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# Escapement Goal Review for Select Arctic–Yukon–Kuskokwim Regional Salmon Stocks, 2023

**by**

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**Alaska Department of Fish and Game** **Divisions of Sport Fish and Commercial Fisheries**

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**Weights and measures (metric)**

| | |
|---|---|
| centimeter | cm |
| deciliter | dL |
| gram | g |
| hectare | ha |
| kilogram | kg |
| kilometer | km |
| liter | L |
| meter | m |
| milliliter | mL |
| millimeter | mm |

**Weights and measures (English)**

| | |
|---|---|
| cubic feet per second | $ft^3/s$ |
| foot | ft |
| gallon | gal |
| inch | in |
| mile | mi |
| nautical mile | nmi |
| ounce | oz |
| pound | lb |
| quart | qt |
| yard | yd |

**Time and temperature**

| | |
|---|---|
| day | d |
| degrees Celsius | °C |
| degrees Fahrenheit | °F |
| degrees kelvin | K |
| hour | h |
| minute | min |
| second | s |

**Physics and chemistry**

| | |
|---|---|
| all atomic symbols | |
| alternating current | AC |
| ampere | A |
| calorie | cal |
| direct current | DC |
| hertz | Hz |
| horsepower | hp |
| hydrogen ion activity (negative log of) | pH |
| parts per million | ppm |
| parts per thousand | ppt, ‰ |
| volts | V |
| watts | W |

**General**

| | |
|---|---|
| Alaska Administrative Code | AAC |
| all commonly accepted abbreviations | e.g., Mr., Mrs., AM, PM, etc. |
| all commonly accepted professional titles | e.g., Dr., Ph.D., R.N., etc. |
| at | @ |
| compass directions: | |
| east | E |
| north | N |
| south | S |
| west | W |
| copyright | © |
| corporate suffixes: | |
| Company | Co. |
| Corporation | Corp. |
| Incorporated | Inc. |
| Limited | Ltd. |
| District of Columbia | D.C. |
| et alii (and others) | et al. |
| et cetera (and so forth) | etc. |
| exempli gratia (for example) | e.g. |
| Federal Information Code | FIC |
| id est (that is) | i.e. |
| latitude or longitude | lat or long |
| monetary symbols (U.S.) | $, ¢ |
| months (tables and figures): first three letters | Jan,...,Dec |
| registered trademark | ® |
| trademark | ™ |
| United States (adjective) | U.S. |
| United States of America (noun) | USA |
| U.S.C. | United States Code |
| U.S. state | use two-letter abbreviations (e.g., AK, WA) |

**Mathematics, statistics**

| | |
|---|---|
| *all standard mathematical signs, symbols and abbreviations* | |
| alternate hypothesis | $H_A$ |
| base of natural logarithm | $e$ |
| catch per unit effort | CPUE |
| coefficient of variation | CV |
| common test statistics | (F, t, $\chi^2$, etc.) |
| confidence interval | CI |
| correlation coefficient (multiple) | R |
| correlation coefficient (simple) | r |
| covariance | cov |
| degree (angular) | ° |
| degrees of freedom | df |
| expected value | $E$ |
| greater than | > |
| greater than or equal to | ≥ |
| harvest per unit effort | HPUE |
| less than | < |
| less than or equal to | ≤ |
| logarithm (natural) | ln |
| logarithm (base 10) | log |
| logarithm (specify base) | $\log_2$, etc. |
| minute (angular) | ′ |
| not significant | NS |
| null hypothesis | $H_O$ |
| percent | % |
| probability | P |
| probability of a type I error (rejection of the null hypothesis when true) | α |
| probability of a type II error (acceptance of the null hypothesis when false) | β |
| second (angular) | ″ |
| standard deviation | SD |
| standard error | SE |
| variance | |
| population | Var |
| sample | var |

*FISHERY MANUSCRIPT NO. 22-08*

# ESCAPEMENT GOAL REVIEW FOR SELECT ARCTIC–YUKON–KUSKOKWIM REGION SALMON STOCKS, 2023

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# ABSTRACT

An Alaska Department of Fish and Game (ADF&G) escapement goal review team evaluated salmon stocks in the Arctic–Yukon–Kuskokwim (AYK) region in advance of the January 2023 Alaska Board of Fisheries (BOF) meeting. At the time of this review there existed 53 escapement goals established by ADF&G for salmon stocks in the AYK Region and 3 goals established by the Yukon River Panel for Yukon River transboundary stocks. The review team found that no new escapement goals were warranted. The review team decided that 1 escapement goal should be revised and 6 escapement goals should be discontinued. The findings made by the review team were intended to align salmon escapement goals throughout the region with current fishery management practices and status of escapement monitoring programs. The review team found no changes to existing escapement goals in Norton Sound–Port Clarence and Kotzebue management areas were warranted. Within the Yukon Area, the review team decided a revision to the Chena River biological escapement goal and discontinuation of the Delta Clearwater River coho salmon sustainable escapement goal (SEG) was warranted. Within the Kuskokwim Area, the review team decided discontinuation of 5 Chinook salmon SEGs established on the Kisaralik River, Aniak River (mainstem), Salmon River (Aniak River drainage), Cheeneetnuk River (Swift River drainage), and Gagarayah River (Swift River drainage) was warranted.

Keywords: Pacific salmon, Oncorhynchus, escapement goal, stock status, Arctic–Yukon–Kuskokwim, Kuskokwim Area, Yukon Area, Norton Sound-Port Clarence Area, Arctic-Kotzebue Sound Area

# INTRODUCTION

This report presents escapement goal findings for salmon stocks of Norton Sound–Port Clarence, Arctic–Kotzebue Sound, Yukon, and Kuskokwim areas (AYK Region; Figure 1). The Alaska Department of Fish and Game (ADF&G) is responsible for establishing, reviewing, and modifying escapement goals as described by the Policy for Statewide Salmon Escapement Goals (Escapement Goal Policy: 5 AAC 39.223) and the Policy for the Management of Sustainable Salmon Fisheries (SSFP: 5 AAC 39.222), which were adopted into regulation by the Alaska Board of Fisheries (BOF). ADF&G is responsible for notifying the public whenever a new escapement goal is established or an existing escapement goal is modified. Similarly, ADF&G is responsible for notifying the BOF whenever allocative impacts arise from management actions necessary to achieve a new or modified escapement goal.

Since 2001, escapement goal reviews have been conducted every 3 years, concurrent with the BOF regulatory cycle. Escapement goals consistent with the SSFP definitions and the Escapement Goal Policy process were established for the first time during the 2001 regulatory cycle (Clark 2001a–c; Clark and Sandone 2001; Eggers 2001; Evenson 2002). Escapement goal reviews were subsequently conducted during the 2004, 2007, 2010, 2013, 2016, and 2019 cycles (ADF&G 2004; Brannian et al. 2006; Volk et al. 2009; Conitz et al. 2012; Conitz et al. 2015; Liller and Savereide 2018). Performance of meeting existing escapement goals in the AYK Region (along with all other regions) has been reported annually, with tabulations of escapement estimates from the most recent 10 years (e.g., Munro and Brenner 2022).

Since 2019, AYK Region escapement goal review activities were coordinated to achieve deadlines associated with the January 2022 AYK Region Finfish in-cycle BOF meeting, which was subsequently rescheduled due to COVID-19. Review timelines were established to achieve a public release of the AYK Region escapement goal review memo by March 10, 2021. The timeline for the memo was approximately one month prior to the April 11, 2021, regulatory proposal deadline set by the BOF. In response to COVID-19 disruptions, the BOF held a special meeting on March 8, 2021, during which they decided to postpone the proposal deadline to April 11, 2022 and reschedule the AYK Finfish meeting for January 2023. Consistent with the original timeline, ADF&G had completed all escapement goal reviews before the proposal and meeting dates were

rescheduled by the BOF. As such, ADF&G decided to conclude escapement goal review effort for the current cycle and present findings based on data available through 2020. ADF&G provided public notice, through the BOF, of the AYK Region escapement goal review on March 22, 2022[1].

The 2023 AYK Region escapement goal review was led by a team composed of regional research coordinators and fisheries scientists from the Divisions of Commercial Fisheries and Sport Fish. The AYK Escapement Goal Review Team (EGRT) met 5 times between April 30, 2020, and September 8, 2022 (Table 1) to plan and review escapement goal analyses in consideration of fishery and stock status, changes in assessment methodology, and new escapement data. Members of the AYK EGRT met more frequently (Table 1) with area research staff and a statewide biometrician to facilitate escapement goal reviews as planned through consultation with fishery managers. The 2023 review cycle focused on a detailed evaluation of the existing escapement goal structure to determine where revisions were needed to better align with current fishery management and assessment.

The result of the escapement goal review process, as outlined above, was a set of findings provided by the EGRT to the directors of the Divisions of Commercial Fisheries and Sport Fish. The EGRT did not find that any new escapement goals for AYK Region during the 2023 cycle were warranted. The EGRT did find that several existing escapement goals be revised or discontinued. Most of the review was done to streamline the number of escapement goals for the AYK Region by discontinuing goals that were no longer effective for informing fishery management decisions, where alternative assessment options exist.

The AYK Region has a long history of public engagement on escapement goals prior to formalizing new or discontinued goals, and improvements to the public engagement process were implemented during the 2023 review cycle. During past review cycles, the AYK Region coordinated a series of public stakeholder meetings to share preliminary findings and solicit feedback. This process was, in part, intended to notify the public of potential changes to escapement goals in advance of BOF proposal deadlines. COVID-19 travel and meeting restrictions prevented in-person meetings from occurring, and large-scale virtual meetings with rural stakeholders were not practical. As such, the AYK Region issued an Advisory Announcement on February 9, 2021 (Appendix A), notifying recipients of ADF&G's escapement goal review plans and options for engagement through the BOF process. The 2023 cycle represented the first time the AYK Region publicly released its escapement goal review memo prior to the BOF proposal deadline. Moving forward, the AYK Region anticipates coordinating all public engagement on escapement goals through the BOF and related stakeholder meetings.

## DEFINITIONS AND PROCESS

The SSFP provides the following definitions (slightly paraphrased) for biological and sustainable escapement goals as discussed in this review.

5 AAC 39.222 (f)(3): *biological escapement goal* (BEG) means the escapement that provides the greatest potential for maximum sustained yield. A BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted; it will be

[1] Zachary Liller (Regional Research Coordinator, Division of Commercial Fisheries, Region III) and James Savereide (Regional Research Coordinator, Division of Sport Fish, Region III). Arctic-Yukon-Kuskokwim, salmon escapement goal review. March 17, 2022 memorandum to Sam Rabung, Director, Division of Commercial Fisheries; and David Rutz, Director, Division of Sport Fish, presented at October 25–26, 2022, Board of Fisheries work session. Available at https://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2022-2023/ws/2022%20AYK%20EG%20Review.pdf

developed from the best available biological information, and should be scientifically defensible on the basis of available biological information. A BEG will be determined by the department and will be expressed as a range based on factors such as salmon stock productivity and data uncertainty; the department will seek to maintain evenly distributed salmon escapements within the bounds of a BEG.

5 AAC 39.222 (f)(36): *sustainable escapement goal* (SEG) means a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5- to 10-year period, used in situations where a BEG cannot be estimated due to the absence of a stock-specific catch estimate. The SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board, and will be developed from the best available biological information. The SEG will be determined by the department and will be stated as a range that takes into account data uncertainty; the department will seek to maintain escapements within the bounds of the SEG.

Both types of escapement goals are designed to provide for sustainable salmon fisheries. The decision to establish a BEG or SEG is dependent on the availability of stock-specific information and the nature of the fishery. Establishment of a BEG requires information about total run, harvest, and escapement to estimate the range of escapements that will maximize yield. Furthermore, establishment of a BEG requires harvest management to achieve escapements within ranges that will maximize yield where appropriate given the nature of the fishery. Subsistence fisheries are particularly important in the AYK Region, and providing stable subsistence harvests large enough to meet subsistence needs may be a higher-priority management objective than maximum sustained yield (MSY). In these cases, an SEG may be established based on a detailed stock-specific spawner-recruit analysis where the resulting SEG goal range does not have the greatest potential for MSY. Relatively few stocks (or stock components) in the AYK Region have adequate information to establish a BEG or SEG based on a spawner-recruit analysis. In particular, stock-specific harvest estimates are often unavailable. For this reason, most escapement goals in the AYK Region are SEGs based on good-quality escapement data where the goal ranges have been shown to produce sustainable harvest in the past and are intended to produce similar levels of harvest in the future. Management implications of escapement goals are also acknowledged, and ADF&G is directed to address issues in management plans and regulations as needed.

During its regulatory process, the BOF reviews the BEGs and SEGs that have been presented by the review team to the directors of the Divisions of Commercial Fisheries and Sport Fish. With the assistance of ADF&G, the BOF may also consider establishing an optimal escapement goal, which is defined (slightly paraphrased) as follows.

5 AAC 39.222 (f)(25): *optimal escapement goal* (OEG) means a specific management objective for salmon escapement that considers biological and allocative factors and may differ from the SEG or BEG. An OEG will be sustainable and may be expressed as a range with the lower bound above the level of Sustainable Escapement Threshold, and will be adopted as a regulation by the board. The department will seek to maintain evenly distributed escapements within the bounds of the OEG.

There are currently no OEGs established by the BOF for the AYK Region.

# METHODS

There are 2 primary methods that have been used to establish escapement goals for the AYK Region: Percentile Approach and spawner-recruit yield analysis. The method chosen is based on availability of stock-specific data. The review team determined that the Percentile Approach was the most appropriate for setting an SEG for fished stocks that lack stock-specific harvest information. The Percentile Approach has been commonly used across Alaska and uses ranges of historical escapement over a given time period as a valid proxy for the range of spawners likely to produce MSY ($S_{MSY}$). The recommendations as presented in Bue and Hasbrouck (*unpublished*)[2] or Clark et al. 2014 have been applied to appropriate AYK stocks, with method-specific consideration of harvest rate, data contrast (contrast indicates the ratio of highest to lowest observed escapement), and measurement error. As per Clark et al. (2014), the Percentile Approach was not recommended in cases of high harvest rates (greater than or equal to 0.40) or combinations of very low escapement contrast (4 or less) and high measurement error (aerial or foot surveys). Spawner-recruitment and yield analyses have been used in instances where reliable stock-specific harvest is available. Current practice within AYK escapement goal setting is to estimate management reference points (e.g., $S_{MSY}$) based on Ricker spawner-recruit parameters and develop optimum yield profiles within a state-space framework, which may directly incorporate a run reconstruction sub-model, often using Bayesian methods. State-space models relate unobserved process or "state" variables to observed data and incorporate specification of both stochastic fluctuation inherent in the system ("process error") and observation error, allowing for a robust and realistic characterization of uncertainty (Rivot et al. 2004; Su and Peterman 2012; Fleischman et al. 2013). State-space models have been shown to provide less biased estimates of population parameters and reference points than traditional spawner-recruitment methods (Su and Peterman 2012).

As part of the 2023 AYK Region escapement goal review process, area research and management staff were directed to review current information and all existing escapement goals to determine whether goal changes or in-depth analyses may be warranted. Data, previous analyses, and estimates for all stocks reviewed were obtained primarily from published research and management reports and the AYK database management system[3]. When necessary, data were supplemented from unpublished staff data sources. In nearly all cases, escapement goal reviews considered data through the 2020 project year. Data from 2021 and 2022 were not available at the time of review. Data quality control measures were integral to the review process, and escapement goals were evaluated based upon the most consistent and reliable data sets that could be obtained. For example, only those aerial survey data listed as "fair" or "good" in the survey notes were used in review analyses. Similarly, estimates of missed passage at weirs/tower projects were reviewed to ensure comparability of escapement estimates throughout the time series. Historical data series, in which older estimates were not comparable with newer ones due to changes in methodologies over time, were statistically adjusted if possible. Poor surveys, incomplete assessments, and noncomparable estimates were omitted from the data series because they could introduce bias and the time series would more accurately represent escapement trends without them.

The extent of each escapement goal review for the 2023 cycle was dependent on the availability of new information such as significant changes in stock assessment methods, fisheries, and trends

[2] Bue, B. G., and J. J. Hasbrouck. Unpublished. Escapement goal review of salmon stocks of Upper Cook Inlet. Report to the Board of Fisheries November 2001 (and February 2002). Alaska Department of Fish and Game, Anchorage.

[3] AYK Database Management System (AYKDBMS). 1954– . Alaska Department of Fish and Game, Anchorage. https://www.adfg.alaska.gov/CF_R3/external/sites/aykdbms_website/Default.aspx

in the data series for each stock. Central to the review was an in-depth discussion with fishery managers to evaluate how each escapement goal has been utilized to make management decisions and how well it has been performing as a management tool. With few exceptions, staff identified no notable changes since the 2019 review to escapement goal analyses, data availability, assessment programs, or fisheries that would warrant establishing any new goals or require fundamental changes to the escapement goal structure within each management area. As such, the 2023 AYK EGRT focused its review efforts on (1) Chena and Salcha Rivers Chinook salmon *O. tshawytscha* escapement goals for which new information suggested an updated analysis might result in a revised escapement goal and (2) Yukon River coho salmon *O. kisutch* and Kuskokwim River Chinook salmon tributary goals that should be discontinued because they no longer align with current fisheries assessment or management practices.

The remainder of this report presents the review team's findings and rationale for revising or discontinuing select escapement goals in each area within the AYK Region. Limited discussion will be provided for select stocks for which substantial reviews were conducted but the review team found no change to the existing goal was warranted. Final approval of escapement goals will be made by the directors of the Divisions of Commercial Fisheries and Sport Fish following the January 2023 BOF meeting.

# NORTON SOUND–PORT CLARENCE AND ARCTIC–KOTZEBUE SOUND AREAS

A total of 18 escapement goals for 17 stocks exist in the Norton Sound–Port Clarence and Kotzebue Areas: 2 Chinook salmon, 7 chum salmon *O. keta*, 3 coho salmon, 4 pink salmon *O. gorbuscha*, and 2 sockeye salmon *O. nerka* (Table 2; Liller and Savereide 2019). There are no BEGs established for the Norton Sound–Port Clarence and Kotzebue Areas. All escapement goals are SEGs. There is one pink salmon stock that has separate even- and odd-year goals.

The AYK EGRT finds no new goals or any changes to existing goals during the 2023 review cycle are warranted. The reason to maintain the current goals stems from the fact that the AYK EGRT implemented substantial revisions during the 2019 review cycle (Liller and Savereide 2018), and no new information was available to justify additional escapement goal refinements. As such, review discussions focused on identifying future escapement goal review priorities related to Unalakleet River Chinook salmon and Pilgrim River (Salmon Lake) sockeye salmon.

## UNALAKLEET RIVER CHINOOK SALMON

A "yield concern" is a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs. Unalakleet River Chinook salmon have been designated as a *stock of yield concern* since January 2004, and escapement goals for Chinook salmon returning to the Unalakleet River drainage have been a regular topic of discussion during AYK escapement goal review cycles. In 2005, SEG ranges were established for 2 tributaries of the Unalakleet River: the North River (1,200–2,600; tower counts) and Old Woman River (500–1,100; aerial survey counts). During the 2007 review cycle, Estensen and Evenson (2006) suggested both SEGs be retained while continuing to collect information to develop a biological escapement goal for the entire drainage. Since that time, a multi-year radiotelemetry study was completed (Wuttig 1998, 1999; Joy and Reed 2014a, 2014b), and a weir has been operated annually on the mainstem Unalakleet River since 2010 (e.g., Bell and Leon 2018). The 2010 (Volk et al. 2009) and 2013 (Conitz et al. 2012)

review cycles both indicated improvements to better align escapement goals with fishery management needs were warranted, but the data needed to establish a drainagewide goal or a Unalakleet River weir-based goal was insufficient. During the 2016 review (Conitz et al. 2015) the Old Woman River aerial survey goal was discontinued due to poor survey conditions, and the review team formally signaled its long-term plan to establish a goal on the mainstem Unalakleet River as soon as the time series of weir counts was adequate. The 2019 cycle explored options to revise the North River goal using updated tower data and percentile prescriptions outlined in Clark et al. 2014, but ultimately no revision was implemented. No action was taken during the 2023 cycle, but there was broad consensus to reallocate future effort away from routine reviews of the North River SEG and instead focus on developing a comprehensive escapement goal plan for Unalakleet River Chinook salmon. This plan should include criteria for establishing a drainagewide escapement goal and options for establishing a weir-based goal on the mainstem Unalakleet River.

## PILGRIM RIVER (SALMON LAKE) SOCKEYE SALMON

The AYK EGRT consideration of the Pilgrim River (Salmon Lake) sockeye salmon escapement goal during the 2023 review cycle aligned with commitments made to the BOF during the 2019 AYK Finfish meeting. The Pilgrim River (Salmon Lake) sockeye salmon SEG of 6,800–36,000 was established in 2019 based on the 15–65 percentiles of historical weir-based escapement estimates. Prior to the 2019 AYK BOF meeting, the Northern Norton Sound Fish and Game Advisory Committee submitted proposal 127[4], which aimed to replace the guideline harvest range for Port Clarence District (5 AAC 04.362) with a management plan for Port Clarence District salmon and Pilgrim River sockeye salmon. The proposed management plan was tied to the escapement goal. Public comments during the meeting included concerns that the upper bound of the SEG established by ADF&G was unnecessarily high and additional information from multi-year lake fertilization and smolt outmigration studies could be used to develop a more informed escapement goal. The BOF directed ADF&G to work with the proponents to discuss available information for informing the Pilgrim River (Salmon Lake) sockeye salmon escapement goal. ADF&G confirmed its commitment to working with the proponents during the October 23, 2019, BOF Work Session[5].

During the 2023 review cycle, ADF&G conducted reviews of available Pilgrim River and Salmon Lake data sets that may help the AYK EGRT consider escapement goal revisions in future cycles. Pilgrim River drains Salmon Lake, and the lake has been fertilized by the Norton Sound Economic Development Corporation (NSEDC) since 1997, except for 4 years in the first decade of the 2000s. The only published review of the efficacy of the lake fertilization efforts on enhanced production of sockeye salmon was completed in 2012 (Hamazaki et al. 2012). At the request of the NSEDC, the ADF&G Kodiak Island Limnology Laboratory (KILL) conducted an updated review of available information and provided summaries of their findings in 2020. Concurrently, ADF&G AYK staff evaluated stock productivity using a simple 2-parameter Ricker spawner-recruitment model to estimate $S_{MSY}$ and spawners at equilibrium ($S_{EQ}$). The analyses conducted by the KILL and other staff have not undergone biometric or peer review and were not formally presented to the AYK EGRT. No action was taken during the 2023 review cycle, but there was broad consensus

[4] Northern Norton Sound Fish and Game Advisory Committee. Proposal 127: Repeal the Guideline Harvest Range for the Port Clarence District and replace with the *Port Clarence District and Pilgrim River Salmon Management Plan*. https://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2018-2019/proposals/127.pdf

[5] Alaska Board of Fisheries Work Session: October 23–24, 2019. Meeting audio, 02:26:55 PM: Department report on Proposal 127 from 2019 AYK meeting ADF&G. https://www.adfg.alaska.gov/index.cfm?adfg=fisheriesboard.meetinginfo&date=10-23-2019&meeting=anchorage

that future discussion pertaining to the Pilgrim River (Salmon Lake) escapement goal should seek to clarify fishery management objectives for this enhanced stock and long-term plans for lake fertilization and monitoring. There is currently no commercial fishery for this stock, and harvest is limited to the local subsistence fishery (Menard et al. 2020).

# YUKON AREA

In the Yukon Area, which includes the portion of the Yukon River drainage within Alaska, there are currently 13 established escapement goals: 6 Chinook salmon, 3 summer chum salmon, 3 fall chum salmon, and 1 coho salmon (Table 3; Liller and Savereide 2018). Of these goals, 4 are BEGs and 9 are SEGs. Not included in this listing are 3 goals for Canadian stocks that were established as part of the *Yukon River Salmon Agreement*. Escapement targets for these Canadian stocks (mainstem Yukon River Chinook salmon, mainstem Yukon River fall chum salmon, and Fishing Branch River fall chum salmon) are set annually by the Yukon River Panel (e.g., JTC 2022). The 2023 escapement goal review did not include goals set by the Yukon River Panel; however, performance of these goals is reported annually by ADF&G (e.g., Munro and Brenner 2021).

The AYK EGRT has found that a revision to the Chena River escapement goal and discontinuation of the Delta Clearwater coho salmon escapement goal is warranted (Table 3). The findings do not have implications for existing management plans. The review team finds that all other existing escapement goals for salmon stocks in the Yukon Area should continue without revision.

The following sections are focused on those goals for which the EGRT found changes were warranted. In addition, we provided a brief discussion of new analyses available for Yukon River Chinook salmon and considerations for the Yukon River summer chum salmon drainagewide goal, which was reviewed but no action was taken.

## CHENA RIVER AND SALCHA RIVER CHINOOK SALMON

The Chena River and Salcha River BEGs were established in 2001 based on a traditional spawner-recruit analysis, which produced estimates of MSY using regression analysis and Ricker's 2-parameter model (Evenson 2002). The model was implemented using multiple run reconstruction derivations that considered variability in the proportion of the commercial and subsistence harvests attributable to Chena and Salcha River populations. The current escapement goals were established based on the $S_{MSY}$ of 4,075 fish in the Salcha River and 3,547 fish in the Chena River. More specifically, goals of 3,300–6,500 for the Salcha River and 2,800–5,700 for the Chena River were based on a range of 0.8–1.6 times the $S_{MSY}$ estimates (Evenson 2002).

In 2007, the Chena and Salcha River stocks were reevaluated using 2 analytical approaches for an age-structured, 2-parameter Ricker spawner-recruit model (Volk et al. 2009; Evenson and Reed *unpublished*[6]). Their analysis involved both a "classical" approach using simple linear regression and Bayesian statistical methods in the Ricker framework to incorporate uncertainty in estimates of spawners, harvest, and age and sex composition. Evenson and Reed (*unpublished*) examined several run reconstructions for each population that included corrected and uncorrected sex ratios (Matter and Tyers 2020) and a female-only data set. For both populations, estimates of $S_{MSY}$ and their 80% credible intervals were within the bounds of the current BEG. Escapements within the range of the current BEGs had at least a 50% probability of achieving yields greater than 90% of

[6] Evenson, D., and D. J. Reed. Unpublished. Chena and Salcha River stock evaluation. Alaska Department of Fish and Game, Anchorage (hereafter cited in text as "Evenson and Reed *unpublished*").

MSY for the Salcha River and at least a 40% probability of achieving yields greater than 90% of MSY for the Chena River. Based on these analyses, retaining the current BEGs for both populations was warranted (Volk et al. 2009; Evenson and Reed *unpublished*).

During the 2023 review, integrated state-space models were fit to all relevant harvest, age composition, and abundance data for the Chena River from 1986–2019 and for the Salcha River from 1987–2019. For both populations, we also fit the same model to data sets that ended in 2006, which was when the last escapement goal evaluation was performed. The integrated state-space model simultaneously reconstructs historical abundance and fits a spawner-recruit relationship while accommodating missing data, measurement error, changes in age at maturity, and other associated uncertainty. The resulting spawner-recruit relationships (Figures 2 and 3) differed from the previous analyses. The number of spawners associated with MSY ($S_{MSY}$) was the biological reference point of most interest. The state-space model for the Chena River in the years 1986–2019 estimated $S_{MSY}$ (4,555) to be within the current goal range but above the $S_{MSY}$ value estimated from the 1986–2006 data set (3,827) and toward the upper end of the established BEG range. Comparing results from the 2 data sets indicated that the Chena River stock began to experience reduced productivity in the early 2000s. The estimate of $S_{MSY}$ for the Salcha River in the years 1987–2019 (4,801) also fell within the current goal range but was higher than the value of $S_{MSY}$ estimated from the truncated time series ending in 2006 (4,173). Expected yields for both populations were considerably lower with the inclusion of the 2007–2019 data (Figure 4).

Ideally, an escapement goal would contain the estimate of $S_{MSY}$ within the goal range to optimize the potential to produce the largest harvestable surplus. However, a decrease in the number of recruits per spawner and age at maturity in recent years strongly suggests the Chena and Salcha Rivers have experienced a decline in productivity. A decline in productivity is further supported by the lower $\alpha$ estimates using all the data in comparison to estimates derived from the truncated time series through 2006 (Table 5).

The AYK EGRT found that the existing BEG range for Chena River Chinook salmon should be revised and that the existing goal for Salcha River Chinook salmon should remain unchanged. These decisions acknowledged the amount of time since the original goal was established, a roughly 34% increase in the amount of new data available, and more robust results from a new state-space model that incorporates all sources of error into the analysis. BEGs for these stocks leveraged optimum yield profiles derived from the spawner-recruit relationship. The AYK EGRT sought to select BEG ranges that maximize the probability of achieving $S_{MSY}$ while minimizing the probability of overfishing and failure to achieve $S_{MSY}$. A goal with a range that is sufficiently broad to be useful for management was also desired. The revised goal for the Chena River of 3,300–5,700 has a 70% chance of achieving 90% of $S_{MSY}$ (Figure 5), and the existing goal for the Salcha River of 3,300–6,500 also has a 70% chance of achieving 90% $S_{MSY}$ (Figure 6). The new and existing goals thus contain $S_{MSY}$, which minimizes the chances of overfishing and allows for conservative management if the stock continues to demonstrate the low productivity seen in the last decade. The optimum yield and recruitment profiles (Figures 5 and 6) illustrate how the new goal trades yield for recruitment.

The AYK escapement goal memo presented at the BOF work session in October 2022 described lowering the upper bound of the Salcha River BEG. In this report we find no change to the existing Salcha River BEG is warranted. The change was in response to an error in the preliminary analysis that did not correctly specify the sport fishery harvest in the run reconstruction. Once this was

corrected, $S_{MSY}$ increased and the yield profile illustrated that the existing goal is more appropriate than the goal presented in the AYK escapement goal memo.

## DELTA CLEARWATER COHO SALMON

Coho salmon assessment throughout much of the Yukon River drainage is quite limited due to expense and the difficulty of operating assessment projects during the fall when high water and icing conditions are common. The majority of coho salmon fishery management decisions are informed by a mainstem sonar located near Pilot Station; 2 mainstem test fisheries operated in the lower portion of the Yukon River near Emmonak and Mountain Village; and inseason commercial and subsistence harvest reports. The only consistent escapement monitoring of coho salmon in the entire Yukon River drainage occurs in the Delta Clearwater River (DCR), which is nearly 1,500 km (i.e., one month travel time) upriver from Pilot Station, where drainagewide coho salmon abundance is indexed inseason.

The DCR drains the upper portion of the Tanana River Management Area and supports the largest documented spawning concentration of coho salmon in the Yukon River (Parker 1991). The DCR is spring fed and remains largely ice free, is about 20 miles in length, is road accessible, and supports the largest sport fishery for coho salmon in the Tanana River drainage. Coho salmon returning to the DCR also contribute unknown numbers of fish to subsistence, personal use, and commercial fisheries in the mainstem Yukon and Tanana Rivers.

An SEG of 5,200–17,000 DCR coho salmon was established in 2005 (ADF&G 2004), based on percentiles of historical escapement estimates derived from boat surveys counts, which are considered minimum counts. Annual evaluation of the escapement goal has been conducted by the Division of Sport Fish (e.g., Matter and Tyers 2020). Peak spawning abundance is indexed from a boat survey conducted during late October or early November throughout 18 miles of navigable water. This index section encompasses approximately 80% of total drainage escapement (Parker 2009). The annual peak spawning survey occurs after nearly all sport fishing has ended for the year; as such, no harvest adjustments are required. Availability of paired aerial and boat survey data is inadequate to reliably estimate total escapement.

The AYK EGRT determined that discontinuing the DCR coho salmon SEG range is warranted because it provides an unreliable index of coho salmon escapement for the Yukon River drainage and is not useful for fisheries management. The DCR is located far upriver from where mainstem Yukon River commercial and subsistence harvest occurs. The timing of DCR escapement surveys occurs after Yukon River coho salmon fisheries (including Tanana River fisheries) have ended and after local DCR sport fishing activity has ceased. The DCR coho salmon escapement index has a poor relationship with drainagewide abundance and escapement as indexed by the Pilot Station sonar project and upriver harvest (Figure 7). As such, inseason management of mainstem fisheries has no ability to predictably affect coho salmon escapement to the DCR. Within the DCR, the escapement goal is not used to make recreational fishing management decisions; rather, management is responsive to actions taken in lower river fisheries and limited preliminary boat surveys conducted in the lower 8 miles of the DCR to assess run strength for inseason management of the sport fishery (see description in Parker 2009). Harvest of coho salmon within the DCR is relatively small (2011–2020 average 213) with most anglers practicing catch-and-release. As such, harvest management within the DCR has limited ability to affect escapement (Figure 8).

ADF&G will continue to monitor escapements to the DCR and has taken steps to improve drainagewide assessment of Yukon River coho salmon. ADF&G is committed to continuing

annual boat surveys of DCR coho salmon escapement, which will be critical for monitoring local inriver abundance and escapement trends. ADF&G is also committed to continuing aerial surveys to monitor abundance of coho salmon in river systems in the Tanana River drainage, including the Nenana and Toklat Rivers, and Upper Tanana River near Delta such as Richardson Clearwater River and Clearwater Lake Outlet. ADF&G has secured funding to investigate Yukon River coho salmon spawning distribution using radiotelemetry techniques. The one-year tagging study was conducted in 2022 (Borba and Padilla 2022). Pending results will inform future coho salmon escapement monitoring activities that may allow for establishing new escapement goals that are useful for informing sustainable fisheries management.

## YUKON RIVER SUMMER CHUM SALMON CONSIDERATIONS

A drainagewide BEG of 500,000–1,200,000 Yukon River summer chum salmon was established in 2016 (Conitz et al. 2015) based on an integrated Bayesian state-space run reconstruction and spawner-recruitment analysis (Hamazaki and Conitz 2015). The BEG range was based on Ricker model reference points and optimal yield profiles, along with consideration of historical ranges of harvest and escapement. Slightly different criteria for the lower and upper bounds were justified by differences in management of subsistence and commercial fisheries, both of which are very important in the Yukon Area for summer chum salmon.

The Yukon River summer chum salmon drainagewide BEG was reevaluated during the 2019 review cycle and discussed at length during the start of the 2023 review cycle. The 2019 review resulted in no change to the drainagewide goal (Liller and Savereide 2018). Discussions with Yukon Area research and management staff during the 2023 review cycle focused on the relationship between drainagewide and tributary escapement performance. In addition to the summer chum salmon drainagewide goal, there is a lower-bound SEG established for the East Fork Andreafsky River (>40,000) and a BEG range for the Anvik River (350,000–700,000). By design, management for the drainagewide escapement goal should accommodate the objective of also achieving tributary goals (see page 17 of Hamazaki and Conitz 2015). However, apparent changes in the productivity of individual spawning tributaries and spatial distribution of spawners have resulted in consistent failure to achieve the Anvik River BEG even when the drainagewide escapement is near the upper end of the goal range (e.g., Munro and Brenner 2022). The AYK EGRT found that no revision to any Yukon River summer chum salmon escapement goals are warranted at this time but recognized the need for a holistic evaluation of Yukon River summer chum salmon escapement goals during future review cycles.

Record low run sizes in 2021 and 2022 prompted the AYK EGRT to revisit the drainagewide Yukon River chum salmon BEG after ADF&G's escapement goal memo was submitted to the BOF. For the first time in history, multi-species salmon run failures in 2021 and 2022 (including Yukon River summer chum salmon) resulted in complete closures to all salmon directed fishing within the Yukon Area during the summer and fall seasons. The extent of fishery closures resulted in unprecedented cultural and traditional disruptions and threatened food security for many residents that rely on salmon. As such, the AYK EGRT conducted a preliminary review of the Yukon River summer chum salmon drainagewide BEG to evaluate if sustainable harvest could be identified at escapement levels below the lower bound of the existing goal. Analysis confirmed that harvestable surpluses could be sustained with annual escapement smaller than the lower bound of the current BEG range. However, the AYK EGRT did not find that reducing the lower bound of the current escapement goal is appropriate, for the following reasons:

1. Model yield and recruitment predictions suggest escapements smaller than 500,000 are sustainable but cannot be grounded with observations.
2. Reducing the lower bound of the drainagewide escapement goal would have unknown consequences for discrete spawning populations and could have negative implications for sustainability and productivity, especially within small tributaries.
3. The cause of the recent run size decline is not known. Therefore, the historical productivity patterns may not be a good indicator of expected future performance.
4. The existing BEG provides the greatest potential for MSY. The BOF has the authority to establish an OEG that remains sustainable but considers the need for a reliable subsistence harvest opportunity.
5. Changes to the drainagewide escapement goal have implications for the Yukon River Summer Chum Salmon Management Plan (5 AAC 05.362), which should be considered if the BOF undertakes OEG deliberation.

## ADVANCEMENTS PERTAINING TO YUKON RIVER CHINOOK SALMON

Current escapement goals for Yukon River Chinook salmon represent only a subset of the drainagewide and stock-specific escapement, but new information may allow for consideration of alternative escapement goal options in the future. Yukon River Chinook salmon consist of hundreds of distinct spawning populations (Brown et al. 2017) that aggregate into 3 large-scale genetic reporting groups (i.e., substocks) relevant to fisheries management: Lower U.S., Middle U.S., and Canada (e.g., Lee et al. 2021). Currently, assessment programs have been sufficient for ADF&G to establish escapement goals for 6 spawning tributaries in the U.S. portion of the drainage, and for the bilateral U.S./Canada Yukon River Panel (YRP) to establish an escapement goal for the Canada stock. Substantial new modeling initiatives have been completed that may have implications for future ADF&G escapement goal reviews. Hamazaki (2021) presented a multi-stock maximum likelihood run reconstruction model, which used inriver abundance, genetics, harvest, and escapement data to simultaneously estimate total run and escapement for the Lower U.S., Middle U.S., and Canada stock components. Hamazaki's model was presented as a proof of concept, because additional data quality and model sensitivity reviews were needed before model results could be used to inform fishery management decisions. Beginning in 2019, the YRP, Joint Technical Committee (JTC) leveraged Hamazaki's model as the building block of a multi-year review of the Canada stock productivity. The JTC conducted a comprehensive data review of all available abundance information relevant to reconstructing Yukon River Chinook salmon run size and escapement. Based on their findings, the JTC made improvements to the data sets used to inform the multi-stock model and restructured the model in a Bayesian context. The JTC extended the multi-stock run reconstruction model to include an integrated state-space spawner-recruitment model for the Canada stock only. The results of these efforts are a newly available data review report (Pestal et al. 2022) and a multi-stock run reconstruction and spawner-recruitment framework for evaluating stock-specific Yukon River Chinook salmon productivity back to 1981. The model has undergone extensive peer review and the report will be available via the Canadian Center for Scientific Advice (Connors et al. *In press*).

JTC model development and productivity evaluation for the Canada stock overlapped with the 2023 AYK EGRT activities. The EGRT met on September 8, 2021, to discuss the JTC activities and the potential utility of pending model outputs for future ADF&G-led escapement goal reviews. Members of the EGRT provided biometric and peer review of draft model reports and participated

in the formal peer review meeting facilitated by the Canadian Center for Science Advice (DFO 2022).

# KUSKOKWIM AREA

The Kuskokwim Area, which includes the Kuskokwim River and Kuskokwim Bay drainages, currently has 22 established escapement goals for 13 Chinook salmon, 2 chum salmon, 3 coho salmon, and 4 sockeye salmon stocks or stock components (Table 4; Liller and Savereide 2018). All goals are SEGs.

All stocks with an existing goal were reviewed during the 2023 cycle. The review team has decided that 5 Kuskokwim River tributary aerial survey escapement goals be discontinued (Table 4). None of the changes have implications for existing management plans. ADF&G finds no changes to Chinook salmon escapement goals in Kuskokwim Bay or any chum, sockeye, or coho salmon goals within the Kuskokwim Area are warranted.

The following sections are focused on Kuskokwim River Chinook salmon, for which all goals were reviewed, and discontinuation of 5 goals were warranted. In addition, we provide a brief discussion of Middle Fork Goodnews River escapement goals established for multiple salmon species, which were reviewed but no action was taken.

## KUSKOKWIM RIVER CHINOOK SALMON

ADF&G has undertaken a multi-year effort to improve the escapement goal structure for Kuskokwim River Chinook salmon. Prior to the 2013 board cycle, there were 11 tributary escapement goals for Kuskokwim River Chinook salmon (e.g., Volk et al. 2009), which are managed as a single unit. Most of these goals were originally established in 2005 or 2007 for tributaries with appropriate type, quality, and amounts of escapement data (ADF&G 2004; Molyneaux and Brannian 2006; Brannian et al. 2006). At the time tributary escapement goals were established, there was no clear description of how these spatially distinct goals should be used to inform management actions, which occur primarily on mixed fisheries in the lower portion of the Kuskokwim River mainstem. In 2013, ADF&G established a drainagewide goal for Kuskokwim River Chinook salmon based on a run reconstruction and spawner-recruit analysis (Hamazaki et al. 2012). At that time, ADF&G took steps to align weir-based tributary goals with the new drainagewide goal, but aerial survey goals were not adjusted (Conitz et al. 2012). During the 2019 BOF cycle, the ADF&G conducted a comprehensive review of the drainagewide goal and discussed, at length, the utility of the multiple tributary goals established for this single stock (Liller and Savereide 2018). Although only minor changes were made to the escapement goal structure in 2019, the review team recommended that all Kuskokwim River Chinook salmon escapement goals be reevaluated during the next review cycle with the expressed purpose of ensuring the drainagewide and tributary goals are aligned and consistent with the geographic scale at which fisheries are managed. Specifically, ADF&G signaled its plan to evaluate tributary goals during the 2023 cycle and discontinue goals that do not add meaningful information for fisheries management.

During the 2023 cycle, the AYK EGRT undertook a series of analyses to evaluate all Kuskokwim River Chinook salmon escapement goals. First, the drainagewide run reconstruction model (Liller et al. 2018) was updated to include revised estimates of weir passage (Dickerson et al. *In prep*). The revised model was used to conduct a Bayesian state-space spawner-recruit analysis using the most up-to-date estimates of total run, total escapement, and age composition for 44 years

(1976–2019). The analysis conducted was identical to that described in Hamazaki et al. (2012), which formed the basis for the existing SEG. The only difference was the updated input data. Finally, a series of correlation and simulation analyses were conducted to evaluate the relationship between drainagewide and tributary escapement.

Updates to the drainagewide run reconstruction model and spawner-recruitment analysis produced results that were similar to past evaluations. In general, the resulting spawner-recruit relationship (Figure 9) and estimated biological reference points (e.g., $S_{MSY}$, $S_{MAX}$, and $S_{EQ}$) were consistent with the previous analysis conducted by Hamazaki et al. (2012; Table 6). However, consistent with the 2019 review (Liller and Savereide 2018), updated yield analyses indicate that the Kuskokwim River Chinook salmon stock is not as productive as previously thought when the goal was established in 2013 (Figure 10).

The AYK EGRT agreed that the existing Kuskokwim River Chinook salmon drainagewide SEG of 65,000–120,000 is appropriate. Reviews during both the 2019 and 2023 cycle indicated the existing goal possibly includes spawning abundances that are expected to maximize both future yields and future recruitment. Review results suggest that modest revisions (e.g., ±10,000 fish) to either the lower or upper bound of the goal range would not be expected to return measurable benefits to fisheries in terms of future yield, run size, or reduced uncertainty in fishery performance. Observed returns from spawning abundances below the lower bound of the current escapement goal range demonstrate that small escapements are sustainable[8], and model predictions suggest that reducing the lower bound may increase future yield on average. However, the AYK EGRT agreed that lowering the goal would be risky and may unintentionally perpetuate below-average run abundance under a poor productivity regime. Conversely, the review team agreed that raising the lower bound of the goal would unnecessarily restrict fisheries with no clear conservation benefits. Currently, the upper bound of the escapement goal plays a negligible role in fishery management decisions, because there is no commercial fishery and the subsistence fishery has limited ability to harvest large surpluses in excess of the goal. Therefore, revisions to the upper bound of the escapement goal range were not considered extensively by the AYK EGRT, except for the acknowledgment that escapements above the current upper bound are associated with model expectations of reduced yield and should be avoided. The Kuskokwim River Chinook salmon drainagewide escapement goal has been reviewed extensively by ADF&G and independent analysts since it was established in 2013, and there has been no strong evidence to support a change (see summary in Liller and Savereide 2018, and indirectly in Connors et al. 2020; Staton et al. 2020; and Staton et al. 2021).

Given that Kuskokwim River Chinook salmon are managed as a single stock group with a drainagewide escapement goal, a primary focus of the AYK EGRT during the 2023 review cycle was to identify and discontinue Kuskokwim River Chinook salmon tributary escapement goals that are no longer used to make fishery management decisions. The review team believes discontinuation of the following 5 tributary SEGs established for Kuskokwim River Chinook salmon is warranted: the Kisaralik River, Aniak River (mainstem), Salmon River (Aniak River drainage), Cheeneetnuk River (Swift River drainage), and Gagarayah River (Swift River drainage). Each of these SEGs was established in 2005 based on historical percentiles (ADF&G 2004) of one-time peak aerial survey index counts. Since that time, the Percentile Approach to

[8] There have been 7 years (1982, 1985, 1986, and 2010–2014) with brood-year escapements less than 65,000, in which adult returns per spawner ranged between 1.6–4.4. The most recent 2010–2014 years of low escapement saw 1.6–3.4 returns per spawner.

establishing SEGs has been reviewed and percentile prescriptions have been updated (Clark et al. 2014). The new Percentile Approach is not recommended for stocks with high harvest rates and high measurement error, both of which apply to the 5 aerial survey goals that are warranted for discontinuation. In addition to being based on outdated methods, evaluation of these 5 aerial survey goals is not used to inform harvest management decisions. Harvest of Chinook salmon within these specific tributaries is small[9] compared to harvest in mainstem Kuskokwim River fisheries. All but the Kisaralik River are located well upstream from where about 80% of the mainstem harvest occurs. In each case, the timing of survey flights occurs after mainstem fisheries have ended, and fisheries managers have few, if any, options to make harvest decisions in the mainstem Kuskokwim River to control escapement to these specific tributary locations.

The review team recognizes the value of the Kuskokwim River Chinook salmon aerial survey program. Annual aerial survey counts provide a cost-effective method to evaluate relative changes in spawning abundance and distribution across a broad geographic scale. Annual aerial survey counts are critical inputs into the Kuskokwim River Chinook salmon run reconstruction model (e.g., Larson 2022), which is used to estimate drainagewide escapement and determine if the drainagewide escapement goal was met. ADF&G is committed to continuing annual aerial survey monitoring of approximately 14 tributaries used as model inputs, including the 5 tributaries where SEGs are being discontinued.

Remaining goals for Kuskokwim River Chinook salmon will include a drainagewide goal and 4 tributary goals for the Kwethluk, George, Kogrukluk, and Salmon (Pitka Fork) Rivers. Management for the drainagewide escapement goal will seek to achieve tributary goals to ensure adequate spatial distribution of spawners to 3 broad geographic areas: lower, middle, and headwater tributaries[10]. Exploratory simulation analyses suggest that when the Kuskokwim River drainagewide Chinook salmon goal is achieved, tributary escapements fall within historical ranges. Concurrence between drainagewide and tributary escapements is not surprising, given tributary escapements throughout the entire Kuskokwim River drainage are generally positively correlated and strong correlations are common among nearby systems (Table 7). However, it is possible that the drainagewide goal could be achieved while one sub-stock component or more experiences poor escapement. As such, it is important to clarify the intent of the 4 tributary escapement goals that will be used to index Chinook salmon to the lower, middle, and headwater portions of the Kuskokwim River drainage. The Kwethluk River weir SEG will be used by ADF&G to index escapement to lower river tributaries. Radiotelemetry studies have shown that Kwethluk River Chinook salmon have similar migration timing and swim speeds as Chinook salmon returning to the nearby Kisaralik River (Moses et al. 2019), indicating management strategies will probably have similar impacts across all lower river tributaries. The Kogrukluk River and George River weir SEGs will be used to index Chinook salmon spawning in north- and south-draining tributaries of the middle portion of the Kuskokwim River. The Salmon (Pitka Fork) River is one of the most important spawning locations for Chinook salmon bound for the headwaters of the Kuskokwim River drainage. Chinook salmon returning to the headwaters tend to enter the Kuskokwim River

[9] There are very little data to quantify subsistence and sport harvest of Chinook salmon within the Kisaralik River, Aniak River (mainstem), Salmon River (Aniak River drainage), Cheeneetnuk River (Swift River drainage), and Gagarayah River (Swift River drainage). Comprehensive subsistence harvest surveys conducted in communities closest to these tributaries suggest that salmon search and harvest areas are concentrated in the mainstem Kuskokwim River near established communities and fish camps.

[10] Radiotelemetry studies have shown that in some years there are distinct sub-stock Chinook salmon migration patterns through the primary mainstem harvest areas in the lower Kuskokwim River (e.g., Stuby 2007; Smith and Liller 2017). Therefore, management actions taken in the lower Kuskokwim River harvest areas are expected to affect groups of fish returning to broad geographic area similarly.

earlier in the run, and managers have some ability to affect escapements to the headwaters through early season harvest strategies.

## MIDDLE FORK GOODNEWS RIVER ESCAPEMENT GOALS

SEGs have been established for Middle Fork Goodnews River (MFGR) Chinook, chum, sockeye, and coho salmon but have not been monitored for several years due to a combination of funding and logistical constraints. The MFGR weir has historically been funded by a combination of State of Alaska, Federal grants, and commercial fishing industry contributions. The standardized annual operational dates for the MFGR are June 25–September 18, and statistical methods are used to estimate missed passage by species for days when the weir is not operational (Dickerson et al. *In prep*). Each SEG was based on historical percentiles of escapement estimates from a weir operated in the lower portion of the MFGR (ADF&G 2004; Liller and Savereide 2018). During 2012–2015 annual weir operations were ended around August 31, preventing reliable estimates of total coho salmon escapement. In all but the 2015 project year, the coho salmon escapement goal could not be assessed. In 2015, a minimum count was adequate to determine the goal was met (Munro and Brenner 2021). During 2016–2019, annual weir operations were ended around July 31, preventing any meaningful assessment of the coho salmon run. Since 2019, the MFGR weir has not operated due to funding limitations, and no salmon escapement goals for this system have been assessed. ADF&G will retain all MFGR weir SEGs while evaluating alternative funding options to reinitiate assessment. However, ADF&G will consider discontinuing the MFGR Chinook, chum, sockeye, and coho salmon weir-based SEGs during the next review cycle if the goals cannot be assessed.

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# TABLES AND FIGURES

Table 1.–Escapement goal planning meetings facilitated by ADF&G during the 2023 review cycle.

| Date | Meeting | Description |
|---|---|---|
| 4/30/2020 | Escapement Goal Review Team [a] | A series of four 1-hr. meetings to establish escapement goal review objectives, staff assignments, and timelines for Arctic Area, Yukon Area summer season, Yukon Area fall season, and Kuskokwim Area |
| 5/19/2020 | Kuskokwim Area | Kuskokwim River Chinook salmon escapement goals |
| 5/22/2020 | Yukon Area summer season | Yukon River summer chum salmon escapement goals |
| 8/4/2020 | Kuskokwim Area | Bimonthly meetings starting 8/4/2020 until 12/8/2020 Kuskokwim River Chinook salmon escapement goals |
| 10/20/2020 | Escapement Goal Review Team [a] | Kuskokwim River Chinook salmon escapement goals |
| 11/4/2020 | Kuskokwim Area | Discussion of stakeholder engagement options |
| 11/5/2020 | Yukon Area | Discussion of stakeholder engagement options |
| 11/10/2020 | Arctic Area | Discussion of stakeholder engagement options |
| 12/9/2020 | Arctic Area | Pilgrim River Sockeye salmon escapement goal |
| 2/25/2021 | Yukon Area | Chena and Salcha Rivers Chinook salmon escapement goals |
| 2/26/2021 | Escapement Goal Review Team [a] | Chena and Salcha Rivers Chinook salmon escapement goals |
| 9/8/2021 | Escapement Goal Review Team [a] | Canadian-origin Yukon River Chinook salmon |
| 9/8/2022 | Escapement Goal Review Team [a] | Yukon River summer chum salmon escapement goal |

[a] Included regional research coordinators and fishery scientists from the Divisions of Commercial Fisheries and Sport Fish. Meetings were attended by area research and management staff as needed.

Table 2.–Summary of 2023 salmon escapement goal changes for Norton Sound/Port Clarence and Kotzebue Areas.

| | | Current escapement goal | | | Action for 2023 | | |
|---|---|---|---|---|---|---|---|
| Stock unit | Assessment method | Goal | Type | Year established or last revised | Action | New or revised goal | Type |
| Norton Sound and Port Clarence Area | | | | | | | |
| Chinook Salmon | | | | | | | |
| Kwiniuk River | Tower | >250 | SEG | 2016 | No change | NA | NA |
| North River [a] | Tower | 1,200–2,600 | SEG | 2005 | No change | NA | NA |
| Chum Salmon | | | | | | | |
| Eldorado River | Weir | 4,400–14,200 | SEG | 2019 | No change | NA | NA |
| Nome River | Weir | 1,600–5,300 | SEG | 2019 | No change | NA | NA |
| Snake River | Tower/weir | 2,000–4,200 | SEG | 2019 | No change | NA | NA |
| Kwiniuk River | Tower | 9,100–32,600 | SEG | 2019 | No change | NA | NA |
| Tubutulik River | Peak aerial survey | 3,100–9,900 | SEG | 2019 | No change | NA | NA |
| Coho Salmon | | | | | | | |
| Kwiniuk River | Peak aerial survey | 650–1,300 | SEG | 2005 | No change | NA | NA |
| Niukluk River/Ophir Creek [b] | Peak aerial survey | 750–1,600 | SEG | 2016 | No change | NA | NA |
| North River [a] | Peak aerial survey | 550–1,100 | SEG | 2005 | No change | NA | NA |
| Pink Salmon | | | | | | | |
| Kwiniuk River (all years) | Tower | >8,400 | SEG | 2005 | No change | NA | NA |
| Nome River (even year) | Weir | >13,000 | SEG | 2005 | No change | NA | NA |
| Nome River (odd-year) | Weir | >3,200 | SEG | 2005 | No change | NA | NA |
| North River [a] (all years) | Tower | >25,000 | SEG | 2005 | No change | NA | NA |
| Sockeye Salmon | | | | | | | |
| Pilgrim River (Salmon Lake) | Weir | 6,800–36,000 | SEG | 2019 | No change | NA | NA |
| Glacial Lake | Peak aerial survey | 800–1,600 | SEG | 2005 | No change | NA | NA |
| Kotzebue Area | | | | | | | |
| Chum Salmon | | | | | | | |
| Noatak / Eli / Kelly Rivers | Peak aerial survey | 43,000–121,000 | SEG | 2019 | No change | NA | NA |
| Upper Kobuk / Selby Rivers | Peak aerial survey | 12,000–32,100 | SEG | 2019 | No change | NA | NA |

*Note*: NA stands for not applicable.

[a] Unalakleet River drainage

[b] Fish River drainage

Table 3.–Summary of 2023 salmon escapement goal changes for the Yukon Area.

| Stock unit | Assessment method | Current escapement goal | | | Action for 2023 | | |
|---|---|---|---|---|---|---|---|
| | | Goal | Type | Year established or last revised | Action | New or revised goal | Type |
| Chinook salmon | | | | | | | |
| Andreafsky River (East Fork) | Weir | 2,100–4,900 | SEG | 2010 | No change | NA | NA |
| Andreafsky River (West Fork) | Peak aerial survey | 640–1,600 | SEG | 2005 | No change | NA | NA |
| Nulato River (forks combined) | Peak aerial survey | 940–1,900 | SEG | 2005 | No change | NA | NA |
| Anvik River | Peak aerial survey | 1,100–1,700 | SEG | 2005 | No change | NA | NA |
| Chena River | Tower/sonar | 2,800–5,700 | BEG | 2001 | Revise | 3,300–5,700 | BEG |
| Salcha River | Tower/sonar | 3,300–6,500 | BEG | 2001 | No change | NA | NA |
| Chum Salmon, Summer | | | | | | | |
| Yukon River Drainage | Reconstruction [a] | 500,000–1,200,000 | BEG | 2016 | No change | NA | NA |
| East Fork Andreafsky River | Weir | >40,000 | SEG | 2010 | No change | NA | NA |
| Anvik River | Sonar | 350,000–700,000 | BEG | 2005 | No change | NA | NA |
| Chum Salmon, Fall | | | | | | | |
| Yukon River Drainage | Reconstruction [a,b] | 300,000–600,000 | SEG | 2010 | No change | NA | NA |
| Delta River | Foot surveys | 7,000–20,000 | SEG | 2019 | No change | NA | NA |
| Teedriinjik (Chandalar) River | Sonar | 85,000–234,000 | SEG | 2019 | No change | NA | NA |
| Coho Salmon | | | | | | | |
| Delta Clearwater River | Boat survey | 5,200–17,000 | SEG | 2005 | Discontinue | NA | NA |

*Note*: NA stands for not applicable. Not included in this table are goals set by the Yukon River Panel for Canadian-origin mainstem Chinook salmon (42,500–55,000), mainstem fall chum salmon (70,000–104,000), and Fishing Branch fall chum salmon (22,000–49,000).

[a] Run reconstruction is conducted postseason and uses a model to estimate total return from a variety of harvest and escapement monitoring projects.

[b] This goal includes all Alaska and Canada stocks.

Table 4.–Summary of 2023 salmon escapement goal changes for the Kuskokwim Area.

| Stock unit | Assessment method | Current escapement goal | | | Finding of 2022 escapement goal review | | |
|---|---|---|---|---|---|---|---|
| | | Goal | Type | Year established or last revised | Action | New or revised goal | Type |
| Chinook Salmon | | | | | | | |
| Kuskokwim River drainage | | | | | | | |
| Kuskokwim River | Reconstruction [a] | 65,00–120,000 | SEG | 2013 | No change | NA | NA |
| Aniak River | Peak aerial survey | 1,200–2,300 | SEG | 2005 | Discontinue | NA | NA |
| Cheeneetnuk River | Peak aerial survey | 340–1,300 | SEG | 2005 | Discontinue | NA | NA |
| Gagarayah River | Peak aerial survey | 300–830 | SEG | 2005 | Discontinue | NA | NA |
| George River | Weir | 1,800–3,300 | SEG | 2013 | No change | NA | NA |
| Kisaralik River | Peak aerial survey | 400–1,200 | SEG | 2005 | Discontinue | NA | NA |
| Kogrukluk River | Weir | 4,800–8,800 | SEG | 2013 | No change | NA | NA |
| Kwethluk River | Weir | 4,100–7,500 | SEG | 2013 | No change | NA | NA |
| Pitka Fork Salmon River | Peak aerial survey | 470–1,600 | SEG | 2005 | No change | NA | NA |
| Salmon River [b] | Peak aerial survey | 330–1,200 | SEG | 2005 | Discontinue | NA | NA |
| Kuskokwim Bay | | | | | | | |
| Kanektok River | Peak aerial survey | 3,900—12,000 | SEG | 2016 | No change | NA | NA |
| Middle Fork Goodnews River | Weir | 1,500–3,600 | SEG | 2019 | No change | NA | NA |
| North Fork Goodnews River | Peak aerial survey | 640–3,300 | SEG | 2005 | No change | NA | NA |
| Chum Salmon | | | | | | | |
| Kuskokwim River drainage | | | | | | | |
| Kogrukluk River | Weir | 15,000–49,000 | SEG | 2005 | No change | NA | NA |
| Kuskokwim Bay | | | | | | | |
| Middle Fork Goodnews River | Weir | >12,000 | SEG | 2005 | No change | NA | NA |

-continued-

Table 4.–Page 2 of 2.

| Stock unit | Assessment method | Current escapement goal | | | Finding of 2022 escapement goal review | | |
|---|---|---|---|---|---|---|---|
| | | Goal | Type | Year established or last revised | Action | New or revised goal | Type |
| Coho Salmon | | | | | | | |
| Kuskokwim River drainage | | | | | | | |
| Kogrukluk River | Weir | 13,000–28,000 | SEG | 2005 | No change | NA | NA |
| Kwethluk River | Weir | >19,000 | SEG | 2010 | No change | NA | NA |
| Kuskokwim Bay | | | | | | | |
| Middle Fork Goodnews River | Weir | >12,000 | SEG | 2005 | No change | NA | NA |
| Sockeye Salmon | | | | | | | |
| Kuskokwim River drainage | | | | | | | |
| Kogrukluk River | Weir | 4,400–17,000 | SEG | 2010 | No change | NA | NA |
| Kuskokwim Bay | | | | | | | |
| Kanektok River | Peak aerial survey | 15,300–41,000 | SEG | 2016 | No change | NA | NA |
| North Fork Goodnews River | Peak aerial survey | 9,600–18,000 | SEG | 2016 | No change | NA | NA |
| Middle Fork Goodnews River | Weir | 22,000–43,000 | SEG | 2019 | No change | NA | NA |

*Note*: NA stands for not applicable.

[a] Run reconstruction is conducted postseason and uses a model to estimate total return from a variety of harvest and escapement monitoring projects.

[b] Aniak River drainage. Full name referenced in other escapement goal reports is Salmon River (Aniak River).

Table 5.–Bayesian state-space Ricker spawner-recruit parameter estimates for Chena and Salcha River Chinook salmon.

| Model run | Parameter | Lower 95% | Median | Upper 95% |
|---|---|---|---|---|
| Chena River | lnalpha | 0.67 | 1.33 | 2.08 |
| 1986–2019 | lnalpha′ | 0.99 | 1.62 | 2.51 |
| | alpha | 1.95 | 3.80 | 8.03 |
| | beta | 0.000056 | 0.000136 | 0.000231 |
| | S.max | 4,337 | 7,329 | 17,952 |
| | S.eq | 8,750 | 11,859 | 21,801 |
| | S.msy | 3,246 | 4,555 | 8,512 |
| Chena River | lnalpha | 1.37 | 2.20 | 2.92 |
| 1986–2006 | lnalpha′ | 1.61 | 2.38 | 3.22 |
| | alpha | 3.95 | 9.03 | 18.60 |
| | beta | 0.000115 | 0.000207 | 0.000292 |
| | S.max | 3,428 | 4,839 | 8,661 |
| | S.eq | 9,765 | 11,519 | 15,851 |
| | S.msy | 2,968 | 3,827 | 5,665 |
| Salcha River | lnalpha | 1.06 | 1.74 | 2.47 |
| 1987–2019 | lnalpha′ | 1.35 | 1.99 | 2.89 |
| | alpha | 2.89 | 5.71 | 11.82 |
| | beta | 0.000088 | 0.000149 | 0.000207 |
| | S.max | 4,830 | 6,718 | 11,365 |
| | S.eq | 10,632 | 13,457 | 20,284 |
| | S.msy | 3,781 | 4,801 | 7,028 |
| Salcha River | lnalpha | 1.91 | 2.55 | 3.14 |
| 1987–2006 | lnalpha′ | 2.08 | 2.69 | 3.35 |
| | alpha | 6.73 | 12.84 | 23.20 |
| | beta | 0.000137 | 0.000200 | 0.00026 |
| | S.max | 3,849 | 4,993 | 7,278 |
| | S.eq | 11,824 | 13,381 | 16,635 |
| | S.msy | 3,380 | 4,173 | 5,517 |

Table 6.–Bayesian state-space Ricker spawner-recruit parameter estimates for Kuskokwim River Chinook salmon.

| Model run | Parameter | Lower 95% | Median | Upper 95% |
|---|---|---|---|---|
| 2020 | lnalpha | 1.15 | 1.81 | 2.17 |
| | alpha | 3.15 | 6.13 | 8.73 |
| | beta | 0.000007 | 0.000010 | 0.000013 |
| | S.max | 79,228 | 99,750 | 135,202 |
| | S.eq | 147,595 | 191,300 | 260,305 |
| | S.msy | 56,009 | 69,680 | 90,830 |
| 2012 [a] | lnalpha | 1.52 | 2.07 | 2.48 |
| | alpha | 4.58 | 7.91 | 11.90 |
| | beta | 0.000008 | 0.000011 | 0.000014 |
| | S.max | 69,000 | 88,515 | 129,300 |
| | S.eq | 161,650 | 185,000 | 223,600 |
| | S.msy | 54,800 | 65,440 | 82,500 |

[a] Hamazaki et al. (2012)

Table 7.–Pearson correlation coefficients for Kuskokwim River Chinook salmon escapement monitoring projects.

| | | Lower river tributaries | | | | | Middle river tributaries | | | | | | | | | | | | Headwaters tributaries | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type[a] | | w | a | a | w | a | a | w | a | a | a | a | w | a | w | w | a | a | w | w | a | a | a |
| Location[b] | | kwe | kwe | kis | tul | tul | ank | sla | sla | kip | hlk | osk | geo | hlt | kog | tat | che | gag | tak | slp | slp | ber | pit |
| Lower river | w.kwe | 1.0 | | | | | | | | | | | | | | | | | | | | | |
| | a.kwe | ***1.0*** | 1.0 | | | | | | | | | | | | | | | | | | | | |
| | a.kis | ***0.8*** | ***0.8*** | 1.0 | | | | | | | | | | | | | | | | | | | |
| | w.tul | ***0.7*** | ***0.7*** | 0.3 | 1.0 | | | | | | | | | | | | | | | | | | |
| | a.tul | ***1.0*** | ***0.9*** | ***0.9*** | 0.6 | 1.0 | | | | | | | | | | | | | | | | | |
| Middle river | a.ank | ***0.8*** | ***0.8*** | ***0.8*** | 0.3 | ***0.7*** | 1.0 | | | | | | | | | | | | | | | | |
| | w.sla | ***1.0*** | -1.0 | ***0.7*** | 0.5 | ***1.0*** | ***0.9*** | 1.0 | | | | | | | | | | | | | | | |
| | a.sla | ***0.9*** | ***0.8*** | 0.5 | ***0.7*** | 0.5 | ***0.9*** | ***0.9*** | 1.0 | | | | | | | | | | | | | | |
| | a.kip | ***0.7*** | 0.6 | 0.5 | 0.5 | 0.5 | ***0.8*** | ***0.9*** | ***0.7*** | 1.0 | | | | | | | | | | | | | |
| | a.hlk | 0.5 | 0.3 | 0.4 | 0.3 | -0.9 | 0.6 | 0.6 | 0.5 | ***0.7*** | 1.0 | | | | | | | | | | | | |
| | a.osk | 0.3 | 0.4 | 0.0 | 0.4 | 0.1 | 0.3 | 0.6 | 0.4 | 0.4 | ***0.9*** | 1.0 | | | | | | | | | | | |
| | w.geo | ***0.8*** | ***0.8*** | 0.4 | 0.4 | 0.6 | 0.5 | ***0.8*** | 0.4 | 0.5 | 0.6 | ***0.9*** | 1.0 | | | | | | | | | | |
| | a.hlt | ***0.9*** | ***0.8*** | ***0.8*** | 0.3 | ***1.0*** | ***0.8*** | ***1.0*** | 0.3 | 0.6 | 0.2 | 0.3 | 0.5 | 1.0 | | | | | | | | | |
| | w.kog | ***0.9*** | ***0.8*** | ***0.7*** | ***0.7*** | ***0.8*** | ***0.7*** | ***0.9*** | ***0.8*** | ***0.7*** | 0.6 | 0.4 | 0.6 | 0.5 | 1.0 | | | | | | | | |
| | w.tat | ***0.7*** | ***0.8*** | 0.4 | ***0.7*** | ***0.8*** | 0.4 | 0.4 | ***0.8*** | ***0.7*** | 0.1 | 0.5 | 0.5 | 0.5 | 0.6 | 1.0 | | | | | | | |
| | a.che | 0.5 | 0.6 | 0.3 | ***0.8*** | 0.5 | 0.5 | ***0.9*** | 0.6 | ***0.7*** | ***0.7*** | 0.2 | 0.3 | 0.3 | 0.5 | ***0.7*** | 1.0 | | | | | | |
| | a.gag | 0.6 | 0.5 | 0.2 | 0.5 | 0.0 | 0.5 | ***0.8*** | 0.6 | ***0.7*** | ***0.8*** | 0.4 | 0.6 | 0.2 | 0.6 | 0.6 | ***0.8*** | 1.0 | | | | | |
| Headwaters | w.tak | 0.3 | 0.0 | 0.1 | 0.5 | 0.2 | 0.1 | ***0.7*** | 0.2 | 0.2 | 0.6 | 0.4 | 0.4 | 0.0 | 0.5 | 0.4 | 0.6 | 0.4 | 1.0 | | | | |
| | w.slp | -0.9 | – | 0.0 | -0.9 | – | -0.2 | ***1.0*** | 0.0 | -0.3 | -0.5 | -0.5 | 0.0 | -0.7 | 0.1 | -0.8 | -0.3 | -0.4 | -0.3 | 1.0 | | | |
| | a.slp | 0.1 | 0.5 | 0.1 | 0.3 | 0.4 | 0.2 | -0.1 | 0.4 | 0.2 | 0.1 | 0.3 | 0.2 | 0.3 | 0.3 | ***0.8*** | 0.5 | 0.4 | 0.2 | -0.4 | 1.0 | | |
| | a.ber | 0.0 | 0.2 | 0.0 | 0.4 | 0.5 | -0.5 | 0.1 | 0.1 | 0.0 | -0.1 | 0.1 | 0.2 | -0.2 | 0.1 | 0.6 | 0.3 | 0.1 | 0.1 | 0.2 | ***0.7*** | 1.0 | |
| | a.pit | 0.4 | 0.5 | 0.1 | ***0.9*** | 0.4 | -0.1 | -0.5 | *0.7* | 0.3 | 0.1 | 0.5 | 0.3 | 0.3 | 0.5 | ***0.7*** | 0.5 | 0.3 | 0.0 | -0.2 | ***0.7*** | 0.6 | 1.0 |

*Note*: Strong positive correlations ≥0.7 are shown in bold italics. Dashes indicate no data.

[a] Refers to the type of assessment method: "w" stands for weir and "a" stands for aerial survey.

[b] Location codes are as follows: "kwe" = Kwethluk River; "kis" = Kisaralik River; "tul" = Tuluksak River; "ank" = Aniak River (mainstem); "sla" = Salmon River (Aniak); "kip" = Kipchuck River; "hlk" = Holokuk River; "osk" = Oskawalik River; "geo" = George River; "hlt" = Holitna River; "kog" = Kogrukluk River; "tat" = Tatlawiksuk River; "che" = Cheeneetnuk River; "gag" = Gagarayah River; "tak" = Takotna River; "slp" = Salmon River (Pitka Fork); "ber" = Bear Creek; and "pit" = Pitka Fork.

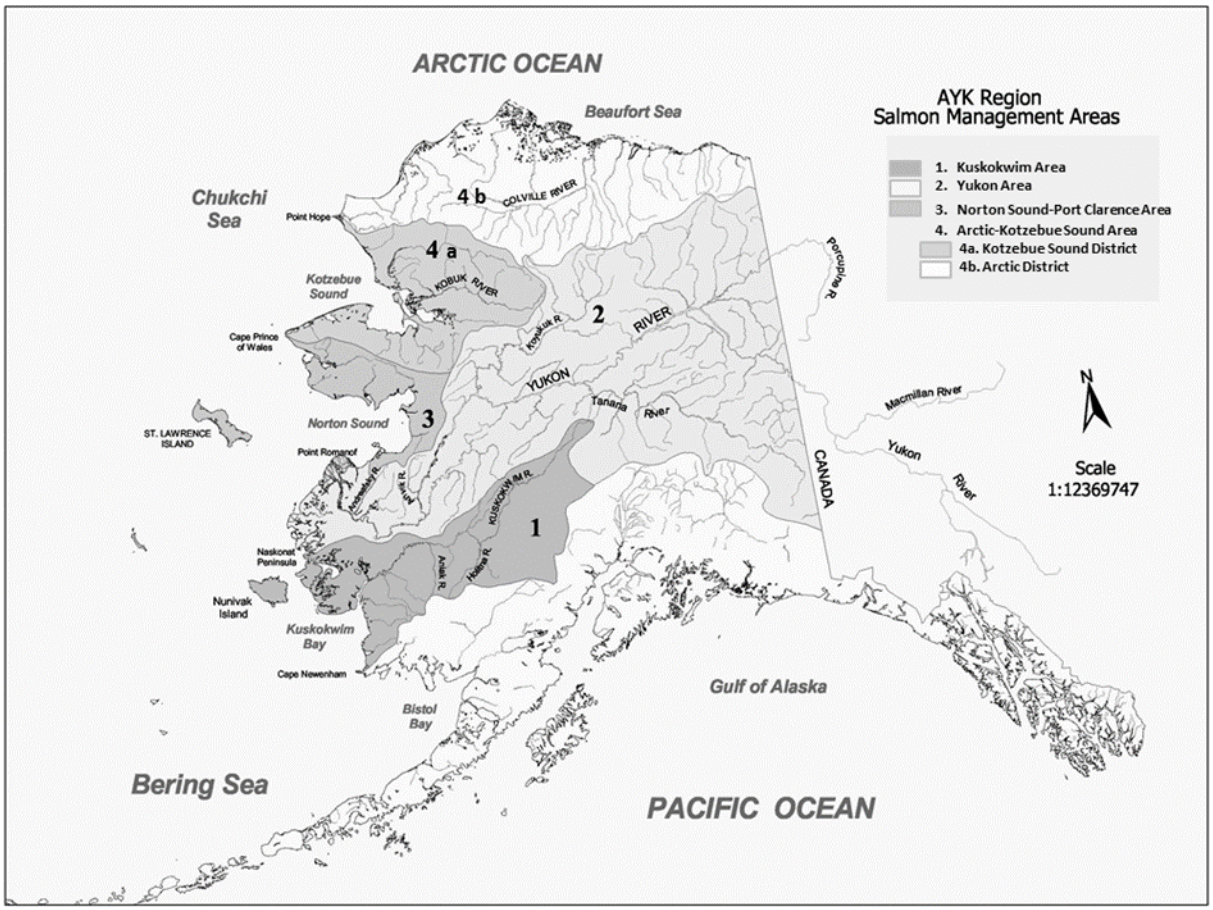


Figure 1.–Arctic–Yukon–Kuskokwim Region salmon management areas for the Division of Commercial Fisheries, ADF&G.

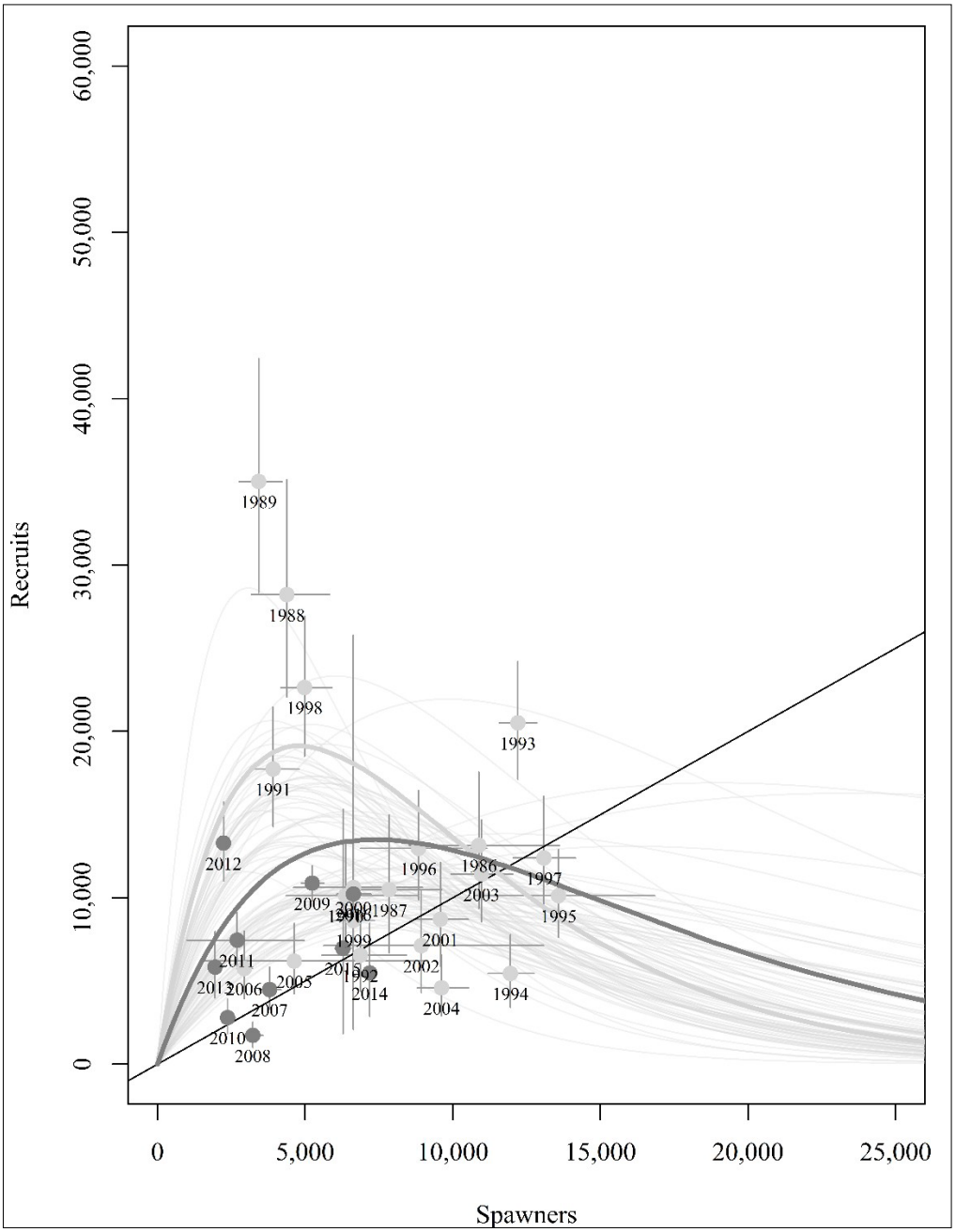


Figure 2.–Plausible spawner-recruit relationships for Chena River Chinook salmon as derived from an age-structured state-space model fitted to abundance, harvest, and age data for 1986–2019 (dark gray) and 1986–2006 (light gray). Light gray circles indicate modeled data from 1986–2006, and dark gray circles indicate data from 2007–2016. Posterior medians of R and S are plotted as brood-year labels with 95% credibility intervals plotted as light lines. The gray and dark lines are the Ricker relationship constructed from $\ln(\alpha)$ and $\beta$ posterior medians. Ricker relationships are also plotted (thin light gray lines) for paired values of $\ln(\alpha)$ and $\beta$ sampled from the posterior probability distribution, representing plausible Ricker relationships that could have generated the observed data. Recruits replace spawners (R = S) on the diagonal line.

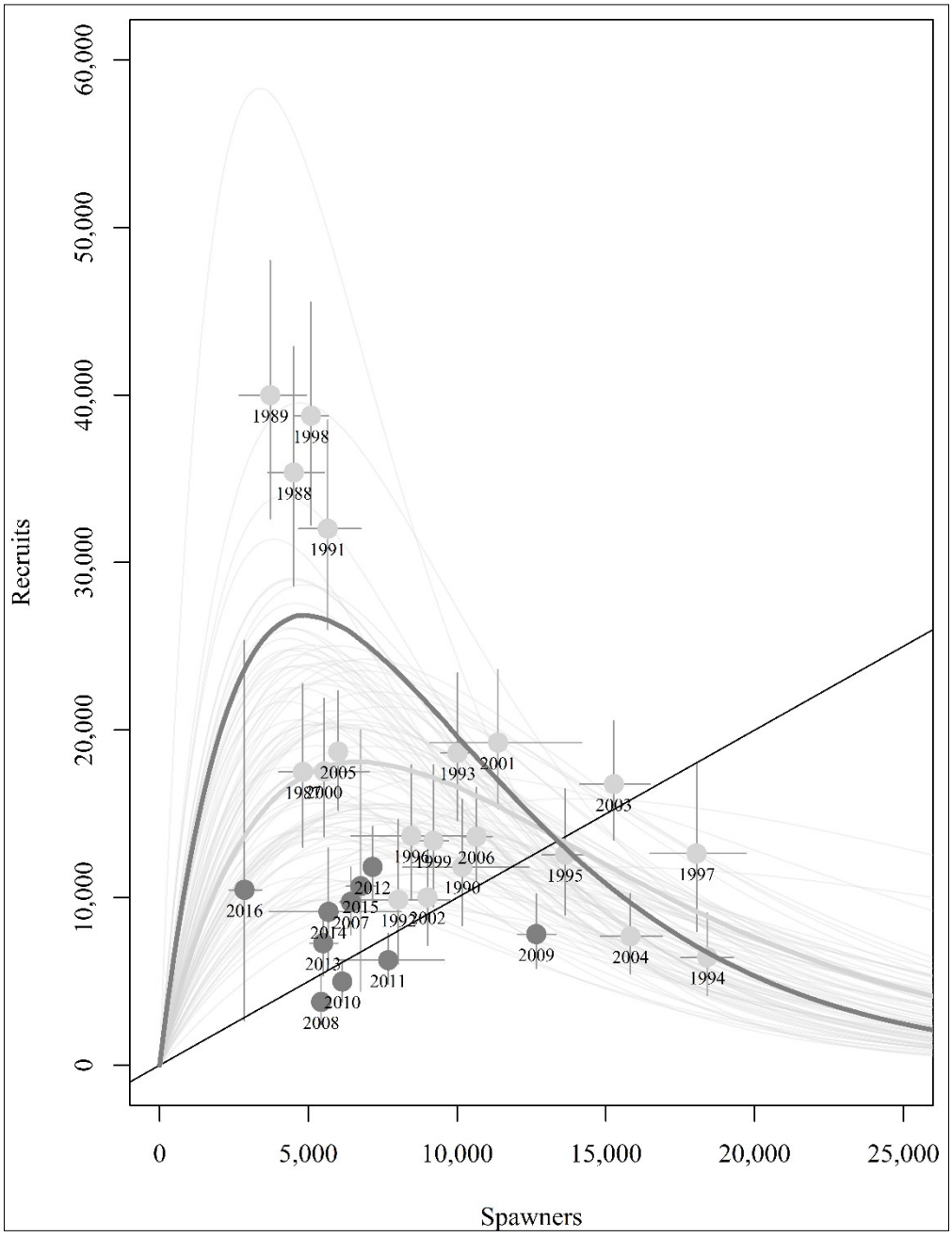


Figure 3.–Plausible spawner-recruit relationships for Salcha River Chinook salmon as derived from an age-structured state-space model fitted to abundance, harvest, and age data for 1986–2019 (dark gray) and 1986–2006 (light gray). Light gray circles indicate modeled data from 1986–2006 and dark gray circles indicate data from 2007–2016. Posterior medians of R and S are plotted as brood-year labels with 95% credibility intervals plotted as light lines. The gray and dark lines are the Ricker relationship constructed from $\ln(\alpha)$ and $\beta$ posterior medians. Ricker relationships are also plotted (thin light gray lines) for paired values of $\ln(\alpha)$ and $\beta$ sampled from the posterior probability distribution, representing plausible Ricker relationships that could have generated the observed data. Recruits replace spawners (R = S) on the diagonal line.

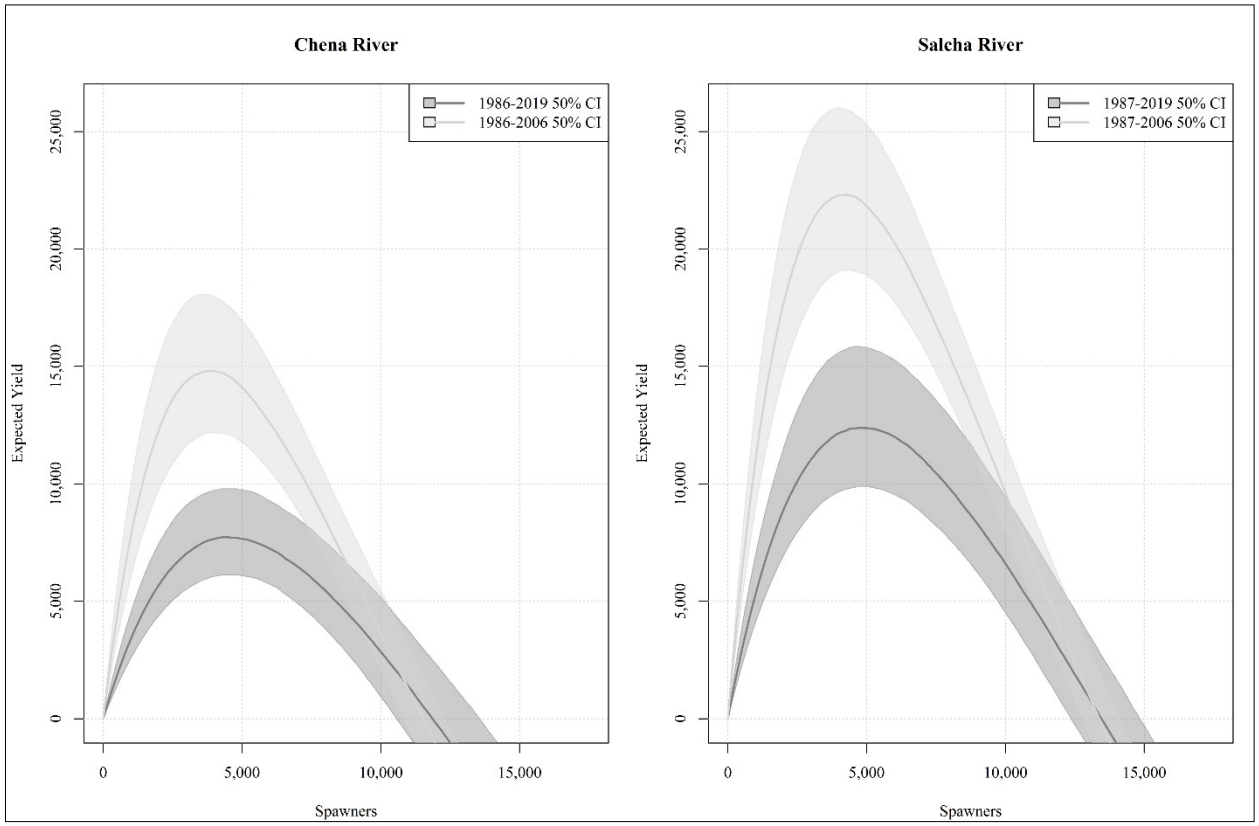


Figure 4.–Expected median yield (solid line) and 50% credibility interval (shaded area) for Chena River Chinook salmon (plot on left) and Salcha River Chinook salmon (plot on right) as derived from an age-structured state-space model fitted to abundance, harvest, and age for 1986, 1987–2006 (light gray) and 1986, and 1987–2019 (dark gray).

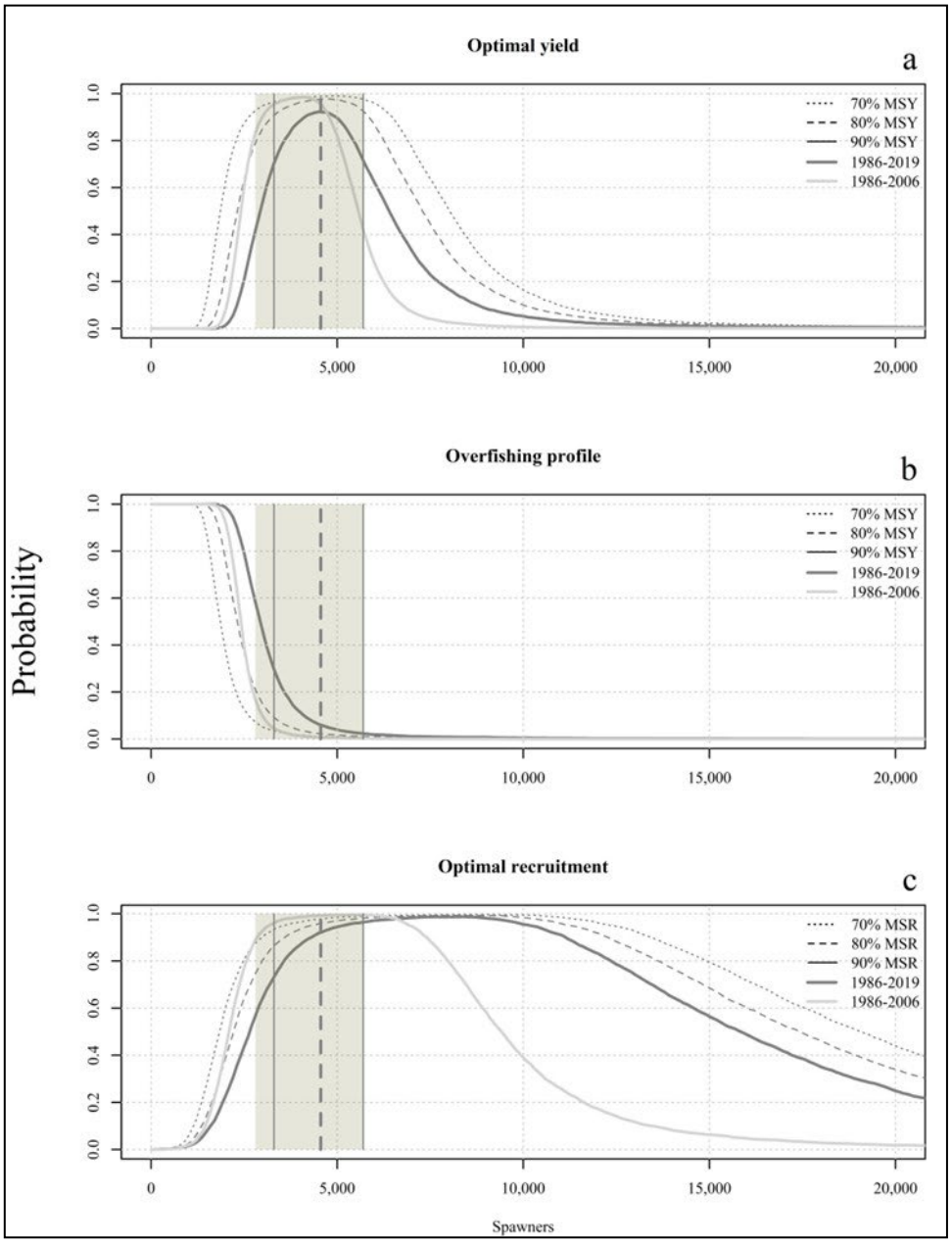


Figure 5.–Optimal yield profiles (OYPs, a), overfishing profiles (OFPs, b), and optimal recruitment profiles (ORPs, c) for Chena River Chinook salmon as derived from an age-structured state-space model fitted to abundance, harvest, and age data for 1986–2019 (dark solid: 90% MSY, and dashed curves: 70% and 80% MSY) and 1986–2006 (grey solid curve: 90% MSY). Shaded areas bracket the current goal range, the vertical solid lines represent the new goal, and the dashed vertical line represents median $S_{MSY}$ from the 1986−2019 analysis.

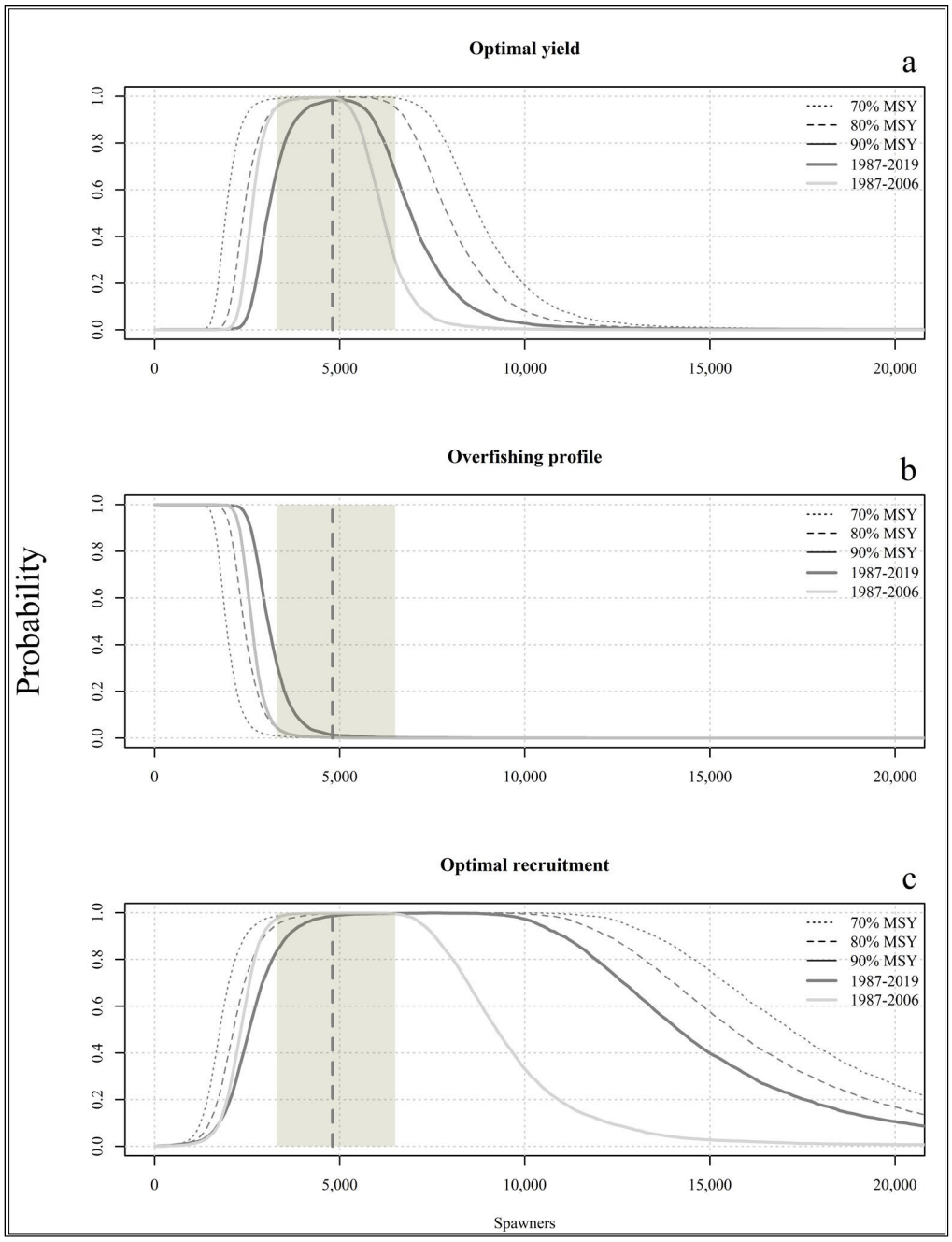


Figure 6.–Optimal yield profiles (OYPs, a), overfishing profiles (OFPs, b), and optimal recruitment profiles (ORPs, c) for Salcha River Chinook salmon as derived from an age-structured state-space model fitted to abundance, harvest, and age data for 1987–2019 (dark solid and dashed curves) and 1987–2006 (grey solid curve). Shaded areas bracket the current goal range and the dashed vertical line represents median $S_{MSY}$ from the 1987−2019 analysis.

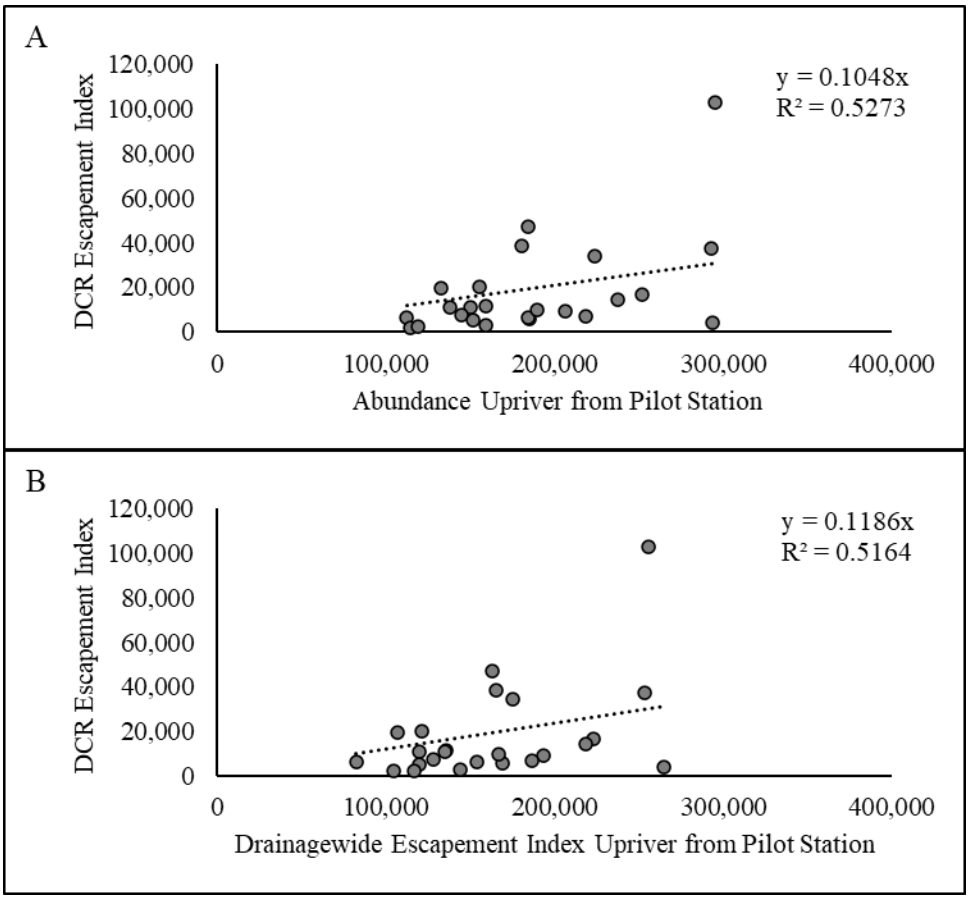


Figure 7.–Relationship between Delta Clearwater River (DCR) coho salmon escapement index and drainagewide coho salmon abundance (A) and escapement (B) upriver from the Yukon River mainstem sonar located near Pilot Station (river kilometer 123).

*Note*: DCR coho salmon escapement index was obtained by peak spawning boat survey conducted throughout a portion of the DCR. Drainagewide abundance upriver from Pilot Station was estimated using a sonar. Annual Pilot Station sonar estimates were expanded to account for coho salmon passage after the mainstem assessment ended. Drainagewide escapement index upriver from Pilot Station was estimated by subtracting upriver coho salmon harvest from the expanded sonar counts.

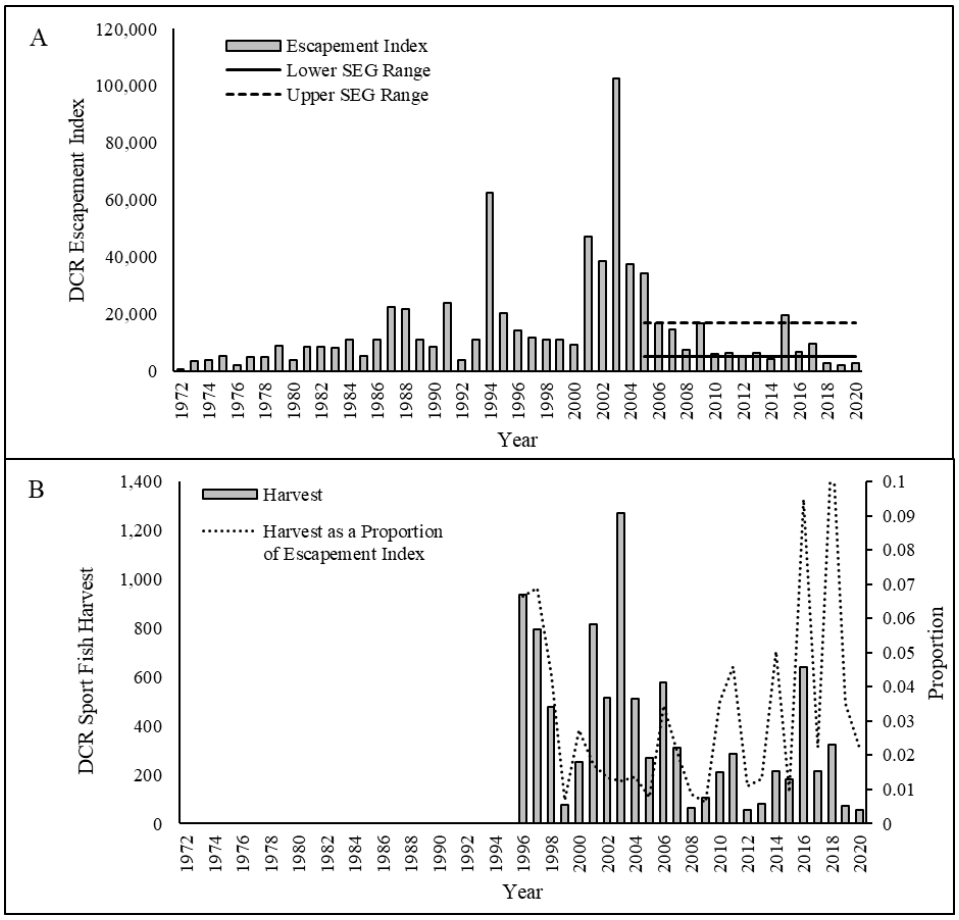


Figure 8.–Delta Clearwater River coho salmon escapement index (A) and sport fish harvest (B).

*Note*: DCR coho salmon escapement index was obtained using a boat survey conducted throughout a portion of the DCR during peak spawning. The Sustainable Escapement Goal (SEG) of 5,700–17,000 was adopted in 2005. From 2005–2020, escapements have fallen below the range 4 times, within the range 10 times, and above the range 2 times. Harvest data for DCR coho salmon prior to 1996 was not available. The 1996–2020 average harvest was 373, and the recent 10-year (2011–2020) was 213.

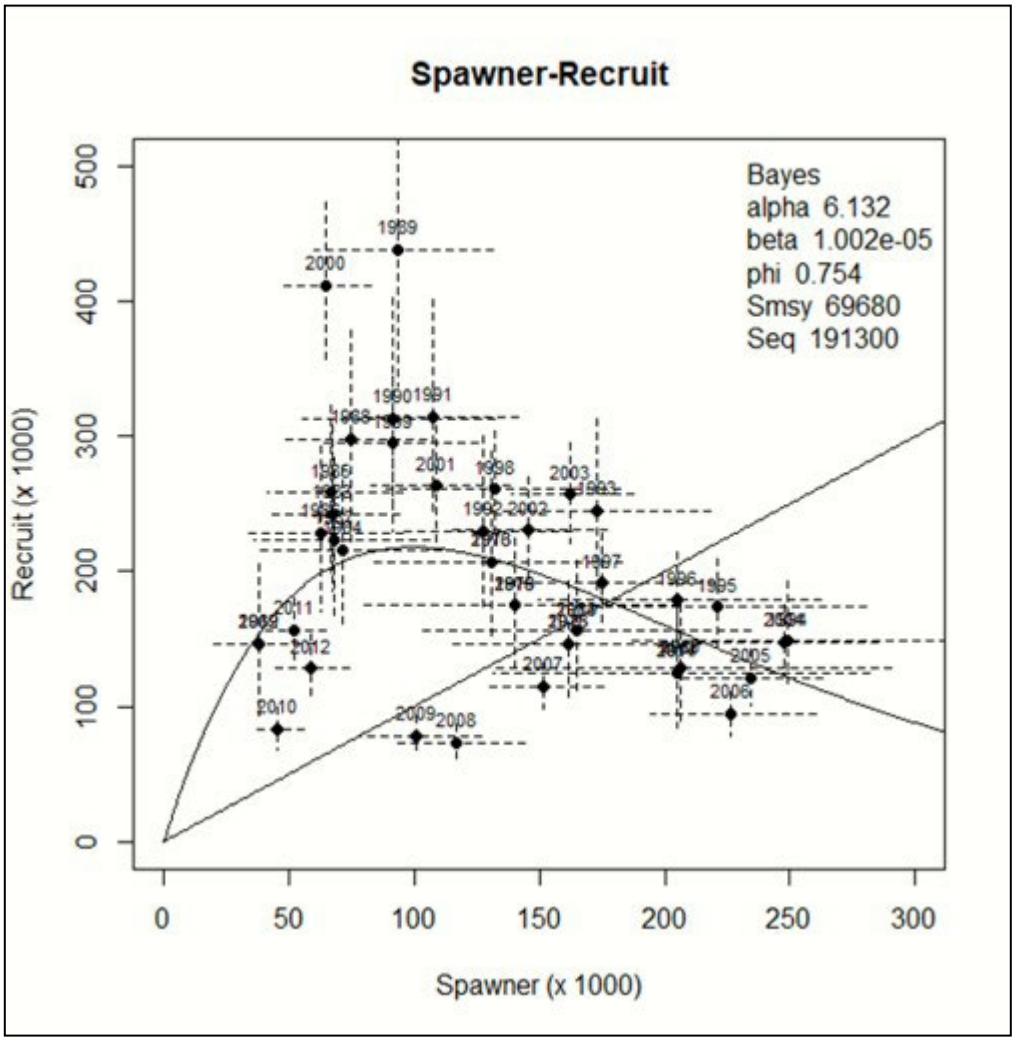


Figure 9.–Bayesian state-space model of the Ricker spawner-recruitment relationship for Kuskokwim River Chinook salmon.

*Note*: Black dots are Bayesian estimates of spawner-recruit pairs, with brood year labels. Dashed vertical and horizontal lines represent 95% CI of the spawner-recruit data pairs. The curved black line is the median Ricker fit to the observed data. The diagonal black line represents one-to-one replacement.

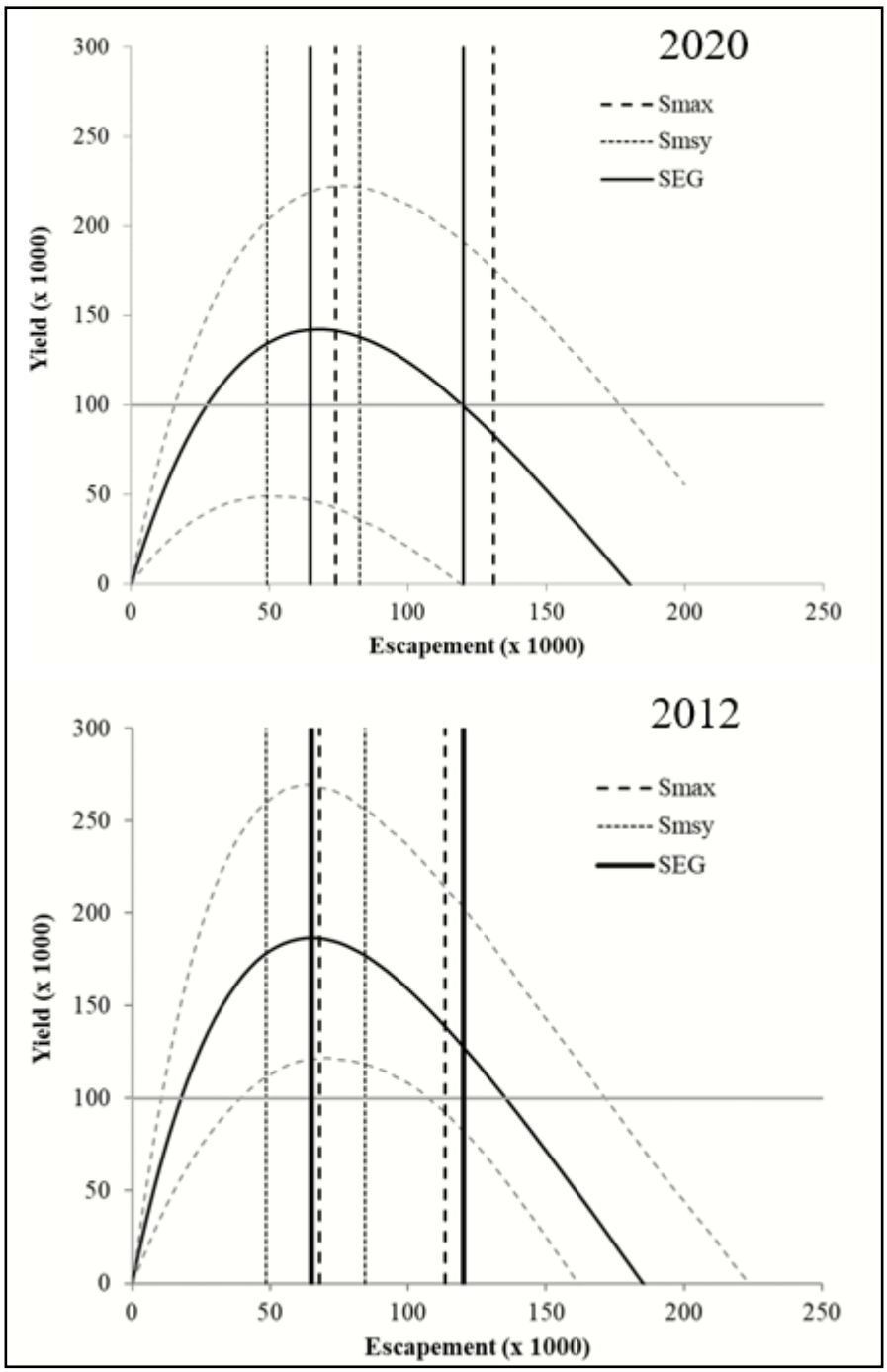


Figure 10.–Expected yield curve (solid line) with 95% CI (dashed line) and 95% CI ranges of $S_{MSY}$ and $S_{MAX}$. The existing drainagewide escapement goal 65,000–120,000 is shown for model runs conducted in 2012 and 2020.

*Note*: Horizontal grey line at 100,000 yield was used as a justification for the goal in 2012, because 100,000 yield was considered adequate to provide full subsistence harvest and allow for other limited uses. Revised 2020 analysis indicates that yield of at least 100,000 cannot be assured at the 95% confidence level.

# APPENDIX A:
# ADVISORY ANNOUNCEMENT: ARCTIC–YUKON–KUSKOKWIM REGION, SALMON ESCAPEMENT GOAL REVIEW

Appendix A1.–Advisory Announcement: Arctic–Yukon–Kuskokwim Region, Salmon Escapement Goal Review.

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# Advisory Announcement

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***Released:*** February 9, 2021

## Arctic–Yukon–Kuskokwim Region, Salmon Escapement Goal Review

The purpose of this advisory announcement is to inform the public of the Alaska Department of Fish and Game's (department) ongoing effort to review salmon escapement goals throughout the Arctic–Yukon–Kuskokwim (AYK) Region and upcoming opportunities for public engagement through the Alaska Board of Fisheries (board) process.

In preparation for the 2022 AYK finfish board meeting, the department has undertaken a comprehensive escapement goal review and is in the process of finalizing escapement goal recommendations. Final recommendations will be submitted for approval by the directors of the Division of Commercial Fisheries and Division of Sport Fish.

The department's AYK Region has a long history of public engagement on escapement goals prior to formalizing recommendations. Unfortunately, COVID-19 travel and meeting restrictions prevented in-person stakeholder meetings over the past year compared to prior review cycles. AYK staff determined that alternative virtual meeting options would likely be ineffective. Options for public engagement regarding AYK Region salmon escapement goals will be available through the board process.

The department will submit to the board a publicly available memo outlining escapement goal recommendations, by March 10, 2021. The timing of the department's escapement goal memo precedes the board's revised May 10, 2021 deadline for regulatory proposals pertaining to AYK finfish. This approach and timeline were intended to ensure that all interested stakeholders will be informed of the department's escapement goal recommendations and will have options to engage through the board process. As always, department staff will be available to address public inquiry.

Information about the board process can be found at Alaska Board of Fisheries Home.

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The following highlights the department's ongoing review efforts for AYK salmon by management area. A detailed escapement goal review report will be publicly available prior to the 2022 board meeting, and staff presentations will be provided at the 2022 board meeting.

**Norton Sound-Port Clarence and Kotzebue Management Areas**

Department review and discussion focused on Pilgrim River sockeye salmon. The department anticipates no changes to existing escapement goals and no new goals for the Norton Sound-Port Clarence or Kotzebue management areas.

**Yukon Management Area**

Department review and discussion focused on Chena River Chinook salmon, Salcha River Chinook salmon, and Delta Clearwater River coho salmon. A comprehensive analysis was undertaken to evaluate existing escapement goals for the Chena and Salcha Rivers, and recommendations will be forthcoming. The department anticipates recommending discontinuation of the Delta Clearwater River coho salmon goal. The department anticipates no changes to existing escapement goals pertaining to summer chum salmon or fall chum salmon and no new goals for any species within the Yukon Management Area.

**Kuskokwim Management Area**

Department review and discussion focused on Kuskokwim River Chinook salmon. A comprehensive analysis was undertaken to evaluate the existing drainagewide and tributary escapement goals. The department anticipates no changes to the Kuskokwim River drainagewide Chinook salmon escapement goal or tributary escapement goals based on weir assessment. The department anticipates recommending discontinuation of a subset of the Kuskokwim River tributary escapement goals based on aerial survey data. Within the Kuskokwim River, the department anticipates no changes to existing escapement goals pertaining to chum, sockeye, or coho salmon and no new goals for any species. Within Kuskokwim Bay, the department anticipates no changes to existing escapement goals and no new goals.

**Important dates:**

March 10, 2021 – anticipated date of department's escapement goal memo to the board
May 10, 2021 – board proposal deadline
Alaska Board of Fisheries meeting schedule – Alaska Board of Fisheries Home

**For additional information concerning this advisory announcement contact:**

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