



THE STATE
of **ALASKA**
GOVERNOR MICHAEL J. DUNLEAVY

**Department of
Fish and Game**

DIVISIONS OF SPORT FISH & COMMERCIAL FISHERIES
Interior Region Office Southcentral Region Office

1300 College Road
Fairbanks, AK 99701-1551
Main: 907.459.7357
Fax: 907.459.7347

333 Raspberry Road
Anchorage, AK 99518 - 1565
Main: 907.267.2105
Fax: 907.267.2442

MEMORANDUM

TO: Sam Rabung, Director
Division of Commercial Fisheries

David Rutz, Director
Division of Sport Fish

THROUGH John Linderman, Regional Supervisor
Division of Commercial Fisheries, Region III *JL*

Jeff Estensen, Regional Supervisor
Division of Sport Fish, Region III *JLE*

FROM: Zachary Liller, Regional Research Coordinator
Division of Commercial Fisheries, Region III *ZUL*

James Savereide, Regional Research Coordinator
Division of Sport Fish, Region III *JS*

DATE: March 17, 2022

SUBJECT: Arctic-Yukon-Kuskokwim, Salmon Escapement Goal Review

The purpose of this memorandum is to inform you of summary results from the Arctic-Yukon-Kuskokwim (AYK) Region salmon escapement goal review. Detailed oral and written reports concerning escapement goals for all areas of the AYK Region will be presented to the Alaska Board of Fisheries (board). These reports will list all existing escapement goals and will describe the data, analytical methods, and results used to justify the department's findings and changes to escapement goals.

The *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223) recognizes the establishment of salmon escapement goals as a joint responsibility of the Alaska Department of Fish and Game (department) and board. The policy describes the concepts, criteria, and procedures for establishing and modifying salmon escapement goals. The policy also describes the procedures that facilitate public review of allocative issues associated with escapement goals. Under the policy, the board recognizes the department's responsibility for establishing and modifying biological escapement

goals (BEG) and sustainable escapement goals (SEG). Further, the policy identifies the board’s responsibility to review BEGs and SEGs established by the department and determine the appropriateness of establishing optimum escapement goals (OEG) to address allocative factors.

Pertinent escapement goal definitions are:

5 AAC 39.222 (f)(3) “*biological escapement goal* (BEG): the escapement that provides the greatest potential for maximum sustained yield . . .;”

5 AAC 39.222 (f)(36) “*sustainable escapement goal* (SEG): a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated or managed for . . .;” and

5 AAC 39.222 (f)(25) “*optimal escapement goal* (OEG): a specific management objective for salmon escapement that considers biological and allocative factors and may differ from the SEG or BEG . . .”

Since the inception of the *Policy for the Management of Sustainable Salmon Fisheries* and the *Policy for Statewide Salmon Escapement Goals* in 2000 and 2001, comprehensive escapement goal reviews have been conducted every 3 years for the AYK Region (ADF&G 2004; Brannian et al. 2006; Molyneaux and Brannian 2006; Volk et al. 2009; Conitz et al. 2012; Conitz et al. 2015; Liller and Saveride 2018). The timing of the department’s escapement goal reviews aligns with regularly scheduled board meetings addressing AYK finfish regulatory proposals. This alignment facilitates review of allocative issues associated with escapement goals and provides opportunity for public input.

In preparation for the board’s 2023 AYK finfish meeting, the department convened an interdivisional team (review team) to consider available information and make changes to salmon escapement goals for the AYK Region, where warranted. The review team was comprised of area managers, area research biologists, regional coordinators, biometricians, and fishery scientists from the Divisions of Commercial Fisheries and Sport Fish. The review team coordinated escapement goal review activities, met periodically, discussed results, and developed consensus on escapement goal changes. Previous teams have made substantial strides in establishing salmon escapement goals based on the best available information at the time. This review team focused its efforts on 1) stocks with existing escapement goals for which new information suggested an updated analysis might result in a revised escapement goal and 2) goals that should be discontinued because they no longer align with current fisheries assessment or management practices. Potential for new goals were discussed but none suggested for the AYK Region.

Public engagement during the escapement goal review process is a high priority for the department. In the past, the department’s AYK Region held in-person meetings to seek public input on escapement goals prior to finalizing results. Due to COVID-19, in-person meetings were not possible during this review cycle. Alternative virtual meetings were considered but not pursued. On February 9, 2021, the department issued an Advisory Announcement to notify the public of ongoing escapement goal review efforts and options for public engagement through the board process. The decision to address public input on escapement goals through the board process aligns AYK Region stakeholder engagement activities with the *Policy for Statewide Salmon Escapement Goals* and is consistent with department, board, and public interactions on salmon escapement goals in other regions of the state.

Escapement goal findings for each management area are summarized below.

Norton Sound-Port Clarence and Kotzebue Management Areas

A total of 18 escapement goals exist across the Norton Sound-Port Clarence and Kotzebue Management Areas (Table 1). All escapement goals are SEGs. Within the Norton Sound-Port Clarence Area there are 16 goals: 2 king salmon; 5 chum salmon; 3 coho salmon; 4 pink salmon, and 2 sockeye salmon. Within the Kotzebue Management Area there are 2 chum salmon escapement goals. The review team found no changes to current goals and no new goals were warranted.

The review team focused on the SEG established for Pilgrim River (Salmon Lake) sockeye salmon. During the 2019 board meeting, concern was expressed that the upper bound of the SEG (36,000) was unnecessarily high, and other information may be available to inform future revisions to the goal. Salmon Lake has been fertilized by Norton Sound Economic Development Corporation in 20 of the last 24 years. There is currently no commercial fishery for this stock and harvest is limited to the local subsistence fishery. The long-term plan for lake fertilization and fishery management objectives for this enhanced stock are unclear. Given these realities, development of an escapement goal to achieve specific fishery performance objectives is not possible. Department staff did review all available data for this stock and conduct a preliminary spawner-recruit analysis, but formal analyses has not been completed at this time. **Given the uncertainties associated with this stock and future fishery plans, no change to the existing Pilgrim River (Salmon Lake) sockeye salmon SEG is warranted.**

Yukon Management Area

In the Yukon Management Area, which includes the entire Yukon River drainage within Alaska, there are currently 13 established escapement goals: 6 king salmon, 3 summer chum salmon, 3 fall chum salmon, and 1 coho salmon (Table 2). Of these, 4 goals are BEGs and 9 are SEGs. Not included in this list are 3 goals for Canadian stocks that were established as part of the *Yukon River Salmon Agreement*: 1) mainstem Yukon River king salmon, 2) mainstem Yukon River fall chum salmon, and 3) Fishing Branch River fall chum salmon. Escapement targets for these Canadian stocks are set annually by the Yukon River Panel.

The review team made changes to a subset of escapement goals pertaining to king salmon and coho salmon. The changes do not have implications for existing management plans or fishery allocations. The review team found that no revisions to existing goals for summer chum salmon or fall chum salmon and no new goals for any species are warranted.

The review team found that the king salmon BEGs for the Chena and Salcha rivers be revised. The current BEG range of 2,800–5,700 king salmon for the Chena River is being revised to 3,300–5,700 fish, and the current BEG range of 3,300–6,500 king salmon for the Salcha River is being revised to 3,300–5,900 fish. The BEGs for the Chena and Salcha rivers were established by the department in 2001 based on a classical spawner-recruit analysis (SRA) applied to each stock (Evenson 2002). A range of 0.8 to 1.6 times the estimate of S_{msy} was applied to the point estimates to develop the BEG range for each stock. Based on that analysis, a BEG of 3,300–6,500 king salmon was adopted for the Salcha River and a BEG of 2,800–5,700 king salmon was adopted for the Chena River.

During this most recent review, the SRAs for each stock was updated with new data using a state-space model (Fleischman et al. 2013) that simultaneously reconstructs runs and fits a Ricker spawner-recruit model to estimate total return, escapement, recruitment, and describe the production relationship for each stock. Results illustrated a decrease in production over the time-series of escapements for both the Chena and Salcha river stocks. The Chena and Salcha river BEG changes are consistent with escapement ranges that have relatively high probabilities of maximizing long-term future yields without being too narrow for use as fishery management targets. Given the strong evidence of decreased productivity for both stocks, the committee recognized that maximum yields indicated by this analysis are substantially smaller than the largest yields observed historically, and actual future yields may be less than the model predictions. However, the new BEG ranges are expected to optimize yields across a range of production states.

The review team found that discontinuing the Delta Clearwater River coho salmon SEG range of 5,200–17,000 fish is warranted. The existing goal was established in 2005, based on percentiles of historical escapement estimated from boat surveys, and is the only coho salmon escapement goal in the Yukon River drainage. Harvest of coho salmon returning to this system occurs in local sport fisheries and in commercial, personal use, and subsistence fisheries executed in the mainstem Yukon River and Tanana River. Escapement estimates of coho salmon in the Delta Clearwater River are not well correlated with abundance of coho salmon at broader spatial scales within the Yukon River drainage. The review team determined that the survey counts from the Delta Clearwater River provide an unreliable index of coho salmon escapement for the Yukon drainage and is not useful for fisheries management. For these reasons, the goal is being discontinued. The department will continue to monitor escapements to the Delta Clearwater River. The department has secured funding to investigate Yukon River coho salmon spawning distribution using radiotelemetry techniques beginning in 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.

Kuskokwim Management Area

The Kuskokwim Management Area, which includes the Kuskokwim River and Kuskokwim Bay drainages, currently has 22 established escapement goals: 13 king salmon, 2 chum salmon, 3 coho salmon, and 4 sockeye salmon (Table 3). All escapement goals are SEGs. Within the Kuskokwim River, the review team found no changes to any escapement goals pertaining to chum, sockeye, or coho salmon and no new goals for any species are warranted. Within Kuskokwim Bay, the review team determined that no changes to existing escapement goals and no new goals for any species are warranted.

There are SEGs established for Middle Fork Goodnews River king, chum, sockeye, and coho salmon in Kuskokwim Bay. There is currently no dedicated funding to support weir operations required to assess these goals, and there had been no commercial fishery for any species from 2016–2019. However, a commercial fishery did occur in 2020 and 2021, which has prompted renewed interest in pursuing funding to operate the weir. As such, we decided to retain the goals at this time.

The department undertook a comprehensive review of the 10 goals pertaining to king salmon within Kuskokwim River. This work continued a multi-year effort to improve escapement goals for Kuskokwim River king salmon. Prior to the 2013 board cycle, there were 11 tributary escapement goals for this stock but no clear description of how these goals should be used to

inform management actions. In 2013, the department established a drainagewide goal for Kuskokwim River king salmon and took steps to align a subset of tributary goals with the new drainagewide goal. During the 2019 board cycle, the department signaled its plan to evaluate tributary goals and discontinue goals that do not add meaningful information for fisheries management. Most recently, the department updated the drainagewide run reconstruction and spawner-recruit analysis to include all years of available data and evaluated the relationship between drainagewide and tributary escapements. Those results were used to determine that an escapement goal structure representative of the populations which comprise the drainagewide stock, properly scaled with existing fisheries, and useful for informing fishery management actions. **The review team found that no change to the Kuskokwim River king salmon drainagewide escapement goal is warranted.**

The review team found that discontinuation of 5 Kuskokwim River king salmon SEGs: the Kisaralik, Aniak (mainstem), Salmon (Aniak River drainage), Cheeneetnuk (Swift River drainage), and Gagarayah (Swift River drainage) rivers is warranted. These tributary escapement goals are all based on aerial survey data. Discontinuing these goals does not have implications for existing management plans or fishery allocations. The review team agreed to discontinue all 5 aerial survey SEGs. These goals are not used for fishery management because there are few (if any) targeted actions taken in mainstem fisheries to predictably control escapement to these specific tributaries. At best, fishery management actions produce predictable escapement outcomes for lower, middle, and headwater tributary groupings. Each group is made up of fish returning to multiple tributaries that share similar run timing patterns and harvest vulnerabilities. The 5 aerial survey goals being discontinued are moderately to strongly correlated with other SEGs that adequately index the lower, middle, and headwater tributaries and are based on higher quality information. As such, these 5 SEGs are redundant.

The review team recognizes the value of the Kuskokwim River king 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 king salmon run reconstruction model (Larson 2020), used to estimate drainagewide escapement and determine if the drainagewide escapement goal was met. The department is committed to continue annual aerial survey monitoring of approximately 14 tributaries used as model inputs including the 5 tributaries where SEGs are being discontinued.

With discontinuation of these 5 SEGs, the remaining goals for Kuskokwim River king salmon will include a drainagewide goal and 4 tributary goals. The 4 remaining tributary goals provide adequate indices of escapement to broad geographic areas, including: Kwethluk River weir-based SEG (lower river); George River and Kogrukuk River weir-based SEGs (middle river), and Salmon Pitka Fork aerial survey-based SEG (headwaters). These goals are based on high quality information and are useful for guiding fisheries management actions to achieve adequate numbers and geographic distribution of spawners.

Age at Maturity Considerations

Recent and ongoing studies indicate age at maturity is decreasing in king salmon throughout Alaska, including the AYK Region. Decreases in age at maturity may contribute to decreases in recruits per spawner (i.e., production) at levels that could have implications for setting escapement goals designed to achieve future fishery harvest needs. Recent work (e.g., Ohlberger et al. 2020; Staton et al 2021; Conners et al. *In press*) has begun to shed light on the magnitude of the issue, but the implications of these changes on future production and yield are not clear. Regardless,

declines in king salmon productivity were considered during the AYK escapement goal review cycle, but that consideration included all possible mechanisms as a composite, meaning that potential changes in productivity are reflected in recruit per spawner data considered by the escapement goal review team. In the face of uncertainty, current king salmon escapement goals have been set conservatively (e.g., lower bound of goal set closer to estimate of S_{msy} than would otherwise be the case). The department will continue to communicate to the board and the public regarding changes in age, sex and length and other relevant data.

LITERATURE CITED

- ADF&G. 2004. Escapement goal review of select AYK Region salmon stocks. Alaska Department of Fish and Game, Regional Information Report No. 3A04-01, Anchorage.
- Brannian, L. K., M. J. Evenson, and J. R. Hilsinger. 2006. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim region salmon stocks, 2007. Alaska Department of Fish and Game, Fishery Manuscript No. 06-07, Anchorage.
- Conitz, J. M., K. G. Howard, and M. J. Evenson. 2012. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2013. Alaska Department of Fish and Game, Fishery Manuscript No. 12-07, Anchorage.
- Conitz, J. M., K. G. Howard, and M. J. Evenson. 2015. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2016. Alaska Department of Fish and Game, Fishery Manuscript No. 15-08, Anchorage.
- Connors, B.M., Cunningham C., Bradley C.A., Hamazaki T., and Liller, Z.W. *In Press*. Estimates of biological benchmarks for the Canadian-origin Yukon River mainstem Chinook salmon (*Oncorhynchus tshawytscha*) stock aggregate. DFO Can. Sci. Advis. Sec. Res. Doc. 2021/nnn. vi + 89 p.
- Evenson, M. J. 2002. Optimal production of chinook salmon from the Chena and Salcha rivers. Alaska Department of Fish and Game, Fishery Manuscript Series No. 02-01, Anchorage.
- Fleischman, S. J., M. J. Catalano, R. A. Clark, and D. R. Bernard. 2013. An age-structured state-space stock–recruit model for Pacific salmon (*Oncorhynchus* spp.). *Can. J. Fish. Aquat. Sci.* 70:401–414.
- Larson, S. 2020. 2019 Kuskokwim River King salmon run reconstruction and 2020 forecast. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A20-02, Anchorage.
- Liller, Z. W., and J. W. Savereide. 2018. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2019. Alaska Department of Fish and Game, Fishery Manuscript No. 18-08, Anchorage.
- Molyneaux, D. B. and L. K. Brannian. 2006. Review of escapement and abundance information for Kuskokwim Area salmon stocks. Alaska Department of Fish and Game, Fishery Manuscript No. 06-08, Anchorage.
- Ohlberger J., D. E. Schindler, R. J. Brown, J. M.S. Harding, M. D. Adkison, A. R. Munro, L. Horstmann, and J. Spaeder. 2020. The reproductive value of large females: consequences of shifts in demographic structure for population reproductive potential in Chinook salmon. *Can. J. Fish. Aquat. Sci.* 77(8): 1–10.
- Staton, B. A., M. J. Catalano, S. J. Fleischman and J. Ohlberger. 2021. Incorporating demographic information into spawner-recruit analyses alters biological reference point estimates for a western Alaska salmon population. *Can. J. Fish. Aquat. Sci.* 78(12): 1755–1769

Volk, E., M. J. Evenson, and R. A. Clark. 2009. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2010. Alaska Department of Fish and Game, Fishery Manuscript No. 09-08, Anchorage.

Table 1.–Summary of 2022 salmon escapement goal changes for Norton Sound/Port Clarence and Kotzebue Management Areas.

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
<i>Norton Sound/Port Clarence Management Area</i>							
King Salmon							
Kwiniuk River	Tower	>250	SEG	2016	No change	-	-
North River ^a	Tower	1,200–2,600	SEG	2005	No change	-	-
Chum Salmon							
Eldorado River	Weir	4,400–14,200	SEG	2019	No change	-	-
Nome River	Weir	1,600–5,300	SEG	2019	No change	-	-
Snake River	Tower/weir	2,000–4,200	SEG	2019	No change	-	-
Kwiniuk River	Tower	9,100–32,600	SEG	2019	No change	-	-
Tubutulik River	Peak aerial survey	3,100–9,900	SEG	2019	No change	-	-
Coho Salmon							
Kwiniuk River	Peak aerial survey	650–1,300	SEG	2005	No change	-	-
Niukluk River/Ophir Creek	Peak aerial Survey	750–1,600	SEG	2016	No change	-	-
North River ^a	Peak aerial Survey	550–1,100	SEG	2005	No change	-	-
Pink Salmon							
Kwiniuk River (all years)	Tower	>8,400	SEG	2005	No change	-	-
Nome River (even year)	Weir	>13,000	SEG	2005	No change	-	-
Nome River (odd year)	Weir	>3,200	SEG	2005	No change	-	-
North River ^a (all years)	Tower	>25,000	SEG	2005	No change	-	-
Sockeye Salmon							
Pilgrim River (Salmon Lake)	Weir	6,800–36,000	SEG	2019	No change	-	-
Glacial Lake	Peak aerial survey	800–1,600	SEG	2005	No change	-	-
<i>Kotzebue Management Area</i>							
Chum Salmon							
Noatak / Eli / Kelly rivers	Peak aerial survey	43,000–121,000	SEG	2019	No change	-	-
Upper Kobuk / Selby rivers	Peak aerial survey	12,000–32,100	SEG	2019	No change	-	-

^a Unalakleet River drainage

Table 2.–Summary of 2022 salmon escapement goal changes for the Yukon Management 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
King salmon							
Andreafsky River (East Fork)	Weir	2,100–4,900	SEG	2010	No change	-	-
Andreafsky River (West Fork)	Peak aerial survey	640–1,600	SEG	2005	No change	-	-
Nulato River (forks combined)	Peak aerial survey	940–1,900	SEG	2005	No change	-	-
Anvik River	Peak aerial survey	1,100–1,700	SEG	2005	No change	-	-
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	Revise	3,300–5,900	BEG
Chum Salmon, Summer							
Yukon River Drainage	Run Reconstruction ^a	500,000–1,200,000	BEG	2016	No change	-	-
East Fork Andreafsky River	Weir	>40,000	SEG	2010	No change	-	-
Anvik River	Sonar	350,000–700,000	BEG	2005	No change	-	-
Chum Salmon, Fall							
Yukon River Drainage	Run Reconstruction ^{a,b}	300,000–600,000	SEG	2010	No change	-	-
Delta River	Foot surveys	7,000–20,000	SEG	2019	No change	-	-
Teedriinjik (Chandalar River)	Sonar	85,000–234,000	SEG	2019	No change	-	-
Coho Salmon							
Delta Clearwater River	Boat survey	5,200–17,000	SEG	2005	Discontinue	-	-

^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 Alaskan and Canadian stocks.

Table 3.–Summary of 2022 salmon escapement goal changes for the Kuskokwim Management 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
King salmon							
<i>Kuskokwim River and tributaries</i>							
Kuskokwim River	Run Reconstruction ^a	65,00–120,000	SEG	2013	No change	-	-
Aniak River	Peak aerial survey	1,200–2,300	SEG	2005	Discontinue	-	-
Cheeneetnuk River	Peak aerial survey	340–1,300	SEG	2005	Discontinue	-	-
Gagarayah River	Peak aerial survey	300–830	SEG	2005	Discontinue	-	-
George River	Weir	1,800–3,300	SEG	2013	No change	-	-
Kisaralik River	Peak aerial survey	400–1,200	SEG	2005	Discontinue	-	-
Kogruklu River	Weir	4,800–8,800	SEG	2013	No change	-	-
Kwethluk River	Weir	4,100–7,500	SEG	2013	No change	-	-
Pitka Fork Salmon River	Peak aerial survey	470–1,600	SEG	2005	No change	-	-
Salmon River (Aniak Drainage)	Peak aerial survey	330–1,200	SEG	2005	Discontinue	-	-
<i>Kuskokwim Bay</i>							
Kanektok River	Peak aerial survey	3,900–12,000	SEG	2016	No change	-	-
Middle Fork Goodnews River	Weir	1,500–3,600	SEG	2019	No change	-	-
North Fork Goodnews River	Peak aerial survey	640–3,300	SEG	2005	No change	-	-
Chum Salmon							
<i>Kuskokwim River and tributaries</i>							
Kogruklu River	Weir	15,000–49,000	SEG	2005	No change	-	-
<i>Kuskokwim Bay</i>							
Middle Fork Goodnews River	Weir	>12,000	SEG	2005	No change	-	-

-continued-

Table 3.--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							
<i>Kuskokwim River and tributaries</i>							
Kogruklu River	Weir	13,000–28,000	SEG	2005	No change	-	-
Kwethluk River	Weir	>19,000	SEG	2010	No change	-	-
<i>Kuskokwim Bay</i>							
Middle Fork Goodnews River	Weir	>12,000	SEG	2005	No change	-	-
Sockeye Salmon							
<i>Kuskokwim River and tributaries</i>							
Kogruklu River	Weir	4,400–17,000	SEG	2010	No change	-	-
<i>Kuskokwim Bay</i>							
Kanektok River	Peak aerial survey	15,300—41,000	SEG	2016	No change	-	-
North Fork Goodnews River	Peak aerial survey	9,600—18,000	SEG	2016	No change	-	-
Middle Fork Goodnews River	Weir	22,000-43,000	SEG	2019	No change	-	-

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