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**Escapement Goal Recommendations for Select Arctic–
Yukon–Kuskokwim Region Salmon Stocks, 2016**

by

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December 2015

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General	Mathematics, statistics
centimeter	cm	Alaska Administrative Code	<i>all standard mathematical signs, symbols and abbreviations</i>
deciliter	dL	all commonly accepted abbreviations	alternate hypothesis H_A
gram	g		base of natural logarithm e
hectare	ha		catch per unit effort CPUE
kilogram	kg	all commonly accepted professional titles	coefficient of variation CV
kilometer	km		common test statistics (F, t, χ^2 , etc.)
liter	L	at	confidence interval CI
meter	m	compass directions:	correlation coefficient (multiple) R
milliliter	mL	east E	correlation coefficient (simple) r
millimeter	mm	north N	covariance cov
		south S	degree (angular) °
		west W	degrees of freedom df
		copyright ©	expected value E
Weights and measures (English)		corporate suffixes:	greater than >
cubic feet per second	ft ³ /s	Company Co.	greater than or equal to ≥
foot	ft	Corporation Corp.	harvest per unit effort HPUE
gallon	gal	Incorporated Inc.	less than <
inch	in	Limited Ltd.	less than or equal to ≤
mile	mi	District of Columbia D.C.	logarithm (natural) ln
nautical mile	nmi	et alii (and others) et al.	logarithm (base 10) log
ounce	oz	et cetera (and so forth) etc.	logarithm (specify base) log ₂ , etc.
pound	lb	exempli gratia (for example) e.g.	minute (angular) '
quart	qt	Federal Information Code FIC	not significant NS
yard	yd	id est (that is) i.e.	null hypothesis H_0
		latitude or longitude lat or long	percent %
		monetary symbols (U.S.) \$, ¢	probability P
Time and temperature		months (tables and figures): first three letters Jan, ..., Dec	probability of a type I error (rejection of the null hypothesis when true) α
day	d	registered trademark ®	probability of a type II error (acceptance of the null hypothesis when false) β
degrees Celsius	°C	trademark ™	second (angular) "
degrees Fahrenheit	°F	United States (adjective) U.S.	standard deviation SD
degrees kelvin	K	United States of America (noun) USA	standard error SE
hour	h	U.S.C. United States Code	variance
minute	min	U.S. state	population Var
second	s		sample var
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		

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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 for the January 2016 Alaska Board of Fisheries (BOF) meeting. The 3-year escapement goal review cycle aligns with the regional BOF meeting schedule and affords an opportunity to notify the public of ADF&G’s plans for any escapement goal changes before the proposal deadline. Directors of the Divisions of Sport Fish and Commercial Fisheries ultimately establish final goals. All existing escapement goal analyses in the AYK region were updated with recent years’ data, and goals were reviewed for changes in assessment or analysis methods, and overall performance. Cases for establishing new goals were also examined. In the Norton Sound–Port Clarence and Arctic–Kotzebue Sound areas, a revision was recommended for the Kwiniuk River Chinook salmon *Oncorhynchus tshawytscha* goal. The review team recommended discontinuing Chinook and chum *O. keta* salmon goals on Old Woman River, a tributary of the Unalakleet River; discontinuing a Chinook salmon goal on the Fish River/Boston Creek index area; and discontinuing chum, pink *O. gorbuscha*, and coho *O. kisutch* salmon goals on the Niukluk River because the tower counting project was discontinued. A new aerial survey-based goal for Niukluk River/Ophir Creek coho salmon was recommended to replace the tower-based goal. In the Yukon Area, a new drainagewide goal was recommended for summer chum salmon. Discontinuation of fall chum salmon goals in the Sheenjek River and Upper Yukon River tributaries (aggregate) were recommended because assessment projects were discontinued. Kuskokwim Area revisions were recommended for Kanektok River Chinook, Kanektok River sockeye *O. nerka*, and North Fork Goodnews River sockeye salmon goals. Discontinuation of the Aniak River chum salmon goal was recommended because the sonar assessment project was discontinued. No other changes to the region’s escapement goals were recommended.

Key words: Pacific salmon, *Oncorhynchus* spp., escapement goal, stock status, Arctic-Yukon-Kuskokwim, Kuskokwim Management Area, Yukon Management Area, Norton Sound-Port Clarence Management Area, Arctic-Kotzebue Sound Management Area.

INTRODUCTION

This report presents escapement goal recommendations for salmon (*Oncorhynchus* spp.) stocks of Norton Sound–Port Clarence, Arctic–Kotzebue Sound, Yukon, and Kuskokwim management areas (Figure 1). Details of a run reconstruction, spawner-recruit analysis, and escapement goal recommendation for Yukon River summer chum salmon *O. keta* are presented in a separate report (Hamazaki and Conitz 2015). Escapement goals were evaluated and recommended based on policies adopted into regulation by the Alaska Board of Fisheries (BOF) *Policy for the management of sustainable salmon fisheries* (SSFP: 5 AAC 39.222) and the *Policy for statewide salmon escapement goals* (Escapement Goal Policy: 5 AAC 39.223). These policies outline certain criteria and a review process for salmon escapement goals, and call for review of escapement goals every 3 years, which is concurrent with the BOF regulatory cycle.

The Arctic–Yukon–Kuskokwim (AYK) Region escapement goal review was led by a review team that included regional research coordinators and fisheries scientists from the Divisions of Commercial Fisheries and Sport Fish. The team met in early October 2014 to review preliminary data compilation and review by area staff, and discuss new information and changes in methodology, stock status, and public input since the previous review cycle. Area staff received direction on finalizing their reviews of individual stocks in preparation for a public meeting in early 2015. Individual members of the review team also coordinated with U.S. Fish and Wildlife (USFWS) and Bureau of Land Management (BLM) staff and stakeholders who had interests in specific goals or in the entire review process. On February 2 and 3, 2015, the review team led meetings with ADF&G staff, USFWS staff, and interested stakeholders, to review the updated information for all stocks with existing or proposed new escapement goals in each area. An additional follow-up teleconference with staff and stakeholders from the Norton Sound Area was

conducted on March 16. After these meetings, preliminary escapement goal recommendations were prepared for all areas and were announced in a letter to stakeholders dated March 31, 2015.

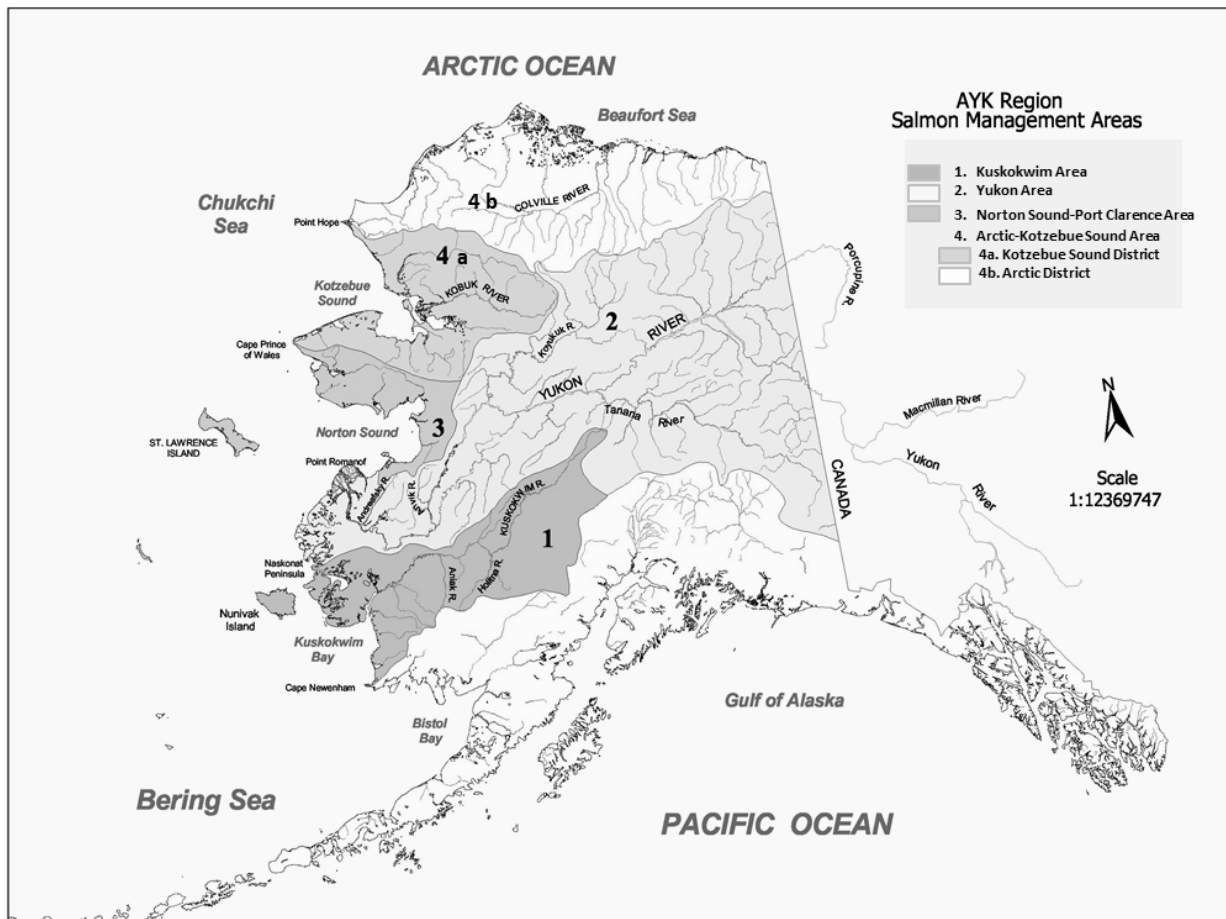


Figure 1.–Arctic–Yukon–Kuskokwim Region commercial salmon management areas.

Escapement goal recommendations in the AYK Region for the 2016 cycle were analyzed and prepared according to the escapement goal policy and SSFP. The SSFP provides the following definitions.

- 5 AAC 39.222 (f)(3) biological escapement goal or (BEG) means the escapement that provides the greatest potential for maximum sustained yield; BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted; BEG will be developed from the best available biological information, and should be scientifically defensible on the basis of available biological information; 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 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 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. However, a BEG is defined as “the escapement that provides the greatest potential for maximum sustained yield” (5 AAC 39.222 (f)(3)). Few stocks in the AYK Region have adequate information to establish BEGs; in particular, stock-specific harvest estimates are unavailable for many stocks. However, with good quality escapement data, SEGs can be determined; they are intended to, and have been shown to, provide levels of escapement that will produce runs and harvests similar to what has occurred in the past. Furthermore, maximizing yield may not be possible in practice, or may not be the most desirable objective for some stocks. Subsistence fisheries are particularly important in the AYK Region, and the inherent nature of subsistence fishing is to fulfill needs and not necessarily to maximize harvest. In some cases, providing for stable subsistence harvests over time may be a higher-priority management objective than maximizing yield from commercial harvest. For these and other reasons, most escapement goals in the AYK Region are SEGs. Management implications of escapement goals are also acknowledged, and ADF&G staff are directed to address issues in management plans and regulations as needed.

During its regulatory process, the BOF will review goals that have been recommended by staff to the directors of the Divisions of Sport Fish and Commercial Fisheries. With the assistance of ADF&G, the BOF may also consider establishing an optimal escapement goal (OEG), which is defined as follows.

5 AAC 39.222 (f)(25) optimal escapement goal or (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 SET, 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.

Biological 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 for the 2004, 2007, 2010, and 2013 cycles (ADF&G 2004; Brannian et al. 2006; Volk et al. 2009; Conitz et al. 2012). The 2016 review cycle focused on evaluation of existing goals (i.e., those established or left unchanged in the 2013 cycle) to determine where revisions were needed. This included considering discontinuation of goals because of a lack of assessment information, and establishment of new goals in a small number of cases.

METHODS

The review team began with the 30 Norton Sound–Port Clarence Area and Kotzebue Sound District stocks, 15 Yukon Area stocks, and the 25 Kuskokwim Area stocks having established escapement goals (Conitz et al. 2012). For these stocks, ADF&G staff updated the data series and analyses, and the updated information was reviewed during the October 2014 and February

2015 meetings. The review team looked at any significant changes in stock assessment methods, fisheries, and trends or patterns in the data series for each stock that would warrant a revision or discontinuation of the goal. They also reviewed management needs and how each escapement goal was utilized in management and how well it was performing. Additionally, new goals were considered based on consideration of management needs and available assessment information. Data, previous analyses, and estimates for all stocks reviewed were obtained primarily from published research and management reports and the AYK Database Management System (<http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx>), and when necessary were supplemented with unpublished ADF&G data sources. Performance of existing escapement goals in the AYK Region (and all other regions) are evaluated and reported annually, with tabulations of the most recent 10 years' escapement estimates in comparison with established goals (e.g., Munro and Volk 2015).

As noted above, the majority of the existing escapement goals in the AYK region are SEGs, and these were based on ranges of historic escapement in a fish stock thought to produce some level of sustained yield over the given time period. This approach has been commonly used across Alaska and is referred to as the percentile method or approach. SEGs developed using percentile approach were recently evaluated (Clark et al. 2014) for validity as proxy for BEGs based on escapements probable to produce maximum sustained yield (S_{msy}). As a result of this evaluation, new recommendations were made for setting the lower and upper escapement bounds based on the time series of observed escapements. The recommendations apply to stocks with low to moderate (less than 0.40) harvest rates, high or low contrast in escapement sizes (contrast indicates the ratio of highest to lowest observed escapement), and high or low measurement error. The percentile approach was not recommended in cases of high harvest rates (greater than or equal to 0.40), or a combination of very low contrast (4 or less) and high measurement error (aerial or foot surveys).

The tiers for percentile escapement ranges were defined as follows:

- Tier 1: high contrast (>8) and high measurement error (aerial and foot surveys) with low to moderate harvest rates (<0.40), the 20th to 60th percentiles;
- Tier 2: high contrast (>8) and low measurement error (weirs, towers) with low to moderate harvest rates (<0.40), the 15th to 65th percentiles; and
- Tier 3: low contrast (8 or less) with low to moderate harvest rates (<0.40), the 5th to 65th percentiles (Clark et al. 2014).

The authors of this reevaluation of the percentile approach (Clark et al. 2014), some of whom were members of the AYK review team, advised not to change existing goals solely on the basis of the reevaluation. Instead, they advised the review team to continue its approach of revising goals when warranted, based on substantial changes in fisheries, assessment data, or other relevant changes, and consider applying the new percentile ranges at that time. Accordingly, the review team considered all existing SEGs, established using the original percentile approach, and in some cases, estimated percentile ranges using the new methods for comparison. However, revised SEGs were recommended only when the new ranges differed substantially from the existing ranges and were judged to represent stock status more accurately and at least as conservatively.

Evaluation of data quality and assessment of datasets for quality control was integral to the review process. For example, quality control review was conducted on the aerial survey data series. Aerial survey data listed as poor or incomplete in the survey notes were omitted from the respective time series because they were judged to be biased low and the time series would more accurately represent escapement without them. Similarly, when older estimates in historical data series were not comparable with newer estimates because of changes in methodologies over time, these estimates were statistically adjusted removed from the dataset. Escapement goals were evaluated based upon the most consistent and reliable data sets that could be obtained from these quality control reviews.

For those AYK Region stocks on which BEGs could be developed, escapement goal analyses have traditionally used a Ricker 2-parameter spawner-recruit model (Hilborn and Walters 1992) to estimate the escapement that produces maximum sustained yield (S_{msy}). The goal range corresponds to the range of escapements around S_{msy} that have the highest probability of achieving MSY (e.g., escapements that produce 90% or more of MSY). This traditional escapement goal analysis has been further refined and developed to include better accounting for uncertainty in both assessment data and spawner and recruitment estimates. Ricker spawner-recruit model parameters are estimated in the framework of a state-space model, 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 stock-recruitment methods (Su and Peterman 2012).

Current and prospective BEGs were evaluated based on standard Ricker spawner-recruitment models as well as Bayesian state-space spawner-recruitment models. A significant new BEG was recommended for Yukon River drainagewide summer chum salmon, based on a run reconstruction and production model implemented in state-space framework. The full details of this analysis are provided in a separate report (Hamazaki and Conitz 2015).

The remainder of this report presents the review team’s recommendations for escapement goals in each area within the AYK Region. Relatively few revisions were recommended. Final approval of escapement goals will be made by the division directors of Commercial Fisheries and Sport Fish following the 2016 BOF meeting.

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

The Norton Sound–Port Clarence and Arctic–Kotzebue areas have 33 escapement goals for 27 stocks recognized in the last BOF cycle. In addition to established goals, several other stocks with available escapement datasets were evaluated. Among these were stocks where more accurate weir or tower information could replace aerial survey information, and stocks where project discontinuation required alternative data sources to assess escapement. Additionally, stakeholders suggested alternative escapement goal assessments based on management utility and local fisheries usage, and these were also evaluated. Although many stocks were assessed in this review cycle, only the most pertinent discussion points are presented here. Unless identified here for discontinuation or revision, all existing escapement goals for salmon stocks in the

Norton Sound–Port Clarence and Arctic–Kotzebue management areas were recommended to continue unchanged.

CHINOOK SALMON

The review team recommended discontinuing 2 goals and revising 1 Chinook *O. tshawytscha* salmon goal for the Norton Sound–Port Clarence Area (Table 1). Chinook salmon are primarily produced in the southeastern portion of Norton Sound, and are absent or in low and inconsistent abundance in Kotzebue Sound and Port Clarence.

The review team recommended discontinuation of the aerial survey SEG for Chinook salmon on the Old Woman River, a tributary of the Unalakleet River. Due to poor weather conditions, uncertainty of the relationship of the survey to peak spawning time, and availability of aircraft, these counts are unreliable for evaluating a goal on this system. Within the Unalakleet River drainage there is an existing tower-based goal for the North River tributary; this provides more robust data than aerial surveys can provide from the Old Woman River. Additionally, a weir project has been operational on the mainstem Unalakleet River since 2010 and has shown to provide accurate escapement information. It is the review team’s long-term plan that when this weir project has sufficient years of data upon which to base escapement goals, steps will be taken to establish escapement goals for the mainstem Unalakleet River weir.

The review team recommended discontinuation of the aerial survey SEG for Chinook salmon for the upper Fish River/Boston Creek index area. Due to poor weather conditions, uncertainty of the relationship of the survey to peak spawning time, and availability of aircraft, these counts are unreliable for evaluating a goal on this system. Aerial survey estimates on both Fish River and Boston Creek have not been conducted since 2004, and it has not been possible to evaluate escapements using this aerial survey estimate since then. Feasibility studies to provide better escapement enumeration estimates on the Fish River are being developed; 2014 was the first year of a tower project on the Fish River.

The review team recommended revision of the Kwiniuk River tower goal to a lower-bound SEG of greater than 250 Chinook salmon. The Kwiniuk River tower provides the longest-standing escapement dataset available in Norton Sound. The Kwiniuk River Chinook salmon stock is and has historically been relatively small. Anecdotal information provided by stakeholders indicates there is little overwintering habitat in this system and that Chinook salmon have established themselves in this system in relatively recent human history, all of which could account for greater volatility in run size. Given this information, the review team recognized that this stock is highly unlikely to support a directed commercial fishery and, consequently, an upper goal bound is not useful for management. The review team reviewed 2 methodologies that can be used for setting a lower-bound goal as an alternative to the SEG escapement goal range: the percentile method and risk assessment method. After updating data with the most recent escapement information, both lower-bound SEG methods indicated that the goal should be set at a minimum escapement of 250 Chinook salmon.

CHUM SALMON

Data and escapement goal performance for the Norton Sound–Port Clarence and Arctic–Kotzebue area chum salmon stocks were reviewed, and the review team recommended discontinuing 2 goals (Table 1). Chum salmon spawning stocks occur throughout Norton Sound and Kotzebue Sound and are the dominant salmon species present in Kotzebue Sound.

As was the case with Chinook salmon, the review team recommended discontinuing the aerial survey SEG for chum salmon on the Old Woman River, a tributary of the Unalakleet River, for the same reasons that poor weather conditions, uncertainty of the relationship of the survey to peak spawning time, and availability of aircraft make these counts unreliable for evaluating a goal on this system. Unlike for Chinook salmon, the North River tower is not a good index of overall chum salmon escapement within the Unalakleet River system, because only a small and variable component of the overall spawning stock spawns above the tower. It is, however, the review team's long-term plan that when the mainstem weir project, which enumerates a more substantial and consistent component of the chum salmon spawning stock, has sufficient years of data upon which to base escapement goals, steps will be taken to establish an escapement goal for the mainstem Unalakleet River.

The review team also recommended that the Niukluk River chum salmon tower goal be discontinued. The Niukluk River tower project is no longer operational and it is no longer possible to assess tower-based goals on this system. Because this system supports important fisheries, the review team assessed all other available escapement data, which included aerial surveys, to determine if alternative escapement goals could be established at this time. Upon review, the historical aerial survey data for chum salmon were not of a quality that would enable a reliable escapement goal to be established.

Stakeholders recommended review of the Norton Sound Subdistrict 1 (Nome) chum salmon aggregate goal and associated river goals. In particular, stakeholders recommended that alternative goals be considered that would divide the subdistrict into eastern and western subdistrict aggregates to better reflect current management practices and stock productivity. After acknowledging some ongoing research projects that would provide additional data to inform such an escapement goal, namely a marine migratory pattern study and new escapement data being collected for some smaller river systems in the subdistrict, it was recommended that the goal be reviewed and potentially revised in a subsequent BOF cycle.

COHO SALMON

Currently there are 3 existing goals for coho salmon *O. kisutch* in the Norton Sound–Port Clarence Management Area (Table 1). Coho salmon spawning stocks primarily occur in Norton Sound. Unfortunately, because of the late run timing of coho salmon and the relatively early ice formation that typically occurs in this area, enumeration of coho salmon spawning stocks can be difficult and inconsistent annually. Coho salmon harvests have been substantial in recent years, including commercial harvest on mixed stocks and subsistence and sport harvest, mostly in individual systems. As such, increased efforts have been taken to assess coho salmon in the past decade.

As with chum salmon, the review team recommended discontinuing the Niukluk River tower-based SEG for the same reason that the tower project is no longer operational. Unlike chum and pink salmon *O. gorbuscha*, aerial survey data for coho salmon have been of relatively good quality and consistently collected. An historical aerial survey goal for coho salmon was based on the combined aerial surveys of Niukluk River and Ophir Creek, and the review team recommended a similar goal be established. Based upon the data available, the review team recommended establishing a new Niukluk River/Ophir Creek coho salmon aerial survey goal: a SEG range of 750–1,600 fish.

Consideration was given to replacing other aerial survey goals with higher-quality tower-based goals and establishing new goals where data were available, because assessment of coho salmon has expanded in recent years. The review team considered replacing the Kwiniuk River and North River aerial survey-based SEGs for coho salmon with tower-based goals but decided it was premature given the data available. The review team also considered whether an escapement goal could be established for the Nome Subdistrict aggregate coho salmon stock. Weirs on the Nome and Snake rivers could potentially provide assessment data for the aggregate stock or be used to estimate escapement in the other systems based on relationships with aerial survey data. However, the weir data did not appear to have a strong relationship with aerial survey data from the other systems in this subdistrict, and the review team did not recommend new goals for the aggregate or any individual coho salmon stocks (Table 1). The review team recommended reassessing some of these stocks in the next review cycle because additional data may improve the capability to establish new coho salmon goals.

SOCKEYE SALMON

The review team considered the possibility of revising sockeye salmon *O. nerka* escapement goals on the Salmon Lake/Pilgrim River and Glacial Lake stocks, changing from aerial survey to weir-based assessments. For both stocks, the amount and quality of weir data are close to being adequate to develop higher-quality weir-based escapement goals. However, the review team decided that 3 additional years of data would make the analysis more robust, allowing the dataset to include returns from both high and low escapement years. The review team did not recommend revision of either sockeye salmon goal at this time but intends to reassess these stocks in the next BOF cycle (Table 1).

PINK SALMON

Pink salmon are an important subsistence resource in the area, but the commercial fishery is limited by market availability. Currently there are 5 SEGs for pink salmon stocks in the Norton Sound–Port Clarence Management Area (Table 1).

The review team recommended discontinuing the Niukluk River tower-based SEG because the tower counting project was discontinued. As with chum salmon, aerial survey data are generally of poor quality, so no new goal was recommended for this stock.

Table 1.–Summary of escapement goal recommendations for Norton Sound–Port Clarence and Arctic–Kotzebue Management Areas for 2016.

Stock unit	Assessment method	Current goal			Escapement goal recommendation for 2016		
		Goal	Type	Year established or last revised	Action	New or revised goal	Type
Norton Sound/Port Clarence Management Area							
Chinook salmon (4 existing)							
Fish R./Boston Cr.	Aerial survey	>100	SEG	2005	Discontinue		
Kwiniuk River	Tower	300–550	SEG	2005	Revise Goal	>250	Lower bound SEG
North River (Unalakleet R.)	Tower	1,200–2,600	SEG	2005	No change		
Old Woman R. (Unalakleet R.)	Aerial survey	550–1,100	SEG	2005	Discontinue		
Chum salmon (10 existing)							
Nome Subdistrict 1 Aggregate	Multiple Expanded aerial survey	23,000–35,000	BEG	2001	No change		
Eldorado River	Expanded aerial survey	6,000–9,200	SEG/OEG	2005	No change		
Nome River	Weir	2,900–4,300	SEG/OEG	2005	No change		
Snake River	Tower/weir	1,600–2,500	SEG/SEG	2005	No change		
Kwiniuk River	Tower	11,500–23,000	OEG	2001	No change		
Kwiniuk River	Tower	10,000–20,000	BEG	2001	No change		
Niukluk River (Fish R.)	Tower	>23,000	SEG	2010	Discontinue		
Old Woman R. (Unalakleet R.)	Aerial survey	2,400–4,800	SEG	2005	Discontinue		
Tubutulik River	Expanded aerial survey	8,000–16,000	BEG	2001	No change		
Tubutulik River	Expanded aerial survey	9,200–18,400	OEG	2001	No change		

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Stock unit	Assessment method	Current goal			Escapement goal recommendation for 2016		
		Goal	Type	Year established or last revised	Action	New or revised goal	Type
Coho salmon (3 existing, 1 proposed)							
Kwiniuk River	Aerial survey	650–1,300	SEG	2005	No change		
Niukluk River	Tower	2,400–7,200	SEG	2010	Discontinue		
Niukluk River/Ophir Creek	Aerial survey				Establish Goal	750–1,600	SEG
North River (Unalakleet R.)	Aerial survey	550–1,100	SEG	2005	No change		
Pink salmon (5 existing)							
Kwiniuk River (all years)	Tower	>8,400	SEG	2005	No change		
Niukluk River (all years)	Tower	>10,500	SEG	2005	Discontinue		
Nome River (even year)	Weir	>13,000	SEG	2005	No change		
Nome River (odd year)	Weir	>3,200	SEG	2005	No change		
North River (Unalakleet. R. all years)	Tower	>25,000	SEG	2005	No change		
Sockeye salmon (2 existing)							
Salmon Lake	Aerial survey	4,000–8,000	SEG	2005	No change		
Glacial Lake	Aerial survey	800–1,600	SEG	2005	No change		
Arctic–Kotzebue Management Area							
Chum salmon (6 existing)							
	Expanded aerial						
Kotzebue (all areas)	survey	196,000–421,000	BEG	2007	No change		
Noatak/Eli Rivers	Aerial survey	42,000–91,000	SEG	2007	No change		
Salmon River (Kobuk R. drainage)	Aerial survey	3,300–7,200	SEG	2007	No change		
Squirrel River (Kobuk R. drainage)	Aerial survey	4,900–10,500	SEG	2007	No change		
Tutuksuk River (Kobuk R. drainage)	Aerial survey	1,400–3,000	SEG	2007	No change		
Upper Kobuk and Selby Rivers	Aerial survey	9,700–21,000	SEG	2007	No change		

YUKON MANAGEMENT AREA

The Yukon Management Area has 15 escapement goals established in 2013. These included goals for 6 Chinook salmon, 2 summer chum salmon, 6 fall chum salmon, and 1 coho salmon stocks. 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 (JTC 2015).

CHINOOK SALMON

The 6 Chinook salmon stocks with goals, including 3 with ground-based assessments and 3 with aerial survey assessments, were reviewed for performance and data quality. In the years since these goals were established, goals were met in all years in West Fork Andreafsky and Salcha rivers. Goals were met in 3 of 5 years in East Fork Andreafsky, only 4 of 10 years in Anvik, 6 of 9 years in Nulato, and 9 of 12 years in Chena rivers. Aerial survey data were reviewed carefully to determine the reliability of assessments of these goals. Aerial survey assessments are subject to problems including standardization of survey areas over time, weather and water visibility conditions during surveys, accounting for poor quality surveys, and other problems in survey notes or metadata. Assessment data should only be considered when the survey data quality is high, and this has not always been the case for the Yukon Chinook salmon escapement goals. In general, the team acknowledged that aerial survey based goals can be difficult to evaluate but felt they should be retained as a postseason check and to help fulfill the expectations and intentions of conservation in management. Additional data review should be conducted before the next escapement goal review cycle, but no changes to any Chinook salmon goals were recommended in this cycle (Table 2).

SUMMER CHUM SALMON

The Yukon Area has had only 2 goals for summer chum salmon. These goals were reviewed, along with analysis for a new drainagewide goal, as suggested in the 2013 review cycle (Conitz et al. 2012). The existing summer chum salmon goals in the East Fork Andreafsky and Anvik rivers have been met in most years since they were established and were recommended to remain unchanged. A new drainagewide BEG of 500,000–1,200,000 summer chum salmon was also recommended (Table 2). The recommended BEG range was based on Ricker model reference points and optimal yield profiles, along with consideration of historical ranges of harvest and escapement (Hamazaki and Conitz 2015). The lower bound is within the range of escapement expected to provide sustained yield at 80% of MSY and the upper bound is within the range of escapement expected to provide sustained yield at 90% of MSY, with greater than 70% probability. The use of slightly different criteria for the lower and upper bounds was 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 management plan will specify targets within the recommended BEG range for the respective fisheries.

FALL CHUM SALMON

For fall chum salmon, having 6 existing goals including a drainagewide goal, a key issue is discontinuation of assessment projects, including sonar on the Tanana and Sheenjek rivers and the Fishing Branch River weir in Canada. Although the Fishing Branch River and associated

assessment projects are in Canada, and the Fishing Branch River goal falls under the Yukon River Salmon Agreement, Fishing Branch River assessments are still used in drainagewide and upper river run reconstructions. The drainagewide fall chum salmon run reconstruction (Fleischman and Borba 2009) was updated to 2014 and can continue to be updated, but it will become less precise with fewer assessment data. The review team decided it was appropriate to recommend discontinuation of escapement goals where the assessment project had been discontinued, including the Sheenjek River fall chum salmon goal. The Upper Yukon Tributaries goal, an aggregate goal combining Chandalar, Sheenjek, and Fishing Branch, was recommended for discontinuation because 2 out of 3 projects are no longer operational (Table 2). This aggregate goal was redundant with individual goals for each component stock and was not relied on for management, although it had generally been met. The sonar assessment project for Tanana River was discontinued very recently but would continue in the future if funding became available. The review team recommended that the Tanana River fall chum salmon goal continue without change during this cycle, even though it cannot be directly assessed; they recommend this goal be reevaluated in the next cycle.

COHO SALMON

For coho salmon, the single established escapement goal in the Delta Clearwater River was recommended to continue unchanged (Table 2). An updated analysis indicated only a small change in the lower bound but a more significant decrease in the upper bound. However, managers could do very little to control escapement at the upper bound, because only a small sport fishery exists on this tributary and lower river mixed stock commercial harvests are incidental to the fall chum salmon fishery. Subsistence harvest of coho salmon is also generally low. A drainagewide coho salmon escapement goal is needed, but abundance data are still pending operation of a drainagewide mark–recapture project, and age data need to be verified.

Table 2.—Summary of escapement goal recommendations for Yukon River Management Area for 2016.

Stock unit	Assessment method	Current goal			Escapement goal recommendation for 2016		
		Goal	Type	Year established or last revised	Action	New or revised goal	Type
Chinook salmon (6 existing) ^a							
Andreafsky River (East Fork)	Weir	2,100–4,900	SEG	2010	No change		
Andreafsky River (West Fork)	Aerial survey	640–1,600	SEG	2005	No change		
Nulato River (forks combined)	Aerial survey	940–1,900	SEG	2005	No change		
Anvik River	Aerial survey	1,100–1,700	SEG	2005	No change		
Chena River	Tower/mark–recapture	2,800–5,700	BEG	2001	No change		
Salcha River	Tower/mark–recapture	3,300–6,500	BEG	2001	No change		
Chum salmon, summer (2 existing, 1 proposed)							
Yukon R. Drainage		No existing goal			Establish goal	500,000–1,200,000	BEG
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 (6 existing) ^b							
Yukon R. Drainage ^c	Multiple ^d	300,000–600,000	SEG	2010	No change		
Tanana River	Multiple ^d	61,000–136,000	BEG	2001	No change		
Delta River	Foot survey	6,000–13,000	BEG	2001	No change		
Upper Yukon R. Tributaries ^e	Multiple ^d	152,000–312,000	BEG	2001	Discontinue		
Chandalar River	Sonar	74,000–152,000	BEG	2001	No change		
Sheenjek River	Sonar	50,000–104,000	BEG	2001	Discontinue		
Coho salmon (1 existing goal)							
Delta Clearwater River	Boat survey	5,200–17,000	SEG	2005	No change		

^a The Canadian border Chinook salmon escapement goal was established under the Yukon River Salmon Agreement and is reviewed annually by the Yukon River Panel. It is not included as part of this summary.

^b The Canadian fall chum salmon mainstem border and Fishing Branch River escapement goals, established under the Yukon River Salmon Agreement and reviewed annually by the Yukon River Panel, are not included in this summary.

^c This goal includes all Alaska and Canadian stocks.

^d Includes combination of any of the following methods: foot survey, aerial survey, weir, and sonar.

^e Includes Chandalar, Sheenjek, and Fishing Branch rivers. Fishing Branch River is not listed as an individual goal.

KUSKOKWIM MANAGEMENT AREA

The Kuskokwim Management Area has 25 escapement goals for 14 Chinook salmon, 3 chum salmon, 3 coho salmon, and 4 sockeye salmon stocks established in 2013. After a review and re-analysis of assessment data, 3 revisions to aerial survey based goals were recommended and 1 goal was recommended to be discontinued because the assessment project ended (Table 3).

CHINOOK SALMON

For Kuskokwim River Chinook salmon, the drainagewide SEG and associated SEGs in the Kwethluk, George, and Kogrukluks rivers established in 2013 (Hamazaki et al. 2012; Conitz et al. 2012) have been the focus of extensive discussions with stakeholders since 2013. The drainagewide goal was not met in 2013 but was met 2014, and the 3 associated tributary goals were not met except for George River in 2014. Overall, Chinook salmon abundance has been low since 2010. The goals were probably not met because of low abundance rather than because the goals are inappropriate. Additionally, because the tributary goals were determined as a proportion of the drainagewide goal, there is a relatively low probability that 1 or more tributary goals will not be achieved in years when the drainagewide goal is achieved (Zach Liller, Commercial Fisheries Biologist, ADF&G; personal communication). These goals have been in place only 3 years and were recommended to continue without change for this cycle. Data for the 7 Chinook salmon aerial survey based goals in the Kuskokwim River were updated and analyzed for quality and consistency, with some changes made accordingly. However, this resulted in no substantial changes to the estimated goal ranges, and all existing goals were recommended to continue unchanged (Table 3).

The 2 aerial survey based goals for Kuskokwim Bay Chinook salmon were reevaluated on the basis of a data quality review. Survey quality (primarily visibility), timing, and survey areas were examined and data were standardized for these and other factors, omitting some data where quality or completeness was inadequate. New percentile-based SEG ranges were then calculated. For the Kanektok River stock, the change included a somewhat higher lower bound and substantially higher upper bound; a revised SEG of 3,900 to 12,000 Chinook salmon was recommended (Table 3). On the other hand, the lower bound for the North Fork Goodnews SEG would not substantially change and the upper bound would be a third lower. Therefore, the SEG for this stock was recommended to continue without change. The Middle Fork Goodnews River Chinook salmon BEG was updated, resulting in only a slight change to the estimated range, and therefore no change was recommended for this BEG (Table 3).

CHUM SALMON

For Kuskokwim River chum salmon, only 2 goals exist, in the Aniak and Kogrukluks rivers which are assessed by sonar and weir, respectively. However, the Aniak River sonar project was discontinued in 2013, and without the sonar counts, the goal can no longer be assessed. Chum salmon have been enumerated at the weir project on the Salmon River tributary of the Aniak River since 2012, but the data series is still too short for a new escapement goal analysis. Therefore, the review team recommended that the Aniak River goal be discontinued. A need for a drainagewide chum salmon goal was recognized but existing information has been inadequate to estimate such a goal. The review team recognized that further consideration of potential new tributary goals is needed; a strategic review of tributary assessment projects would help to determine if any could contribute towards a meaningful escapement goal. The single chum

salmon goal in the Kuskokwim Bay on the Middle Fork Goodnews River was recommended to continue without change (Table 3).

SOCKEYE SALMON

No change was recommended for the single existing Kuskokwim River sockeye salmon goal on the Kogrukluk River stock, and no new goals were recommended (Table 3). Continuing work on a whole-river abundance estimate for sockeye salmon should inform future consideration of a new drainagewide goal or possible tributary goals.

For the Kuskokwim Bay, revisions were recommended for 2 of the 3 sockeye salmon goals. These 2 goals are based on aerial surveys, and an extensive review of survey data was conducted to standardize for data quality, time, and survey areas, similar to the review of Chinook salmon aerial survey data. In both cases, the lower bounds were revised substantially upwards after standardization of these data sets and the new percentile method recommendations (Clark et al. 2014) were applied (Table 3). The BEG on the Middle Fork Goodnews River stock was re-analyzed but was recommended to continue without change.

COHO SALMON

No changes were recommended for the 2 existing Kuskokwim River coho salmon goals, and no new goals were recommended (Table 3). ADF&G has been working toward a drainagewide goal for coho salmon. A drainagewide coho salmon run reconstruction was completed, although not published in time for this escapement goal review cycle; when finalized it will eventually enable the department to produce a coho salmon outlook. Any new tributary goals for coho salmon need to be considered in the context of the drainagewide run reconstruction and potential goal.

For Kuskokwim Bay stocks, no change was recommended for the single coho salmon goal on the Middle Fork Goodnews River (Table 3). Problems with flooding in the fall sometimes prevent operation of the weir for the entire coho salmon run. However, managers can normally ensure that the lower bound is met or exceeded before opening fisheries, and most fishing is thought to occur in the earlier part of the run.

Table 3.–Summary of escapement goal recommendations for Kuskokwim Management Area salmon stocks for 2016.

Stock unit	Assessment method	Current goal			Recommendation for 2016		
		Goal	Type	Year established	Action	New or revised goal	Type
Chinook salmon (14 existing)							
Kuskokwim River							
Kuskokwim R Drainage	Run reconstruction ^a	65,00–120,000	SEG	2013	No change		
Aniak River	Aerial survey	1,200–2,300	SEG	2005	No change		
Cheeneetnuk River	Aerial survey	340–1,300	SEG	2005	No change		
Gagarayah River	Aerial survey	300–830	SEG	2005	No change		
George River	Weir	1,800–3,300	SEG	2013	No change		
Holitna River	Aerial survey	970–2,100	SEG	2005	No change		
Kisaralik River	Aerial survey	400–1,200	SEG	2005	No change		
Kogruklu River	Weir	4,800–8,800	SEG	2013	No change		
Kwethluk River	Weir	4,100–7,500	SEG	2013	No change		
Salmon River (Pitka Fork)	Aerial survey	470–1,600	SEG	2005	No change		
Salmon River (Aniak Drainage)	Aerial survey	330–1,200	SEG	2005	No change		
Kuskokwim Bay							
Kanektok River	Aerial survey	3,500–8,000	SEG	2005	Revise	3,900–12,000	SEG
Middle Fork Goodnews River	Weir	1,500–2,900	BEG	2005	No change		
North (Main) Fork Goodnews River	Aerial survey	640–3,300	SEG	2005	No change		

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Stock unit	Assessment method	Current goal			Recommendation for 2016		
		Goal	Type	Year established	Action	New or revised goal	Type
Chum salmon (3 existing)							
Kuskokwim River							
Aniak River	Sonar	220,000–480,000	SEG	2007	Discontinue		
Kogrukluk River	Weir	15,000–49,000	SEG	2005	No change		
Kuskokwim Bay							
Middle Fork Goodnews River	Weir	>12,000	SEG	2005	No change		
Sockeye salmon (4 existing)							
Kuskokwim River							
Kogrukluk River	Weir	4,400–17,000	SEG	2010	No change		
Kuskokwim Bay							
Kanektok River	Aerial survey	14,000–34,000	SEG	2005	Revise	15,300–41,000	SEG
North (Main) Fork Goodnews River	Aerial survey	5,500–19,500	SEG	2005	Revise	9,600–18,000	SEG
Middle Fork Goodnews River	Weir	18,000–40,000	BEG	2007	No change		
Coho salmon (3 existing)							
Kuskokwim River							
Kogrukluk River	Weir	13,000–28,000	SEG	2005	No change		
Kwethluk River	Weir	>19,000	SEG	2010	No change		
Kuskokwim Bay							
Middle Fork Goodnews River	Weir	>12,000	SEG	2005	No change		

^a Run reconstruction is conducted postseason, using a model to estimate total return from harvest and escapement monitoring projects.

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**APPENDIX A: LIST OF AYK ESCAPEMENT GOAL
MEETING ATTENDEES**

Appendix A1.–List of attendees at the AYK region escapement goal review meetings held in Anchorage, February 2 and 3, 2015.

Yukon and Kuskokwim Area Meeting Attendance (February 2, 2015)

Aaron Poetter	Hamachan Hamazaki
Aaron Tiernan	James Hasbrouck
Andrew Munro	Jan Conitz
Art Nelson	John Linderman
Bev Hoffman	Josh Clark
Bill Bechtol	Ken Harper
Bob Aloysius	Neil Lalonde
Bonnie Borba	Sabrina Garcia
Brian McCaffery	Sean Larson
Brittany Blain	Stephanie Schmidt
Chris Shelden	Steve Fleischman
Don Rivard	Stuart Cogswell
Eric Volk	Tom Doolittle
Gene Sandone	Tom Taube
George Pappas	Zachary Liller

Norton Sound Area Meeting Attendance (February 3, 2015)

Andrew Munro
Art Nelson
Beverly Hoffman
Don Rivard
Hamachan Hamazaki
Jan Conitz
Jennifer Bell
Jim Hasbrouck
Jim Menard
John Linderman
Katie Howard
Roy Ashenfelter
Scott Kent
Tom Taube
Wes Jones