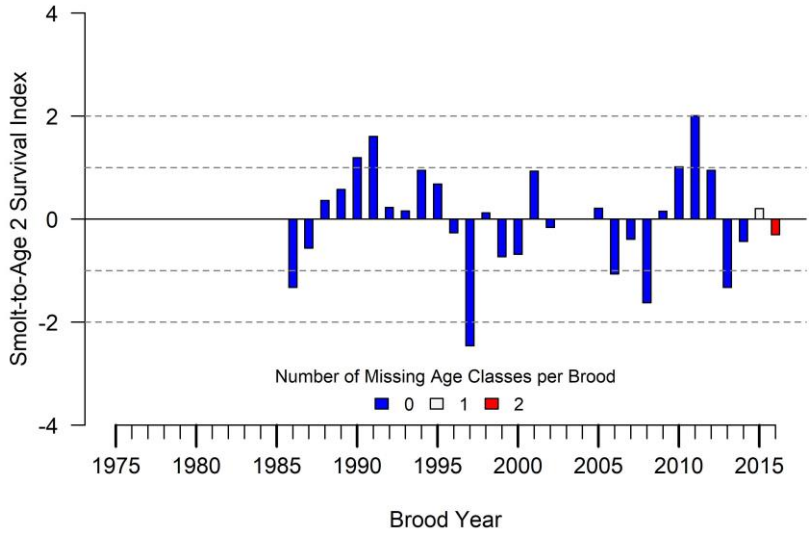


Figure 3.16–Marine survival index (standardized to a mean of zero) for subyearling releases of the Atnarko River stock of Chinook salmon, 1986–2016 brood years. There were no CWT releases for brood years 2003 and 2004.

Estimates of total large adults (wild and hatchery, excluding jacks) have exceeded 10,000 fish in most years except in 1997 and 2007–2012 period when adult escapement reached its lowest point (4,622; Figure 3.17). However, escapement estimates for large wild adults have been below the S_{MSY} goal of 5,009 fish in 1997, 2012, and 2019 and below the 0.85 S_{MSY} threshold of 4,258, in 1997 and 2012 (Figure 3.18). Since MRE exploitation rates have been below the threshold reference line in all years, this stock has been in the safe zone for most years.

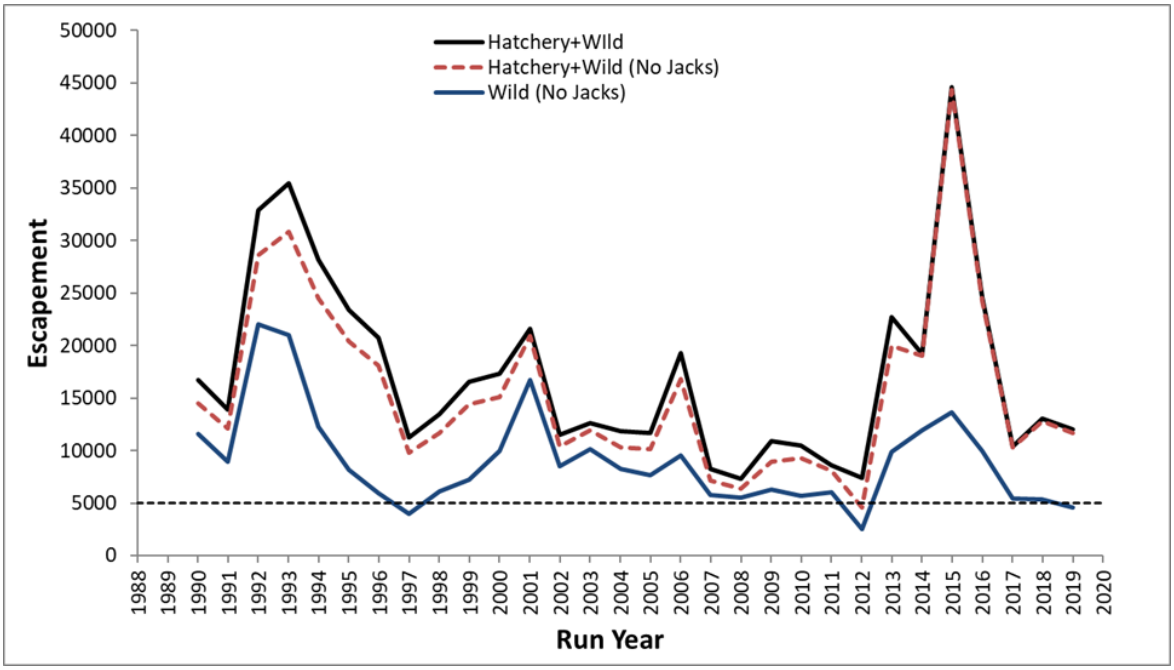


Figure 3.17–Time series of Atnarko Chinook escapement integrating the calibrated values from the best Generalized Linear Model and best Maximum Likelihood estimates for years with mark–recapture studies (2001–2003 and 2009–2019).

Note: The horizontal dashed line shows the habitat-based escapement goal of 5,009 large adults.

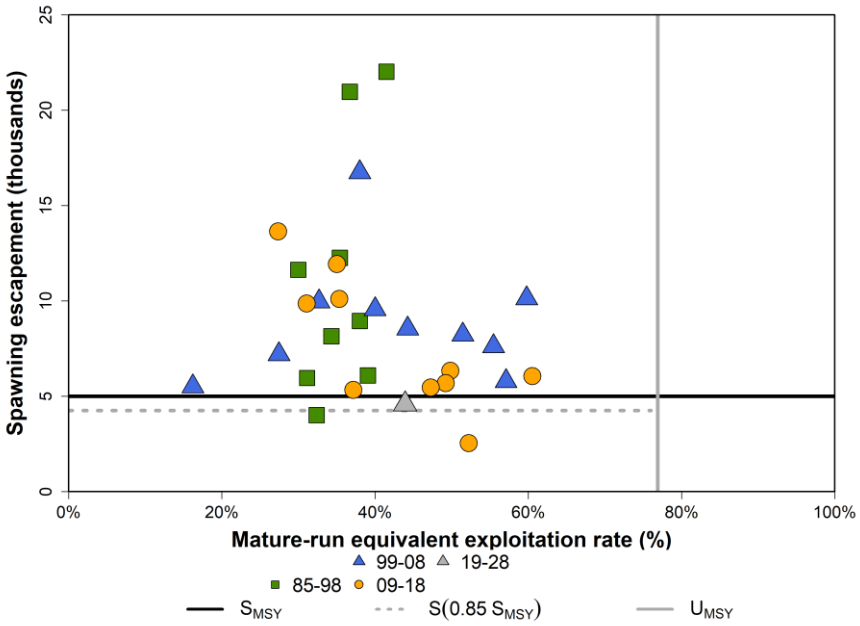


Figure 3.18–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Atnarko River stock of Chinook salmon, 1990–2019.

Note: Spawning escapement excludes jacks to be consistent with the units represented by the S_{MSY}-based escapement goal.

3.2.3.3 Lower Strait of Georgia: Cowichan River

The Lower Strait of Georgia natural stock group includes the Cowichan River and Nanaimo River escapement indicators. Currently, only the Cowichan has a PSC-agreed escapement goal, and an estimated stock-recruitment relationship (Tomkins et al. 2005). The Cowichan River is an exploitation rate indicator stock with a high level of enhancement (mean enhanced contribution = 20%) for years 1982–2019 (Figure 3.19), with the largest contribution in 2002 (62%). Escapement estimates are produced by counting fence (weir) and MR methods. A habitat-based estimate of S_{MSY} is available for the Nanaimo River; however, the exploitation rate indicator monitoring program was discontinued after brood year 2004.

Marine survival was generally above the mean for twelve brood years 1985 to 1994, and 2009 to 2011. Fourteen brood years were below the mean from 1995 to 1997, 1999 to 2003, 2005-2008 and 2012 to 2013. Two brood years were slightly above average in 1998 and 2014 (Figure 3.20). Similarly, the mature-run equivalent exploitation rates were above the threshold reference line in most years from 1985-1998. Escapements were below S_{MSY} between 1997 and 2015 and exceeded S_{MSY} from 2016 to 2019 (Figure 3.21). The stock has rarely been in the safe zone of the synoptic plot, only twice during the last 27 years, with most of the recent years in the high risk zone. However, in 2019, the stock appears to be approaching the safe zone with exploitation rates at the upper MSY. The stock experiences the highest exploitation of the stocks examined in Section 3.

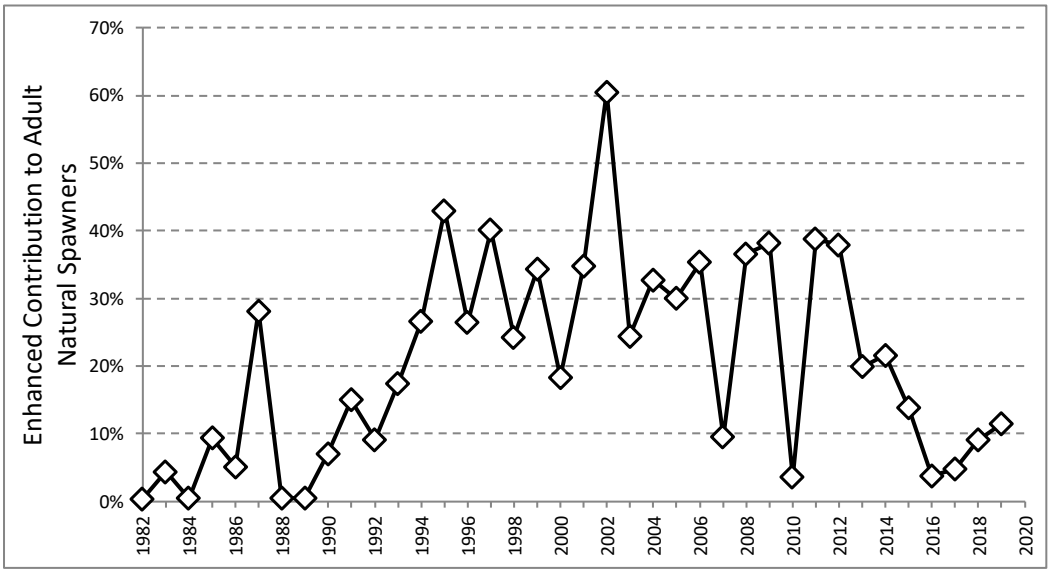


Figure 3.19–The percentage of first generation hatchery-origin Chinook salmon in the Cowichan River adult spawning population, 1982–2019.

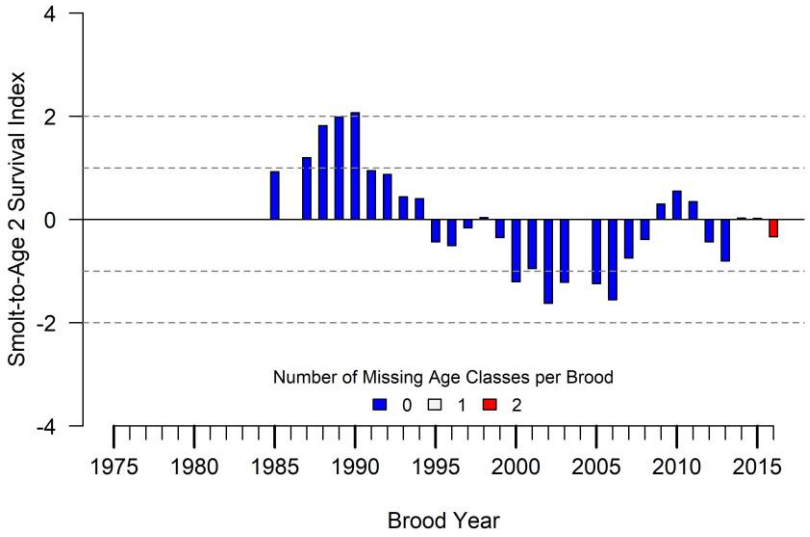


Figure 3.20–Marine survival index (standardized to a mean of zero) for the Cowichan River stock of Chinook salmon, 1985–2016 brood years. Brood years 1986 and 2004 were not represented by CWTs, thus no data are available.

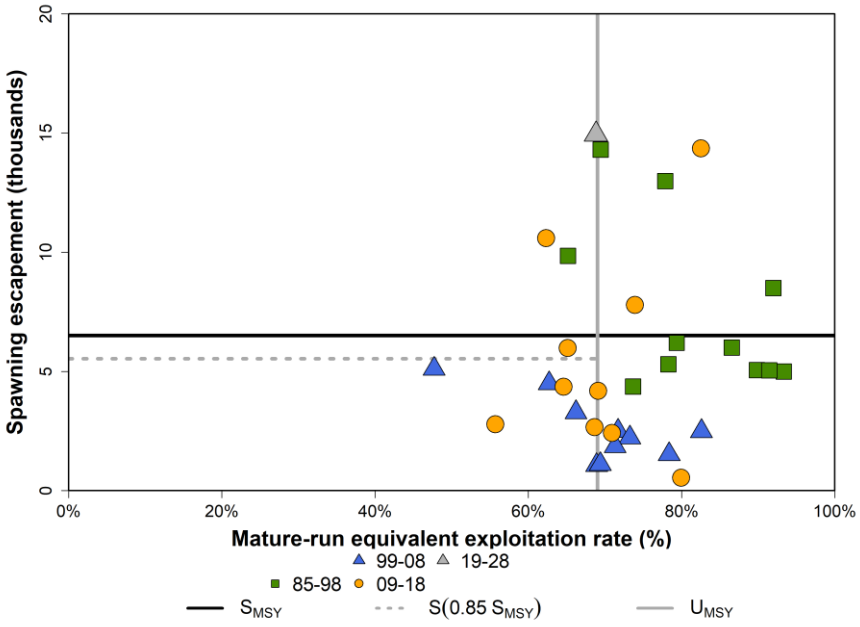


Figure 3.21–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Cowichan River stock of Chinook salmon, 1988–2019.

3.2.3.4 Fraser River Stocks

Within the Fraser River, three of five escapement indicator stocks are currently represented by exploitation rate indicator stocks. The Fraser River spring run age 1.2, Fraser River summer run

age 0.3, and Fraser River late run age 0.3 are represented by the exploitation rate indicator stocks at the Nicola, Lower Shuswap, and Harrison rivers, respectively. Fraser River spring run age 1.3 and Fraser River summer run age 1.3 are not currently represented by CWT-based indicator stocks.

3.2.3.4.1 Fraser River Spring Run Age 1.2: Nicola River

The Fraser River spring run age 1.2 stocks are small-bodied, early-maturing stocks that spawn in tributaries to the Lower Thompson River, and Louis Creek in the North Thompson River. The Nicola River is an exploitation rate indicator stock that has escapement estimates produced using MR methods. Currently, there are no CTC-agreed escapement goals for this group. Harvest occurs almost exclusively during the return migration while passing through Juan de Fuca and Johnstone Straits and Fraser River fisheries. Estimated escapements declined steeply between 2003 and 2009 and have remained low; currently this is a stock group of concern for Canadian fishery planning, and is being assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) for potential for listing under the Canadian Species at Risk Act (SARA). This stock has had a moderate level of enhancement (mean enhanced contribution 30%, years 1987–2019, range 4–79%), which influences its representativeness for stocks in the stock group (Figure 3.22).

The threshold reference lines in Figure 3.23 were estimated from habitat-based methods (Parken et al. 2006). The Nicola River stock has been in the low escapement and low exploitation zone of the synoptic plot since 2009, which corresponds to a period of low productivity for many Chinook stocks (Dorner et al. 2018).

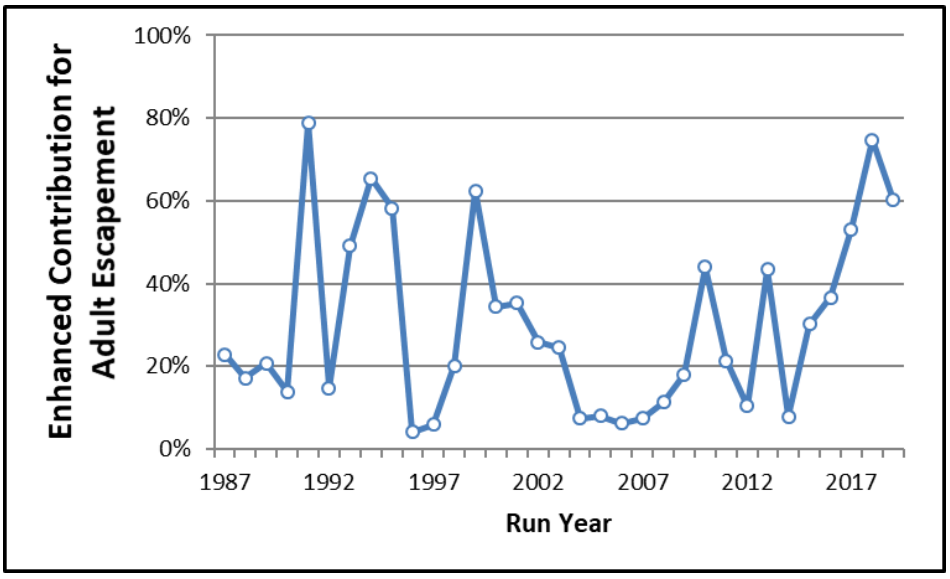


Figure 3.22–The percentage of first generation hatchery-origin Chinook salmon in the Nicola River escapement, 1987–2019.

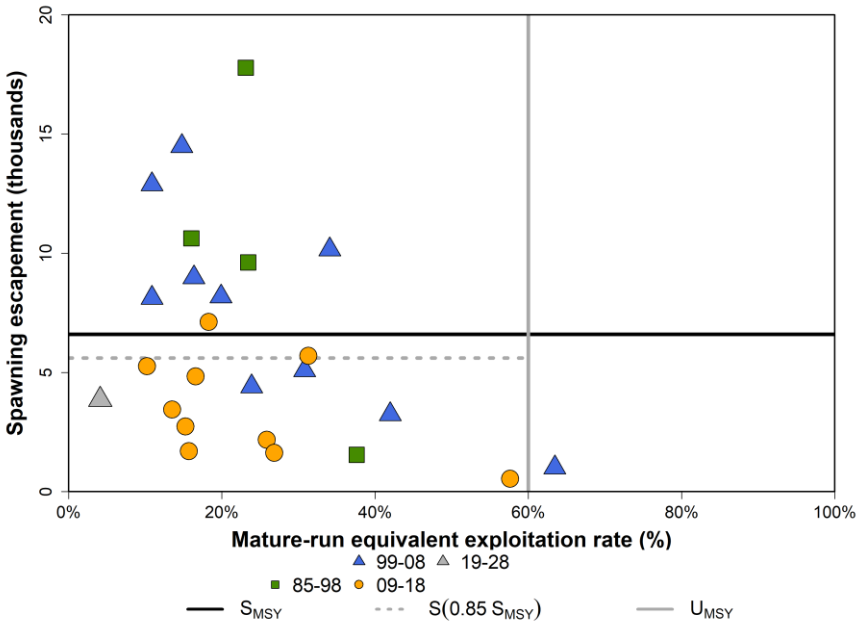


Figure 3.23–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Nicola River stock of Chinook salmon, 1995–2019.

Survival decreased steeply starting with the 2000 brood (2002 ocean entry) and subsequently have remained at or below average, with the modest exception of the 2006 brood (2008 ocean entry; Figure 3.24). The very low survival for the 1992 brood year was caused by a *Myxobacteria* infection at Spius hatchery, and the survival for the 1994 brood year was affected by high pre-spawn mortality in 1998 (not measured).

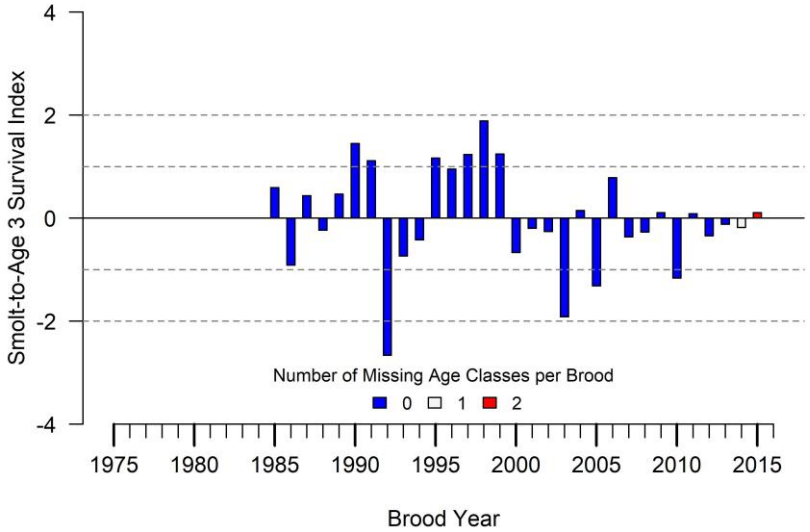


Figure 3.24–Marine survival index (standardized to a mean of zero) for the Nicola River stock of Chinook salmon, 1985–2015 brood years.

3.2.3.4.2 Fraser River Summer Run Age 0.3: Lower Shuswap River

The Fraser River summer run age0.3 stocks are far north migrating, ocean-type stocks that spawn in Maria Slough (Lower Fraser River), the Lower Thompson River, and South Thompson River and tributaries. Marine survival has been fluctuating since 1984; however, many of the brood years since 2000 have experienced below average survivals (Figure 3.25). These fish remain on the continental shelf for their entire marine residence and are vulnerable to harvest throughout that period and during return migration, in both marine and Fraser River fisheries. Annual escapements to this stock group increased from about 25,000 through the 1980s to more than 85,000 between 2006 and 2011, peaking in 2010 at an estimated 180,000 fish, and declining steeply in 2012 to about 48,000 fish. Escapements to this stock group have returned to a high level, with approximately 170,000 returning in 2019.

The Lower Shuswap River is an exploitation rate indicator stock that has had escapement estimates produced using MR methods since 2000. The PSC adopted an escapement goal in the 2019 Agreement, which is the same value as the agency goal, and was estimated from habitat-based methods (Parken et al. 2006). The Lower Shuswap River has had a low to moderate level of enhancement (mean enhanced contribution 10%, years 1987–2019), which influences its representativeness for non-enhanced stocks in the stock group (Figure 3.26). The Lower Shuswap CWT stock has been below the U_{MSY} reference line in the synoptic plot in all but five years. Since implementation of the 2009 Agreement, six years were in the safe zone and two years (2012 and 2016) were in the low escapement and low exploitation zone.

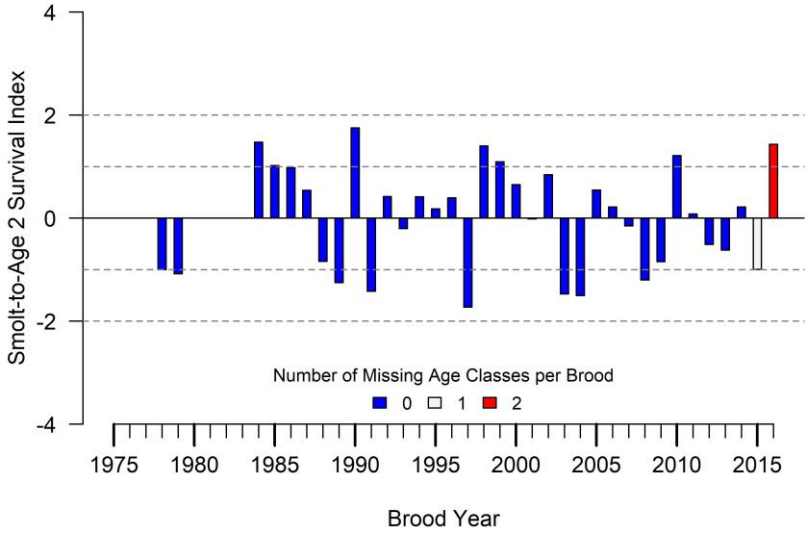


Figure 3.25–Marine survival index (standardized to a mean of zero) for the Lower Shuswap River stock of Chinook salmon, 1978–2016 brood years.

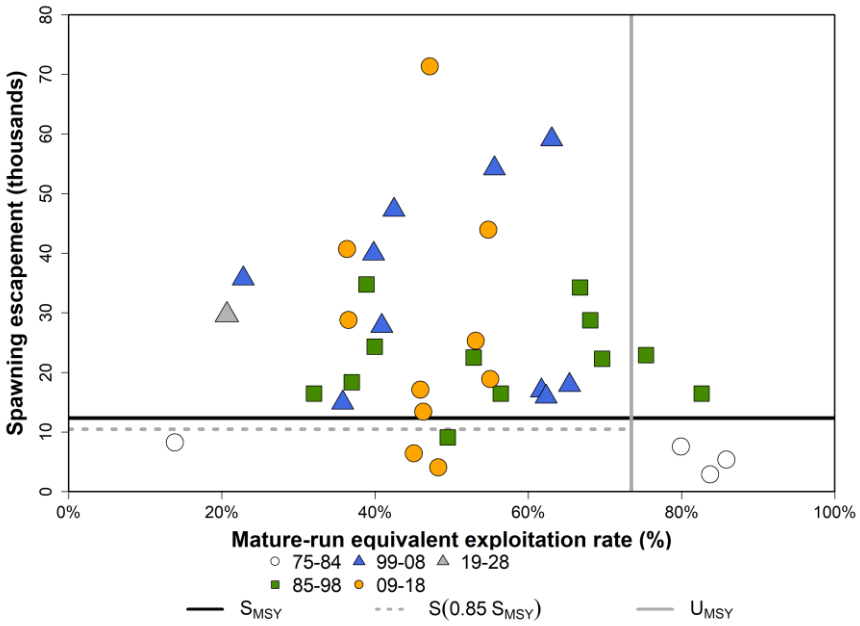


Figure 3.26–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Lower Shuswap River stock of Chinook salmon, 1981–2019.

3.2.3.5 Fraser Late Run Age 0.3: Harrison River

The Fraser late stocks are white-fleshed fall-run Chinook salmon, originating from the Harrison River downstream of Harrison Lake in the Lower Fraser River. Juveniles migrate to the Fraser estuary immediately after emergence and remain in the estuary area for up to six weeks before moving into the Strait of Georgia. Their ocean distribution is principally in the Salish Sea, WCVI, and Coastal Washington, where they are vulnerable to fisheries throughout their ocean residence. From 1984 to 2019, the enhanced contribution to this stock has averaged 4% (range: 0–17%). With a few exceptions, marine survivals have been below average since 1990 (Figure 3.27). Spawning escapements have been below the goal range for seven of the past eight years (Figure 3.28). The synoptic plot shows the stock with exploitation rates higher than the reference line in the majority of years from 1985 to 1998, with two years in the high risk zone and only one year in the safe zone. Cumulative exploitation rates were reduced under the 1999 Agreement, with most years having exploitation rates less than U_{MSY}. Exploitation rates were further reduced under the 2009 Agreement and exploitation rates have been below the reference line; however, only three years have been in the safe zone since 2009. The recent low escapements and low exploitation rates correspond with a period of low productivity for many Chinook stocks (Dorner et al. 2018).

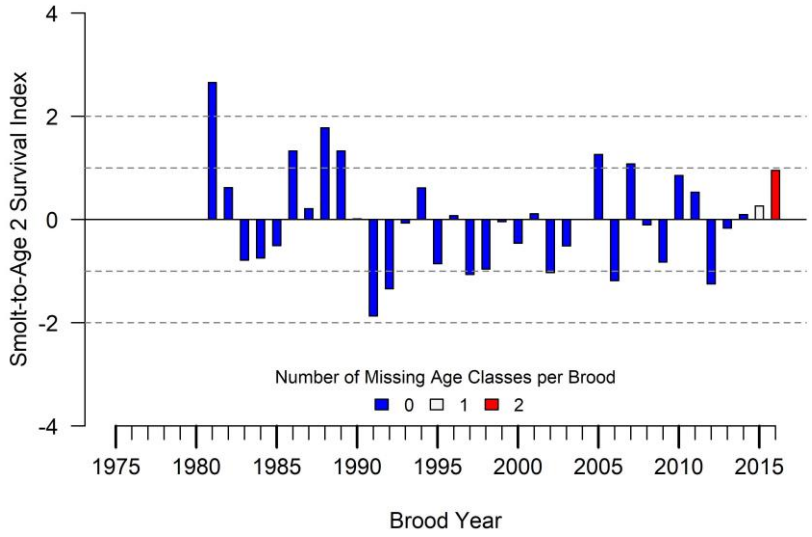


Figure 3.27–Marine survival index (standardized to a mean of zero) for the Harrison River stock of Chinook salmon, 1981–2016 brood years. No data are available for brood year 2004.

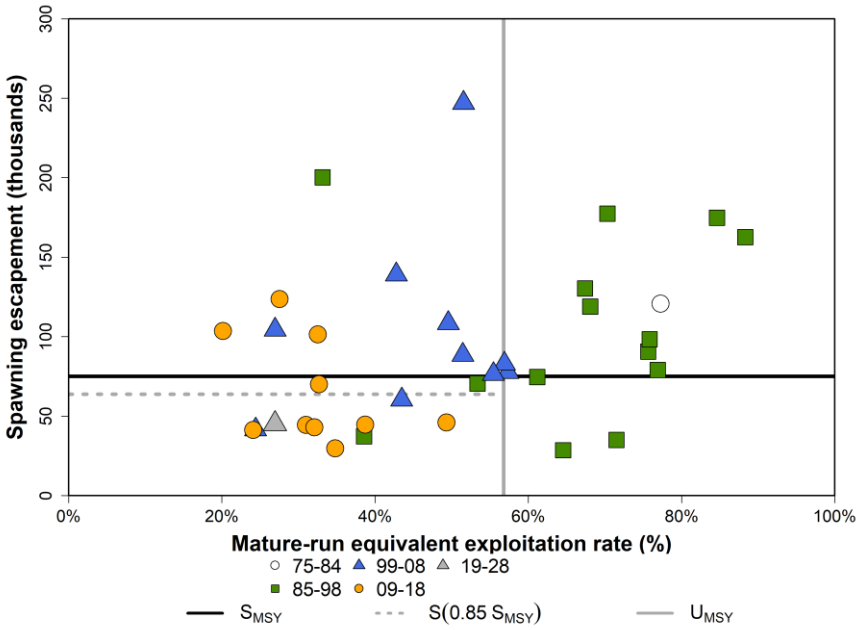


Figure 3.28–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Harrison River stock of Chinook salmon, 1984–2019.

3.2.4 Puget Sound, Coastal Washington, Columbia River, and Coastal Oregon Stocks

3.2.4.1 Puget Sound

Puget Sound stocks are a mixture of natural- and hatchery-origin production of spring run and summer/fall run fish that influences both the fisheries within Puget Sound, and escapement to the spawning grounds. The hatchery stocks contribute to terminal fisheries and in some cases many hatchery strays escape to the spawning grounds. Consequently, historic patterns of wild Puget Sound Chinook salmon abundance may be obscured because of the interaction of hatchery- and natural-origin production in the fishery and escapement accounting. Hatchery programs in Puget Sound have annually released between about 23 million (1976) to over 56 million (1989) Chinook salmon (Figure 3.29). Since Puget Sound Chinook salmon were listed as threatened under the ESA in 1999, hatchery production has averaged about 31 million releases annually. Although Puget Sound hatchery programs historically emphasized production for fisheries alone, many of today's programs are also associated with endangered species recovery or wild broodstock CWT indicator programs. The harvest rate in terminal fisheries for these stocks has generally declined from between 40% and 60% in the early 1980s to about 10% at the time of listing under the ESA in 1999. In most years, the majority of the terminal fishery harvest has depended on the status of Green River Chinook salmon and to a lesser extent on Skagit River fish. Directed terminal fisheries do not occur on Snohomish River, Stillaguamish River, and Lake Washington Chinook salmon. Terminal harvest data for 2019 have not been reviewed by co-managers, although indications are that catches were lower than those in 2018.

Spring run stocks in Puget Sound exhibit both ocean-type (age-0 fingerling outmigrants) and stream-type (age-1 yearling outmigrants) life histories. Key spring stocks are the CTC escapement indicators in the Nooksack and Skagit rivers, as well as the White River (CWT indicator), with associated hatchery programs in each. Escapement in the Nooksack River is predominately hatchery-origin fish, whereas on the Skagit River, hatchery-origin fish are rarely seen in the spawning areas. The majority of Chinook salmon production from Puget Sound is comprised of summer/fall run ocean-type stocks. Skagit River summer/fall Chinook salmon is the largest stock in Puget Sound, and consists almost exclusively of natural-origin fish. The Skagit and Stillaguamish rivers have CWT exploitation rate indicator stocks but only Stillaguamish has a supplementation program that uses broodstock collected from the spawning grounds. Basins with large hatchery programs include the Snohomish and Green River CTC escapement indicators as well as the Samish, Puyallup, Nisqually and Skokomish rivers. In addition, net-pen programs in Bellingham and Tulalip bays release large number of juvenile Chinook salmon.

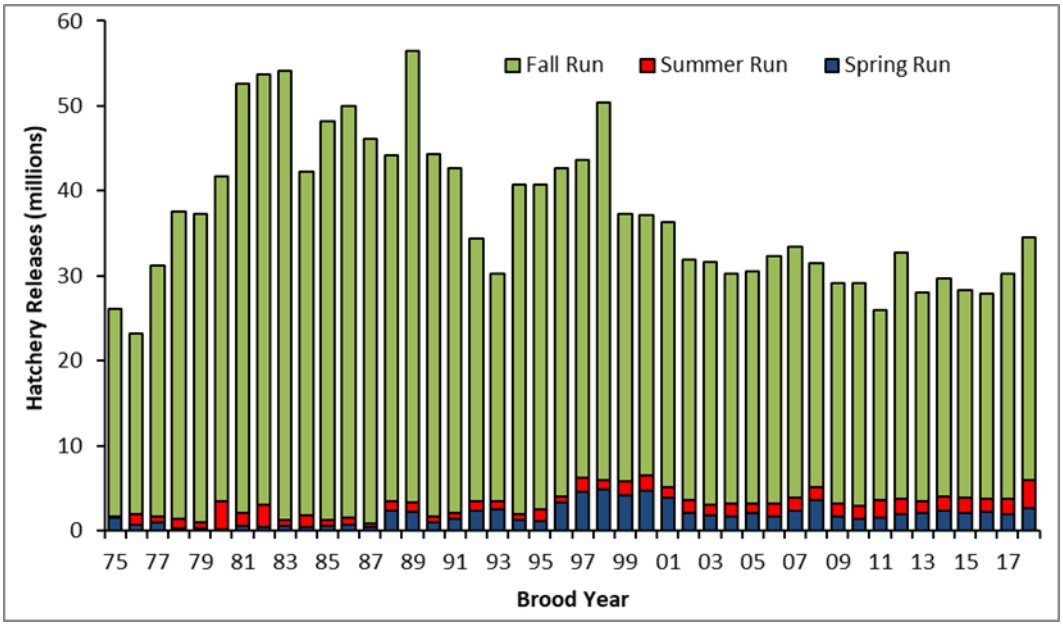


Figure 3.29–Chinook salmon released from Puget Sound hatcheries.

Estimates of total production for the Puget Sound CTC escapement indicator stocks have not been made in part because of the lack of long-term representative tag groups for the natural stocks (except Green River). The trend in the escapement of Puget Sound summer/fall CTC escapement indicator stocks is driven primarily by the status of Skagit River summer/fall stocks. In most years, the abundance of Skagit River fish is higher than the sum of the escapements of other Puget Sound CTC indicator stocks. This is especially true when the escapement of Skagit River summer/fall Chinook salmon averaged 17,900 from 2000 to 2006 and exceeded 20,000 from 2004 to 2006. For the period of 1975 to 2018, the aggregate escapement of Puget Sound summer/fall indicator stocks ranged from a low of about 10,300 in 2011, to a high of 45,000 in 2004 (Figure 3.30). The aggregate escapement was 18,090 in 2019, which is similar to the long-term average. As part of the 2019 Agreement, escapement goals were included in Attachment I for the Skagit spring and Skagit summer/fall stocks.

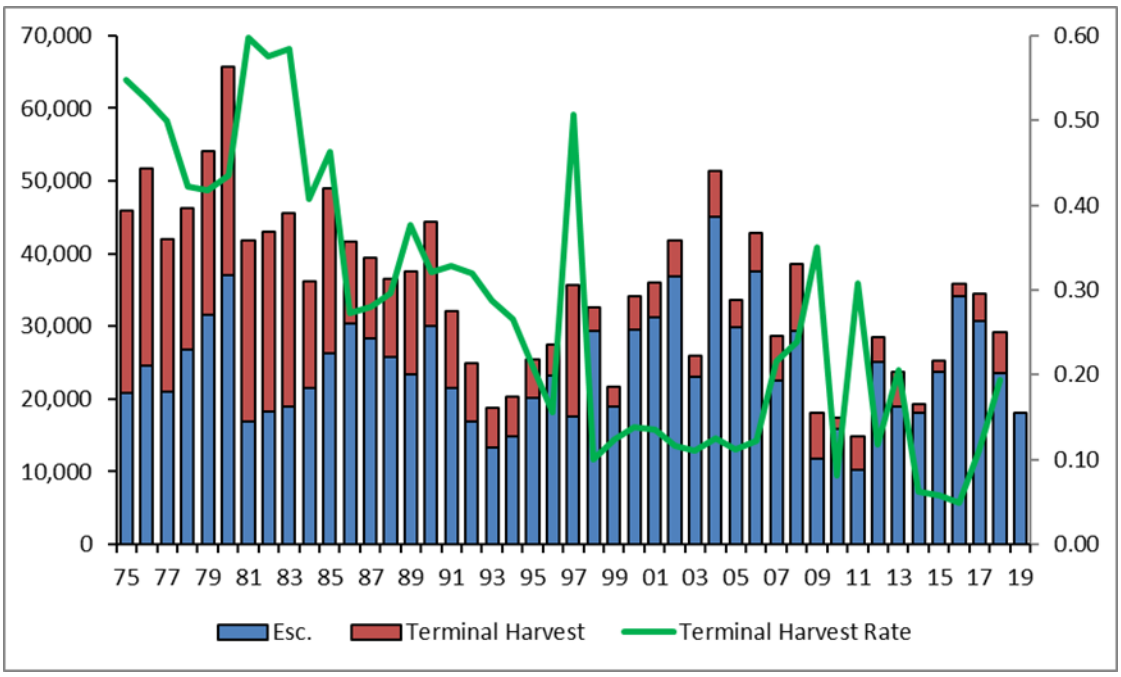


Figure 3.30–Escapement and terminal fishery harvest for the aggregate of Puget Sound summer/fall Chinook salmon PSC escapement indicator stocks.

Note: Terminal harvest not available for last year.

The long-term escapement trends for Puget Sound Chinook salmon stocks cannot be identified with certainty because of the inability to assess total production of natural stocks in Puget Sound, coupled with the changes in fishery patterns and hatchery production over the 1975 to 2019 time period. Data limitations notwithstanding, it is still possible to make some generalizations about the current status of Puget Sound escapement indicators based on the recent past at both the aggregate and individual population levels. Spring Chinook salmon in the Nooksack and Skagit rivers, for example, exhibit annual variability with no apparent escapement trend. Since ESA listing in 1999, aggregated summer/fall escapements have averaged around 25,000 with no apparent trend, however, they have varied considerably, peaking at approximately 45,000 in 2004 then declining to a low of around 10,000 in 2011. Some variation on this general theme emerges at the individual stock level (Section 2.3.4). The average summer/fall escapement in 2009–2018 was about 18% lower than the long-term average during 1999–2018 with exception of Lake Washington, which remained nearly the same (Appendix Table B7). Although it is important to acknowledge the influence of the time period choice on conclusions about recent abundance trends (i.e., near-record escapements were seen for many Puget Sound populations in the early 2000s), the observation of low escapements in recent years for multiple populations suggests this group of stocks remains depressed overall. Future assessments of escapement trends should attempt to separate hatchery strays from natural-origin spawners, where data permit.

3.2.4.2 Coastal Washington

Coastal Washington is the only region in Washington accessible to anadromous salmonids where Chinook salmon are not listed under the U.S. Endangered Species Act. Consequently,

salmon fishery management of the coastal Chinook salmon stocks in this region has one less regulatory framework to consider, but still has to balance conservation needs with state and tribal co-management, federal fishery management plans, and international agreement under the PST. Additionally, compared to Puget Sound, the confounding influence of hatchery production on trend assessments is considerably less.

The aggregate escapement of spring and summer Chinook salmon CTC escapement indicator stocks in the Quillayute, Hoh, and Queets rivers and Grays Harbor ranged from a high of 11,740 in 1989 to a low of 2,316 in 2007 (Figure 3.31). Since 1999, the Quillayute River summer Chinook population has only met its PSC escapement goal two times. Over the same time period the Queets River spring/summer population only met its PSC escapement goal four times, although two of those were in recent years (2016, 2017). Both the Quillayute and Hoh stocks exhibit escapement trends indicating considerable decline since the late 1980s but stability since the 1999 PST went into effect (Section 2.3.4.2). Terminal harvest rates on these stocks have averaged less than 15% since the mid-1990s and were 10% in 2018. There is no CTC exploitation rate indicator stock that is considered representative of this stock group. There is no CTC exploitation rate indicator stock that is considered representative of this stock group. However, Chinook with CWTs were released from Sol Duc Salmon Hatchery in the Quillayute Basin in the early 1990s and discontinued for about 10 years before starting new tagging programs with the 2004 brood. Based on limited information from these tag recoveries that generally showed poor survival, the Quillayute summer stock has a northerly ocean catch distribution. Exploitation rates cannot be determined because recoveries are low and escapement area sampling appears inadequate in some years to appropriately index exploitation rates.

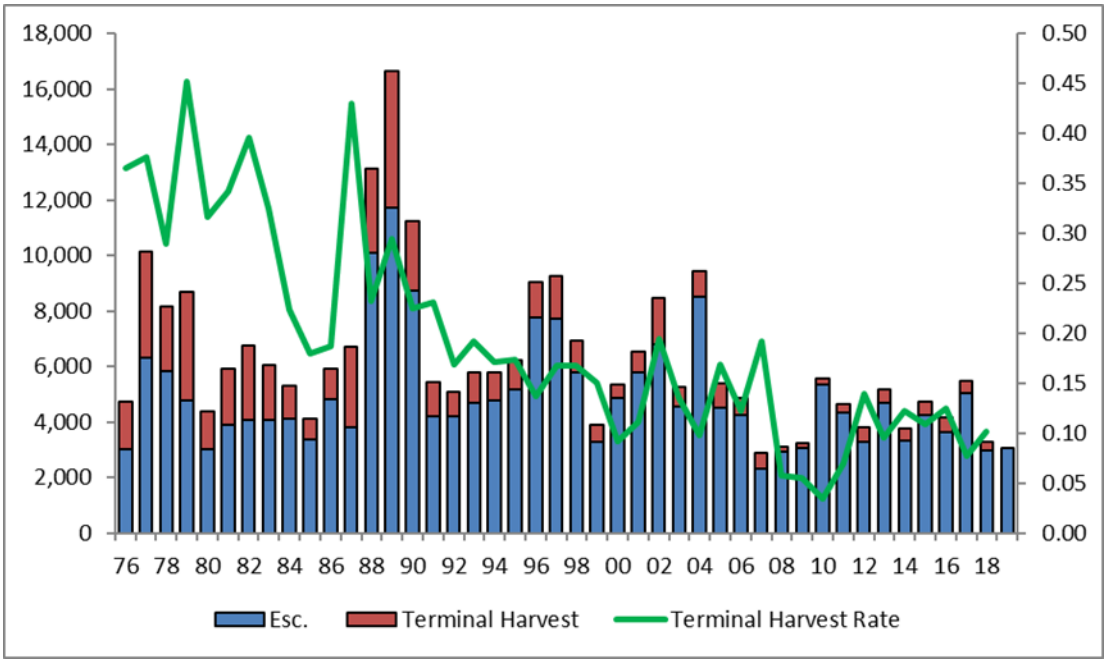


Figure 3.31–Escapements, terminal harvests, and terminal harvest rates for the aggregate of Washington coastal spring/summer Chinook salmon PSC escapement indicator stocks.

Note: Terminal harvest not available for last year.

Coastal Washington fall Chinook salmon escapement indicator stocks include Quillayute, Hoh, Queets, and Grays Harbor, which have PSC-accepted escapement goals, along with the Hoko stock that does not have a PSC escapement goal. The coastal fall Chinook salmon aggregate escapement has ranged from a low of 13,801 in 1983 to a high of 57,634 in 1988 (Figure 3.32). Similar to the Washington Coast spring/summer stocks, Washington coastal fall stocks are characterized by escapement declines since the highs of the late 1980s, and generally stable escapements in recent years (Section 2.3.4.2). Over the entire 1975 to 2015 time period, terminal harvest rates have varied substantially without a definitive trend and have averaged about 32% since 1999. With the exception of the Hoko where there are no terminal fisheries, harvest in terminal fisheries is a mixture of directed catch on Chinook salmon stocks and incidental catch while targeting other species (Figure 3.32).

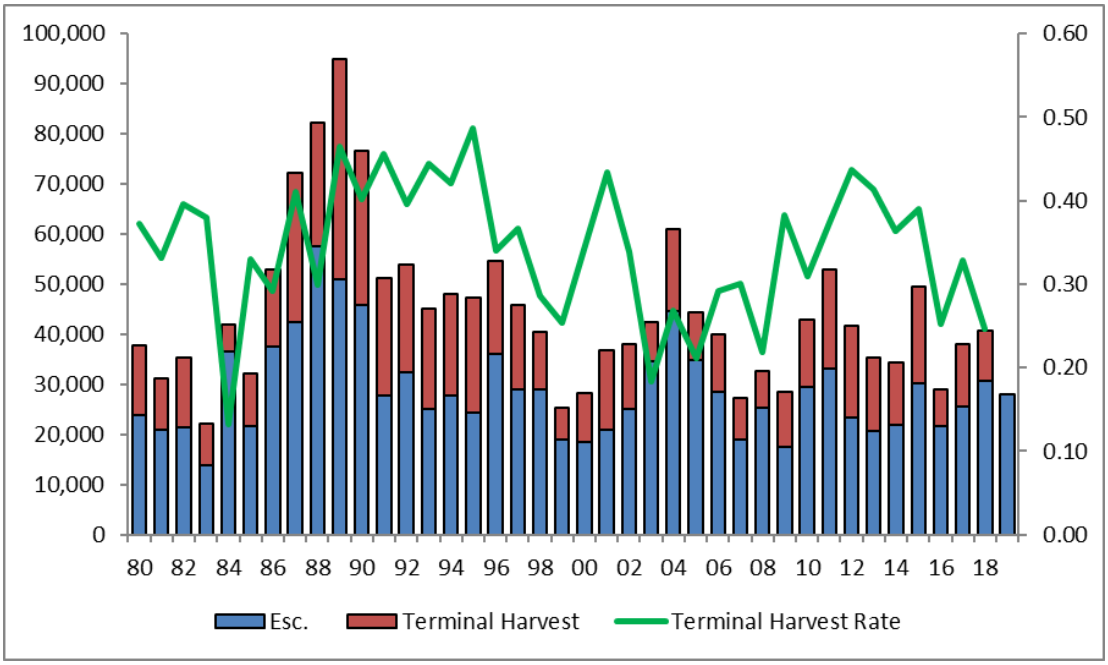


Figure 3.32–Escapement, terminal harvest, and terminal harvest rates for the aggregate of Washington coastal fall Chinook salmon PSC escapement indicator stocks.

Note: Terminal harvest not available the last year.

Fall Chinook salmon hatchery production is limited on the Washington Coast compared to Puget Sound, and not extensive in the CTC indicator stock basins. The current fall Chinook salmon hatchery programs include the Hoko Falls Hatchery that releases smolts for natural stock supplementation/CWT indicator stock purposes, Salmon River Fish Culture Hatchery in the Queets Basin, and Humptulips Salmon Hatchery in the Grays Harbor watershed. Other significant programs outside of the CTC escapement indicator stock programs include releases from Makah National Fish Hatchery on Tsoo-Yess River (formerly Sooes River), and Forks Creek Hatchery in Willapa Bay. All of these hatchery programs influence the management of terminal fisheries and the extent of directed harvest on fall run Chinook salmon of Washington Coast origin.

Despite a lack of clear trends in escapement for coastal Chinook salmon stocks (Section 2.3.4.2), conclusions on stock status and population trend are speculative without a full CWT-based run reconstruction that can account for total production. Ocean fishery impacts for these stocks, however, are estimated using the Queets CWT indicator tag releases under the assumption that it is a suitable surrogate for the exploitation and ocean distribution of other fall Chinook stocks on the Washington Coast. From a simple fishery distribution basis, the portion of the Queets exploitation rate indicator stock impacted in ocean fisheries shows no apparent temporal trend and has averaged about 40% of the total accounting in all fisheries and escapements from 1985 to 2016 (CTC 2019), while terminal returns have declined over the same period. Further investigation and analysis is needed to confirm whether the Queets indicator stock truly is a suitable surrogate for other Washington Coast fall Chinook salmon stocks.

Queets CWT indicator tag releases were used to produce plots for a synoptic evaluation of three coastal Washington fall Chinook salmon stocks with PSC escapement goals—Quillayute, Hoh, and Queets rivers. A synoptic plot was not produced for Grays Harbor because of the short time since the escapement goal was accepted by the CTC. Queets CWT indicator stock releases were assumed to be representative of the exploitation and ocean distribution of Queets, Quillayute and Hoh natural stocks. All three stocks have active terminal fisheries with terminal fishery harvest rates that can vary considerably from year to year.

A simultaneous evaluation of spawning escapements and assumed cumulative MRE exploitation rates shows management of Queets River fall Chinook salmon (Figure 3.33) in the safe zone in all but five years, with exploitation rates below U_{MSY} and spawning escapement exceeding S_{MSY}. Escapements in 2002 and 2013 were in the buffer zone, while those in 1999, 2007, and 2018 were below $0.85*S_{MSY}$, putting them in the “Low Escapement Low Exploitation” zone. Management for escapement and MRE exploitation rate was in the safe zone in all years for Quillayute (Figure 3.34) and Hoh (Figure 3.35) rivers, with the exception of Quillayute in 2014, where escapement was in the buffer zone.. As evidenced by the high U_{MSY} values (0.87 for Queets and Quillayute; 0.90 for Hoh), productivity of these stocks is assumed to be high and suggests that less stringent management than is required for stocks with lower U_{MSY}. This assumption is supported by historical stock-recruit analyses that were conducted in the mid-1980’s, however, given their age, it is a worthwhile exercise to re-examine these relationships. From this synoptic evaluation perspective, these coastal Washington stocks exhibit a track record of sustainable management. Further, this view of the fishery impact and escapement data suggests that much of the variation in escapements for these stocks has been driven by non-fishing factors (e.g., anomalously high or low marine survival).

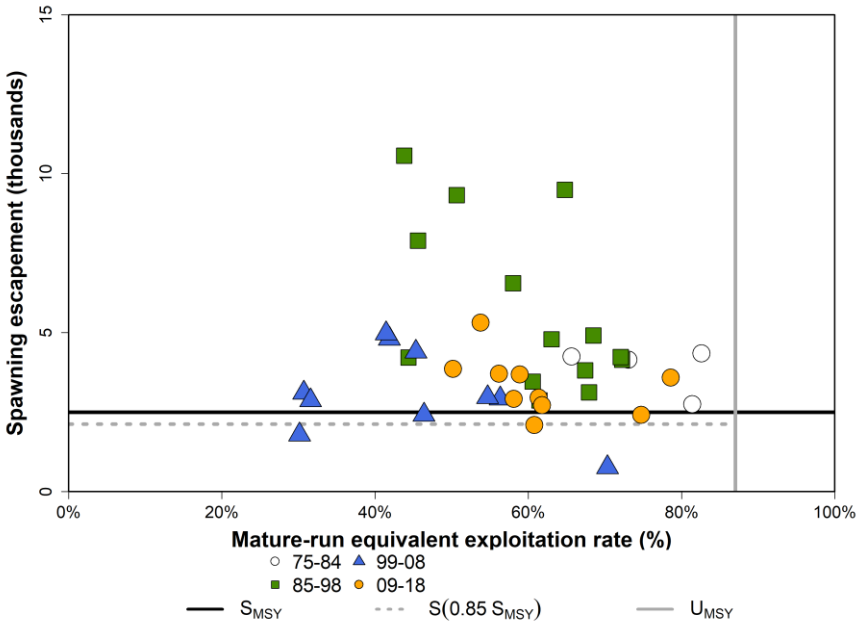


Figure 3.33–Queets River fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Queets River PSC indicator CWTs.

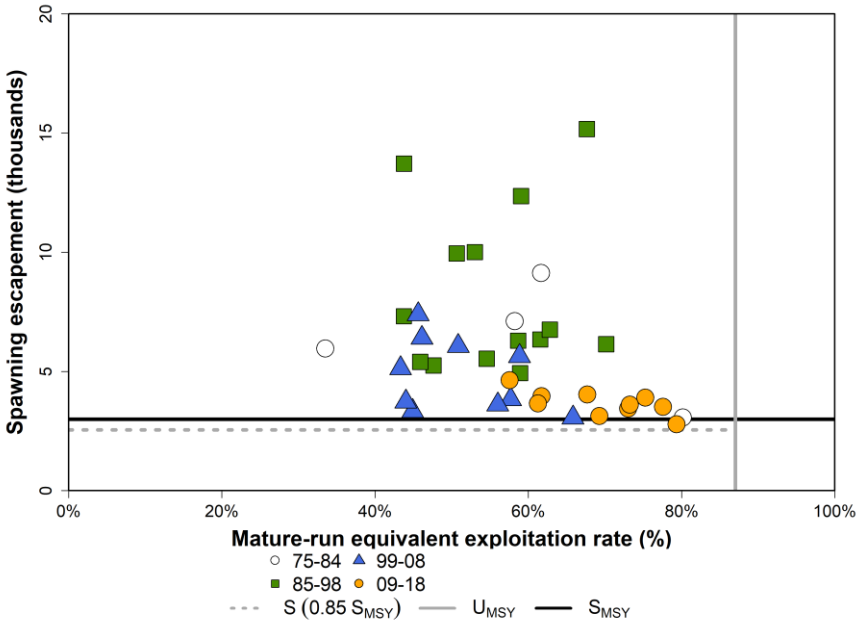


Figure 3.34–Quillayute River fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Queets River PSC indicator CWTs.

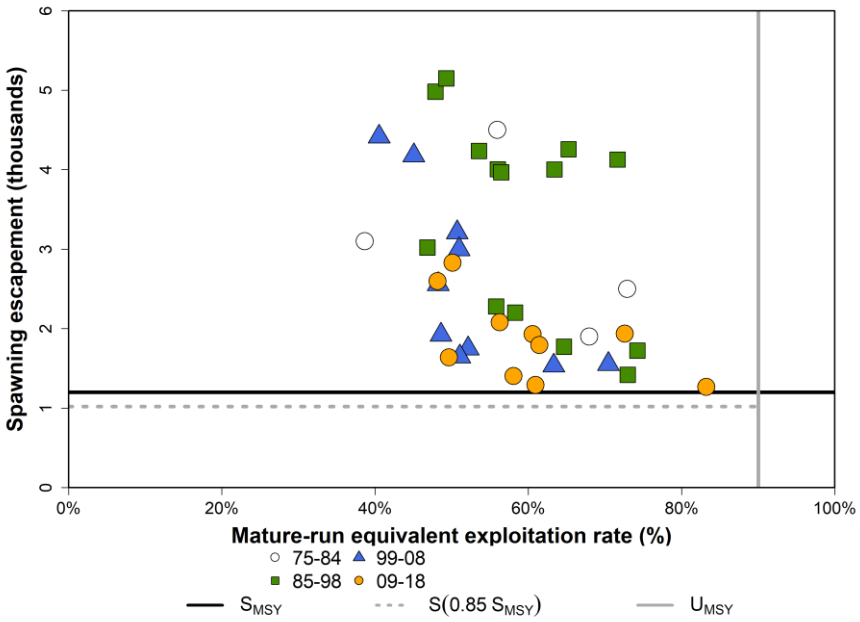


Figure 3.35–Hoh River fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Queets River PSC indicator CWTs.

3.2.4.3 Columbia River

3.2.4.3.1 Columbia River Summers

Mid-Columbia Summer Chinook includes populations in the Okanogan, Methow, and Wenatchee rivers as well as hatchery production from Wells and Chief Joseph hatcheries. Since 2018, mid-Columbia Summer Chinook have been managed for interim management goal of 29,000 hatchery and natural origin adults as measured at the Columbia River mouth. The management goal is based on an interim combined spawning escapement goal of 20,000 hatchery and natural adults.

The synoptic evaluation (Figure 3.36) shows Rock Island Dam counts as escapement for this stock group. Except for 2018, these counts have exceeded 40,000 since 2009, while the stock experienced MRE exploitation rates below U_{MSY}. The CTC goal of 12,143 adult Chinook salmon past Rock Island Dam was developed prior to sport and non-treaty tribal fisheries that now take place above Rock Island Dam, so the dam counts are consistent with the goal but overestimate escapement. Except for 2015, Colville tribal catches above Rock Island Dam have been under 3,600 and sport catches above Priest Rapids Dam since 2009 have been between 2,500-4,000, so escapement was still well above goal. The synoptic evaluation shows the Columbia Summer stock group in the safe zone in all but two years since 1998 (Figure 3.36). Until the recent 2016 brood, mid-Columbia Summers demonstrated positive survival deviations since 1995, within less than 1.5 standard deviations (Figure 3.37).

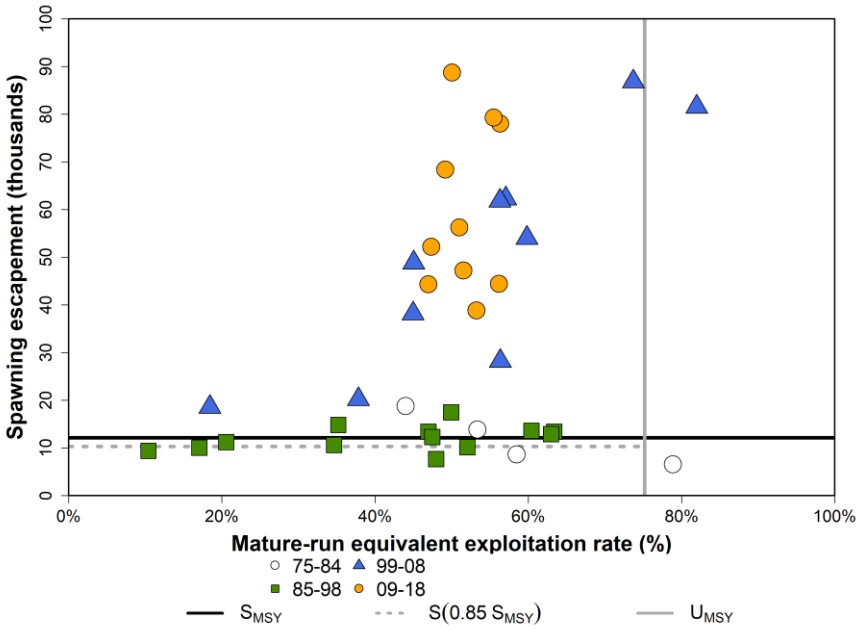


Figure 3.36–Columbia River Summer Chinook salmon spawning escapement past Rock Island Dam and cumulative mature-run equivalent exploitation rate calculated from Wells Hatchery PSC indicator CWTs.

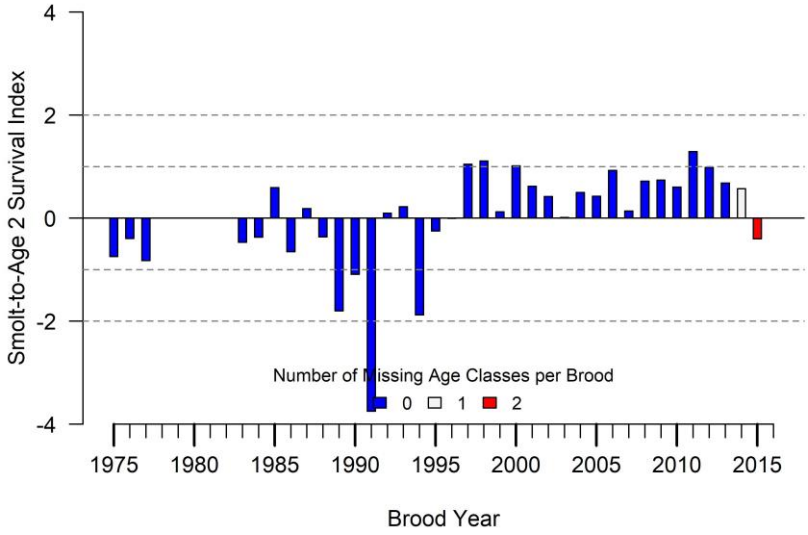


Figure 3.37–Marine survival index (standardized to a mean of zero) for Columbia River Summer Chinook salmon.

3.2.4.3.2 Columbia River Fall

The Columbia River Fall stock group has two escapement indicator stocks: Upriver Brights and Lewis River Wilds. In *U.S. v. Oregon Management Agreement*, the Upriver Bright Fall Chinook

management unit is comprised of all bright fall Chinook populations returning above Bonneville Dam, including those in the Deschutes, upper Columbia and Snake rivers, but the Upriver Bright escapement indicator only represents fall Chinook in the Columbia River above McNary Dam.

From 2009–2018, MRE exploitation rates for Upriver Brights were usually 40–50%, while escapements exceeded S_{MSY} (Figure 3.38). The two most recent broods for Columbia River falls have had worse survival than the 2007–2013 broods (Figure 3.39 and Figure 3.40).

For Lewis River Wild fall Chinook salmon, exploitation rates since 2008 have been well below the estimated U_{MSY} of 76% and the PSC-agreed escapement goal has been above 85% of S_{MSY} (Figure 3.41). Recent broods of Lewis River wild fall Chinook have had better survival than previous broods since 2008 (Figure 3.42).

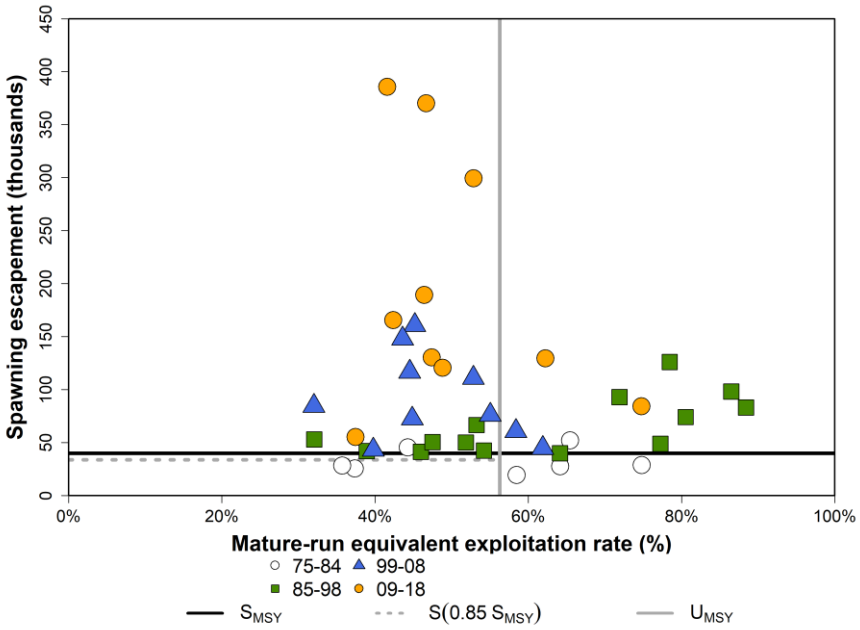


Figure 3.38–Upriver Bright fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Priest Rapids Hatchery PSC indicator CWTs.

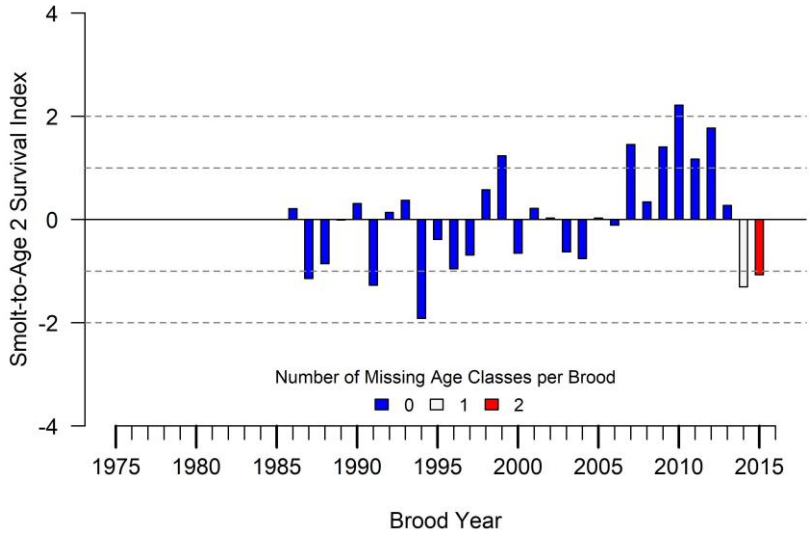


Figure 3.39–Marine survival index (standardized to a mean of zero) for Upriver Bright Chinook salmon, as represented by Hanford Reach Wild Chinook salmon.

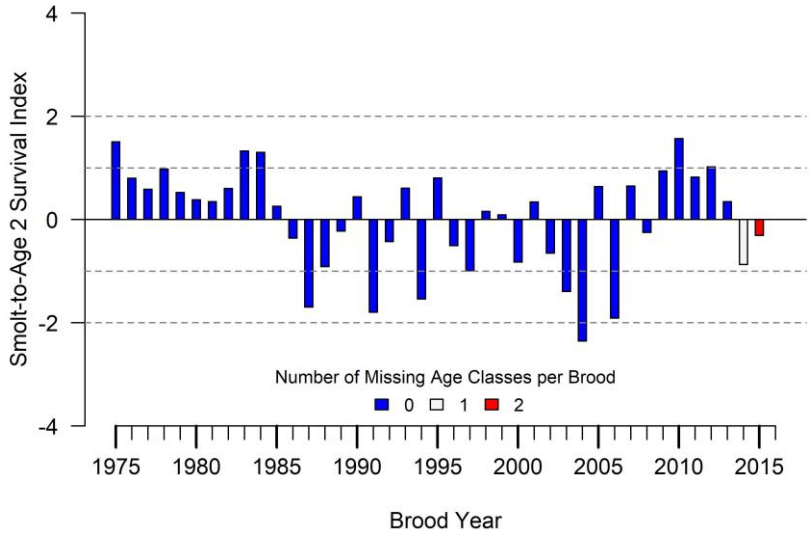


Figure 3.40–Marine survival index (standardized to a mean of zero) for Upriver Bright Chinook salmon, as represented by Priest Rapids Hatchery Chinook salmon.

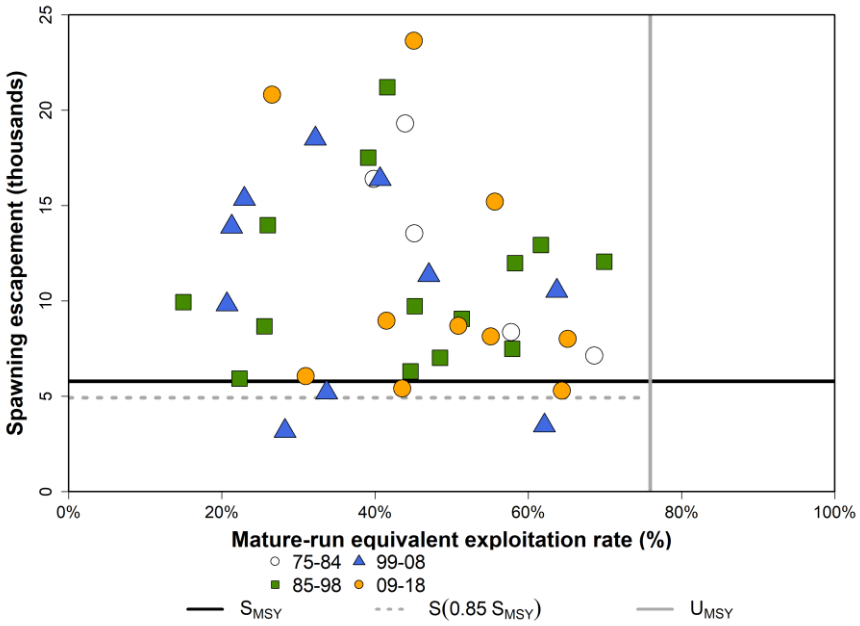


Figure 3.41–Lewis River Wild fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Lewis River Wild PSC indicator CWTs.

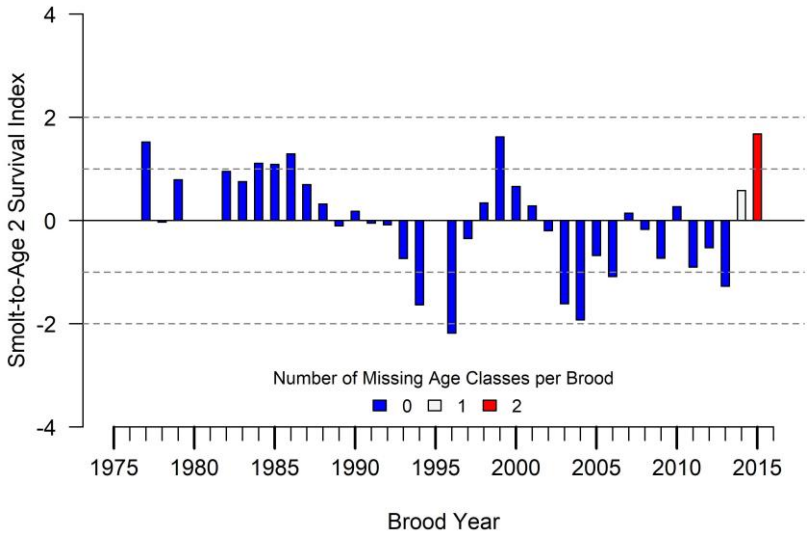


Figure 3.42–Marine survival index (standardized to a mean of zero) for Lewis River Wild fall Chinook salmon.

3.2.4.4 Coastal Oregon

3.2.4.4.1 North Oregon Coast

Total estimated spawning escapement for the NOC aggregate stock has ranged from approximately 24,000 Chinook salmon in 2008 to 137,000 in 1988. The recent 10-year (2008–2019) average for aggregate escapement is approximately 71,000. Estimated escapement in

2019 was 68,592. The abundance forecast expressed in terms of spawning escapement is approximately 45,000 for 2020.

After low escapements from 2007 to 2009, the NOC stock aggregate had returned to average or above-average escapement from 2013 onwards through 2016. All three NOC escapement indicator stocks—the Nehalem, Siuslaw, and Siletz—failed to achieve their escapement objectives in 2007 and 2008. The Nehalem stock did not attain its goal in 2009 and 2010. The most recent year's escapement for the NOC showed mixed results, with both the Nehalem and the Siletz exceeding their escapement goals, and the Siuslaw only attaining 37% of its escapement goal. It is likely that the NOC has recently experienced a period of lower-than-normal marine survival, as indicated in Figure 3.43. The later years in the survival index are generated from incomplete broods, and although it is tempting to interpret these initial signals in both fisheries recruitment and robust escapement, these results are only preliminary.

Management actions in terminal fisheries, along with reductions in AABM fisheries, and better-than-average survival rates (Figure 3.43) appear to have contributed to the increased escapements following a period of decline in the 2007–2009 return years. Despite these indications of robust survival and management actions positively affecting NOC stocks, this past year's observations showed 1 out of 3 of the NOC escapement indicator stocks failed to meet escapement goals. The observation of very poor standardized survival indexes for the latest year, which follows a low index from the previous year should temper expectations of this stock aggregates' performance in the coming year.

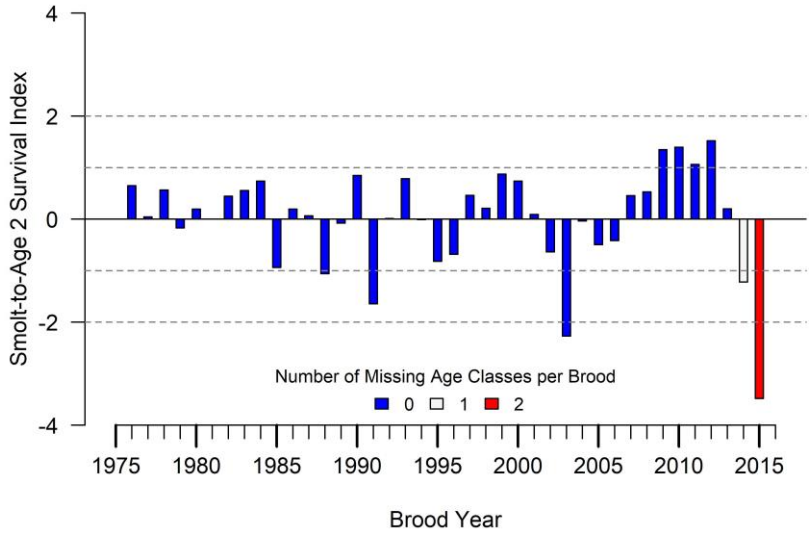


Figure 3.43–Marine survival index (standardized to a mean of zero) for the Salmon River hatchery stock of Chinook salmon.

Note: Brood years 1976–2013 are shown, with the exception of 1981, for which there is no information.

A review of the synoptic plots shows that three NOC escapement indicator stocks have spent most years in the upper left sector. Exploitation rates have been lower and escapements have been higher than required for MSY for the majority of years in each stock. Of the three stocks, the Nehalem stock has spent more years below the escapement objective than the others, and the Siuslaw stock has the most years with high exploitation rates.

The Nehalem River stock of Chinook salmon has experienced a wide array of both exploitation and escapement from 1979 to 2018 From 2006 to 2010 this stock failed to meet 85% of its escapement goal (Figure 3.44). In 2017 and 2018, the Nehalem missed goal but was above 85% of the escapement goal.

The Siletz River stock of Chinook salmon exhibit high productivity as demonstrated by one of the higher U_{MSY}s presented in this chapter. All but one of the observed points of escapement and exploitation are within the safe zone, with the most recent year displaying the exception to this pattern (Figure 3.45). Recent year's escapements (2010–2017) have increased over lower escapements observed in return years 2007 to 2009. While meeting goal in the last year of the examined series (2018), the poor survival index for the aggregate noted earlier coupled with high exploitation rates should indicate caution for this stock's overall performance into the near future.

The Siuslaw stock of Chinook salmon, similar to the Nehalem stock, has experienced a wide range of both escapement and exploitation since 1979 (Figure 3.46). Most of the observations of escapement below S_{MSY} occurred during the pre-Treaty period of 1979 to 1984. Recently, this stock has failed to perform to escapement goal for three years consecutively. Indications from these failed escapement performances, high exploitation and low survival are flags to cautious management into the near future not only for the Siuslaw stock, but the entirety of this aggregate. Indications of high exploitation and low survival from recent escapements suggest cautious management not only for the Siuslaw stock but for the entirety of this aggregate.

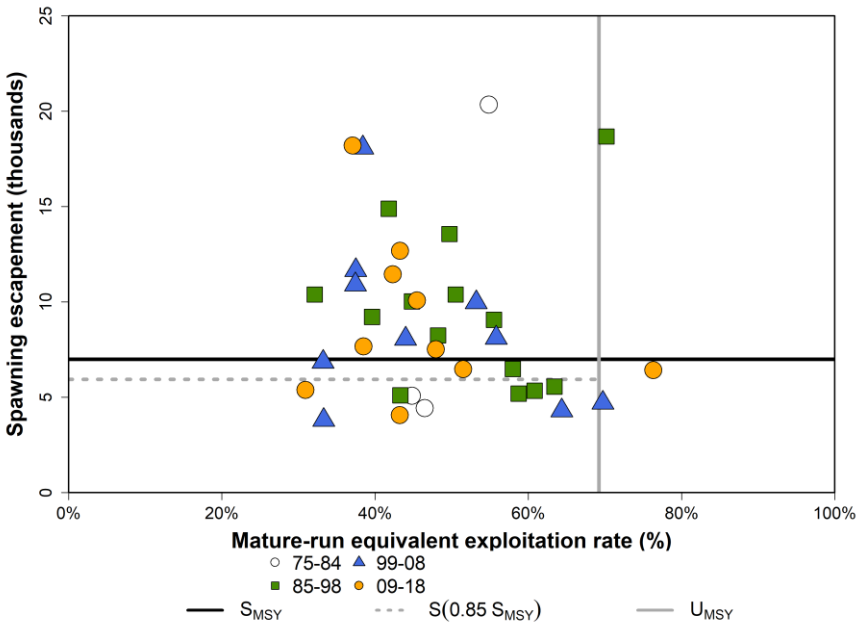


Figure 3.44–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Nehalem River stock of Chinook salmon, 1979–2018.

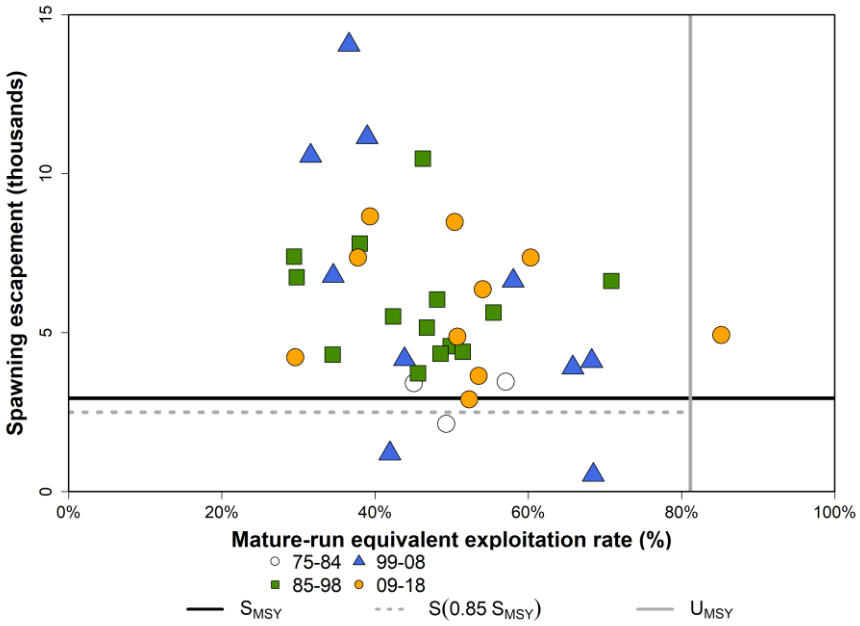


Figure 3.45–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Siletz River stock of Chinook salmon, 1979–2018.

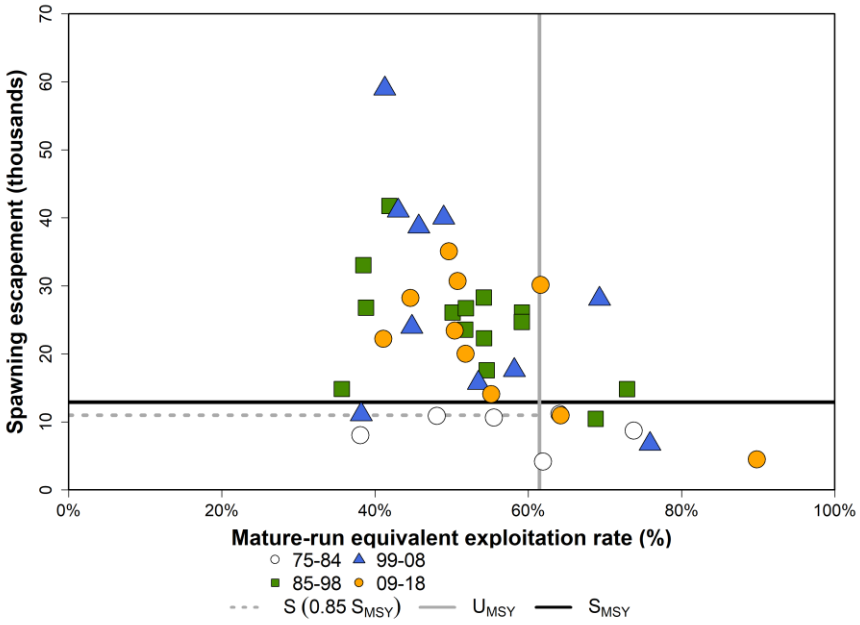


Figure 3.46–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Siuslaw River stock of Chinook salmon, 1979–2018.

3.2.4.4.2 Mid-Oregon Coast

After a period of declines in escapement from 2005 to 2008, the Mid-Oregon Coast (MOC) stock aggregate rebounded to historical averages during the 2010–2016 return years. Total aggregated estimated escapement for the MOC has ranged from a low of 15,000 in 2007 to a high of 110,000 in 2015. The 10-year average (2010–2019) escapement for the MOC is about 46,000. Estimated escapement for the MOC stock group in 2019 was about 17,000. Forecasted escapement for the 2020 return year is at about 28,000 spawning adults. Last year's narrative warning that the two most recent marine survival brood year metrics showed below average survival and would translate into reduced expectations for this aggregate's production have proven true. The most recent indication that marine survival is on the downswing for this aggregate (Figure 3.47), so there is reason for tempered expectations for the coming year's terminal return in 2020.

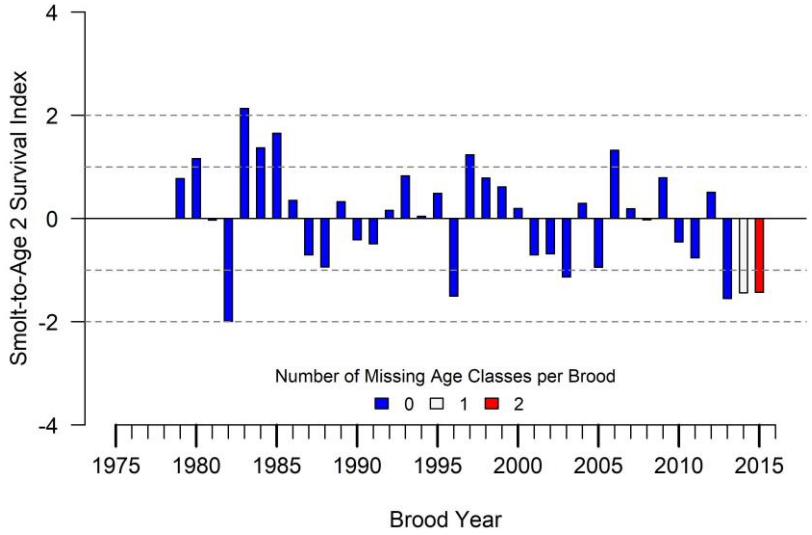


Figure 3.47–Marine survival index (standardized to a mean of zero) for the Elk River hatchery stock of Chinook salmon.

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APPENDICES

APPENDIX A. LANDED CHINOOK SALMON CATCHES BY REGION AND GEAR, 2009–2019

Appendix **Page**

Appendix **Page**

Table A1.–Southeast Alaska AABM Chinook salmon catches.

Year	Southeast Alaska						
	Troll	Net	Sport	Total	Add-on	Terminal Exclusion	Treaty Catch
1975-1978	291,559	15,706	17,000	324,265			
1979-1984	272,913	27,728	21,370	322,011			
1985-1995	222,752	29,441	38,622	290,815	31,229		259,586
1996-1998	193,309	28,627	61,349	283,285	48,028	6,975	228,282
1999-2008	250,972	48,181	73,151	372,304	64,800	9,857	297,646
2009	175,644	48,438	69,565	293,647	61,960	3,733	227,954
2010	195,620	30,629	58,503	284,752	53,640	501	230,611
2011	242,569	48,230	66,575	357,374	65,474	739	291,161
2012	209,074	39,750	46,495	295,319	51,392	1,106	242,821
2013	149,541	51,319	56,392	257,252	65,598	266	191,388
2014	355,570	50,010	86,942	492,522	56,592	736	435,195
2015	269,862	53,718	79,759	403,339	68,097	216	335,026
2016	276,432	42,263	68,347	387,042	35,673	664	350,704
2017	129,649	25,097	52,306	207,052	31,638	0	175,414
2018	107,565	30,777	26,400	164,742	36,966	0	127,776
2019	109,364	36,032	29,700	175,096	34,578	211	140,307

Note: Troll, net, sport and total catches include catch of SEAK hatchery-origin fish and terminal exclusion catch; catches that count towards the all-gear ceiling (with hatchery add-on and terminal exclusion subtracted) are shown as treaty catch.

Table A2.–Estimates of incidental mortality associated with Southeast Alaska AABM Chinook salmon Treaty catches.

Year	Troll		Sport		Net		Total Treaty
	LIM	SIM	LIM	SIM	LIM	SIM	IM
1985-1995	21,320	49,708	3,077	5,595	6,830	29,818	116,347
1996-1998	10,606	21,477	4,884	5,236	708	3,445	46,356
1999-2008	11,497	19,750	5,573	7,209	1,146	5,082	50,258
2009	11,620	18,361	4,817	6,434	136	3,595	44,963
2010	12,763	16,942	3,754	4,558	142	261	38,420
2011	10,400	14,809	6,144	7,231	379	2,651	41,613
2012	7,315	22,797	3,703	4,948	1,414	5,712	45,890
2013	14,569	14,930	6,662	8,381	2,987	11,853	59,382
2014	14,441	16,445	6,376	7,950	105	5,630	50,945
2015	10,761	11,747	7,538	8,192	1,859	9,051	49,148
2016	9,825	20,897	4,649	7,111	99	8,399	50,978
2017	14,538	14,681	5,706	8,018	754	2,902	46,599
2018	8,613	13,714	2,537	4,706	391	1,193	31,153
2019	10,983	12,228	2,938	5,449	4,732	20,337	56,666

Note: LIM = Legal Incident Mortality, SIM = Sublegal Incident Mortality.

Table A3.–Estimates of incidental mortality associated with Southeast Alaska Chinook salmon total catches.

Year	Troll		Sport		Net		Total
	LIM	SIM	LIM	SIM	LIM	SIM	IM
1985-1995	22,174	51,995	3,740	6,849	8,044	34,618	127,420
1996-1998	11,090	23,176	6,475	6,946	1,700	8,061	57,448
1999-2008	12,053	21,478	7,966	10,194	2,125	8,863	62,679
2009	12,141	19,722	6,964	9,302	389	7,498	56,015
2010	13,237	17,992	4,956	6,018	498	1,243	43,944
2011	10,786	15,760	7,580	8,921	1,104	7,325	51,477
2012	7,631	24,601	4,565	6,099	4,437	18,192	65,525
2013	15,073	15,702	8,675	10,914	10,505	41,352	102,221
2014	14,749	16,917	7,496	9,346	453	9,632	58,592
2015	11,107	12,261	9,225	10,025	4,892	23,284	70,795
2016	9,977	21,529	5,345	8,176	280	11,692	57,000
2017	14,852	15,081	6,764	9,504	2,748	10,833	59,782
2018	8,915	14,366	3,153	5,848	5,890	21,707	59,880
2019	11,178	12,596	3,547	6,579	10,950	46,444	91,295

Note: Includes total treaty, terminal exclusion, and hatchery add-on estimates of incidental mortality.

Table A4.–Canadian Transboundary Rivers (Taku, Stikine, Alsek) ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

	Transboundary Rivers											
	First Nations			Net			Sport			Total		
Year	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	825	0	38	144	0	7	200	0	14	1,169	0	58
1979-1984	1,151	0	53	1,268	0	58	500	0	34	2,918	0	146
1985-1995	1,375	0	63	2,537	0	117	828	0	57	4,740	0	237
1996-1998	1,279	0	59	5,038	0	232	869	0	60	7,186	0	351
1999-2008	1,326	0	61	8,672	0	399	506	0	35	10,505	0	495
2009	940	0	43	10,031	510	944	140	0	10	11,111	510	997
2010	1,090	0	50	9,410	124	550	247	0	17	10,747	124	617
2011	999	0	46	7,769	158	507	299	275	73	9,067	433	626
2012	764	0	35	9,119	63	479	254	367	88	10,137	430	602
2013	1,454	0	67	4,858	38	259	160	197	49	6,472	235	375
2014	1,252	0	58	5,830	23	290	181	166	44	7,263	189	392
2015	1,226	0	56	5,385	0	248	225	48	25	6,836	48	329
2016	726	0	33	4,149	0	191	20	0	1	4,895	0	226
2017	295	0	14	568	272	283	64	0	4	927	272	301
2018	172	0	8	21	0	1	0	0	0	193	0	9
2019	607	0	28	0	783	741	5	0	0	612	783	769

Table A5.–Northern British Columbia (NBC) AABM Chinook salmon catches.

Year	Northern British Columbia		
	Area 1-5 Troll[1,2]	Areas 1,2E, 2W Sport	Total
1975-1978	173,835	116	173,893
1979-1984	163,214	143	163,357
1985-1995	159,332	14,740	174,072
1996-1998	64,114	20,846	84,960
1999-2008	94,939	49,593	144,532
2009	75,470	34,000	109,470
2010	90,213	46,400	136,613
2011	74,660	48,000	122,660
2012	80,256	40,050	120,306
2013	69,264	46,650	115,914
2014	172,001	44,900	216,901
2015	106,703	52,200	158,903
2016	147,381	42,800	190,181
2017	97,730	45,600	143,330
2018	72,276	36,700	108,976
2019	42,826	45,200	88,026

Note: troll (Areas 1–5) and tidal sport (Areas 1, 2E, 2W) are the components of the NBC AABM fishery.

[1] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. To make comparisons to previous years more meaningful, the same catch accounting period was applied for years prior to 1998.

[2] Troll catches from 1996 to 2004 have been updated with data from DFO (2009).

Table A6.–Estimates of incidental mortality associated with Northern British Columbia (NBC) AABM Chinook salmon catches.

Year	Area 1-5 Troll[1]		Areas 1, 2E, 2W Sport[2]		Total IM
	LIM	SIM	LIM	SIM	
1985-1995	4,102	34,419	2,531	0	41,051
1996-1998	1,090		4,895	0	5,985
1999-2008	3,315	1,407	8,430	0	13,152
2009	2,069	3,625	4,011	0	9,705
2010	2,798	3,164	6,777	0	12,739
2011	7,732	1,773	9,114	0	18,619
2012	2,152	4,427	4,977	0	11,556
2013	7,236	3,390	9,300	0	19,926
2014	4,273	5,516	7,487	0	17,276
2015	5,442	2,785	13,446	0	21,673
2016	2,810	5,061	6,265	0	14,136
2017	3,824	9,266	6,209	0	19,299
2018	4,450	2,269	7,694	0	14,413
2019	6,647	4,272	5,547	0	16,466

Note: Troll (Areas 1–5) and tidal sport (Areas 1, 2E, 2W) are the components of the NBC AABM fishery.
Note: LIM = Legal Incident Mortality, SIM = Sublegal Incident Mortality.
[1] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. To make comparisons to previous years more meaningful, the same catch accounting period was applied for years prior to 1998.
[2] Release data are not yet available for 1996 to 1998.

Table A7.–Northern British Columbia (NBC) ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Area 1-5 First Nations			Area 1-5 Net			Tyee Test Fishery			Area 3-5 Sport			Area 1-5 Freshwater Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	4,802		221	28,073	0	1,291	257		12	1,669		60	4,384		302	36,158	0	1,705
1979-1984	11,116		511	33,478	0	1,540	375		17	3,217		116	3,436		237	51,622	0	2,421
1985-1995	20,711		953	29,740	0	1,368	634		29	3,989		144	4,514		311	59,588	0	2,805
1996-1998	16,192		745	19,185	0	2,403	1,904		88	2,711		98	1,250		86	40,409	0	3,362
1999-2008	19,387	0	892	12,000	2,904	2,733	1,823	0	84	9,127	1,643	355	2,856	0	197	42,909	3,068	4,103
2009	13,083	0	602	4,348	2,003	1,642	1,189	0	55	9,177	1,703	601	0	0	0	27,797	3,706	2,900
2010	13,693		630	2,191	0	101	959		44	7,570	563	362	2,689		186	27,102	563	1,322
2011	10,863		500	3,586	0	165	976		45	14,677	2,246	885	2,540		175	32,642	2,246	1,770
2012	8,189		377	788	3,067	2,661	575	0	26	7,017		253	421		29	16,990	3,067	3,346
2013	8,557		394	2,126	3,163	2,739	547	0	25	10,259	560	458	2,024	958	324	23,513	4,681	3,940
2014	11,936		549	2,632	3,317	3,022	482	0	22	11,973	4,692	1,177	2,302	178	193	29,325	8,187	4,963
2015	17,524		806	2,434	2,300	2,090	750	9	43	12,760		459	3,442	0	237	36,910	2,309	3,636
2016	9,051		416	1,222	2,219	1,851	392	0	18	10,043	2,190	710	2,246	0	155	22,954	4,409	3,151
2017	9,015		415	1,655	1,506	1,301	375	0	17	10,108	5,308	1,208	1,240	909	260	22,393	7,723	3,201
2018	11,766		541	0	1,378	1,119	671	20	50	5,821	5,980	1,160	0	0	0	18,258	7,378	2,870
2019	9,260		426	0	1,010	896	462	11	32	15,152	11,129	2,315	0	0	0	24,874	12,150	3,669

Note: NA = Not available.

Table A8.–Central British Columbia ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Central British Columbia																	
	First Nations			Net[2]			Troll[1,2]			Tidal Sport[3]			Freshwater Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	7,458		343	35,443	0	35,443	123,597		2,101	5,234		188	1,657		114	166,214	0	37,867
1979-1984	7,469		344	24,446	0	24,446	86,304		1,467	4,594		165	1,273		88	124,085	0	26,510
1985-1995	7,162		329	14,064	0	14,064	32,805		558	4,129		149	2,441		168	60,601	0	15,268
1996-1998	7,786		358	5,440	0	5,440	3,821		65	5,658		204	1,968		136	24,672	0	6,202
1999-2008	3,923	0	180	4,513	2,220	4,373	256	1,180	78	7,920	280	312	774	10	54	17,049	2,744	4,997
2009	4,011		185	3,132	0	144	0		0	3,239	0	117	550		38	10,932	0	483
2010	3,710		171	1,549	0	71	0		0	4,043		146	646		45	9,302	0	432
2011	2,323		107	4,794	0	221	0		0	7,701	498	356	646		45	15,464	498	728
2012	1,745		80	3,624	500	533	0		0	5,861		211	524		36	11,754	500	860
2013	3,945	0	181	5,301	2,044	1,728	0	453	93	4,457		160	1,506		104	15,209	2,474	2,267
2014	2,909		134	2,238	498	463	0	0	0	7,800	0	281	2,134		147	15,081	498	1,025
2015	2,780		128	5,351	1,527	1,370	0	0	0	10,597		381	1,270		88	19,998	1,527	1,967
2016	1,912	0	88	3,192	1,050	931	0	287	58	5,769	60	217	1,493		103	12,366	1,397	1,397
2017	1,907		88	3,119	1,558	1,276	0	2,013	407	6,679		240	977		67	12,682	3,571	2,078
2018	1,567		72	5,162	1,989	1,684	0	0	0	7,704	96	293	546		38	14,979	2,085	2,087
2019	2,045		94	6,092	576	707	0	1,878	419	10,750	153	411	1,895		131	20,782	2,607	1,762

Note: NA = Not available.

[1] Troll and net catches from 1996 to 2004 have been updated with data from DFO (2009), catch excludes jacks and small red-fleshed Chinook salmon.

[2] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. To make comparisons to previous years more meaningful, the same catch accounting period was applied for years prior to 1998.

Table A9.–West Coast Vancouver Island (WCVI) AABM Chinook salmon catches.

Year	West Coast Vancouver Island AABM		
	Troll[1,2,3]	AABM Sport[4]	Total
1975-1978	581,418		581,418
1979-1984	465,372		465,372
1985-1995	276,098	24,291	282,107
1996-1998	19,277	6,935	26,213
1999-2008	104,823	37,729	142,552
2009	58,191	66,426	124,617
2010	84,123	54,924	139,047
2011	129,023	75,209	204,232
2012	69,054	66,156	135,210
2013	49,526	67,345	116,871
2014	133,499	59,206	192,705
2015	68,522	50,452	118,974
2016	60,478	42,615	103,093
2017	60,356	57,060	117,416
2018	36,065	49,265	85,330
2019	36,841	36,641	73,482

Note: Troll = Areas 21, 23–27, and 121–127; Net = Areas 21, and 23–27; Sport = Areas 23a, 23b, 24–27.

[1] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. The same catch accounting period was applied for years prior to 1998.

[2] Troll catches from 1996 to 2004 have been updated with data from DFO (2009).

[3] AABM sport catch 1975 to 1991 is under review. No estimate available; it is currently included in ISBM catch in Appendix A11.

[4] Including 5,000 First Nations food, social, and ceremonial troll catch; 945 Brooks test fishery catch; and 6,877 T'aaq-wiihak troll catch.

Table A10.–Estimates of incidental mortality (IM) associated with West Coast Vancouver Island (WCVI) AABM Chinook salmon catches.

Year	Troll[1,2,3]		Outside Sport[4]		Total IM
	LIM	SIM	LIM	SIM	
1985-1995	6,574	93,397	1,942	731	100,700
1996-1998					0
1999-2008	2,129	3,981	4,841	1,910	12,670
2009	1,059	1,653	7,755	5,350	15,817
2010	1,506	1,936	10,679	1,896	16,017
2011	2,281	2,313	9,660	2,751	17,005
2012	1,214	629	11,186	3,658	16,687
2013	852	1,734	11,350	3,522	17,458
2014	2,293	3,161	9,447	3,642	18,543
2015	1,383	932	7,471	1,765	11,551
2016	1,047	1,853	4,412	2,868	10,180
2017	1,048	2,270	7,105	3,540	13,963
2018	751	718	6,245	8,715	16,429
2019	692	220	4,982	5,113	11,007

Note: Troll = Areas 21, 23–27, and 121–127; Net = Areas 21, and 23–27; Sport = Areas 23a, 23b, 24–27.

Note: LIM = Legal Incident Mortality, SIM = Sublegal Incident Mortality.

1 Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. The same catch accounting period was applied for years prior to 1998.

2 Troll and net catches from 1996 to 2004 have been updated with data from DFO, 2009.

3 Before 1992, catch was not reported as inside or outside, thus inside catch for those years represents total tidal sport catch.

4 First Nations catch is mainly commercial catch 1996–2004 has been updated.

5 Release data are not yet available for 1996–1998.

6 Includes 5,000 First Nations food, social, and ceremonial troll catch; 945 Brooks test fishery catch; and 6,877 T'aaq-wiihak troll catch.

Table A11.–West Coast Vancouver Island (WCVI) ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	West Coast Vancouver Island ISBM														
	First Nations[3]			Net[1]			Tidal Sport[2]			Freshwater Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	NA			18,903	0	18,903	NA			NA			18,903	0	18,903
1979-1984	NA			38,211	0	38,211	NA			NA			38,211	0	38,211
1985-1995	10,550		485	18,362	0	18,362	34,547	20,311	6,283	NA			52,382	16,618	23,768
1996-1998	6,449		297	204	0	204	35,106	18,105	5,898	NA			39,609	18,105	6,300
1999-2008	16,808	0	773	10,115	67	3,609	35,926	14,593	5,281	2,505	0	173	60,740	14,660	9,594
2009	9,026	0	415	9,765	0	2,200	31,921	16,641	5,398	0	0	0	50,712	16,641	8,013
2010	7,485	0	344	1,747	372	372	24,687	12,721	4,146	0	0	0	33,919	13,093	4,863
2011	22,794	0	1,049	21,843	355	1,337	52,131	15,539	6,581	NA			96,768	15,894	8,966
2012	9,700		446	10,214	521	917	26,693	17,555	5,212	0	0	0	46,607	18,076	6,576
2013	1,101	0	51	8,854	259	597	23,152	19,965	5,431	0	0	0	33,107	20,224	6,079
2014	4,280		197	19,090	53	928	28,756	19,183	5,667	0	0	0	52,126	19,236	6,792
2015	9,743		448	10,131	362	751	34,838	17,125	5,692	0	0	0	54,712	17,487	6,891
2016	14,091	0	648	5,125	925	913	23,843	27,827	6,988	0	0	0	43,059	28,752	8,549
2017	17,533	21	826	30,486	687	4,031	40,107	18,440	6,308	0	0	0	88,126	19,148	11,165
2018	24,586	120	1,244	21,663	257	5,507	33,631	20,131	6,186	0	0	0	79,880	20,508	12,937
2019	33,498	10	1,550	45,505	402	6,810	42,876	25,353	7,826	0	0	0	121,879	25,765	16,186

Note: NA = Not available.

[1] First Nations catch is mainly commercial catch, 1996 to 2004 has been updated.

[2] Net catches from 1996 to 2004 have been updated with data from DFO Catch Finalization Project (2009).

[3] Prior to 1992, catch was not reported as inside or outside. Therefore, inside catch for those years represents total tidal sport catch.

Table A12.–Johnstone Strait ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Johnstone Strait														
	First Nations			Net[2]			Troll[1,2]			Tidal Sport[3]			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	NA			41,702	0	34,477	22,206		377	NA			63,908	0	34,854
1979-1984	NA			27,736	0	27,736	12,163		207	NA			39,899	0	27,943
1985-1995	281		13	15,831	0	15,831	2,304		39	9,438		651	22,553	0	16,173
1996-1998	141		7	606	0	606	1,125		19	3,271		226	5,144	0	857
1999-2008	259	0	12	307	801	878	198	433	33	8,970	5,962	1,077	9,708	3,315	1,999
2009	344	0	16	597	14	426	0		0	11,501	15,984	3,862	12,442	15,998	4,304
2010	250		12	55	2,510	1,983	2	715	169	10,016	9,092	2,437	10,323	12,317	4,601
2011	268	0	12	46	2,312	1,710	0	36	7	11,934	5,169	1,816	12,248	7,517	3,546
2012	321		15	37	468	346	0	44	9	8,512	8,494	2,218	8,870	9,006	2,588
2013	258	0	12	35	241	181	0	0	0	8,894	7,555	2,064	9,187	7,796	2,257
2014	1,637	0	75	311	3,634	2,840	0	0	0	10,093	7,592	2,154	12,041	11,226	5,070
2015	261		12	54	1,162	848	0	0	0	13,475	10,694	2,983	13,790	11,856	3,843
2016	347	0	16	0	15	13	0	0	0	9,261	8,021	2,179	9,608	8,036	2,208
2017	216	7	17	12	747	544	0	0	0	14,053	15,984	4,038	14,281	16,738	4,599
2018	507	0	23	28	1,678	1,458	0	0	0	14,045	15,434	3,932	14,580	17,112	5,413
2019	356	3	19	60	560	415	0	0	0	11,226	14,904	3,636	11,642	15,467	4,070

Note: Troll = Area 12; Net = Areas 11–13.

Note: Sport based on July and August creel census in Area 12 and northern half of Area 13.

[1] Troll and net catches from 1996 to 2004 have been updated with data from DFO (2009).

[2] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. The same catch accounting period was applied for years prior to 1998.

[3] Tidal sport creel catches include additional catch estimated using Argue et al. (1977).

Table A13.–Georgia Strait ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Georgia Strait																	
	First Nations			Net[2,3]			Troll[1,2]			Tidal Sport[3]			Freshwater Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978				0	0	0	210,067		3,571	440,000		30,360				650,067	0	33,931
1979-1984				0	0	0	190,309		3,235	240,601		16,601				430,910	0	19,837
1985-1995				0	0	0	30,636		521	126,762		8,747				157,398	0	9,267
1996-1998				7	0	7	374		6	55,615		3,837				55,996	0	3,850
1999-2008	4,848		223	6	462	338	227	126	24	24,158	12,300	2,612	0	676	130	24,875	5,685	3,035
2009				239	0	171	0	135	27	17,884	21,644	5,390	0	0	0	18,123	21,779	5,588
2010	40	0	2	54	1,128	863	5	600	142	14,942	13,704	3,662	0	0	0	15,041	15,432	4,670
2011	2,379	17	126	3	113	86	0	177	36	21,651	20,327	5,397	0	0	0	24,033	20,634	5,644
2012	3,096		142	0	0	0	0	0	0	28,194	59,954	13,457	0	0	0	31,290	59,954	13,599
2013	843	0	39	4	188	138	0	0	0	45,769	106,655	23,636	0	0	0	46,616	106,843	23,813
2014	28	1	2	0	44	32	0	0	0	51,661	59,451	14,979	0	0	0	51,689	59,496	15,013
2015				0	13	10	0	17	3	76,684	47,325	14,378	0	0	0	76,684	47,355	14,391
2016	650	0	30	3	136	115	0	42	8	50,713	88,169	20,428	0	0	0	51,366	88,347	20,581
2017	1,086	2	52	0	62	47	0	33	7	68,234	108,417	25,524	0	0	0	69,320	108,514	25,629
2018	1,033	0	48	0	0	0	0	0	0	76,159	94,676	23,433	0	0	0	77,192	94,676	23,480
2019	1,016	4	51	0	0	0	0	0	0	50,868	156,093	33,480	2	2,157	414	51,886	158,254	33,945

Note: Troll = Areas 13–18; Net = Areas 14–19; Sport = Areas 13–18, 19a.

[1] Troll and net catches, 1996–2004, have been updated with data from DFO (2009).

[2] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. The same catch accounting period was applied for years prior to 1998.

Table A14.–Fraser River ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Fraser River Watershed											
	First Nations[4]			Net[1]			Freshwater Sport[2,3]			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	20,553	0	945	68,652	0	3,158	5,198	0	359	94,402	0	4,462
1979-1984	14,527	0	668	31,883	0	1,467	772	0	53	47,182	0	2,188
1985-1995	12,621	0	581	16,004	0	736	3,403	0	235	32,029	0	1,552
1996-1998	13,607	0	626	20,693	0	952	10,253	0	707	44,553	0	2,285
1999-2008	20,912	119	1,074	9,040	113	520	18,972	3,638	2,007	48,924	3,870	3,602
2009	27,288	105	1,355	7,848	146	499	17,485	15,845	4,249	52,621	16,096	6,102
2010	15,432	298	992	13,953	67	705	14,324	13,512	3,583	43,709	13,877	5,280
2011	33,118	96	1,614	17,989	1,073	1,843	20,349	9,022	3,136	71,456	10,191	6,593
2012	36,521	104	1,778	2,899	1,059	1,135	11,396	7,333	2,194	50,816	8,496	5,108
2013	17,092	113	893	3,124	6,537	6,328	11,506	10,211	2,754	31,722	16,861	9,975
2014	22,434	62	1,091	17,149	9,200	9,492	13,105	13,004	3,401	52,688	22,266	13,984
2015	24,693	73	1,205	7,051	1,928	2,148	18,487	8,703	2,947	50,231	10,704	6,300
2016	10,291	338	793	2,292	373	458	7,512	5,218	1,520	20,095	5,929	2,772
2017	14,939	109	790	3,920	617	764	8,471	6,603	1,852	27,330	7,329	3,407
2018	17,687	463	1,252	1,953	3,542	3,441	9,291	303	699	28,931	4,308	5,392
2019	29,057	149	1,478	4,129	1,051	1,181	11,450	4,867	1,725	44,636	6,067	4,384

[1] First Nations Chinook salmon catch includes food, social, and ceremonial from the mainstem and tributaries. Economic opportunity included in commercial net.
[2] Fraser River net includes commercial Area E Gillnet, test fisheries, First Nations economic opportunities, and scientific licenses.
[3] Freshwater sport catch includes Fraser mainstem and tributary Chinook salmon catch (adults only).
[4] Updated 1975 to 1980 sport catch from Fraser et al. 1982.

Table A15.–Canada: Strait of Juan de Fuca ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Canada – Strait of Juan de Fuca											
	First Nations			Net[1]			Tidal Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	NA			14,468	0	14,468	NA			14,468	0	14,468
1979-1984	NA			5,954	0	5,954	30,592		2,111	31,447	0	7,713
1985-1995	377		17	9,596	0	9,596	23,987		1,655	33,789	0	11,260
1996-1998	521		24	602	0	602	15,267		1,053	16,390	0	1,680
1999-2008	46		7	285	206	393	24,656	8,827	2,379	24,988	3,737	2,774
2009	0			385	0	277	25,587	44,169	10,246	25,972	44,169	10,523
2010	0			206	1,239	920	15,612	4,868	2,012	15,818	6,107	2,932
2011	0			278	1,522	1,166	21,075	12,878	3,927	21,353	14,400	5,093
2012	0			284	1,124	853	24,510	21,436	5,807	24,794	22,560	6,660
2013	0			251	1,411	1,098	34,725	30,005	8,157	34,976	31,416	9,255
2014	0			137	495	475	21,704	19,002	5,146	21,841	19,497	5,621
2015	0			17	2,610	1,885	47,051	42,327	11,373	47,068	44,937	13,258
2016	0			0	1,256	924	30,852	48,395	11,421	30,852	49,651	12,345
2017	0			50	1,870	1,374	37,608	46,601	11,542	37,658	48,471	12,917
2018	0			29	1,214	894	37,624	59,848	14,087	37,653	61,062	14,981
2019	0	0	0	155	2,039	1,537	25,778	44,133	10,252	25,933	46,172	11,789

Note: NA = Not available.

Note: Net = Area 20; Sport = Areas 19b and 20.

[1] Net catches from 1996 to 2004 have been updated with data from DFO (2009).

Table A16.–Washington: Strait of Juan de Fuca ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Washington – Strait of Juan de Fuca											
	Troll			Net			Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	8,802	NA	220	10,898	NA	872	68,132	NA	9,879	87,831	NA	10,971
1979-1984	14,522	NA	363	17,078	NA	1,366	51,794	NA	7,510	83,394	NA	9,239
1985-1995	30,859	NA	771	7,793	NA	623	38,793	NA	5,625	77,445	NA	7,020
1996-1998	3,821	NA	96	454	NA	36	6,407	NA	929	10,683	NA	1,061
1999-2008	3,852	NA	96	1,075	NA	86	4,052	18,663	3,589	8,979	18,663	3,771
2009	3,359	NA	84	99	NA	8	11,167	46,047	13,960	14,625	46,047	14,052
2010	2,216	NA	55	2,220	NA	178	11,508	38,036	11,862	15,944	38,036	12,095
2011	3,818	NA	95	359	NA	29	9,504	20,601	6,899	13,681	20,601	7,023
2012	2,350	NA	59	1,544	NA	124	13,854	27,475	9,372	17,748	27,475	9,554
2013	3,295	NA	82	511	NA	41	14,900	57,363	17,534	18,706	57,363	17,657
2014	4,512	NA	113	1,314	NA	105	11,059	26,098	8,598	16,885	26,098	8,816
2015	4,876	NA	122	831	NA	66	11,811	31,565	10,172	17,518	31,565	10,360
2016	578	NA	14	254	NA	20	9,651	25,124	8,133	10,483	25,124	8,167
2017	1,703	NA	43	50	NA	4	9,894	47,535	14,174	11,647	47,535	14,221
2018	1,772	NA	44	1,830	NA	146	14,308	34,688	11,371	17,910	34,688	11,562
2019[1]	1,520	NA	38	41	NA	3	11,284	27,358	8,968	12,845	27,358	9,009

Note: Troll: Areas 5, 6, and 6C; Area 4B from January 1 – April 30 and October 1 – December 31; Net = Areas 4B, 5, 6, and 6C; Sport = Areas 5 and 6, 4B Neah Bay "add-on" fishery.
Note: NA = Not available; for fisheries without estimate of releases, IM is dropoff/dropout only.
[1] Current year not available; values are average of previous three years.

Table A17.–Washington: San Juan ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Washington – San Juan											
	Troll			Net			Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	3	NA	0	81,374	NA	6,510	23,906	NA	3,466	105,284	NA	9,976
1979-1984	0	NA	0	43,078	NA	3,446	14,534	NA	2,107	57,611	NA	5,554
1985-1995	122	NA	3	17,779	NA	1,422	9,042	NA	1,311	26,942	NA	2,736
1996-1998	6	NA	0	12,442	NA	995	8,299	NA	1,203	20,747	NA	2,199
1999-2008	1	NA	0	2,594	371	326	4,185	2,044	936	6,779	2,291	1,262
2009	0	NA	0	1,014	2,012	1,691	4,077	5,375	2,032	5,091	7,387	3,722
2010	0	NA	0	6,129	4,972	4,468	3,157	2,402	1,102	9,286	7,374	5,570
2011	0	NA	0	5,630	11,893	9,965	6,193	6,603	2,668	11,823	18,496	12,632
2012	0	NA	0	420	218	208	5,764	5,528	2,317	6,184	5,746	2,525
2013	0	NA	0	3,908	12,160	10,041	9,502	8,028	3,529	13,410	20,188	13,570
2014	0	NA	0	6,826	5,711	5,115	9,216	8,939	3,732	16,042	14,650	8,847
2015	0	NA	0	4,773	7,928	6,724	8,551	11,347	4,281	13,324	19,275	11,005
2016	0	NA	0	22	0	2	6,173	9,501	3,441	6,195	9,501	3,443
2017	0	NA	0	2,630	46	247	11,321	19,295	6,813	13,951	19,341	7,060
2018	0	NA	0	3,429	783	901	7,303	7,030	2,943	10,732	7,813	3,844
2019[1]	0	NA	0	3,661	757	898	8,266	7,957	3,331	11,927	8,714	4,229

Note: Troll = Areas 6, 6A, 7, and 7A; Net = Areas 6, 6A, 7 and 7A.

Note: NA = Not available; for fisheries without estimate of releases, IM is dropoff/dropout only.

[1] Current year not available; values are average of previous three years.

Table A18.–Washington: Other Puget Sound ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Washington – Other Puget Sound								
	Net			Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	142,258	NA	11,381	134,768	NA	19,541	277,026	NA	30,922
1979-1984	151,459	NA	12,117	119,574	NA	17,338	271,033	NA	29,455
1985-1995	115,327	NA	9,226	63,258	NA	9,172	178,585	NA	18,399
1996-1998	53,365	NA	4,269	44,172	NA	6,405	97,537	NA	10,674
1999-2008	97,083	557	7,821	35,878	99,424	21,190	132,486	99,517	29,011
2009	68,764	NA	5,501	33,332	75,820	25,153	102,096	75,820	30,654
2010	80,599	NA	6,448	32,817	43,512	16,420	113,416	43,512	22,868
2011	100,353	NA	8,028	29,829	78,760	25,433	130,182	78,760	33,461
2012	117,295	NA	9,384	45,279	99,703	33,286	162,574	99,703	42,670
2013	105,106	NA	8,408	36,276	55,190	20,051	141,382	55,190	28,459
2014	50,879	NA	4,070	23,903	42,237	14,786	74,782	42,237	18,856
2015	58,300	NA	4,664	19,898	91,711	27,464	78,198	91,711	32,128
2016	79,525	NA	6,362	22,944	48,792	16,403	102,469	48,792	22,765
2017	135,907	NA	10,873	41,352	142,624	44,219	177,259	142,624	55,092
2018	112,261	NA	8,981	43,237	55,600	21,170	155,498	55,600	30,151
2019[1]	110,114	NA	8,809	35,844	46,093	17,550	145,958	46,093	26,360

Note: Net = Areas 6B, 6D, 7B, 7C, and 7E, Areas 8–13 (including all subareas), and Areas 74C–83F; Sport = Areas 8–13 and all Puget Sound rivers.
Note: NA = Not available; for fisheries without estimate of releases, IM is dropoff/dropout only.
[1] Current year not available; values are average of previous three years.

Table A19.–Washington: Inside Coastal ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Washington – Inside Coastal								
	Net			Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	47,996	NA	960	2,344	NA	162	50,340	NA	1,122
1979-1984	31,130	NA	623	1,391	NA	96	32,521	NA	719
1985-1995	53,853	NA	1,077	5,920	NA	408	59,773	NA	1,486
1996-1998	34,648	NA	693	8,416	NA	581	43,063	NA	1,274
1999-2008	18,578	NA	372	6,315	NA	436	24,893	NA	807
2009	18,728	NA	375	6,629	NA	457	25,357	NA	832
2010	12,794	NA	256	6,831	NA	471	19,625	NA	727
2011	39,034	NA	781	13,340	NA	920	52,374	NA	1,701
2012	29,232	NA	585	9,646	NA	666	38,878	NA	1,250
2013	31,111	NA	622	10,188	NA	703	41,299	NA	1,325
2014	39,514	NA	790	9,740	NA	672	49,254	NA	1,462
2015	32,760	NA	655	22,612	NA	1,560	55,372	NA	2,215
2016	14,134	NA	283	14,004	NA	966	28,138	NA	1,249
2017	20,491	NA	410	13,626	NA	940	34,117	NA	1,350
2018	15,337	NA	307	10,522	NA	726	25,859	NA	1,033
2019[1]	17,478	NA	350	12,717	NA	877	30,195	NA	1,227

Note: Net = Areas 2A–2M and Areas 72B–73H; Sport = All coastal rivers, Area 2.1, and Area 2.2 (when Area 2 is closed)
Note: NA = Not available; for fisheries without estimate of releases, IM is dropoff/dropout only.
[1] Current year sport estimate not available; values are average of previous three years.

Table A20.–Washington/Oregon North of Cape Falcon ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Washington/Oregon North of Cape Falcon											
	Troll			Net			Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	258,844	NA	6,471	356	NA	7	195,743	NA	5,285	454,943	NA	11,763
1979-1984	100,327	NA	2,508	293	NA	6	68,991	NA	1,863	169,611	NA	4,377
1985-1995	57,028	NA	1,426	772	0	15	19,672	NA	531	77,472	NA	1,972
1996-1998	17,805	12,496	1,466	0	0	0	2,197	2,676	193	20,002	15,172	1,659
1999-2008	63,396	44,207	11,333	0	0	0	24,600	29,644	5,111	87,996	69,430	16,443
2009	25,410	NA	635	0	0	0	13,331	34,341	5,511	38,741	34,341	6,146
2010	88,565	NA	2,214	0	0	0	38,686	34,652	6,242	127,251	34,652	8,456
2011	61,433	NA	1,536	0	0	0	30,826	49,623	8,276	92,259	49,623	9,812
2012	99,792	NA	2,495	0	0	0	35,428	38,283	6,699	135,220	38,283	9,194
2013	91,915	NA	2,298	0	0	0	30,837	32,048	5,640	122,752	32,048	7,938
2014	116,489	NA	2,912	0	0	0	42,327	26,578	5,130	158,816	26,578	8,042
2015	125,384	NA	3,135	0	0	0	42,179	15,219	3,422	167,563	15,219	6,556
2016	42,234	NA	1,056	0	0	0	17,948	21,133	3,654	60,182	21,133	4,710
2017	59,974	NA	1,499	0	0	0	21,945	18,604	3,383	81,919	18,604	4,882
2018	47,792	NA	1,195	0	0	0	10,603	10,321	1,834	58,395	10,321	3,029
2019	41,665	NA	1,042	0	0	0	10,714	6,988	1,337	52,379	6,988	2,379

Note: Troll = Oregon Area 2; Washington Areas 1, 2, 3 and 4: Area 4B from May 1 through September 30 (during Pacific Fishery Management Council management); Net = Washington Areas 1, 2, 3, 4, 4A; Sport = Oregon Area 2; Washington Areas 1, 1.1, 1.2, 2, 3, 4 and 2.2 (when Area 2 is open).

Note: For fisheries without estimate of releases, IM is dropoff/dropout only.

Note: NA = Not available.

[1] Current year not available; values are average of previous three years.

Table A21.–Columbia River ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

	Washington and Oregon Columbia River[1]											
	Non-Treaty Net			Treaty Indian Net			Sport			Total		
Year	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	264,025	0	7,921				48,204	NA	3,326	312,229	NA	11,247
1979-1984	86,631	0	2,599	44,131	0	1,324	28,844	NA	1,990	159,606	NA	5,913
1985-1995	112,444	0	3,373	93,129	0	2,794	67,378	NA	4,649	272,951	NA	10,816
1996-1998	11,817	0	355	67,830	0	2,035	37,333	NA	2,576	116,979	NA	4,965
1999-2008	47,419	3,268	2,166	135,388	0	4,062	99,417	15,167	9,178	282,223	18,435	15,406
2009	55,675	921	1,928	121,760	0	3,653	90,213	10,095	8,040	267,648	11,016	13,621
2010	90,673	1,684	3,192	218,915	0	6,567	166,147	12,152	13,603	475,735	13,836	23,362
2011	92,396	1,765	3,266	183,204	0	5,496	150,135	11,157	12,263	425,734	12,922	21,025
2012	75,891	1,260	2,630	166,440	0	4,993	153,034	16,067	13,376	395,366	17,327	20,999
2013	122,782	1,037	3,974	259,213	0	7,776	164,018	30,147	16,688	546,012	31,184	28,438
2014	135,519	2,182	4,677	324,783	0	9,743	184,820	45,257	20,723	645,122	47,439	35,144
2015	135,390	3,738	5,108	336,688	0	10,101	252,400	42,931	25,018	724,477	46,669	40,227
2016	88,080	1,887	3,171	174,219	0	5,227	146,694	24,365	14,085	408,992	26,252	22,482
2017	50,600	0	1,518	137,525	0	4,126	121,263	14,757	10,874	309,388	14,757	16,518
2018	27,059	0	812	78,594	1	2,358	62,251	9,660	6,023	167,903	9,661	9,193
2019	15,949	0	478	76,777	2	2,303	50,312	23,489	7,845	143,038	23,491	10,627

Note: NA = Not available.

1 The historical time series of catches in this year's report has changed from previous year's report. Catches after 1980 have been broken out into nontreaty net and treaty Indian due to the inability to separate Treaty Indian commercial versus noncommercial. Non-treaty net includes catches by Wanapum and Colville tribes. Sport and total catches from 1975 to 1980 are consistent with previous year's reports.

2 The Treaty Indian Net catch estimates for 1975–1979 are not available, but are believed to be of the magnitude seen after 1979; the catch for 1979 represents spring-run catches and does not include catch estimates for summer and fall stocks. Sport and total catch estimates from 1975-1979 are consistent with previous year's reports, but the total is underestimated because of the missing estimates.

3 Preliminary.

Table A22.–Oregon ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

Year	Oregon Coastal Inside								
	Troll			Sport			Total		
	LC	Rel.	IM	LC	Rel.	IM	LC	Rel.	IM
1975-1978	1,325	NA	23	25,285	NA	1,745	26,610	NA	1,767
1979-1984	615	NA	10	19,299	NA	1,332	19,914	NA	1,342
1985-1995	1,646	NA	26	30,435	NA	2,100	32,081	NA	2,126
1996-1998	787	NA	13	26,068	NA	1,799	26,855	NA	1,811
1999-2008	1,469	NA	24	28,329	NA	1,955	29,798	NA	1,978
2009	293	NA	5	9,307	NA	642	9,600	NA	647
2010	1,315	NA	21	17,617	NA	1,216	18,932	NA	1,237
2011	1,954	NA	31	33,059	NA	2,281	35,013	NA	2,312
2012	636	NA	16	26,260	NA	1,812	26,896	NA	1,828
2013	1,188	NA	30	51,082	NA	3,525	52,270	NA	3,554
2014	847	NA	21	43,255	NA	2,985	44,102	NA	3,006
2015	1,164	NA	29	69,790	NA	4,816	70,954	NA	4,845
2016	182	NA	5	31,967	NA	2,206	32,862	NA	2,210
2017	70	NA	2	40,880	NA	2,821	40,950	NA	2,822
2018	322	NA	8	19,469	NA	1,343	19,791	NA	1,351
2019	0	NA	0	15,115	NA	1,043	15,115	NA	1,043

Note: Troll = late season off Elk River mouth, Sport = estuary and inland.

Note: NA = Not available.

[1] Preliminary value based on average harvest rates.

Table A23.–Summary of landed catches (LC) of PSC AABM and ISBM fisheries.

Year [1]	SEAK AABM [2,3]	SEAK Non-Treaty	U.S. ISBM [4]	U.S. Total	NBC AABM [2]	WCVI AABM [2]	Can ISBM [4,5]	Can Total	PSC Total
1975-1978	324,265		1,314,262	1,638,527	173,893	581,418	1,045,289	1,800,600	3,439,126
1979-1984	322,011		793,691	1,115,702	163,357	465,372	766,274	1,395,003	2,510,705
1985-1995	259,586	31,229	725,249	984,835	174,072	282,107	423,080	879,259	1,864,094
1996-1998	228,282	55,003	335,866	564,148	84,960	26,213	233,958	345,130	909,278
1999-2008	297,646	74,657	573,155	870,802	144,532	142,552	239,698	526,782	1,397,584
2009	227,954	65,693	463,158	691,112	109,470	124,617	209,710	443,797	1,134,909
2010	230,611	54,141	780,189	1,010,800	136,613	139,047	165,961	441,621	1,452,421
2011	291,161	66,213	761,066	1,052,228	122,660	204,232	283,031	609,923	1,662,151
2012	242,821	52,498	782,866	1,025,686	120,306	135,210	201,258	456,774	1,482,460
2013	191,388	65,864	935,831	1,127,219	115,914	116,871	200,802	433,587	1,560,806
2014	435,195	57,327	1,005,003	1,440,198	216,901	192,705	242,054	651,660	2,091,858
2015	335,026	68,313	1,127,406	1,462,432	158,903	118,974	306,229	584,106	2,046,538
2016	350,704	36,338	649,321	1,000,025	190,181	103,093	195,195	488,469	1,488,494
2017	175,414	31,638	669,232	844,645	143,330	117,416	272,717	533,463	1,378,108
2018	127,776	36,966	456,089	583,865	108,976	85,330	271,666	465,972	1,049,837
2019	140,307	34,789	411,458	551,765	88,026	73,482	302,244	463,752	1,015,517

[1] All LC from 1975 to 1984 were taken prior to implementation of the PST.
[2] LC in AABM fisheries from 1985 to 1994 were taken under fixed ceiling management per the 1985 PST Agreement. Catches from 1995 to 1998 were between agreements. LC from 1999 to present was taken commensurate with abundance-based management per the 1999 PST Agreement (1999–2008) and the 2009 PST Agreement (2009–present).
[3] Southeast Alaska nontreaty catches are primarily Alaska hatchery add-ons, but include terminal exclusions in some years from terminal catches from the Situk, Taku and Stikine rivers.
[4] US and Canadian ISBM fisheries had a pass-through obligation from 1985 to 1994 under the 1985 PST Agreement and have operated with ISBM index obligations since 1999, under the 1999 and 2009 Agreements
[5] Catches in the Canada ISBM column include catches in the Strait of Georgia (troll and sport), Central British Columbia troll, and Northern British Columbia net and mainland sport fisheries from 1985 to 1994 when these were AABM fisheries operating under fixed ceiling management provisions of the 1985 PST Agreement.
[6] Does not include SEAK AABM fishery nontreaty catch from hatchery add-on and terminal exclusion.

Table A24.–Estimated incidental mortality (LIM and SIM in nominal fish) associated with Chinook salmon catches in US and Canadian AABM and ISBM fisheries.[1]

Year [1]	SEAK AABM	SEAK Non-Treaty	U.S. ISBM	U.S. Total	NBC AABM[2]	WCVI AABM[2]	Can ISBM[3]	Can Total	PSC Total[4]
1985-1995	116,347	11,073	44,555	160,902	41,051	100,700	NA	141,751	302,653
1996-1998	46,356	11,092	23,643	69,999	5,985	0	NA	5,985	75,983
1999-2008	50,258	12,421	68,679	118,937	13,152	12,670	30,598	56,420	175,357
2009	44,963	11,052	69,674	114,637	9,705	15,817	38,911	64,433	179,069
2010	38,420	5,523	74,315	112,735	12,739	16,017	24,717	53,473	166,208
2011	41,613	9,864	87,967	129,580	18,619	17,005	32,967	68,591	198,171
2012	45,890	19,635	88,020	133,910	11,556	16,687	39,338	67,581	201,491
2013	59,382	42,839	100,942	160,324	19,926	17,458	57,961	95,345	255,669
2014	50,945	7,647	84,172	135,117	17,276	18,543	52,860	88,679	223,796
2015	49,148	21,647	107,337	156,485	21,673	11,551	50,614	83,838	240,323
2016	50,978	6,021	65,027	116,006	14,136	10,180	51,228	75,544	191,550
2017	46,599	13,184	101,945	148,544	19,299	13,963	63,297	96,559	245,102
2018	31,153	28,727	60,163	91,316	14,413	16,429	67,169	98,011	189,327
2019	56,666	34,629	54,874	111,540	16,466	11,007	76,574	104,047	215,587

Note: LIM = Legal Incident Mortality, SIM = Sublegal Incident Mortality.

[1] The IM estimates presented in this table are not equivalent to LC on a one-to-one fish basis because of the inclusion of SIMs, which are smaller, less mature fish.

[2] IM estimates (LIM + SIM) are available for AABM fisheries from 1985 to present (CTC 2011).

[3] IM estimates for the ISBM fisheries prior to 2005 were not available for many subcomponents of these fisheries at this printing, but will be included in next year's CTC catch and escapement report.

[4] The PST total needs to be viewed with caution per footnote 1.

[5] Does not include SEAK AABM fishery nontreaty catch from hatchery add-on and terminal exclusion.

Table A25.–Estimated total mortality (LC and IM) associated with Chinook salmon catches in US and Canadian AABM and ISBM fisheries.

Year	SEAK AABM	SEAK Non-Treaty	U.S. ISBM	U.S. Total	NBC AABM	WCVI AABM	Can ISBM	Can Total	PSC Total
1985-1995	375,933	42,303	769,804	1,145,737	215,124	382,807	NA	597,930	1,743,668
1996-1998	274,637	66,095	359,509	634,146	90,944	26,213	NA	117,157	751,303
1999-2008	347,905	87,078	641,834	989,738	157,683	155,223	270,296	583,202	1,572,940
2009	272,917	76,746	532,832	805,749	119,175	140,434	248,621	508,230	1,313,978
2010	269,031	59,664	854,503	1,123,535	149,352	155,064	190,678	495,094	1,618,629
2011	332,774	76,076	849,033	1,181,808	141,279	221,237	315,998	678,514	1,860,322
2012	288,711	72,133	870,885	1,159,596	131,862	151,897	240,596	524,355	1,683,951
2013	250,770	108,703	1,036,773	1,287,543	135,840	134,329	258,763	528,932	1,816,475
2014	486,141	64,974	1,089,175	1,575,315	234,177	211,248	294,914	740,339	2,315,654
2015	384,174	89,960	1,234,743	1,618,917	180,576	130,525	356,843	667,944	2,286,861
2016	401,683	42,359	714,349	1,116,031	204,317	113,273	246,423	564,013	1,680,044
2017	174,375	50,150	771,176	945,551	128,275	131,379	336,014	595,668	1,541,219
2018	158,929	65,693	516,252	675,181	123,389	101,759	338,835	563,983	1,239,164
2019	196,973	69,417	466,332	663,305	104,492	84,489	378,818	567,799	1,231,104

[1] Total mortality estimates prior to 2005 will be included in next year's CTC catch and escapement report when estimates from the ISBM fisheries are available.

[2] Does not include SEAK AABM fishery nontreaty catch from hatchery add-on and terminal exclusion.

APPENDIX B. ESCAPEMENTS AND TERMINAL RUNS OF PACIFIC SALMON COMMISSION CHINOOK TECHNICAL COMMITTEE CHINOOK SALMON ESCAPEMENT INDICATOR STOCKS, 2009–2019

Appendix **Page**

Table B1.–Southeast Alaska estimates of escapement and CVs of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

Year	Southeast Alaska Chinook Stocks					
	Situk River		Chilkat River		Unuk River	
	Esc	CV[1]	Esc	CV	Esc	CV
1975-1978	1,320				5,025	0.12
1979-1984	941				5,344	0.12
1985-1995	1,467	0.02	5,236	0.15	5,644	0.12
1996-1998	1,534	0.11	5,549	0.12	4,247	0.10
1999-2008	970	0.04	3,255	0.14	5,598	0.10
2009	902		4,406	0.13	3,157	0.11
2010	167		1,797	0.13	3,835	0.12
2011	240		2,674	0.10	3,195	0.21
2012	322		1,723	0.15	956	0.12
2013	912		1,719	0.19	1,135	0.12
2014	475		1,529	0.20	1,691	0.12
2015	174		2,456	0.11	2,623	0.12
2016	329		1,380	0.14	1,463	0.12
2017	1,187		1,173	0.20	1,203	0.12
2018	420		873	0.19	1,971	0.12
2019[2]	623		2,028	0.12	3,115	0.12
Lower	500		1,750		1,800	
Upper	1,000		3,500		3,800	

[1] Escapement is enumerated using a weir on the Situk River and CVs are only applicable for years having estimates of sport.

[2] Preliminary data.

Table B2.–Transboundary River estimates of escapement and CVs of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

	Transboundary River Stocks					
	Alsek R.		Taku R.		Stikine R.	
Year	Esc	CV	Esc	CV	Esc	CV
1975-1978	10,007	0.37	21,031	0.38	7,894	0.19
1979-1984	10,629	0.37	27,473	0.31	23,358	0.19
1985-1995	11,606	0.37	45,072	0.24	27,835	0.15
1996-1998	11,750	0.36	74,999	0.20	27,304	0.12
1999-2008	5,928	0.39	38,811	0.17	35,542	0.14
2009	6,239	0.36	22,801	0.10	11,086	0.22
2010	9,518	0.36	29,302	0.09	15,180	0.13
2011	6,668	0.36	27,523	0.15	14,569	0.11
2012	2,660	0.36	19,429	0.12	22,671	0.17
2013	5,044	0.36	18,002	0.38	16,735	0.17
2014	3,357	0.36	23,532	0.09	24,360	0.18
2015	5,697	0.36	28,850	0.14	21,343	0.16
2016	2,574	0.36	12,381	0.12	10,343	0.19
2017	1,718	0.36	8,754	0.10	7,206	0.29
2018	4,312	0.36	7,271	0.11	8,355	0.35
2019	6,356	0.36	11,558	0.12	13,817	0.25
Lower	3,500		19,000		14,000	
Upper	5,300		36,000		28,000	

Table B3.–Northern British Columbia escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

	Northern British Columbia									
	Area 3[1] Nass R.			Area 4 Skeena R.			Area 8[2] Atnarko R.			Area 9
Year	Above GW[1]	Esc	t. run	Total Esc	GSI[3] esc	GSI[3] SD	Total Esc	CV	Wild[4]	Rivers Inlet
1975-1978	14,587	14,972	18,669	21,269			9,900			2,486
1979-1984	13,255	15,532	19,632	24,115	51,348	14,818	7,218			2,437
1985-1995	19,901	21,626	28,604	56,436	76,713	14,516	20,109	0.14	13,994	5,345
1996-1998	21,252	22,886	31,156	54,322	97,894	20,468	13,191	0.09	5,356	4,449
1999-2008	19,518	21,756	30,282	45,133	95,818	14,427	12,350	0.09	8,932	4,569
2009	28,710	30,334	36,865	38,297	80,900	16,297	***8,917***	**0.05**	***6,331***	4,580
2010	19,341	20,821	26,052	43,331	101,486	19,344	***9,317***	**0.06**	***5,683***	4,225
2011	9,639	10,415	15,092	37,073	53,682	12,239	***8,082***	**0.07**	***6,061***	4,400
2012	8,309	9,815	15,086	34,024	33,473	5,746	***4,622***	**0.06**	***2,542***	4,142
2013	8,011	9,306	13,525	26,699	39,179	4,903	***19,962***	**0.05**	***9,860***	4,672
2014	11,623	13,108	19,789	28,496	44,200	6,876	***19,011***	**0.05**	***11,935***	NA
2015	16,433	19,465	28,557	41,658	53,770	6,700	***44,329***	**0.12**	***13,640***	5,328
2016	9,037	10,191	15,977	34,153	31,297	4,632	***24,234***	**0.05**	***10,100***	NA
2017	4,419	4,984	8,947	11,920	18,480	4,709	***10,308***	**0.05**	***5,464***	NA
2018	14,470	16,319	21,862	37,481	35,005	5,416	***12,774***	**0.07**	***5,328***	NA
2019	10,493	11,833	18,707	24,536	23,248	3,336	***11,675***		***4,587***	3,862

Note: NA = Not available.

[1] GW refers to Gitwinksihlkw, the location of the lower fish wheels on the Nass River used to capture Chinook salmon for the MR estimate.

[2] Estimates prior to 1990 are visual counts, 1990–2000 and 2004–2008 are based on time series calibration, 2001–2003 and 2009–2017 are maximum likelihood estimates based on MR estimates.

[3] Genetic Stock Identification.

[4] Large wild Atnarko Chinook salmon.

[5] The Docee River was dropped as an escapement indicator beginning in 2002 due to an inability to obtain reliable escapement estimates.

Table B4.–Southern British Columbia escapements of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

	Lower Strait of Georgia		Upper Strait of Georgia
Year	**Nanaimo**	**Cowichan**	**Phillips**
1975-1978	5,710		350
1979-1984	2,020	5,770	483
1985-1995	1,227	6,720	940
1996-1998	1,814	10,142	244
1999-2008	1,834	3,639	279
2009	1,470	785	247
2010	2,201	2,761	856
2011	3,937	3,215	889
2012	1,063	3,508	2,171
2013	593	4,547	2,621
2014	1,689	4,590	2,571
2015	3,146	6,394	2,092
2016	1,982	8,186	2,109
2017	2,108	11,029	2,468
2018	2,961	14,773	1,242
2019	2,744	15,522	2,531
Goal		6,500	

Table B5.– Southwest Vancouver Island 3-stream index, Northwest Vancouver Island 4-stream index, and West Coast Vancouver Island 14-stream index escapements of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

	SWVI				NWVI					WCVI
Year	Bedwell	Megin	Moyeha	SWVI 3-Stream Index	Colonial	Artlish	Kaouk	Tahsish	NWVI 4-Stream Index	WCVI 14-Stream Index
1975-1978						40	56	50	147	
1979-1984	25	115	19	135	12	298	177	733	1,217	5,763
1985-1995	208	208	210	463	35	92	108	506	726	6,824
1996-1998	370	267	161	797	92	252	534	747	1,625	14,011
1999-2008	126	88	148	361	529	242	336	356	1,462	10,891
2009	44	15	60	119	630	214	550	80	1,474	12,040
2010	50	9	185	244	520	110	185	355	1,170	11,482
2011	85	48	67	200	409	95	302	263	1,069	10,511
2012	205	80	108	393	93	141	223	138	595	8,999
2013	596	73	208	877	98	399	240	350	1,087	16,670
2014	289	37	167	493	348	91	192	653	1,284	11,037
2015	746	49	252	1,047	586	1,113	331	768	2,798	23,366
2016	658	17	139	814	398	160	370	615	1,543	22,006
2017	796	61	136	993	793	274	605	1,561	3,233	17,749
2018	723	7	20	750	270	555	420	918	2,163	16,060
2019	379	10	22	411	733	441	239	787	2,200	15,624

[1] The escapement methodology changed for the WCVI streams in 1995, and the earlier estimates have not been calibrated.

Table B6.–Fraser River escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

	Fraser River								
	Fraser Spring Age 1.2	Fraser Spring Age 1.3	Fraser Summer Age 0.3	Fraser Summer Age 1.3	Fraser Spring/ Summer	Harrison		Lower Shuswap[1]	
Year	Esc	Esc	Esc	Esc	t. run	Esc	CV	Esc	CV
1975-1978	5,901	10,753	24,117	16,089	56,931			16,910	0.37
1979-1984	5,431	17,845	13,917	12,600	82,485	120,835	0.08	7,716	0.29
1985-1995	10,258	39,659	31,782	21,773	131,313	106,416	0.08	18,731	0.33
1996-1998	17,994	30,487	71,313	33,759	194,910	102,721	0.08	30,510	0.35
1999-2008	15,210	24,209	88,707	24,239	194,062	102,689	0.09	32,973	0.09
2009	2,173	24,321	86,318	21,596	175,012	70,142	0.06	25,288	0.02
2010	9,406	15,584	158,003	20,377	239,623	103,558	0.06	71,353	0.02
2011	5,181	10,998	126,679	16,332	216,130	123,647	0.05	18,895	0.02
2012	11,359	11,186	47,695	9,769	113,573	44,467	0.09	4,091	0.03
2013	6,821	16,009	119,609	11,263	175,788	42,953	0.07	28,797	0.01
2014	24,614	32,905	84,308	24,424	210,313	44,686	0.09	43,952	0.03
2015	11,150	22,990	179,162	30,537	283,627	101,516	0.07	40,682	0.02
2016	8,904	13,781	93,206	9,522	138,919	41,327	0.11	6,438	0.06
2017	5,103	8,343	84,470	6,390	123,657	29,799	0.08	13,430	0.03
2018	2,100	8,482	46,543	5,443	84,373	46,094	0.07	17,120	0.04
Goal Lower						75,100			
Goal Upper						98,500			

[1] Escapement was estimated by MR methods from 1983 to 1985, 2000 to 2002, and 2004 to 2012. All other years are calibrated values that have been estimated using a relationship between MR and peak methods.

Table B7.–Puget Sound escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

	Puget Sound (includes hatchery strays in natural escapement unless noted otherwise)																	
	Nooksack Spring			Skagit River Spring		Skagit River Summer/Fall		Stillaguamish River			Snohomish River			Lake Washington		Green River		
Year	MR esc[1]	Tot Esc[2]	NOR Esc[3]	Esc	t. run	Esc	t. run[4]	MR esc[1]	Esc	t. run[4]	MR esc[1]	Esc	t. run	Esc	t. run	MR esc[1]	Esc	t. run
1975-1978				678	678	11,933	26,169		1,511	2,762		5,515	10,060	922	1,046		3,411	6,447
1979-1984		520		879	879	12,151	22,175		671	2,267		4,684	12,398	1,510	2,049		4,988	8,834
1985-1995		520		1,389	1,443	9,945	13,625	1,040	981	1,845		3,877	5,759	1,220	1,849		6,808	10,557
1996-1998		687	37	1,059	1,078	10,031	10,628	1,656	1,315	7,336		5,078	5,423	570	458		6,363	8,073
1999-2008	2,714	2,256	360	1,224	1,238	15,308	16,463	1,561	1,274	1,866		6,735	7,096	1,274	1,350	15,595	5,804	8,697
2009	2,889	2,360	372	983	983	6,955	12,460	1,239	1,001	1,218		2,309	2,370	793	951		688	1,067
2010	4,303	2,596	277	1,361	1,537	8,037	9,060	837	783	1,014		4,299	4,435	729	734	4,541	2,092	2,112
2011	2,620	1,192	250	825	1,015	5,536	9,181	1,637	1,017	1,264	5,384	1,880	1,972	890	1,034	3,382	993	1,464
2012	2,176	1,125	569	2,774	3,278	13,817	15,864	1,787	1,534	1,733	5,692	5,124	5,216	1,581	1,875	4,528	3,091	3,804
2013	4,879	1,558	149	2,010	2,398	10,882	14,082	997	854	1,003	14,173	3,244	3,320	1,863	3,024		2,041	2,332
2014	2,249	1,585	169	1,608	1,746	10,457	11,387	419	432	440	5,214	3,901	3,949	614	649		2,730	2,910
2015	3,878	1,783	447	1,408	1,491	13,315	14,580	709	459	468	5,885	3,863	3,948	2,014	2,022		4,087	4,181
2016	3,711	1,776	700	2,429	2,584	16,761	18,337	1,053	861	882	14,914	5,153	5,277	1,287	1,308		10,063	10,103
2017	6,727	2,926	317	2,851	3,140	12,784	13,998	1,070	1,075	1,117	15,011	6,119	6,364	2,302	2,422		8,357	10,513
2018	NA	NA	NA	2,376	2,579	10,903	12,239	665	562	597		4,210	4,475	968	1,013		6,891	10,881
2019	NA	NA	NA	1,131		11,810		503	440			1,644		1,220			2,976	
Goal				690		9,202												

Note: NA = Not available.

[1] Escapement estimated from MR studies conducted with Treaty-related funding. For the Stillaguamish River, 1988-2007 estimates are converted to a tGMR equivalent using a regression relationship derived from ground based and tGMR escapements from the period 2008 to 2016 when both methods were used concurrently.

[2] Estimate of total natural spawners (hatchery + natural) during the spring Chinook salmon escapement accounting period (prior to Oct. 1); includes some early-timed summer/fall Chinook salmon in the south Fork but is assumedly spring Chinook salmon only in the north fork/middle fork Chinook salmon (due to spawn timing differences).

[3] Natural-origin spring Chinook salmon isolated from total natural spawners based on carcass mark–sampling details (otolith thermal marks, fin clips, CWTs) and genetic stock

identification.

[4] Escapement excludes brood stock collected for supplementation program. Total run includes redd count based escapement of all natural spawners, terminal catch, and adult brood stock collected for supplementation and PSC indicator program.

Table B8.–Washington Coast escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

	Washington Coast																	
	Hoko Fall		Quillayute Summer		Quillayute Fall		Hoh Spr/Sum		Hoh Fall		Queets Spr/Sum		Queets Fall		Grays Harbor Spring		Grays Harbor Fall	
Year	Esc[1]	t. run	Esc	t. run	Esc	t. run	Esc	t. run	Esc	t. run	Esc	t. run	Esc	t. run	Esc	t. run	Esc	t. run
1976-1978			2,467	3,233			1,000	1,924	2,167	3,267	782	1,099	2,333	3,700	800	1,433	3,862	11,028
1979-1984			1,029	2,100	6,393	8,066	1,396	1,962	2,650	3,450	947	1,253	3,767	6,000	623	875	10,127	14,761
1985-1995	661	747	1,305	1,798	8,699	11,992	1,951	2,802	3,463	5,064	1,033	1,433	6,229	8,609	1,669	1,788	16,779	33,340
1996-1998	1,204	1,294	1,220	1,465	6,491	7,760	1,495	2,182	3,017	4,161	603	707	3,635	5,348	3,770	4,049	16,975	28,400
1999-2008	699	846	912	1,032	4,822	6,757	1,164	1,429	2,578	3,616	399	412	3,106	4,791	2,308	2,641	15,836	21,575
2009	103	385	555	682	3,130	5,874	880	913	2,081	2,747	495	495	2,960	4,918	1,133	1,150	9,290	14,498
2010	319	793	772	941	4,635	6,985	828	852	2,599	3,204	259	259	3,861	6,001	3,495	3,495	18,158	25,795
2011	1,275	1,504	569	823	3,963	6,765	827	885	1,293	2,163	373	373	3,710	6,649	2,563	2,573	22,870	35,829
2012	401	663	729	841	3,518	6,682	915	1,059	1,937	2,770	760	760	3,586	6,757	878	1,151	14,034	24,788
2013	656	1,406	957	1,148	3,901	6,993	750	873	1,269	3,287	520	520	2,413	4,967	2,459	2,638	12,503	18,749
2014	1,534	1,760	608	843	2,782	7,327	744	819	1,933	2,628	377	452	3,684	5,145	1,583	1,659	11,893	17,409
2015	2,282	2,877	783	1,006	3,440	6,676	1,070	1,096	1,795	2,439	532	576	5,313	7,452	1,841	2,065	17,304	30,007
2016	965	1,195	871	1,171	3,654	5,005	1,144	1,158	2,831	3,012	704	777	2,915	3,888	926	1,056	11,248	15,784
2017	695	970	1,060	1,362	3,604	7,957	1,778	1,798	1,405	1,907	825	915	2,721	4,462	1,384	1,391	17,145	22,749
2018	2,115	2,351	1,185	1,445	4,031	6,638	793	808	1,638	1,790	484	508	2,095	3,104	493	526	20,741	26,754
2019	1,779	2,043	991	1,125	7,256	9,627	766	NA	1,552	NA	322	NA	2,504	NA	983	984	14,880	NA
Goal					3,000		900		1,200		700		2,500				13,326	

Note: NA = Not available.

[1] Escapement excludes brood stock for supplementation program. Total run includes redd-count-based escapement, terminal catch, and adult brood stock collected for supplementation and PSC indicator program.

Table B9.–Mid-Columbia summer, Columbia Fall Chinook below Bonneville Dam, and Columbia Upriver fall Chinook escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee Chinook salmon escapement indicator stocks.

	Mid-Columbia Summers[1]		Fall Chinook Below Bonneville			Columbia Upriver Fall Chinook			
			Coweeman	Lewis River[2]		Deschutes River[3]		Upriver Brights[4]	
Year	Esc	t.run	Esc	Esc	t.run	Esc	t.run	Esc	t.run
1975-1978	14,943		351	7,381	7,381	6,648	8,564	29,790	108,480
1979-1984	11,366	18,278	265	12,126	12,987	4,848	6,491	33,961	81,692
1985-1995	12,824	17,147	1,097	11,384	12,676	7,274	8,130	69,986	190,045
1996-1998	10,235	15,108	1,162	9,523	9,523	15,450	15,689	48,394	131,867
1999-2008	50,058	56,604	697	10,766	11,721	10,297	11,095	90,514	227,796
2009	44,295	53,881	783	5,410	5,760	6,429	7,116	83,778	204,987
2010	47,220	72,346	639	8,701	8,701	9,275	10,066	164,917	314,842
2011	44,432	80,574	566	8,009	11,025	17,117	18,168	128,280	305,940
2012	52,184	58,300	463	8,143	8,450	17,624	18,785	128,074	277,071
2013	68,386	67,603	2,035	15,197	20,267	18,068	20,305	366,101	764,029
2014	77,982	78,254	890	20,808	22,915	17,993	19,432	297,323	664,807
2015	88,691	126,882	1,449	23,631	25,327	17,074	18,194	384,539	777,721
2016	79,253	91,048	407	8,957	10,463	11,628	12,390	186,565	394,182
2017	56,265	68,204	921	6,058	6,740	4,942	5,931	125,673	291,492
2018	38,816	42,120	230	5,499	6,099	4,158	4,799	74,994	144,244
2019	41,090	34,619	374	14,307		20,815	21,782	96,268	190,456
Goal	12,143			5,700		4,532		40,000	

[1]Based on a S-R analysis of model data which included both hatchery and wild fish, an interim goal of 12,143 adult Mid-Columbia Summers at Rock Island Dam was developed. For consistency with the goal, the escapement time series reported here is total adult Rock Island Dam count. The terminal run is that reported for Upriver Summer Chinook in the Joint Staffs Reports as the Bonneville Dam Count plus catch in lower river fisheries.

[2]This is the number of naturally spawning adult fish in the Lewis River. The terminal run given is the escapement plus the Lewis River sport catch of wild adults.

[3]Estimate is based on the ratio of redds above and below Sherar's Falls. The time series of data through 2009 were updated based on a comprehensive analysis done by Warm Springs, ODFW and CRITFC staff (Sharma et. al. 2010). Deschutes fall Chinook are part of the Upriver Bright management unit, but are not listed in Attachment I.

[4]In 2002, the CRFMP escapement goal of 40,000 was agreed to by the CTC. The 2018 CRFMP states a management goal of 46,000 and an escapement goal of 43,500. Escapement numbers given are McNary adult dam count minus adult sport and broodstock above the dam. The terminal run is the Columbia River mouth terminal run of Upriver Brights minus the Deschutes River fall chinook terminal run.

Table B10.–North Oregon Coastal escapements as estimated via traditional habitat expansion methods and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

Year	Northern Oregon Coastal					
	Nehalem R.		Siletz R.		Siuslaw R.	
	Esc	t. run	Esc	t. run	Esc	t. run
1975-1978	9,635	9,887	2,191	3,086	6,948	7,486
1979-1984	9,728	10,112	4,057	5,449	8,936	9,737
1985-1995	9,513	11,838	6,012	7,567	23,365	26,010
1996-1998	9,161	12,408	5,545	7,871	26,688	32,034
1999-2008	8,649	11,435	6,309	9,387	28,208	32,221
2009	5,390	5,390	2,905	3,343	14,094	15,881
2010	5,384	7,254	4,225	5,118	22,197	25,846
2011	7,665	9,780	3,638	5,861	30,713	36,546
2012	7,515	10,068	4,812	6,657	20,018	24,112
2013	18,194	22,073	7,364	10,836	23,411	32,213
2014	11,452	16,210	8,655	13,136	28,200	34,750
2015	12,678	18,660	6,367	14,335	35,087	45,169
2016	10,074	12,109	8,479	12,917	30,135	35,645
2017	6,473	7,937	7,364	13,347	10,957	15,248
2018	6,420	7,277	4,929	7,402	4,481	7,110
2019	9,746	11,258	3,521	4,923	4,797	NA
Goal	6,989		2,944		12,925	

Table B11.–Oregon Coastal escapements and terminal runs (t. run) as estimated by MR calibrated indexes of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. Estimates presented in boldface represent estimates generated from direct MR studies.

	Oregon Coastal								
	Nehalem R.		**Siletz R.**		**Siuslaw R.**		**Umpqua R. S. Fork**	**Coquille R.**	
Year	**Esc**	**t. run**	**Esc**	**t. run**	**Esc**	**t. run**	**Esc**	**Esc**	**t. run**
1975-1978	9,580	9,724	6,127	7,944	3,492	3,813	254	5,586	7,646
1979-1984	9,826	10,505	11,144	12,540	3,766	4,567	1,248	4,377	5,022
1985-1995	10,055	12,197	13,776	15,298	11,899	14,499	5,860	9,078	10,837
1996-1998	10,336	12,861	14,647	16,538	11,448	15,827	7,015	8,855	10,696
1999-2008	11,370	13,546	15,230	18,193	14,481	18,380	5,139	9,758	11,998
2009	**5,786**	**5,869**	**2,201**	**2,656**	5,109	6,562	3,100	15,526	16,625
2010	**7,097**	**7,804**	**10,985**	**11,852**	12,155	15,668	6,725	32,071	35,563
2011	**11,084**	**13,179**	**4,985**	**7,846**	12,000	17,833	6,026	14,124	18,530
2012	**12,952**	**15,008**	**8,738**	**10,701**	16,234	20,328	5,929	8,117	11,358
2013	**15,989**	**19,766**	**13,878**	**17,350**	15,502	24,317	9,337	5,358	8,953
2014	13,145	17,231	16,895	21,069	16,395	22,395	8,356	12,586	16,852
2015	14,710	20,339	11,232	19,184	19,756	29,835	24,690	14,669	21,306
2016	12,456	14,413	17,327	21,765	8,586	14,096	NA	9,720	12,115
2017	8,325	9,789	14,063	20,046	7,433	11,724	5,514	6,470	8,218
2018	5,633	6,490	5,757	8,230	2,484	5,114	2,983	470	1,254
2019	8,574	10,086	3,263	4,665	1,691	NA	824	275	NA
Goal	pending		pending		pending		pending	pending	

Note: NA = Not available.