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MEMORANDUM

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Subject: Kodiak Management Area Escapement Goal Recommendations

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The purpose of this memorandum is to report our progress reviewing and recommending escapement goals for Kodiak Management Area (KMA). 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 the Alaska Board of Fisheries (board) and describes the concepts, criteria, and procedures for establishing and modifying salmon escapement goals. Under the policy, the board recognizes the department's responsibility for establishing and modifying biological escapement goals and sustainable escapement goals.

In March 2019, an interdivisional team, including staff from the divisions of Commercial Fisheries and Sport Fish, was formed to review existing Pacific salmon *Oncorhynchus* spp. escapement goals for KMA. This memorandum summarizes the preliminary results of the salmon escapement goal review and subsequent recommendations. The team has reached consensus on all recommendations outlined below.

Four important terms defined in the *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222) are:

- *biological escapement goal* (BEG): the escapement that provides the greatest potential for maximum sustained yield (MSY);
- *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;
- *inriver run goal* (IRRG): a specific management objective for salmon stocks that are subject to harvest upstream of the point where escapement is estimated; the inriver run goal will be set in regulation by the board and is comprised of the SEG, BEG, or OEG, plus specific allocations to inriver fisheries; and
- *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; the OEG will be sustainable and will be set by the board.

The previous escapement goal review for KMA occurred in 2016 (Schaberg et al. 2016). For the 2019 review the team added 3 years of data (2016–2018) since the last review (Table 1). Based on these new data, the team determined if enough information was added to justify altering existing goals or to create new goals for systems that do not have goals. If new information indicated review was necessary, we determined which type of goal was most likely to be supported and conducted the analysis indicated by the data quality and type of goal. The team did not identify any systems suitable for creating new goals, and only systems with goals currently in place were further evaluated.

For those stocks in which the escapement goal was evaluated, the review team determined the appropriate goal type based on the quality and quantity of available data, and then determined the most appropriate methods to evaluate the escapement goal. If a sufficient time series of escapement and total return estimates was available and the data contained sufficient information to provide a scientifically defensible, accurate estimate of the spawning escapement with the greatest potential to produce maximum sustained yield (S_{MSY}), then the data were considered sufficient to develop a BEG. Methods used to develop BEGs included spawner-recruit and Markov yield analysis. If return estimates were not available and/or the data were not sufficient to estimate S_{MSY}, the data were used to establish an SEG. Methods used to develop SEGs included the percentile approach (Clark et al. 2014).

Following these analyses, the team developed escapement goals for each stock, compared these with the current goal, and agreed on a recommendation to keep the current goal, revise the goal, or eliminate the goal. The methods used to evaluate KMA escapement goals as well as the rationale used to make subsequent recommendations are described in detail in a forthcoming report. Preliminary results are summarized below.

King Salmon

There are 2 escapement goals for king salmon in the KMA (Table 1). Both goals were assessed in 2016 by fitting age-structured state-space spawner recruit models (Fleischman and McKinley 2013) to data from both stocks. The assessment resulted in a change to the Ayakulik River BEG (currently 4,800–8,400), while the existing Karluk River BEG (3,000–6,000) was deemed appropriate (Schaberg et al. 2016). During this cycle the team assessed the recent year's returns

for these stocks and agreed that a reevaluation of these goals was unnecessary. The team also discussed changing these goals from BEGs to SEGs, due to the lack of recent age data for both Karluk and Ayakulik river king salmon stocks, as well as uncertainty in actual escapement of king salmon at Ayakulik River due to flooding events affecting weir operations. It was decided to leave both as BEGs, and to make a concerted effort to increase the efficacy of king salmon passage estimates during flood events on the Ayakulik River.

Sockeye Salmon

There are 12 escapement goals for sockeye salmon in the KMA (Table 1). The team assessed new data for each of these systems and determined no additional analyses or goal revision was necessary for Ayakulik early-run, Ayakulik late-run, Buskin, Frazer, Karluk early-run, Karluk late-run, Malina, Pasagshak, Saltery, and Upper Station early-run sockeye salmon.

Upper Station Late-Run

The team further evaluated the Upper Station late-run BEG, as it had not been revised since 2005, and more recent assessments have indicated that model fits are not statistically significant. During this review cycle spawner-recruit analyses, Markov yield analyses, percentile approach, euphotic volume (EV; Koenings and Burkett 1985), and zooplankton biomass (ZB; Koenings and Kyle 1997) were all considered with several data sets of different duration (1970–2012; 1970–2018; 1996–2012; 1996–2018). These data sets were selected to avoid the effect of specific (or expected) changes in system productivity that would likely have significant influence on the results. For example, the average contribution of zero-check sockeye salmon (fish that do not overwinter in freshwater) between 1975 and 1993 was 31%, since then zero checks have averaged 3% of the brood year return. This demonstrates how the system has changed from a stock dominated by age-1 and age-0 fish in the 1970s and 1980s to one that is heavily dominated by freshwater age-2 fish, and that using the data prior to this observed shift would result in an estimate that may not reflect the current production in the system.

Unfortunately, analyzing the truncated data sets with various methods did not produce a result that was satisfactory in updating the Upper Station sockeye salmon escapement goal. Considering the different data sets separately, the spawner-recruit models were not significant ($p < 0.1$) and non-stationary. Contrast in the truncated data sets was <4, which is not high enough for results from the percentile method to be robust (Clark et al. 2014). The Markov yield analysis suggested a narrower escapement goal range would be appropriate; however, the suggested midpoint did corroborate the midpoint of the current escapement goal. Additionally, the EV and ZB models produced estimates for the combined early- and late-run goals that are below the current late-run goal.

Due to the amount of inconsistency in the model outcomes, and lack of a statistically significant spawner-recruit model, the team recommends keeping the Upper Station late-run sockeye salmon escapement goal range of 120,000–265,000 but changing the designation to an SEG. This escapement goal range has been demonstrated to be sustainable, and it recognizes the lack of certainty in the assessment by making it an SEG.

Afognak River

The team also assessed the Afognak River sockeye salmon BEG. Afognak Lake has undergone significant enhancement and rehabilitation over the years: a hatchery operated at the lake from 1908–1933, nutrient fertilization of the lake occurred from 1990–2000, and back stocking occurred for 5 years in the 1990s. These manipulations make it difficult to assess the entire data set, as the effects to the run from fertilization and back stocking extend at least a full salmon life cycle after enhancement discontinues (~2005). The data set was reduced to mitigate against most influence from the enhancement activities and the brood years 2000–2012 were used for the spawner-recruit analysis. This resulted in a statistically significant estimate for S_{MSY} of 11,286 – 19,947. However, this would result in mid-point (15,616) of the escapement goal, that is near the lowest escapements that have been measured (lowest escapement was 15,181 fish in 2004), meaning we would be targeting escapement values that have an unknown level of sustainability.

We also considered the percentile approach, but the escapement data had low contrast (<4). Lake environmental conditions were assessed, using the euphotic volume (EV) and zooplankton biomass (ZB) models. Both environmental models suggest the current goal range is appropriate, and the percentile method, although not robust, also indicated the current goal range is appropriate. The Markov yield analysis was possibly influenced by the lagged effects of enhancement with notably large yields between 2000 and 2004 and was considered biased.

Due to concerns for managing a population below values we have seen historically, and with the support of the EV, ZB, and percentile estimates, the team recommends leaving the escapement goal at 20,000–50,000 fish, but changing the goal type to an SEG to reflect the uncertainty in achieving MSY over the long-term.

Pink Salmon

There are 3 aggregate goals for KMA pink salmon that include even- and odd-year specific SEGs for the Kodiak Archipelago. All three SEGs were revised in 2011 and recent escapements were within historical ranges; therefore, there was no compelling reason to review further in 2019.

Chum Salmon

There is one aggregate lower bound SEG (LB SEG) for chum salmon in the KMA. The Kodiak Archipelago aggregate LB SEG was revised in 2016 (Schaberg et al. 2016). Since it was just revised and there were only 3 years of escapement indices to add to the data set, the team determined that no change was necessary.

Coho Salmon

There are 4 escapement goals for coho salmon in the KMA. The American, Olds, and Pasagshak rivers have LB SEGs, and the Buskin River has a BEG. The team reviewed the most recent escapement data available for KMA coho salmon stocks and concluded that these goals should undergo further analyses.

The team reevaluated the Buskin River coho salmon BEG and updated the escapement information. Buskin River coho salmon escapement estimates are annually comprised of a series

of weir counts and estimates of fish passage during inoperable periods due to highwater. For this review escapement estimates were considered an index because missed passage has not been consistently estimated over the duration of the data set. Changing the perspective of the escapement from census to an index puts uncertainty in the data that disallows utility towards a spawner-recruit analysis, so an escapement goal was developed using the percentile approach. The results confirmed the current range is appropriate, so the team recommended changing the Buskin River coho salmon BEG to an SEG and leaving the range as 4,700–9,600 fish.

The American, Olds, and Pasagshak rivers all use foot surveys to enumerate coho salmon. Each of these systems are a LB SEG and data since the last review was assessed with the Clark et al. (2014) percentile approach and did not indicate a change was necessary for the American River. The escapement information for the Olds and Pasagshak rivers was also assessed with the percentile approach, and it did suggest the escapement goals could be reduced. The team recommended revising the Olds River LB SEG from 1,000 fish to 500 fish. However, a new assessment method is being developed at the Pasagshak River to accommodate changing conditions in the drainage that have been making foot surveys unreliable. The team recommended not changing the goal in anticipation of escapement data from the new method.

In summary, this comprehensive review of the 22 existing escapement goals in the KMA resulted in 21 goals remaining unchanged, the revision of 1 goal (Olds River coho salmon LB SEG of 500 fish), and a change in designation from a BEG to a SEG for 3 goals (Afognak River sockeye salmon, Upper Station late-run sockeye salmon, and Buskin River coho salmon). None of these changes are anticipated to have management or allocative implications to the subsistence, commercial, or sport fisheries.

Staff are preparing a report to document this escapement goal review in more detail, including all current and recommended changes to escapement goals, as well as detailed descriptions of the analyses performed. This report will be published prior to the January 2020 Kodiak finfish board meeting. In addition, an oral report on escapement goals will be presented at the same board meeting.

REFERENCES CITED

Clark, R. A., D. M. Eggers, A. R. Munro, S. J. Fleischman, B. G. Bue, and J. J. Hasbrouck. 2014. An evaluation of the percentile approach for establishing sustainable escapement goals in lieu of stock productivity information. Alaska Department of Fish and Game, Fishery Manuscript No. 14-06, Anchorage.

Fleischman, S. J., and T. R. McKinley. 2013. Run reconstruction, spawner–recruit analysis, and escapement goal recommendation for late-run Chinook salmon in the Kenai River. Alaska Department of Fish and Game, Fishery Manuscript Series No. 13-02, Anchorage.

Koenings, J. P., and R. D, Burkett. 1985. The production patterns of sockeye salmon (*Oncorhynchus nerka*) smolts relative to temperature regimes, euphotic volume, fry density, and forage base within Alaskan lakes: Proceedings of the International Sockeye Salmon Symposium held November 1985.

Koenings, J. P., and G. B. Kyle. 1997. Consequences to juvenile sockeye salmon and the zooplankton community resulting from intense predation. Alaska Fisheries Research Bulletin 4(2):120-135.

Schaberg, K. L., M. B. Foster, M. Wattum, and T. R. McKinley. 2016. Review of salmon escapement goals in the Kodiak Management Area, 2016. Alaska Department of Fish and Game, Fishery Manuscript Series No. 16-09, Anchorage.

Table 1.–Escapement goals and escapements observed from 2009 through 2018 for king, sockeye, coho, pink, and chum salmon stocks of the Kodiak Management Area.

System	2018 Goal Range Lower	2018 Goal Range Upper	Type	Initial Year	Escapement 2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019 Recommendation
KING SALMON															
Karluk River	3,000	6,000	BEG	2011	1,306	2,917	3,420	3,197	1,824	1,182	2,777	3,434	2,600	3,155	No Change
Ayakulik River[a]	4,800	8,400	BEG	2017	2,595	5,281	4,296	4,740	2,349	897	2,392	4,574	3,712	2,149	No Change
SOCKEYE SALMON															
Malina Creek	1,000	10,000	SEG	2005	1,400	4,000	3,800	4,100	3,800	4,900	1,000	2,000	1,000	500	No Change
Afognak (Litnik) River[b]	20,000	50,000	BEG	2005	31,358	52,255	49,193	41,553	42,153	36,345	38,151	33,167	22,151	17,601	SEG 20,000-50,000
Karluk River Early Run	150,000	250,000	BEG	2017	52,798	71,453	87,049	188,085	234,880	252,097	260,758	164,760	242,599	205,054	No Change
Karluk River Late Run	200,000	450,000	BEG	2017	277,280	276,649	230,273	314,605	336,479	543,469	396,618	324,049	385,896	428,225	No Change
Ayakulik River Early Run	140,000	280,000	SEG	2011	200,648	201,933	177,480	213,501	214,969	210,040	218,178	182,589	204,497	189,008	No Change
Ayakulik River Late Run	60,000	120,000	SEG	2011	114,536	60,394	83,661	114,753	67,195	87,671	108,257	71,978	120,361	77,325	No Change
Upper Station River Early Run[c]	43,000	93,000	BEG	2011	34,585	42,060	28,759	25,487	27,712	36,823	54,473	48,047	83,614	61,732	No Change
Upper Station River Late Run	120,000	265,000	BEG	2005	161,736	141,139	101,893	149,325	125,573	181,411	132,864	145,013	209,298	235,669	SEG 120,000-265,000
Frazer Lake	75,000	170,000	BEG	2008	101,845	94,680	134,642	148,884	136,059	200,296	219,093	122,585	129,227	201,161	No Change
Saltery Lake[d]	15,000	35,000	BEG	2011	43,468	24,102	27,803	25,155	35,939	29,047	44,796	57,867	35,218	19,299	No Change
Pasagshak River	3,000		LB SEG	2011	1,400	4,800	8,100	2,600	9,750	350	600	3,200	4,800	1,100	No Change
Buskin Lake	5,000	8,000	BEG	2011	7,757	9,800	11,982	8,565	16,189	13,976	8,719	11,584	7,222	4,284	No Change
COHO SALMON															
Pasagshak River	1,200		LB SEG	2011	2,385	1,971	1,083	3,132	1,648	4,934	1,790	737	701	3,186	No Change
Buskin River[e]	4,700	9,600	BEG	2014	8,176	6,239	5,342	4,906	4,401	6,730	NA[f]	2,134	5,091	4,523[g]	SEG 4,700-9,600
Olds River	1,000		LB SEG	2011	697	NA	1,003	624	2,145	1,320	1,357	1,634	1,054	878	LB SEG 500
American River	400		LB SEG	2011	639	NA	1,061	427	841	1,595	530	500	410	78	No Change
PINK SALMON															
Mainland District	250,000	1,000,000	SEG	2011	430,100	265,650	273,500	413,325	620,680	254,650	754,600	65,305	1,010,100	280,400	No Change
Kodiak Archipelago (odd year)	2,000,000	5,000,000	SEG	2011	4,707,894		2,506,714		4,450,711		5,151,731		5,079,016		No Change
Kodiak Archipelago (even year)	3,000,000	7,000,000	SEG	2011		3,378,483		5,111,049		2,733,282		1,699,281		4,874,342	No Change
CHUM SALMON															
Kodiak Archipelago	101,000		LB SEG	2017	105,750	119,000	143,550	94,900	NA	84,700	171,800	89,700	184,500	115,100	No Change

[a] Final escapements include estimated weir counts due to flooding at the weir during the king salmon run. King salmon escapement estimated for Ayakulik includes an estimated 20 king salmon harvested above the weir when a fishery has occurred as harvest estimates are typically not available for Ayakulik River sport harvest. King salmon sport harvest since 2011 is assumed to be zero as the fishery was closed to retention. All years include fish counts from post-weir aerial surveys.

[b] Afognak (Litnik) River sockeye salmon escapement does not incorporate egg take removals.

[c] OEG for Upper Station River early run sockeye salmon was 25,000 from 1999–2013, the OEG was increased to 30,000 from 2014–2016 and managed for only if the department determined that the upper end of the Frazer Lake escapement goal would be exceeded. The OEG was eliminated in 2017.

[d] Saltery Lake sockeye salmon escapements are weir counts minus fish removed for egg-takes.

[e] Buskin River coho salmon escapements include estimated weir counts due to flooding.

[f] Buskin River coho salmon escapement in 2015 was incomplete as the weir was washed out for much of the season.

[g] Buskin coho salmon escapement is preliminary for 2018, as escapement here is not reduced by the Statewide Harvest Survey estimate of Buskin River coho salmon estimated to be harvested above the weir, as that report is not final.