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MEMORANDUM

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SUBJECT: Prince William Sound Escapement Goal Memorandum

This memorandum summarizes the Alaska Department of Fish and Game (department) review of Prince William Sound (PWS; including the Copper River drainage) escapement goals and associated recommendations for escapement goals. Escapement goals in this management area have been set and evaluated at regular intervals since statehood. All PWS escapement goals were last reviewed by the department (Haught et al. 2017) during the 2017–2018 Alaska Board of Fisheries (board) cycle.

Between May 2019 and February 2020, an interdivisional salmon escapement goal review committee, including staff from the divisions of Commercial Fisheries and Sport Fish, met and reviewed existing salmon escapement goals in the PWS management area.

The department recognizes the importance of releasing escapement goal recommendations earlier in the year so the public may submit proposals to the board relative to goal recommendations before the deadline of Friday April 10, 2020. Thus, department staff completed their review on an accelerated timeline, and developed recommendations for PWS salmon escapement goals (Table 1). It is important to note that any recommended changes will not take effect until the 2021 fishing season, as they are not officially adopted until approved by the department after the 2020/2021 board regulatory cycle.

The review was based on the *Policy for the management of sustainable salmon fisheries* (5 AAC 39.222) and the *Policy for statewide salmon escapement goals* (5 AAC 39.223). Two important terms are used:

> 5 AAC 39.222(f)(3) "biological escapement goal" or "(BEG)" means the escapement that provides the greatest potential for maximum sustained yield . . .;" and
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> 5 AAC 39.222(f)(36) "sustainable escapement goal" or "(SEG)" means a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated or managed for . . .;"

Accordingly, the committee also determined the appropriate goal type (BEG or SEG) for each salmon stock with an existing goal. Based on the quality and quantity of available data, the committee determined the most appropriate methods to evaluate the escapement goals.

Escapement goals were evaluated (or developed in the case of new goals) for PWS salmon stocks using a variety of methods: 1) spawner-recruit analyses, 2) yield analyses, and/or 3) the percentile approach (Clark et al. 2014). The committee developed escapement goals for each stock, compared them with the current goal if one exists, and agreed on a recommendation to keep the current goal, change the goal, eliminate the goal, or adopt a new goal if no prior goal existed. The methods used to evaluate the escapement goals and the rationale for making subsequent recommendations will be described in a published report (Joy et al. *In prep*) available prior to the December 2020 PWS regulatory meeting.

There are 29 established escapement goals in the PWS area. This memorandum only discusses recommendations to change 5 of the existing goals. All other goals are recommended to remain unchanged and no new goals were proposed.

Copper River King Salmon

The lower bound SEG of 24,000 or more spawners was established in 2003 (Bue et al. 2002) to keep escapements near the 1980–2000 historical average of 25,800 fish, estimated using a catch-age model (Savereide and Quinn 2004). The catch-age model estimate of the number of spawners that produced the maximum sustained yield (S_{MSY}) was 19,711 king salmon. During the last review in 2017, a state-space model (Savereide et al. 2018) that simultaneously reconstructs runs and fits

a Ricker spawner-recruit model to estimate total return, escapement, and recruitment of Copper River king salmon was completed. The model uses harvest, age composition, and relative and absolute measures of inriver run abundance to estimate parameters that describe the production relationship for this stock. Uncertainty from the run reconstruction is passed through to the spawner-recruit analysis and all relevant data are considered and weighted by their precision. The model accommodates missing data, measurement error in the data, absolute and relative abundance indices, and changes in age at maturity. The estimate of S_{MSY} from this model was 18,595 and an escapement goal recommendation of 18,500–33,000 was made to department leadership. During the 2017 board meeting there were numerous questions raised by the public and board about both the department's ability to effectively manage to the recommended goal range as well as the allocative implications of the change. The department agreed with concerns raised during that meeting and withdrew its recommendation to change the goal.

During this review, the state-space model was updated with 2 additional years of escapement data and 5 additional years of mixed-stock analysis information from the commercial harvest (Joy et al. *In prep*). This report is being peer reviewed outside of ADF&G and will be available at the October 2020 board work session. The time series of escapements (1980–2018) never failed to replace themselves, so there is little information to accurately understand the density-dependent effects of large escapements. In this situation, the Ricker model provided the best estimate of S_{MSY}, but the estimates remain potentially sensitive to additional (large escapement) data. However, the optimum yield profiles suggest yields diminish as you approach 40,000 spawners, which justifies an upper boundary for an escapement goal. Similar to the catch-age model and the previous iteration of the state-space model, the estimate of S_{MSY} (22,844) was lower than the current lower bound SEG. This implies the current escapement goal is too high and a lower bound could improve yields. The results are robust across the different model scenarios and indicate escapements between 21,000 and 31,000 will produce sustained yields and are more likely to produce maximum sustained yield. This range is similar to the recommendation (18,500–33,000) during the review in 2017. Escapements in this range (21,000 to 31,000) have a high probability (64–85%) of achieving 80% of MSY. **Based on these results, the committee recommends the Copper River king salmon SEG be updated to 21,000–31,000 fish.** Changing this escapement goal may have allocative impacts if fishery management actions to achieve this goal result in changes in king salmon availability to various user groups.

Bering River Sockeye Salmon

The current SEG (15,000–33,000) for Bering River sockeye salmon was adopted in 2012 (Fair et al. 2011) and was developed from peak count aerial surveys using the percentile approach (Bue and Hasbrouck, unpublished[1]). For this review, the data set was updated through 2018 and the percentile approach was applied using current recommendations (Clark et al. 2014). **Based on**

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

these results, the committee recommends the Bering River sockeye salmon SEG be updated to 15,000–24,000 fish. Because only the upper bound of the goal range is being decreased, the change in this goal should not result in allocative implications to fisheries.

Coghill Lake Sockeye Salmon

The current SEG (20,000–60,000) for Coghill Lake sockeye salmon was established in 2012 after extensive analyses that included comparisons of yield from the Ricker and Beverton-Holt models (Fair et al. 2011). For this review, the Bayesian spawner-recruit analysis (SRA) using the updated escapement time series through 2018 estimated S_{MSY} at 57,232 sockeye salmon. Similar to the previous analyses, S_{MSY} is near the upper bound of the current SEG. Even though there is considerable uncertainty surrounding these estimates of S_{MSY}, the estimates are robust across analyses and measured yields have remained relatively constant across the range of historical escapements, which suggests a large range of escapements can result in high or low yields. In addition, the yield and overfishing profiles from the latest SRA suggest that similar historical yields can be observed at higher levels of escapement with a much lower probability of overfishing. Increasing the upper bound to 75,000 would result in a 90% probability of achieving at least 80% of MSY (and a 67% probability of achieving at least 90% of MSY). However, there is some evidence that multiple years of high spawning escapements into Coghill Lake may result in density-dependent effects including depleted zooplankton abundances for rearing juvenile sockeye salmon (Edmundson et al. 1997; Koenings and Kyle 1997). **Based on these results, the committee recommends the Coghill Lake sockeye salmon SEG be updated to 20,000–75,000 fish.** Because only the upper bound of the goal range is being increased, the change in this goal should not result in allocative implications to fisheries.

Copper River Delta Coho Salmon

The current SEG (32,000–67,000) for Copper River Delta coho salmon was established in 2003 and was developed from peak count aerial surveys using the percentile approach[1]. For this review, the data set was updated through 2018 and spawner-recruit analyses and recommendations from Clark et al. 2014 were applied to determine escapements that provide sustained yield. This stock is low contrast (4.1) with an average harvest rate likely greater than 40% and high measurement error (aerial surveys). A percentile approach is not recommended for stocks with average harvest rates of 40% or greater (Clark et al. 2014).

We calculated yields from complete brood years (1981–2013) and generated Markov yield tables. Yield analysis indicates the highest (>360,000) mean yields occur within an aerial escapement index range of 40,000–50,000, and that escapement indices from 20,000 to 50,000 produce average yields greater than 240,000 fish. **Based on these results, the committee recommends the Copper River Delta coho salmon SEG be updated to 32,000–50,000 fish.** Because only the upper bound of the goal range is being decreased, the change in this goal should not result in allocative implications to fisheries.

Bering River Coho Salmon

The current SEG (13,000–33,000) for Bering River coho salmon was established in 2003 and was developed from peak count aerial surveys using the percentile approach[1]. For this review, the data set was updated through 2018 and spawner-recruit analyses and recommendations from Clark et al. 2014 were applied to determine escapements that provide sustained yield. This stock is high contrast (14.4) with an average harvest rate likely greater than 40% and high measurement error (aerial surveys). A percentile approach is not recommended for stocks with average harvest rates of 40% or greater (Clark et al. 2014).

We calculated yields from complete brood years (1982–2013) and generated Markov yield tables. Markov yield analysis indicates the highest (>100,000) mean yields occur within an aerial escapement index range of 10,000–25,000. **Based on these results, the committee recommends the Bering River coho salmon SEG be updated to 13,000–25,000 fish.** Because only the upper bound of the goal range is being decreased, the change in this goal should not result in allocative implications to fisheries.

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Table 1.–Summary of current and recommended escapement goals for salmon stocks in the Prince William Sound management area, 2020.

	Current escapement goal			Recommended escapement goal			
System	Goal	Type	Year adopted	Goal	Type	Data	Action
King salmon							
Copper River	24,000	LB SEG	2003	21,000–31,000	SEG	Mark-recapture	Establish range
Sockeye salmon							
Upper Copper River	360,000–750,000	SEG	2012		SEG	Sonar	No change
Copper River Delta	55,000–130,000	SEG	2003		SEG	Aerial surveys	No change
Bering River	15,000–33,000	SEG	2012	15,000–24,000	SEG	Aerial surveys	Change in range
Coghill Lake	20,000–60,000	SEG	2012	20,000–75,000	SEG	Weir	Change in range
Eshamy Lake	13,000–28,000	BEG	2009			Weir	No change
Coho salmon							
Copper River Delta	32,000–67,000	SEG	2003	32,000–50,000	SEG	Aerial surveys	Change in range
Bering River	13,000–33,000	SEG	2003	13,000–25,000	SEG	Aerial surveys	Change in range
Chum salmon							
Eastern District	79,000	LB SEG	2018			Aerial surveys	No change
Northern District	28,000	LB SEG	2018			Aerial surveys	No change
Coghill District	10,000	LB SEG	2018			Aerial surveys	No change
Northwestern District	7,000	LB SEG	2018			Aerial surveys	No change
Southeastern District	11,000	LB SEG	2018			Aerial surveys	No change
Pink salmon							
Eastern District (even year)	203,000–328,000	SEG	2018			Aerial surveys	No change
Eastern District (odd year)	346,000–863,000	SEG	2018			Aerial surveys	No change
Northern District (even year)	96,000–127,000	SEG	2018			Aerial surveys	No change
Northern District (odd year)	111,000–208,000	SEG	2018			Aerial surveys	No change
Coghill District (even year)	37,000–110,000	SEG	2018			Aerial surveys	No change
Coghill District (odd year)	54,000–233,000	SEG	2018			Aerial surveys	No change
Northwestern District (even year)	52,000–93,000	SEG	2018			Aerial surveys	No change
Northwestern District (odd year)	64,000–144,000	SEG	2018			Aerial surveys	No change
Eshamy District (even year)	1,000–4,000	SEG	2018			Aerial surveys	No change
Eshamy District (odd year)	5,000–31,000	SEG	2018			Aerial surveys	No change
Southwestern District (even year)	62,000–105,000	SEG	2018			Aerial surveys	No change
Southwestern District (odd year)	112,000–231,000	SEG	2018			Aerial surveys	No change
Montague District (even year)	36,000–72,000	SEG	2018			Aerial surveys	No change
Montague District (odd year)	143,000–330,000	SEG	2018			Aerial surveys	No change
Southeastern District (even year)	88,000–153,000	SEG	2018			Aerial surveys	No change
Southeastern District (odd year)	286,000–515,000	SEG	2018			Aerial surveys	No change

Note: SEG = Sustainable escapement goal. LB SEG = Lower-bound sustainable escapement goal.