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UPPER COOK INLET PACIFIC SALMON BIOLOGICAL ESCAPEMENT GOAL REVIEW:

DEPARTMENT FINDINGS AND RECOMMENDATIONS TO THE ALASKA BOARD OF FISHERIES

by

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INTRODUCTION

The purpose of this report is to document results of the Alaska Department of Fish and Game's (hereafter referred to as either the Department or ADF&G) examination of biological escapement goals (BEG's) for Upper Cook Inlet salmon stocks. The Department had previously established BEG's for 25 chinook *Oncorhynchus tshawytscha*, seven coho *O. kisutch*, and eight sockeye *O. nerka* salmon stocks in the Upper Cook Inlet management area (Fried 1994). The Department made only one change to an existing BEG: the Susitna River sockeye salmon BEG was replaced by a Yentna sockeye salmon BEG which has been used as a surrogate for the Susitna River BEG since 1986. The Department also discovered that a previously established BEG for Crooked Creek chinook salmon had not been included in the original compilation of escapement goals (Fried 1994):

The Salmon Escapement Goal Policy adopted by The Department in 1992, defines the BEG for a salmon stock as the estimated number of spawners that produces the greatest yield (Appendix A). The BEG is determined by the department, is developed from the best available biological information, and is scientifically defensible. The BEG may be modified by the department only if new information suggests that future sustained harvest levels can be increased by that change. The Policy also sets specific guidelines for establishing, modifying, and reviewing escapement goals.

An Upper Cook Inlet BEG Interdivisional Review Team (hereafter referred to as the Team) was formed in 1995 to evaluate Pacific salmon *Oncorhynchus sp.* BEG's for the stock management units within this area. The Team included representatives from both the Commercial Fisheries Management and Development Division and Sport Fish Division. The goal of the Team was to determine whether existing Upper Cook Inlet BEG's needed to be modified and whether new BEG's needed to be established. To do this, the Team reviewed available information for all existing BEG's and gathered any information that could be used to set new BEG's. As a result of this initial screening, the Team found a BEG which had been omitted from the initial compilation of escapement goals published in 1994 (Fried): Crooked Creek chinook salmon. The Team decided to further examine four existing BEG's for potential modifications: Kenai River late-run chinook salmon, Kenai River sockeye salmon, Russian River late-run sockeye salmon, and Susitna River sockeye salmon. In addition the Team considered the establishment of two new BEG's: Hidden Lake sockeye and Yentna River coho salmon. Formal Team meetings to discuss and develop recommendations for these six BEG's were held in Soldotna on 14 September 1995 and in Anchorage on 21 December 1995.

Meetings among Department regional and headquarters staff were held after the Team developed and submitted BEG recommendations. The purpose of these meetings was to review these recommendations and determine whether they should be adopted by the department. Once these decisions were made, the department developed recommendations to the Alaska Board of

Fisheries concerning optimal escapement goals (OEG's). The Salmon Escapement Goal Policy defines the OEG for a salmon stock as the escapement management objective based on both biological and allocative factors. The OEG is determined by the Alaska Board of Fisheries and, while it may differ from the BEG, it must be sustainable.

References to BEG's or OEG's are included in Alaska Board of Fisheries proposals addressing the following existing regulatory management plans (ADF&G 1995):

1. Fish Creek Sockeye Salmon Management Plan (5AAC 21.364; proposal 167);

2. Upper Cook Inlet Salmon Management Plan (5AAC 21.363; proposals 206, 207, 216, 224 relating to Susitna River sockeye salmon; proposals 226, 245, 248, 249 relating to Kenai River sockeye salmon; proposal 253 relating to Kenai River late-run chinook salmon; proposal 257 relating to Crescent River sockeye salmon; proposals 229 to 234 relating to escapement goals in general);

3. Little Susitna River Coho Salmon Management Plan (5AAC 61.060; proposal 388);

as well as proposals addressing the establishment of new regulatory management plans:

1. Susitna River Personal Use Salmon Management Plan (5AAC 77.5XX; proposal 163 referring to Susitna River and Kenai River sockeye salmon);

2. Cook Inlet Comprehensive Salmon Management Plan (5AAC 21.3XX; proposal 242 relating to establishment of escapement goals in general).

This report provides a listing of all existing escapement goals for Upper Cook Inlet salmon, an explanation of department findings concerning the six BEG's evaluated in detail during two Team meetings, and Department recommendations to the Alaska Board of Fisheries for developing OEG's for Kenai and Susitna River sockeye salmon.

DATA ANALYSIS METHODS

Three general approaches can be used to describe stock-recruitment relationships: 1) rough and ready, 2) stock-recruitment curves with variances, and 3) tabular or Markov models (a more formal version of the rough-and-ready method (Hilborn and Walters 1992). The rough and ready approach is a qualitative method in which data are tabulated or plotted and examined for trends, patterns, or groupings that are useful in providing advice about stock and recruitment in a

population. Stock-recruitment curves is a quantitative method in which various mathematical relationships are fit to available data. The most commonly used models were developed by Ricker (1954 and 1975) and Beverton and Holt (1957). Finally, tabular or Markov models is a very data intensive method which accommodates, but is not based on, any form of stock-recruitment curve and includes the variation seen in the data. This method is essentially a tabular representation of recruitment probabilities directly based on available data. Due to the large amounts of data needed for this method, 30 to 50 data points, Department staff were unable to use tabular or Markov models to examine stock-recruitment relationships for any Upper Cook Inlet salmon stock.

While attempts were made to fit stock-recruitment curves with variances to some data sets, fits were often poor. Even in cases where some curves fit the data well, it was difficult to determine whether the correct model had been chosen due to errors and biases often inherent in stock-recruitment data (errors in measurement, time series biases, etc.; Hilborn and Walters 1992). Therefore, most of the Team's final recommendations relied heavily on a qualitative, rough and ready approach to examining the data. While most available data sets consisted of estimates of spawner and subsequent adult return numbers, information on rearing juveniles, zooplankton, and other indicators of freshwater carrying capacity were available for Kenai and Susitna River sockeye salmon.

RESULTS AND DISCUSSION

The only change made to an existing BEG was replacement of a Susitna River sockeye salmon BEG with a Yentna River sockeye salmon BEG. This accurately reflects the existing management objective for this system, since a Yentna River escapement goal has been used as a surrogate for the Susitna BEG since 1986 (Appendices B.1 and D.1). While no changes were made to the Kenai River sockeye salmon BEG, the Department developed recommendations to the Board of Fisheries for setting an OEG for this stock (Appendices B.2 and D.2).

No new BEG's were adopted, and the existing Crooked Creek chinook salmon BEG was added to the updated escapement goal listing (Tables 1-3, Appendix D.3). There are now a total of 26 chinook, seven coho, and eight sockeye salmon BEG's for the Upper Cook Inlet management area.

The following sections provide more detailed information on the six BEG's discussed in detail during Team meetings: Kenai late-run chinook, Russian River late-run sockeye, Hidden Lake sockeye, Kenai River sockeye, Susitna River sockeye, and Susitna River coho salmon.

Kenai River Late-Run Chinook Salmon

The Department made no changes to the existing BEG of 22,300 Kenai River Late-Run chinook salmon (Table 1, Appendix D.4). Little information was available for evaluating this BEG. Total production estimates were available for only five brood years (Table 4), so even a rough and ready approach was of little use in evaluating the existing goal. Also, the hydroacoustic program used to estimate chinook salmon entering the Kenai River, dual beam equipment located at river mile 8.5, is currently undergoing review since effects of various factors have not been well defined. For example, while estimates of accepted targets within the ensonified area are very precise (Eggers, Skvorc and Berwin 1995), effects of errors associated with setting criteria for target acceptance and discriminating among species have not yet been fully evaluated. Past studies have shown that while it is not possible to separate large chinook from sockeye salmon at the hydroacoustic site based on target strength criteria (Eggers 1994), it may be possible to do so based on spatial distribution along the hydroacoustic transect (Eggers, Skvorc and Berwin 1995). However, preliminary results of gillnet sampling conducted in 1995 suggest that chinook and sockeye salmon are not always spatially segregated at the hydroacoustic site (D.L. Berwin, ADF&G, Sport Fish Division, personal communications). To further examine this matter, the Department will use underwater radio telemetry to obtain independent estimates of chinook salmon run size based on inriver exploitation of tagged chinook salmon.

Russian River Late-Run Sockeye Salmon

The existing BEG of 30,000 sockeye salmon was not changed (Table 3, Appendix D.5). Actual escapements in most recent years have been well above the current BEG, and limnological collections indicate that the plankton population continues to be very healthy. However, while it was recognized that the existing BEG represents a minimum number of spawners needed to maintain a harvestable surplus rather than the number of spawners needed to produce maximum sustained yield, brood year tables have not been developed to evaluate production. The main impediment to brood stock table development has been the lack of a technique to accurately determine the number of Russian River late-run sockeye salmon harvested by the commercial fishery. However, recent stock identification studies, funded by the *Exxon Valdez* Oil Spill Trustee Council, have shown that genetic data provides a very effective method to discriminate among various Upper Cook Inlet sockeye salmon stocks (Seeb et al. 1995). Allozyme analysis has shown that Russian River sockeye salmon can be uniquely characterized from all other Upper Cook Inlet stocks examined and that even Russian River early- and late-run stocks are genetically distinct. Development of a full scale stock identification program will depend upon availability of funds.

Hidden Lake Sockeye Salmon

A BEG was not adopted for this enhanced stock, and current management practices do not appear to pose any threat of overexploiting this population. Although enhanced Hidden Lake sockeye salmon comprised nearly 20% of the Kenai River sockeye salmon inriver goal obtained in 1991, fry stocking levels for subsequent returns have been lowered, and the run to this system now typically comprises less than 10% of the total return to the Kenai River system. However, there was still concern that enhanced stocks were contributing to attainment of wild stock escapement goals monitored at the river mile 19 enumeration site. To ensure achievement of wild stock spawning escapements into other portions of the Kenai River, the Department decided that escapement of sockeye salmon into Hidden Lake resulting from enhancement activities not be counted towards attainment of the Kenai River sockeye salmon BEG.

Production from Hidden Lake appears to be limited by available spawning area rather than rearing habitat. Since Hidden Lake is within a National Wildlife Refuge, the Department has entered into agreements with the U.S. Fish and Wildlife Service in past years to stock the lake with fry and, thus, increase adult returns. According to this agreement, the total run produced is not supposed to result in an escapement greater than 30,000 sockeye salmon. Cook Inlet Aquaculture Association currently stocks about 1.8 million fry into Hidden Lake each year, and is not allowed to remove brood stock unless at least 2,000 spawners have entered the system. Due to their philosophy concerning management of wildlife on refuges, the U.S. Fish and Wildlife Service may not allow this lake to be stocked with fry in the future. Cook Inlet Aquaculture Association operates a smolt and adult salmon weir at the outlet of Hidden Lake.

Kenai River Sockeye Salmon

No change was made to the existing BEG of 300,000 to 570,000 sockeye salmon for mainstem spawning areas (Table 3, Appendix B.2 and D.2). Although this BEG does not include Russian River late-run spawners or enhanced sockeye salmon bound for Hidden Lake, Kenai River sockeye salmon production data has been examined without separating these other stock components because harvests have not been apportioned among these stocks, and because a combined BEG of 330,000 to 600,000, monitored by single beam hydroacoustic equipment at river mile 19, has been used as a primary inseason management objective.

Extensive review and analysis of data for this stock was done in 1994 (Fried 1995), so little additional information was available for further study. While there is good contrast in available spawner-recruitment data, with information from spawning escapements ranging from 51,000 to 1,407,000 sockeye salmon, no returns have been observed from spawning escapements between about 660,00 to 900,000 sockeye salmon (Table 5, Figure 1). Spawning escapements within this

range were obtained in 1992, 1993 and 1994, but returns have not yet occurred and will not be complete for the 1994 brood year until 1999. Nevertheless, the available data strongly indicated that the existing BEG should not be changed since spawning escapements 1) below 300,000 sockeye salmon have consistently produced yields less than 850,000 sockeye salmon; 2) between 300,000 and 660,000 sockeye salmon have produced yields greater than 1,400,000 sockeye salmon in all years, including three of the four greatest yields ever documented; and 3) greater than 900,000 sockeye salmon, which were obtained in three consecutive years (1987, 1988 and 1989), have only produced yields similar to those obtained in the existing BEG range of 330,000 to 600,000 spawners.

Additionally, *Exxon Valdez* Oil Spill Trustee Council studies being conducted in the Kenai River system have indicated potential density dependent effects resulting from successive escapements in excess of 900,000 spawners (Schmidt, D.C. 1994; Schmidt, D.C. and K.E. Tarbox *in press* and 1993). The greatest return-per-spawner value for these three large escapements (7.1) was obtained for the first one in this series (1,407,000). The succeeding two large escapements (910,000 and 1,379,000), as well as an escapement within the BEG range that followed the last large escapement (515,000), produced three of the lowest return-per-spawner values on record (2.2, 2.7 and 1.7, respectively). Process control analysis has shown that these return-per-spawner values were much lower than would have been expected from the past production history of this system (S.Carlson, ADF&G, Soldotna, personal communication). A recent analysis has suggested that the mechanism causing these effects is competition for a single prey item, cyclopoid copepods, by successive cohorts of sockeye salmon juveniles (Schmidt and Tarbox 1995).

Susitna River Sockeye Salmon

A Yentna River sockeye salmon estimate of 100,000 to 150,000 sockeye salmon, which has been used to assure a total Susitna River drainage escapement of 200,000 sockeye salmon since 1986, was adopted as a Yentna River sockeye salmon BEG, and the Susitna River BEG of 200,000 sockeye salmon was eliminated (Table 3, Appendix B.1 and D.1). This action formally acknowledged the loss of the Susitna River drainage escapement estimation project in 1986. A sonar project on the Susitna River, at Susitna Station, was started in 1979, but was discontinued in 1986 when the site was destroyed by flooding. A single beam sonar project established at river mile 4 on the Yentna River in 1981 has been continued through the present time (e.g. Davis and King 1995). There has been some confusion about the Susitna River sockeye salmon BEG since its attainment each year since 1986 has been based on sonar information from the Yentna River site. The total Susitna River drainage BEG was assumed to have been reached when 100,000 to 150,000 sockeye salmon enter the Yentna River. This range was based on five years of hydroacoustic estimates obtained at both the Yentna River and the Susitna River sites. During

this five-year period, the Yentna River estimate represented an average of about 48.7% of the total drainage sockeye salmon estimate.

Yentna River sockeye salmon production was examined without separating commercial catches between the Yentna and Susitna Rivers. While this overestimates Yentna sockeye salmon productivity, it is not yet possible to accurately identify these stocks separately within catches. Limited information on rearing fry density and size, as well as euphotic volume estimates, all suggested that the Yentna River, as well as the Susitna River, were producing adult sockeye salmon at a fairly high and sustainable level. The introduction and present wide dispersal of northern pike *Esox lucius* within these systems is of concern, but presently appears to be having a much greater effect on coho rather than on sockeye salmon (D. Rutz and L. Peltz, ADF&G, Palmer, personal communications).

It is not possible to predict the level of sockeye salmon production that might be obtained outside the current range of 100,000 to 150,000 sockeye salmon. All escapements obtained since the beginning of the sonar project in 1981 have been within this range, and production from these escapements have generally been similar and well above replacement values (Table 6). Available zooplankton data were too sparse to use in a model to examine sockeye salmon production, and euphotic volume information was judged to be barely adequate to characterize rearing lakes. Adult production estimates, based on euphotic volume of major rearing lakes, ranged from about 350,000 to 640,000 sockeye salmon, depending upon the importance assigned to Chelatna Lake (Table 7). Assuming an average return-per-spawner value of 4.0, escapements ranging from 90,000 to 160,000 sockeye salmon would be adequate to maintain these lakes at their estimated fry rearing capacities. The density and size of rearing fry sampled in the fall, suggest that these lakes are producing well (Table 8).

Finally, the Department was concerned that sockeye salmon enhancement efforts at Chelatna Lake, the largest sockeye salmon rearing lake in the Susitna River drainage, could eventually affect the Department's ability to enumerate wild stock spawning escapement at the Yentna River sonar site and measure wild stock production. Cook Inlet Aquaculture Association stocks fry into Chelatna Lake and operates a smolt and adult weir at the outlet of this lake. Although current stocking levels of 2,000,000 fry will probably only account for about 5% to 10% of the total number of sockeye salmon passing the sonar site, Cook Inlet Aquaculture Association would like to increase fry stocking in future years to produce a return of 400,000 adults to this lake (the production level which euphotic volume estimates indicate this lake is capable of achieving). If this production level can be attained, more than 100,000 of these enhanced sockeye salmon could pass the Yentna River sonar site each year. This would equal the lower end of the current BEG range. Since the thermal marking technology being used for stocked fry has not been rigorously evaluated, and problems still exist in enumerating smolt and adults at the lake outlet, the Department must work closely with Cook Inlet Aquaculture Association to ensure development of a technically sound program to measure enhanced and wild production from this important sockeye salmon rearing lake.

Yentna River Coho Salmon

No BEG could be set for this stock since estimates of coho spawning escapement could not be obtained from information collected during operation of the Yentna River single beam hydroacoustic project used to assess sockeye salmon escapement (e.g. Davis and King 1995). Fish wheels are operated to estimate the proportion of sockeye salmon passing the hydroacoustic site, and this information is used to adjust hydroacoustic estimates of sockeye salmon. While coho salmon are captured in fish wheels, this species is typically much less abundant than either sockeye or pink salmon. The spatial and temporal coverage of the project is focused on obtaining accurate estimates of sockeye salmon, so the number of coho salmon passing the site in portions of the river not covered by the sonar beams, as well as the number of coho passing the site after the project ends each season, is unknown and could be considerable.

LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). 1995. Alaska Board of Fisheries 1995/96 proposals, Cook Inlet & Kodiak/Chignik areas finfish, statewide king/tanner crab shellfish proposals and supplemental issues. Alaska Department of Fish and Game, Boards Support section, Juneau.

Beverton, R.J.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Fisheries Investment Series 2, Volume 19 U.K. Ministry of Agriculture and Fisheries, London.

Davis, R.Z. and B.E. King. 1995. Upper Cook Inlet salmon escapement studies, 1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 2A95-44, Anchorage.

Eggers, D.M. 1994. On the discrimination of sockeye and chinook salmon in the Kenai River based on target strength determined with 420 kHz dual-beam sonar. Alaska Fishery Research Bulletin 1(2): 125-139.

Fried, S.M. 1995. Kenai River sockeye salmon biological escapement goal review team findings. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 2A95-05, Anchorage.

Fried, S.M. 1994. Pacific salmon spawning escapement goals for the Prince William Sound, Cook Inlet, and Bristol Bay areas of Alaska. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Special Publication No. 8, Juneau.

Hilborn, R. and C.J. Walters. 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty. Chapman and Hall, New York, U.S.A.

Ricker, W.E. 1954. Stock and recruitment. Journal of the Fisheries Research Board of Canada, 11: 559-623.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin No. 191.

Seeb, L.W., C. Habicht, W.D. Templin, J.W. Fetzner, Jr., R.B. Gates, and J.E. Seeb. 1995. Genetic diversity of sockeye salmon (*Oncorhynchus nerka*) of Cook Inlet, Alaska, and its application to restoration of injured populations of the Kenai River. *Exxon Valdez* Oil Spill Restoration Project Final Report. *Exxon Valdez* Oil Spill Trustee Council, Anchorage.

LITERATURE CITED (continued)

Schmidt, D.C. 1994. State/federal natural resource damage assessment draft status report. Project title: Sockeye salmon overescapement; Study ID Number: 930002; Lead Agency: Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division. Exxon Valdez Oil Spill Trustee Council, Anchorage.

Schmidt, D.C. and K.E. Tarbox. *In press*. Kenai River sockeye salmon restoration project 94258 annual report; Lead Agency: Alaska and Game, Commercial Fisheries Management and Development Division. *Exxon Valdez* Oil Spill Trustee Council, Anchorage.

Schmidt, D.C. and K.E. Tarbox. 1995. Investigations of the Kenai River Sockeye Salmon Escapements Funded by the EVOS Trustee Council: Seasonal Cyclops abundance as a predictor of fall fry recruitment. Report to the Board of Fisheries. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Soldotna.

Schmidt, D.C. and K.E. Tarbox. 1993 Sockeye salmon overescapement state/federal natural resource damage assessment status report. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development, FRED Report Number 136, Juneau.

Table 1. Escapement goals and estimation methods for chinook salmon stocks, Upper Cook Inlet, 1995.

Stock	Biological Goal	Optimal Goal	Inriver Goal	Estimation Method
Alexander Creek	2,700			Aerial Survey
Anchor River	1,790			Aerial/Foot Survey
Campbell Creek	250			Foot Survey
Chuitna River	1,400			Aerial Survey
Chulitna River	2,000			Aerial Survey
Clear Creek	1,300			Aerial Survey
Crooked Creek	750			Weir
Deep Creek	950			Aerial/Foot Survey
Deshka River	11,200			Aerial Survey
Eagle River - South Fork	300			Foot Survey
Goose Creek	350			Aerial Survey
Kenai River Early-Run	9,000	9,000		Hydroacoustics
Kenai River Late-Run	22,300	22,300		Hydroacoustics
Lake Creek	2,900			Aerial Survey
Lewis River	400			Aerial Survey
Little Susitna River	850			Aerial Survey
Little Willow Creek	650			Aerial Survey
Montana Creek	1,100			Aerial Survey
Ninilchik River	830			Aerial/Foot Survey
Peters Creek	1,300			Aerial Survey
Prairie Creek	4,700			Aerial Survey
Sheep Creek	650			Aerial Survey
Ship Creek	250			Foot Survey
Talachulitna River	2,700			Aerial Survey
Theodore River	750			Aerial Survey
Willow Creek	1,750			Aerial Survey

Table 2. Escapement goals and estimation methods for coho salmon stocks in Upper Cook Inlet, 1995.

Stock	Biological Goal	Optimal Goal	Inriver Goal	Estimation Method
Campbell Creek	200			Foot Survey/Weir
Cottonwood Creek	300			Foot Survey
Fish Creek (Knik Arm)	2,700			Weir
Jim Creek	830			Foot Survey
Little Susitna River	7,500	7,500		Weir
Ship Creek	200			Foot Survey
Wasilla Creek	300			Foot Survey

Table 3. Escapement goals and estimation methods for sockeye salmon stocks, Upper Cook Inlet, 1995.

Stock	Biological Goal	Optimal Goal	Inriver Goal	Estimation Method
Crescent River	50,000 to 100,000			Hydroacoustics
Fish Creek (Knik Arm)	50,000	50,000		Weir
Kasilof River	150,000 to 250,000			Hydroacoustics
Kenai River	300,000 to 570,000	300,000 to 570,000	450,000 to 700,000	Hydroacoustics
Packers Creek	15,000 to 25,000			Weir
Russian River - Early-Run	16,000	16,000		Weir
Russian River - Late-Run	30,000	30,000		Weir
Yentna River	100,000 to 150,000			Hydroacoustics

Table 4. Kenai River late-run chinook salmon production, 1984-1991 brood years. Total return data includes the inriver recreational harvest, eastside set gillnet commercial harvest, and estimated spawning escapement, but does not include the marine recreational fishery harvest

Brood Year	Spawning Escapement	Total Return	Return Per Spawner	Yield (Total Return minus Spawning Escapement)
1984	31,796	36,495	1.2	4,699
1985	21,708	40,355	1.9	18,647
1986	48,037	46,928	1.0	0
1987	35,518	63,736	1.8	28,218
1988	34,024	72,373	2.1	38,349
1989	19,581	N/A.	N/A.	N/A.
1990	27,662	N/A.	N/A.	N/A.
1991	27,662	N/A.	N/A.	N/A.
1992	23,326	N/A.	N/A.	N/A.
1993	34,032	N/A.	N/A.	N/A.
1994	38,549	N/A.	N/A.	N/A.
1995	33,899	N/A.	N/A.	N/A.

Table 5. Kenai River sockeye salmon production, 1968-1990 brood years. Total return includes Russian River late-run sockeye salmon harvested in commercial and subsistence fisheries.

Brood Year	Spawning Escapement	Total Return	Return Per Spawner	Yield (Total Return minus Spawning Escapement)
1968	82,000	926,000	11.3	844,000
1969	51,000	412,000	8.1	361,000
1970	72,000	526,000	7.3	454,000
1971	289,000	993,000	3.4	704,000
1972	301,000	2,199,000	7.3	1,898,000
1973	358,000	1,990,000	5.6	1,633,000
1974	144,000	686,000	4.8	542,000
1975	128,000	859,000	6.7	731,000
1976	353,000	1,183,000	3.4	830,000
1977	663,000	2,701,000	4.1	2,038,000
1978	349,000	3,235,000	9.3	2,886,000
1979	245,000	1,037,000	4.2	792,000
1980	411,000	2,359,000	5.7	1,948,000
1981	339,000	2,216,000	6.0	1,877,000
1982	571,000	9,281,000	16.3	8,710,000
1983	566,000	6,178,000	10.9	5,612,000
1984	311,000	5,671,000	18.2	5,360,000
1985	403,000	2,469,000	6.1	2,066,000
1986	422,000	1,812,000	4.3	1,390,000
1987	1,407,000	9,998,000	7.1	8,591,000
1988	910,000	1,995,000	2.2	1,085,000
1989	1,379,000	3,693,000	2.7	2,314,000
1990	515,000	871,000	1.7	356,000
1991	430,000	N/A.	N/A.	N/A.
1992	805,000	N/A.	N/A.	N/A.
1993	695,000	N/A.	N/A.	N/A.
1994	859,000	N/A.	N/A.	N/A.
1995	572,000	N/A.	N/A.	N/A.

Table 6. Yentna River sockeye salmon production, 1981-1990 brood years. Total return includes both Yentna and Susitna River sockeye salmon harvested in commercial fishery.

Brood Year	Total Spawning Escapement (A)	Yentna River Spawning Escapement	Total Return (B)	Return Per Spawner (B/A)	Yield (B-A)
1981	338,000	139,400	1,160,000	3.4	1,020,600
1982	189,000	113,800	789,000	4.2	675,200
1983	176,000	104,400	340,000	1.9	235,600
1984	279,000	149,400	775,000	2.8	625,600
1985	227,000	107,100	982,000	4.3	874,900
1986	179,000	92,100	795,000	4.4	702,900
1987	128,000	66,000	736,000	5.7	670,000
1988	102,000	52,300	940,000	9.2	887,700
1989	187,000	96,300	841,000	4.5	744,700
1990	273,000	140,300	645,000	2.4	553,700
1991	213,000	105,000	N/A.	N/A.	N/A.
1992	128,000	66,057	N/A.	N/A.	N/A.
1993	276,000	141,694	N/A.	N/A.	N/A.
1994	247,000	128,000	N/A.	N/A.	N/A.
1995	236,000	121,479	N/A.	N/A.	N/A.

Table 7. Susitna-Yentna River adult sockeye salmon production potential estimated from euphotic volume of lakes used by rearing juveniles.

Lake	Surface Area (acres)	Adult Production Potential (numbers)	Proportion of Total Potential Adult Production
		Susitna Drainage	
Byers	368	37,200	0.037
Swan	385	11,000	0.011
Spink	252	23,500	0.023
Bunco	106	1,600	0.002
Caswell	159	13,700	0.014
Trapper	1,188	16,800	0.017
Fish	132	10,600	0.011
Sucker	273	8,300	0.008
Red Shirt	1,272	69,500	0.069
Neil	115	7,600	0.008
Larson	437	45,100	0.045
Stephan	899	63,700	0.063
		Yentna Drainage	
Chelatna	4,181	389,200	0.389
Trinity	308	19,300	0.019
Whiskey	271	23,600	0.023
Fish Creek	111	9,000	0.009
Shell	1,487	103,800	0.103
Puntilla	90	8,800	0.009
Eightmile	115	5,600	0.006
Movie	110	6,700	0.007
Lockwood	233	11,000	0.011
Judd	316	59,500	0.059
Hewitt	697	60,600	0.060
Red Salmon	113	3,400	0.003
Total	13,618	1,009,100	1.000

Table 9. Susitna-Yentna River sockeye salmon juvenile estimated abundance and size in selected lakes, 1993-1995. Juvenile estimates were less than actual numbers since fish near the surface could not be assessed with hydroacoustic equipment.

Lake	Juvenile Numbers	Juvenile Mean Length (mm)	Proportion of Juveniles in Tow Net Catches
	1993:	*141,694 Yentna spawners*	
Chelatna	1,411,114	62.1	0.907
Judd	277,865	45.8	0.809
Hewitt	447,080	48.5	0.144
Byers	91,252	63.9	0.845
Red Shirt	1,082	N/A.	0.001
Larson	9,737	55.0	0.036
Shell	19,843	55.0	0.015
	1994:	*128,000 Yentna spawners*	
Chelatna	1,863,537	55.7	0.959
Judd	1,036,661	38.6	0.903
Hewitt	925,748	39.9	0.239
Larson	520,270	53.4	0.976
Shell	367,469	54.9	0.169
Stephan	38,466	56.0	0.235
	1995:	*121,479 Yentna spawners*	
Chelatna	1,227,483	55.7	0.983
Judd	777,424	37.2	0.983
Hewitt	348,102	42.7	0.110

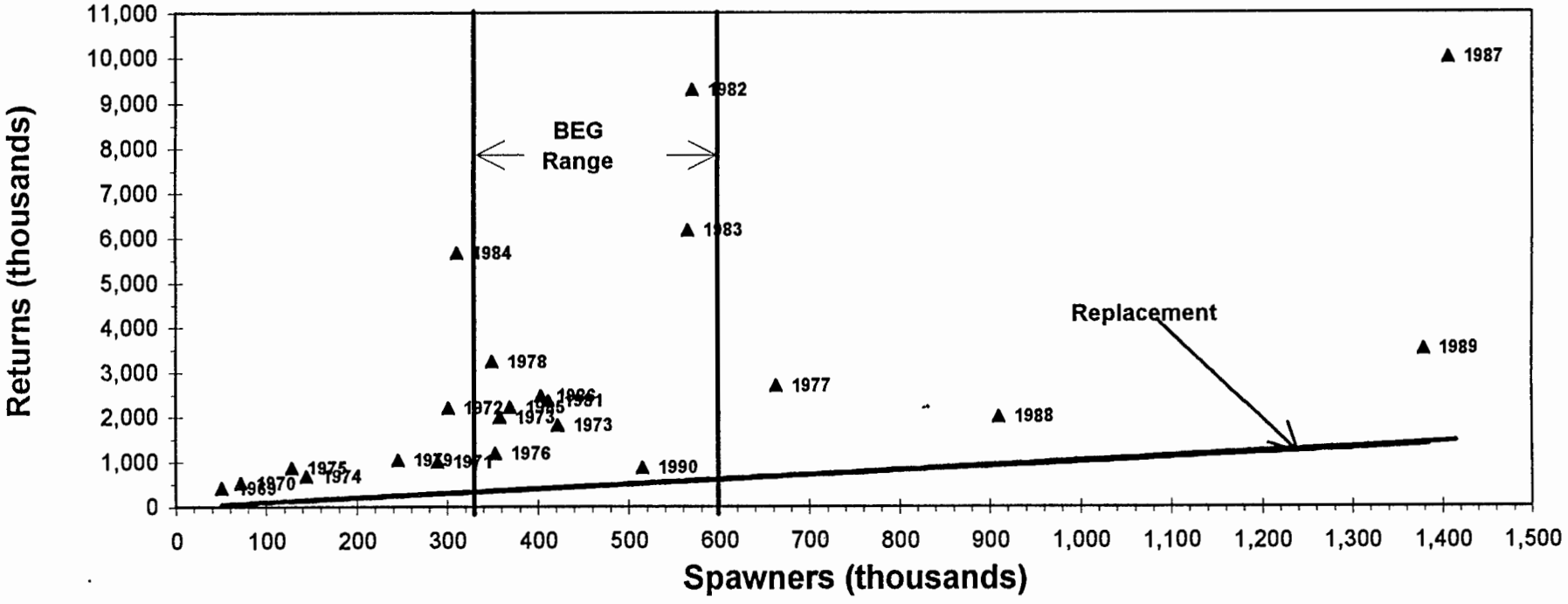

Figure 1. Kenai River sockeye salmon spawning escapements and adult returns, 1968-1990 brood years.

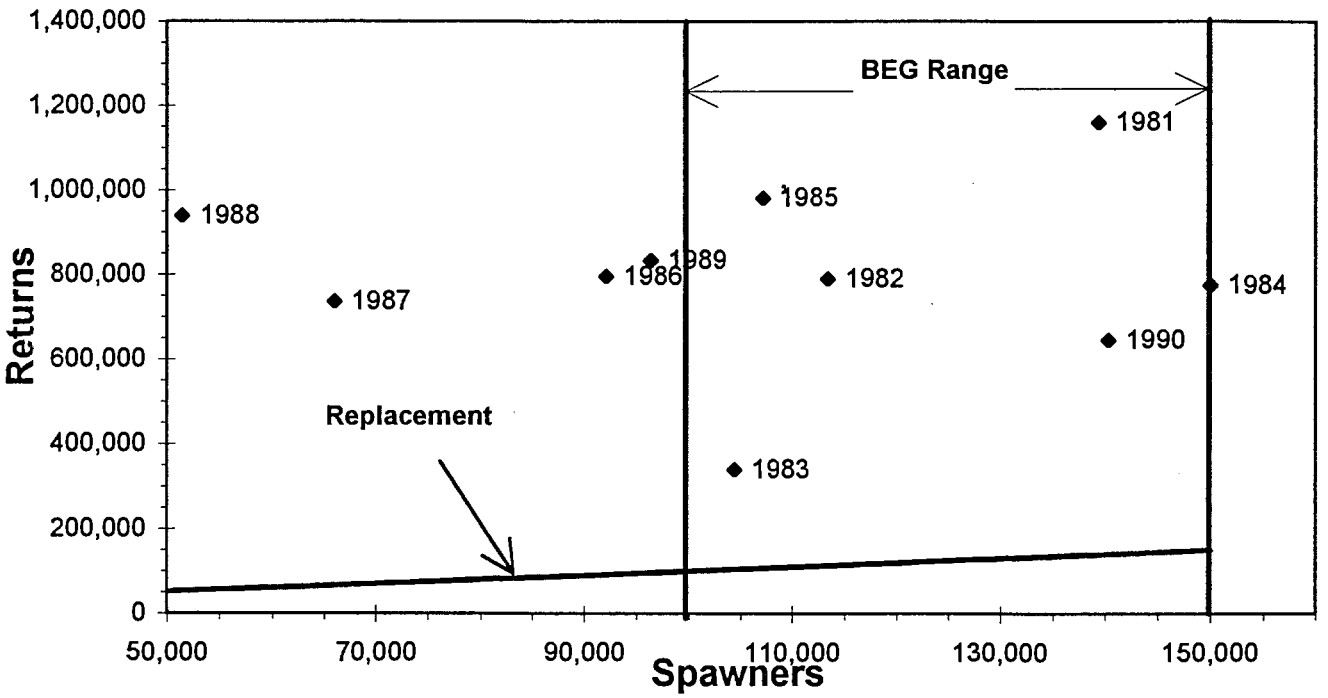

Figure 2. Yentna River sockeye salmon spawning escapements and adult returns, 1981-1990 brood years.

APPENDIX

APPENDIX A. Salmon Escapement Goal Policy Adopted by the Alaska Department of Fish and Game in 1992

SALMON ESCAPEMENT GOAL POLICY

Alaska Department of Fish and Game

Introduction:

The Alaska Constitution mandates the Department of Fish and Game to manage fishery resources on a sustained yield basis. For salmon fisheries with stable fishing effort, sustained yield can be achieved by conservative management practices such as limited catch quotas and limited scheduled fishing periods. However, for fisheries with expanding levels of fishing effort or excessive fishing power, sustained yield management requires that the department assess the number of salmon that spawn on an annual basis. The department has the authority to establish the annual level of salmon spawning stock required to maintain a sustainable harvest and also to manage commercial, sport, personal use, and subsistence fisheries to ensure that annual spawning escapement requirements are met.

The mission of the department needs to be clearly defined with respect to the mandated sustained yield principle. A wide range of sustainable yields are possible for salmon fisheries. The department has improved the methods and procedures for enumerating salmon spawning stock levels. The department has also developed methods for estimating the salmon carrying capacity of freshwater rearing environment for selected stocks. This information has enabled the department to obtain a better scientific understanding of the relationship between salmon spawning stock level and resulting level of return. Consequently, scientifically based spawning stock levels that produce the maximum number of harvestable fish can be estimated for many salmon fisheries.

There are many fisheries where the department lacks the necessary management program and scientific information to manage for maximum sustained yield. For these situations where fishing effort is expanding or fishing power is excessive, the department must necessarily implement more conservative fisheries management measures to assure sustainable yield. For fisheries that are supported by numerous, small, and unsurveyed streams, management will remain more a matter of scientific judgement. In all cases, conservative fishery management practices will result in yields that are lower than the stock's potential.

Unless otherwise directed by regulation, the department will manage Alaska's salmon fisheries, to the extent possible, for maximum sustained yield. To this end, the department will aggressively pursue the further development of escapement enumeration programs, in-season fishery management programs, and scientific methods to determine escapement levels which produce maximum sustained yield.

Purpose of the Escapement Goal Policy:

This policy applies to wild anadromous Pacific salmon. The purposes for this policy are to:

1. Establish definitions and concepts relating to escapement goals.

2. Specify criteria and procedures for establishing and modifying escapement goals.

3. Set up a process that facilitates public review of allocative issues associated with establishing and modifying escapement goals.

Definitions:

Salmon: is any of the five wild anadromous Pacific salmon species native to Alaska: chinook, coho, sockeye, chum and pink salmon.

Stock: is a locally interbreeding group of salmon that is distinguished by a distinct combination of genetic, phenotype, life history, and habitat characteristics. Recognizing that most fisheries harvest mixed stocks and when this constrains management, stocks may be aggregated into larger groups for purposes of this policy. This definition is consistent with "stock" as defined in statute (AS 16.05.940(15)).

Escapement: is the annual estimated size of the spawning stock. Quality as characterized by sex and age composition may be considered in estimating escapement.

Yield: is the number of fish harvested in a particular year or season from a stock.

Sustainable Yield: is the average annual yield that results from a level of escapement that can be maintained on a continuing basis. A wide range of average annual yield levels are sustainable.

Maximum Sustainable Yield (MSY): is the greatest average annual yield from a stock. In practice, MSY is approached when a constant level of escapement is maintained on an annual basis regardless of run strength. The achievement of MSY requires a high degree of management precision and scientific information regarding the relationship between escapement and subsequent return.

Biological Escapement Goal (BEG): is the estimated escapement that produces the greatest yield, is the specific management objective for the escapement, is developed from the best available biological information, and is scientifically defensible on the basis of available biological information. The BEG is determined by the Department of Fish and Game.

Optimal Escapement Goal (OEG): is a specific management objective for the escapement that considers biological and allocative factors. The optimal escapement goal is determined by the Alaska Board of Fisheries. The optimal escapement goal may or may not be equal to the BEG but is always sustainable.

Action Point: is a threshold value for some quantitative indicator of stock run strength at which some explicit management action will be taken to reach the optimal escapement goal. An action point may be derived from criteria about locations or dates and may include a statistical projection of abundance, escapement, or harvest.

In-River Run Goal: is defined by the Board of Fisheries for stocks that are subject

to in-river harvest above the point where escapement can be estimated. The in-river run goal is comprised of the optimal escapement goal plus specific allocations to in-river fisheries and may include allocations to provide higher catch per unit effort for in-river sport fisheries.

Procedures for Documenting, Establishing and Modifying, and Reviewing Escapement Goals:

Documentation of Existing Escapement Goals:

The department will document existing escapement goals for Alaska salmon fisheries in a single report. The development of the report will be coordinated by the Chief Fisheries Scientist, Division of Commercial Fisheries. Escapement goals will be summarized by fishery, species and stock for the following commercial finfish regulatory areas or groups of areas: 1) Southeast Alaska and Yakutat areas, 2) Prince William Sound area, 3) Cook Inlet area, 4) Kodiak area, 5) Chignik area, 6) Alaska Peninsula and Aleutian Islands areas, 7) Bristol Bay area, and 8) Kuskokwim, Yukon, Norton Sound-Port Clarence, and Kotzebue-Northern areas.

The report will encompass all stocks which are currently managed for an escapement goal or other repeatable, quantitative estimate of spawner abundance. The department will classify each goal so that it is consistent with this policy, provide a brief explanation of the genesis of the current goal, identify the method for estimating or indexing escapement, and identify the fishery division having primary management responsibility. It is the department's intent to revise the report as escapement goals are established or modified.

Establishing and Modifying Escapement Goals:

The department will follow these guidelines for establishing and modifying escapement goals:

1. Biological escapement goals should be established for stocks for which the department can estimate or index salmon escapement levels. Biological escapement goals will be changed whenever new information suggests that future sustained harvest levels can be increased by that change.

2. Biological escapement goals may be a single escapement level or a range of escapement levels. Whenever the biological escapement goal is specified as a range; the lower and upper limits of escapement will be consistent with MSY and based on the inherent variability in production of the stock.

3. Whenever the department wishes to establish a new biological escapement goal or modify an existing biological escapement goal, a scientific analysis with supporting data must be prepared.

4. The department will determine whether there is substantive allocation impacts arising from management actions needed to achieve any proposed biological escapement goal. When such a determination is made, it will be presented to the Board of Fisheries.

Review Process for Escapement Goals:

An analysis supporting the proposed biological escapement goal or biological escapement goal change will be developed by the region of the division with primary management responsibility for the affected stock. The region developing the proposal will provide opportunities for appropriate personnel from other divisions to participate in developing the analysis of the proposed BEG.

Following development of the analysis supporting the proposed BEG, an inter-divisional review team will be appointed by the appropriate regional supervisors of the Divisions of Commercial Fisheries and Sport Fish. The regional supervisors will request technical assistance from their respective division's headquarters, FRED Division, and also non-departmental experts as appropriate. The review team will assess the scientific merits of the BEG by reviewing available scientific information and by analyzing the impact of the proposed BEG on the existing management program for affected stocks. In addition, the review team will make a determination of whether there is substantive allocative impacts arising from management actions needed to achieve the proposed biological escapement goal.

If the team, by consensus, determines there is no substantive allocative impact arising from management actions to achieve the BEG, the proposed BEG will be submitted to the director of the division of primary management responsibility with a recommendation for its approval.

If the team cannot achieve a consensus, either with respect to the level of the BEG or the determination of allocative impact, the proposed BEG will be submitted to the division directors (and to the Commissioner, if necessary) for resolution.

If a determination of substantive allocative impact is made by the review team or a division director, the division directors will develop a joint proposal for the Commissioner to present to the Board of Fisheries to establish an optimal escapement goal and associated management plan to achieve the goal.

Cycle for Review of Existing Escapement Goals and Establishing New Escapement goals:

At a minimum, the department will review existing BEGs or propose new BEGs on a schedule that conforms to the Board of Fisheries triennial cycle of consideration of area regulatory proposals. Specific proposals for establishing and modifying BEGs will be developed, as appropriate within limits of available personnel, based on the availability of new scientific information and new techniques or programs for escapement enumeration.

Public Review and Implementation of Biological Escapement Goals:

Escapement Goals with Little or No Allocative Impact:

An effort to inform the public of any change in a biological escapement goal will be made. This process may include review of the change with Advisory Committees in the affected area and with user groups that depend on the affected stock.

Escapement Goals with Potentially Substantive Allocative Impact:

Whenever substantive allocation issues arise from proposed management actions needed to achieve a biological escapement goal, the department will request regulatory action from the Alaska Board of Fisheries to adopt a management plan for the fisheries involved. The management plan may identify an optimal escapement goal that differs from the proposed biological escapement goal to achieve the specific allocation objectives of the Board of Fisheries. The management plan will be drafted with departmental assistance and submitted to the Board of Fisheries for consideration.

The department will determine the biological escapement goals for the affected stocks, together with analyses of allocation impacts of alternative optimal escapement goals that the Board may consider.

In development of draft management plans for stocks with significant in-river fisheries, specific allocations to in-river fisheries will be added to the optimal escapement goal to set an in-river run goal. The fisheries outside the river will be managed to achieve the in-river run goal. The draft management plan will define specific action points and associated management actions for the department to follow in managing fisheries to meet the optimal escapement goal and/or the in-river run goal.

APPROVED:

R C Clasby — 10/16/92
Robert C. Clasby — Date
Acting Director, Division of Commercial Fisheries

Norval Netsch — 10/16/92
Norval Netsch — Date
Director, Sport Fish Division

Jeff Koenings — 10/16/92
Jeff Koenings — Date
Director, FRED Division

C Meacham — 10-16-92
Charles P. Meacham — Date
Deputy Commissioner, ~~Alaska~~ Department of Fish and Game

Carl L Rosier — 10/21/92
Carl L. Rosier — Date
Commissioner, Alaska Department of Fish and Game

APPENDIX B: DEPARTMENT POSITION ON SELECTED UPPER COOK INLET SALMON ESCAPEMENT GOALS

B.1. Department Position on Yentna River Sockeye Salmon Escapement Goals

The Department has conducted an extensive internal review of the biological escapement goal (BEG) for Yentna River sockeye salmon. The Department's Salmon Escapement Goal Policy defines the BEG as the estimated number of spawners that produces the greatest yield (harvest), is developed from the best available biological information, and is scientifically defensible. The Department may recommend modification of an existing BEG only if new information suggest that future sustained harvest levels can be increased by that change.

A Yentna River sockeye salmon estimate of 100,000 to 150,000 sockeye salmon, which has been used to assure a total Susitna River drainage escapement of 200,000 sockeye salmon since 1986, has been adopted as a BEG in place of the Susitna River BEG. No optimal escapement or inriver goals have been set for this stock. The Department's review of existing data finds that the Yentna River BEG for sockeye salmon should remain at 100,000 to 150,000 spawners. The Department recognizes that the Yentna River system is a diverse collection of lakes, clearwater streams, and glacial streams and that estimation of a BEG for this system as a whole may not represent the biologically optimum escapement for each individual tributary of the Yentna River. However, adult return data indicated that yields of sockeye salmon from the Yentna River are consistently high when escapements are in the range of 100,000 to 150,000 spawners. These returns are also consistent with juvenile rearing conditions and estimates of potential lake production in the Yentna drainage. Potential effects of raising the BEG above the current range cannot be predicted because there are presently no escapements greater than 150,000 spawners from which to estimate the potential yield.

Proposals that seek to raise the escapement level from the current 100,000 to 150,000 sockeye to 150,000 to 200,000 (proposals 206 and 207) and greater than 200,000 sockeye (proposals 216 and 224) are based on the assumption that increased escapement into the Yentna drainage will result in larger returns of sockeye salmon in the future. The Department has no data that indicate escapements greater than 100,000 to 150,000 spawners will increase, stabilize, or decrease returns in the future. The Department does recognize that the Board can adopt an escapement level in excess of the BEG to create optimal or inriver escapement goals for sockeye or other salmon species for social or economic reasons which are not considered in setting a BEG.

B.2. Department Position on Kenai River Sockeye Salmon Escapement Goals

The Alaska Department of Fish and Game (hereafter referred to as the Department) has conducted an extensive internal review of the biological escapement goal (BEG) for Kenai River sockeye salmon. The Department's Salmon Escapement Goal Policy defines the BEG as the estimated number of spawners that produces the greatest yield (harvest), is developed from the best available biological information, and is scientifically defensible. The Department may recommend modification of an existing BEG only if new information suggests that future sustained harvest levels can be increased by that change.

The present BEG for Kenai River sockeye salmon (including the BEG for Russian River late-run sockeye salmon) is 330,000 to 600,000 spawners. To account for the current allocation to recreational fisheries conducted above the hydroacoustic site, the Alaska Board of Fisheries (hereafter referred to as the Board) established an inriver goal of 450,000 to 700,000 sockeye salmon.

The Department's review of existing data finds that:

1. Spawning escapements of less than 300,000 spawners consistently produce poor returns and yields of less than 850,000 harvest.

2. Spawning escapements in the range of 300,000 to 660,000 spawners are well represented in our spawner evaluation data, produced yields in excess of 1,400,000 harvest in all years but one, and produced three of the four greatest yields including the highest documented yield. These are compelling reasons to conclude that the BEG lies within this range.

3. We have no return data from spawning escapements in the range of 660,000 to 900,000. Spawning escapements in this range have been achieved in recent years and returns from these escapements will be observed by the turn of the century.

4. Spawning escapements in excess of 900,000 occurred during the three years from 1987-89. These escapements have resulted in a wide range of production of about 2 to 7 returning adults per spawner and produced yields similar to those realized in the range of 300,000 to 660,000 spawners. The greatest of these return-per-spawner values and yields was obtained for the first large escapement in this series. The succeeding two large escapements, as well as an escapement within the BEG range that followed the last large escapement, produced three of the lowest return-per-spawner values on record.

5. Exxon Valdez Trustee Council studies (hereafter referred to as overescapement studies) being conducted in the rearing lakes (Kenai and Skilak), have indicated potential density dependent effects resulting from escapements in excess of 900,000 spawners.

B.2. (continued)

Based on these results, the Department did not change the current BEG of 330,000 to 600,000 spawners. The current BEG is within the range supported by the data (300,000 to 660,000) and there are no data to suggest that increasing the BEG would increase future yields.

A number of proposals are before the Board which would establish an optimal escapement goal (OEG) greater than the BEG. The OEG is defined as a specific management objective, set by the Board, for the number of spawners that considers biological and allocative factors. The OEG may or may not equal to the BEG but is always sustainable. In this case the additional spawners associated with the higher OEG would improve recreational harvests in the river by increasing the density of sockeye in the river. While some of these additional salmon would be harvested, a large proportion of them would become spawners.

The Department has looked at potential effects of establishing an OEG for Kenai River sockeye salmon greater than the BEG and has the following comments:

1. An OEG up to 660,000 spawners would be expected to produce similar long term yield (harvest) of sockeye salmon as the current BEG range. There would be a short term (first life cycle) loss of yield equal to the difference between the OEG and BEG (up to 60,000 sockeye salmon). In the long term there would be some reallocation of salmon from commercial users to recreational users.

2. The Department has little information to evaluate an OEG between 660,000 and 900,000 spawners. The potential for loss of yield increases with increased escapement above the current BEG. There would be a greater reallocation of salmon from commercial users to recreational users than described above.

3. Studies indicate that an OEG that consistently delivered spawning escapements in excess of 900,000 would decrease long term yield and production as well as result in the greatest short term loss of yield. This scenario would result in the greatest reallocation of salmon from commercial users to recreational users.

APPENDIX D: ESCAPEMENT GOAL SUMMARIES FOR UPPER COOK INLET PACIFIC SALMON

D.1. Kenai River Late-Run Chinook Salmon

REGULATORY AREA: Cook Inlet - Kenai Peninsula Area

STOCK UNIT: Kenai River - Late Run (escapement obtained after 30 June)

MANAGEMENT DIVISION: Sport Fish

PRIMARY FISHERY: Recreational

BIOLOGICAL ESCAPEMENT GOAL: 22,300 chinook salmon (adopted 1988)

OPTIMAL ESCAPEMENT GOAL: 22,300 chinook salmon (adopted 1988)

INRIVER GOAL: None

ACTION POINTS:

Less than 15,500 chinook salmon (adopted 1988)	Chinook salmon inriver recreational fishery closed; chinook salmon marine recreational fishery north of Bluff Point closed; commercial set gillnet fishery in Upper Subdistrict of Central District closed; commercial drift gillnet fishery in Central District closed within 3 miles of shore
Between 15,500 and 22,300 chinook salmon (adopted 1988)	Chinook salmon inriver recreational fishery restricted to single hook artificial lures, time and area may be reduced, and catch-and-release fishing may be instituted (except for retention of chinook salmon only 52 inches or larger)
Between 15,500 and 19,000 chinook salmon (adopted 1988)	Commercial set gillnet fishery in Upper Subdistrict of Central District limited to regular periods; commercial drift gillnet fishery in Central District limited to regular periods within 3 miles of shore - however, if Kenai River sockeye salmon sonar estimate is projected to exceed 700,000, neither the commercial set nor drift gillnet fisheries will be restricted unless chinook escapement is projected to be less than 15,500.

D.1. Kenai River Late-Run Chinook Salmon (continued)

ACTION POINTS (continued):

At and above 22,300 chinook salmon (adopted 1988)	Use of bait for inriver recreational chinook salmon fishery is permitted, and time and bag limits revert to those published in regulation; commercial set and drift gillnet fishery not constrained by chinook salmon considerations

ESCAPEMENT ENUMERATION METHODS: Estimates have been made from dual beam hydroacoustic equipment, placed on both sides of the Kenai River at river mile 8.5, since 1987. Mark-recapture estimates were made from 1984 to 1986.

HISTORY OF GOAL

An escapement goal for this stock was adopted under regulation as the *Kenai River Late Chinook Salmon Management Plan* (5 AAC 21.359) by the Alaska Board of Fisheries in 1988 and has been applied since 1989 for management of the inriver recreational fishery. The goal was based on only four years of total return data for which total returns ranged from 46,500 to 80,000 chinook salmon. Using an average return per spawner value of three, obtained from a review of available literature, the Board chose to manage for the average observed total return of 66,900 chinook salmon by adopting an optimal escapement goal of 22,300 chinook salmon. The Board also set a minimum goal of 15,500 chinook salmon, to help ensure that total return would not fall below the smallest observed value of 46,500 chinook salmon.

D.2 Russian River Late-Run Sockeye Salmon

REGULATORY AREA: Cook Inlet - Kenai Peninsula Area

STOCK UNIT: Russian River Late-Run (sockeye salmon returning after 21 June)

MANAGEMENT DIVISION: Sport Fish

PRIMARY FISHERY: Recreational

BIOLOGICAL ESCAPEMENT GOAL: 30,000 sockeye salmon (adopted early 1970's)

OPTIMAL ESCAPEMENT GOAL: 30,000 sockeye salmon (adopted 1979)

INRIVER GOAL: None

ACTION POINTS:

Less than 30,000 sockeye salmon (adopted 1979)	Inriver sockeye salmon sport fishery closed

ESCAPEMENT ENUMERATION METHOD: Visual estimates have been made at a weir since 1968. Visual estimates were made from counting towers during 1963 to 1967.

HISTORY OF GOAL

An escapement goal of 30,000 sockeye salmon was established by the department in the early 1970's and adopted by the Alaska Board of Fisheries in 1979 as part of the *Russian River Sockeye Salmon Management Plan* (5 AAC 21.361). The biological escapement goal represents the average escapement estimate for 16 years: 1963 to 1978. These estimates represent total escapement into this system and are expected to produce a high sustainable yield. Total runs to Russian River since the early 1980's have been much greater than those documented in prior years, and average annual escapement since 1980 has been more than twice the optimal escapement goal adopted in 1979.

D.3 Kenai River Sockeye Salmon

REGULATORY AREA: Cook Inlet - Central District

STOCK UNIT: Kenai River Drainage (sockeye salmon returning after 21 June, excluding Russian River late-run and Hidden Lake stocks)

MANAGEMENT DIVISION: Commercial Fisheries Management and Development

PRIMARY FISHERY: Commercial Set and Drift Gillnet

BIOLOGICAL ESCAPEMENT GOAL: 300,000 to 570,000 sockeye salmon (excludes Russian River Late Run biological goal [30,000] as well as sockeye salmon bound for Hidden Lake)

OPTIMAL ESCAPEMENT GOAL: 300,000 to 570,000 (implied from inriver goal; excludes Russian River Late Run optimal goal [30,000])

INRIVER GOAL: 450,000 to 700,000 sockeye salmon (provides sockeye salmon for inriver sport fishery; implicitly provides for Russian River Late Run sport harvest [average 30,000] and spawning escapement [30,000]; adopted 1987, modified 1995)

ACTION POINTS:

Less than 400,000 sockeye salmon (adopted 1989)	Sockeye salmon inriver sport fisheries closed; commercial fisheries restricted
450,000 sockeye salmon (adopted 1989; modified 1995)	Personal use dip net fishery may be opened below hydroacoustic site
400,000 to 700,000 sockeye salmon (adopted 1989; modified 1995)	Sockeye salmon inriver sport fisheries opened 7 days per week, 24 hours per day with bag limit of three
Greater than 700,000 sockeye salmon (adopted 1989)	Inriver sport fish daily bag and possession limit increased from 3 to 6 sockeye salmon; no restrictions on commercial fishery (even if chinook salmon escapement goal not met)

ESCAPEMENT ENUMERATION METHOD: Estimates have been made with single beam hydroacoustic equipment, placed on both sides of the Kenai River at river mile 19, in conjunction with fish wheels, since 1969.

HISTORY OF GOAL

An escapement goal of 150,000 sockeye salmon was first established in 1968, based on estimated average contribution (30%) of Russian River sockeye salmon (estimated at a weir) to total Kenai River escapement. In 1972, the goal was changed from a point value to a range of 150,000 to 250,000. The basis for this change was not documented, but it may have been due to revised estimates of Russian River contribution (20%). In 1978, the goal was increased to 350,000 to 500,000 sockeye salmon. This change appears to be based on 1971 to 1973 escapements, which were thought to be responsible for the recovery, in 1976 to 1978, of the formerly depressed run; return-per-spawner data; and estimated fry production. A continued trend of increasing returns and escapements prompted the Alaska Board of Fisheries to establish the existing inriver goal and two action points under the *Kenai River Sockeye Salmon Management Plan* (5 AAC 21.360). An additional action point was established by the *Cook Inlet Personal Use Salmon Dip Net Fishery Management Plan* (5 AAC 77.545). Escapement goals for this system have been reviewed almost every year since 1992 by an interdivisional review team established by ADF&G (Fried 1995 and 1996). No further changes have been made to the biological escapement goal, except to explicitly state that it does not include sockeye salmon bound to Hidden Lake. This will allow managers to obtain escapement for wild stock sockeye salmon during years when the enhanced Hidden Lake was unusually large. The Alaska Board of Fisheries increased the inriver goal by 50,000 sockeye salmon, and modified some action points in 1995.

D.4 Crooked Creek Chinook Salmon

REGULATORY AREA: Cook Inlet - Kenai Peninsula Area

STOCK UNIT: Crooked Creek

MANAGEMENT DIVISION: Sport Fish

PRIMARY FISHERY: Recreational

BIOLOGICAL ESCAPEMENT GOAL: 750 chinook salmon (adopted 1988)

OPTIMAL ESCAPEMENT GOAL: None

INRIVER GOAL: None

ACTION POINTS: None

ESCAPEMENT ENUMERATION METHOD: Visual estimates have been made at a weir since 1978.

HISTORY OF GOAL

This system has a mix of wild and hatchery stocks. Construction of a hatchery on Crooked Creek began in 1973, and chinook salmon smolt releases began in 1975 (Gary Kyle, ADF&G, Soldotna, personal communication). Visual estimates have been made at a weir located just above the hatchery site since 1978. Chinook salmon must be individually handled to pass them above the weir. On average, 3,221 chinook salmon were passed above the weir each year during the period 1978-1987. In 1988 the number of chinook salmon allowed to pass above the weir was reduced to 750 because 1) there was concern that larger numbers of spawning chinook salmon would increase the probability of diseases being introduced into the hatchery water supply, and 2) anecdotal evidence suggested that annual escapement into the creek had been less than 1,000 chinook salmon prior to enhancement activities (Nelson, D.C. 1989. Kenai Peninsula Management Report, 1989. Alaska Department of Fish and Game, Sport Fish Division, Soldotna.). According to the most recent hatchery management plan (Crooked Creek Hatchery Annual Management Plan Calendar Year 1995), the 750 chinook salmon passed above the weir should represent a broad cross section of the total run, have a 50:50 sex ratio, and contain 50 one-ocean males (jacks).

D.5 Yentna River Sockeye Salmon

REGULATORY AREA: Cook Inlet - Northern District

STOCK UNIT: Susitna River Drainage

MANAGEMENT DIVISION: Commercial Fisheries Management and Development

PRIMARY FISHERY: Commercial Set and Drift Gillnet

BIOLOGICAL ESCAPEMENT GOAL: 100,000 to 150,000 sockeye salmon (adopted 1996)

OPTIMAL ESCAPEMENT GOAL: None

INRIVER GOAL: None

ACTION POINTS: None

ESCAPEMENT ENUMERATION METHOD: Estimates have been made with single beam hydroacoustic equipment, placed on both banks of the Yentna River at river mile 4, in conjunction with fish wheels, since 1981. Estimates were made with single beam hydroacoustic equipment, placed on both banks of the Susitna River at Susitna Station, from 1979 to 1985. Mark/recapture estimates at Sunshine Station were done from 1982 to 1985.

HISTORY OF GOAL

A total Susitna River escapement goal of 200,000 sockeye salmon was established in 1979 during comprehensive salmon development planning for Cook Inlet. It was set using a return-per-spawner value of four and the assumption that the Susitna River could produce about 800,000 adult sockeye salmon. A review of the goal in 1989, based on euphotic volume of rearing lakes, suggested that the existing goal was valid. In 1986 the hydroacoustic site at Susitna Station was destroyed by flooding, and no alternative hydroacoustic site could be found on the mainstem of the Susitna. Therefore, Yentna River hydroacoustic estimates were used as an index of total Susitna River escapement. Based on comparisons of estimates for the Yentna and the Susitna rivers during five years, 1981 to 1985, it was decided that an escapement of 100,000 to 150,000 sockeye salmon into the Yentna River would usually result in a total escapement of at least 200,000 sockeye into the entire Susitna drainage. This was based on the average proportion of the total Susitna River escapement which entered the Yentna River (48.7%) during the five years studied as well as the range of annual proportions (41.0% to 59.3%) for these five years. In 1996, ADF&G formally adopted the Yentna goal as a BEG and discontinued use of the Sustina River BEG. This action recognizes the inability of ADF&G to assess total system escapement and the use of the Yentna River BEG as the primary management objective

HISTORY OF GOAL (continued)

for this system. This action does not alter the ability of ADF&G to achieve escapement throughout the drainage, since the Yentna goal was originally set to ensure drainage-wide escapement. Future spawning goal analyses will assign all production from the Susitna drainage to the Yentna, since it is not possible to apportion commercial harvests between the Yentna and Susitna runs. This will inflate actual production on a per-spawner basis for the Yentna River, but will help ensure that drainage-wide production is maintained at a high sustained level.

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