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 the department) examination of biological escapement goals (BEG's) for Upper Cook Inlet salmon stocks. The department had initially 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). Since that time, the department made one change to an existing BEG (a Susitna River sockeye salmon BEG was replaced by a Yentna sockeye salmon BEG which had been used as a surrogate for the Susitna River BEG since 1986), and officially recognized one BEG (Crooked Creek chinook salmon BEG) not included in the original compilation of escapement goals (Fried 1995 and 1996):

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 will be modified by the department if new information suggests future sustained harvest levels can be increased by that change. The policy 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 first formed in 1995 to evaluate Pacific salmon *Oncorhynchus sp.* BEG's for stock management units within this area. The team includes representatives from both the Commercial Fisheries and Sport Fish divisions. The purpose of the team is to determine whether existing Upper Cook Inlet BEG's need to be modified and whether new BEG's need to be established. To do this, the team reviews available information for existing and any potential new BEG's. During 1998, the team closely examined all existing BEG's for potential modifications, evaluated information for setting new BEG's for Hidden Lake sockeye salmon and Deception Creek chinook salmon, and reviewed proposals for eliminating existing BEG's for Crooked Creek and Goose Creek chinook salmon. Formal team meetings to discuss and develop recommendations for these BEG's were held in Anchorage on 14 October and 24 November 1998. All team recommendations were reviewed by department regional and headquarters staff prior to being adopted by the department.

Once the team developed final BEG recommendations, they also assisted the department in compiling information and developing analyses to assist the Alaska Board of Fisheries in setting or modifying optimal escapement goals (OEG's), action points, and in-river run goals. This information will presented in other reports. The Salmon Escapement Goal Policy defines the OEG for a salmon stock as a sustainable spawning escapement management objective based on both biological and allocative factors. An action point is defined as a threshold value for a quantitative indicator of stock size at which a specific management action is taken to reach the

OEG. The in-river goal provides harvest allocations to inriver fisheries occurring above the point where escapement is estimated and consists of the OEG plus the specific allocations.

References to BEG’s, OEG’s, action points, or in-river goals are included in Alaska Board of Fisheries proposals addressing the following existing regulatory management plans and regulations (ADF&G 1998):

1. Upper Cook Inlet Salmon Management Plan (5AAC 21.363; proposal 141 suggests changes to the Kenai River sockeye salmon in-river goal; proposals);

2. Northern District King Salmon Management Plan (5AAC 21.366; proposal 148 refers to Theodore and Chuitna rivers chinook salmon BEG's);

3. Kenai River Late Run Sockeye Salmon Management Plan (5AAC 21.360; proposal 152 suggests changes to each year's target BEG and OEG based on previous year's spawning escapement; proposal 153 seeks establishment of maximum escapement goal; proposals 157 and 161 seek establishment of new action points);

4. Russian River Sockeye Salmon Management Plan (5AAC 21.361; proposals 165 and 166 refer to BEG's);

5. Kenai River Late Run Chinook Salmon Management Plan (5AAC 21.359; proposal 167 suggests changes to the BEG and OEG as well as an action point based on sockeye salmon escapement; proposal; 169 addresses action points; proposal 171 addresses the BEG, OEG, and action points);

6. Fish Creek Sockeye Salmon Management Plan (5AAC 21.364; proposal 184 would repeal this plan and, in doing so, eliminate the OEG for this system);

7. Northern District Coho Salmon Management Plan (5AAC 21.358; proposal 186 seeks to establish chum and pink salmon escapement goals for the Little Susitna River; proposal 190 refers to sockeye salmon OEG's; proposal 194 refers to Little Susitna River coho salmon escapement goal)

8. Little Susitna River Coho Salmon Management Plan (5AAC 61.060; proposal 194 refers to coho salmon escapement goals);

9. Kenai River Early Run Chinook Salmon Management Plan (5AAC 56.070; proposal 235 seeks to establish action points; proposal 236 refers to the BEG);

10. Waters; Seasons; Bag, Possession, and Size Limits; And Special Provisions (5AAC 61.022; proposal 261, 270, and 271 refer to Deshka River chinook salmon BEG);

11. Method and Means (5AAC 61.053; proposal 279 refers to Deshka River chinook salmon escapement objectives).

References to BEG’s, OEG’s, action points, or in-river goals are also included in Alaska Board of Fisheries proposals addressing establishment of new regulatory management plans (ADF&G 1998):

1. Kasilof River Chinook Salmon Management Plan (5AAC 21.XXX; proposal 170 seeks to establish a BEG for late run Kasilof River wild chinook salmon);

2. Susitna River Sockeye Salmon Management Plan (5AAC 21.XXX; proposal 176 seeks to establish an OEG for Yentna River sockeye salmon);

3. Northern District Sockeye Salmon Management Plan (5AAC 21.XXX; proposal 179 seeks to change the Kenai River sockeye salmon OEG, establish a Yentna River sockeye salmon OEG, and set In River Run Goals for Yentna River and Fish Creek sockeye salmon; proposals 180 and 181 refer to escapement goals in general and OEG's for Yentna River and Fish Creek specifically);

4. Knik Arm Coho Salmon Management Plan (5AAC 21.XXX; proposal 193 refers to sockeye and coho salmon escapement goals);

5. Deshka River Chinook Salmon Management Plan (5AAC 21.XXX or 5AAC 61.XXX; proposals 261 and 276 refer to the BEG and suggest setting an OEG and action points).

This report provides a listing and explains department findings concerning 10 BEG’s which were modified (Anchor River, Deep Creek, Deshka River, Kenai River Early Run, Kenai River Late Run, Ninilchik River, and Willow Creek chinook salmon; Little Susitna coho salmon; Crescent River and Kenai River sockeye salmon), as well as a new BEG (Deception Creek chinook salmon) resulting from a modification of an existing BEG (Willow Creek chinook salmon).

DATA ANALYSIS METHODS

Three general approaches can be used to describe stock and 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 and 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 used tabular or Markov models to examine stock and recruitment relationships only for Kenai River sockeye salmon.

While attempts were made to fit stock-recruitment curves with variances to several data sets, fits were often poor. Even in cases where 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 and recruitment data (errors in measurement, time series biases, etc.; Hilborn and Walters 1992). Therefore, many 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 Crescent, Kenai and Susitna river sockeye salmon.

Sockeye salmon BEG analyses described in this report were based on newly revised production data. First, Hidden Lake enhanced sockeye salmon were removed from escapements and harvests. Second, an aging error in 1989 samples was found and corrected by rereading scales and making corrections in production data. Third, stock contribution estimates to commercial harvests were altered based on assumptions of which stocks were present in various harvest areas rather than assuming equal exploitation of all stocks in all fisheries. New contribution estimates were calculated assuming 1) Crescent River sockeye salmon were only present in Western sub-district harvests and not in either drift or eastside set gill net harvests; 2) the eastside set gill net fishery harvests only sockeye salmon bound for either the Kenai or Kasilof rivers; and 3) the Northern District set gill net fishery harvests only sockeye salmon bound for Northern District streams.

RESULTS AND DISCUSSION

There are now a total of 27 chinook, seven coho, and eight sockeye salmon BEG's for the Upper Cook Inlet management area (Tables 1-3). The following sections provide detailed information on BEG's recently modified by the department.

Chinook Salmon

All 27 existing Upper Cook Inlet chinook salmon BEG's were reviewed, and modifications were adopted for seven stocks: Anchor River, Deep Creek, Deshka River, Kenai River Early Run, Kenai River Late Run, Ninilchik River, and Willow Creek (Table 1). Modification of the Willow Creek BEG involved creating a separate BEG for Deception Creek, a major tributary within the Willow Creek drainage. The department also discussed eliminating the BEG for Crooked Creek chinook salmon since escapement has not been monitored for three years. However, consideration of changes to the existing BEG of 750 spawners was deferred until an enhancement project review and evaluation is completed.

Anchor River

The department changed the BEG from a single escapement level of 1,790 spawners to a range of 1,050 to 2,200 spawners. The previous BEG was calculated as the mean of aerial survey counts adjusted with data from supplemental foot surveys for a 26 year period (1966-1991). Since foot surveys are no longer conducted, the BEG was recalculated using only aerial survey counts from helicopters obtained during the period 1976-1997 (16 years:1976-1979, 1981-1984, 1986-1989, 1991, 1994, 1996, and 1997; Table 4). The median survey count for these years was 1,211 spawners, and the mean count was 1,455 spawners. The BEG range was calculated as the 40^{th} to 80^{th} percentile values, rounded to the nearest 50 spawners, of these aerial survey counts. The 40^{th} percentile was chosen as the lower end of the range since it was the lowest percentile, in increments of 10, that contained 1,000 or more spawners. Aerial survey counts greater than or equal to 1,000 spawners have consistently been associated with inriver harvests of 500 to 2,100 chinook salmon. Surveys within the 16 years used have exceeded 1,050 spawners 10 times.

Deep Creek

The department changed the BEG from a single escapement level of 905 spawners to a range of 400 to 950 spawners. The previous BEG was calculated as the mean of aerial survey counts adjusted with data from supplemental foot surveys for a 24 year period (1966-1969 and 1972-1991). Since foot surveys are no longer conducted, the BEG was recalculated using only aerial survey counts from helicopters obtained during the period 1976-1997 (17 years:1976-1979, 1981-1984, 1986-1989, 1991, 1994-1997; Table 5). The median survey count for these years was 550 spawners, and the mean count was 573 spawners. The BEG range was calculated as the

40^{th} to 80^{th} percentile values, rounded to the nearest 50 spawners, of these aerial survey counts. The 40^{th} percentile was chosen as the lower end of the range since it was the lowest percentile, in increments of 10, that contained 375 or more spawners. Aerial survey counts greater than or equal to 375 spawners have consistently been associated with inriver harvests of 200 to 1,000 chinook salmon. Surveys within the 17 years used have exceeded 400 spawners 11 times.

Deshka River

The department changed the BEG from 11,200 spawners counted during an aerial survey to 17,500 spawners counted at a weir, which is equivalent to an aerial survey count of about 8,750 spawners. The previous BEG was calculated as 66% of the average aerial index count for 11 years (1979, 1982-1988, 1990-1992). A percentage of the average was used since biologists working on this system thought escapements achieved during this 11 year period were generally above the level needed to sustain high yields. Escapement has been counted at a weir since 1995, and comparisons between weir and aerial counts for three years (1995-1997) indicate aerial surveys tend to account for about 50% of the total escapement. The BEG was reexamined using expanded (i.e. doubled) aerial survey counts for the years 1974-1994 and 1998 and weir counts for the years 1995-1997 (Table 6). During these years, escapements have ranged from 9,500 to 79,500 spawners. Escapements for three years (1980, 1981, and 1989) were missing and had to be estimated, and poor production during a series of five years (1987-1991) was thought to be due to unfavorable spawning and rearing conditions rather than number of spawners present (Gene Sandone, Alaska Department of Fish and Game, personal communication). The greatest yield (44,000 chinook salmon) was obtained for an escapement of 10,500 spawners, while the second greatest yield (33,500) was obtained for an escapement of 32,000 spawners. Only one escapement in the data set (1992, 15,600 spawners) was within the range between 15,000 and 30,000 spawners. Ricker stock-recruitment models fit to data for the 1974-1986 and 1992 brood years produced BEG values of 16,500 and 17,400 spawners.

Kenai River Early Run

The department adopted a BEG of 7,200 to 14,400 spawners, which represents a range about the previous BEG of 9,000 spawners that better captures production potential of this stock. The previous BEG represents the number of spawners needed to maintain mean runs of 27,000 chinook salmon, assuming an average recruitment of three adults per spawner. Recruitment from only eight brood years is available for examination (Table 7). Good production (2.5 returns per spawner) and the greatest yield (11,900 sockeye salmon) was obtained at the smallest spawning escapement in the data set (7,800 spawners), while poor production (0.5 returns per spawner) and no yield was obtained at the largest escapement (19,200 spawners). Production has generally been good (1.4 to 2.3 returns per spawner) and always above replacement (yields ranging from 2,700 to 11,700 chinook salmon; mean yield 7,500 chinook salmon) for the six other escapements within the data set (8,000 to 12,000 spawners). Too few data points were available to reliably fit either stock and recruitment models or to use Markov models. While the best production was obtained at escapements of 7,800 and 8,700 spawners, the department set the BEG range around the previous BEG point estimate of 9,000 spawners (S_{msy}) using Eggers (1993) recommendation of $0.8S_{msy}$ to $1.6S_{msy}$. This range is similar to the actual range of escapements that have produced good yields (7,800 to 12,000 spawners). Returns over the next three to four years will come from four relatively large escapements, ranging from 12,000 to 17,300 spawners.

The department will provide advice on the OEG and action points contained within regulatory management plans in an oral report to the board. Examination of past performance indicated that, with current regulations and management tools, the department is able to effectively control escapement and project final run size.

Kenai River Late Run

The department adopted a BEG of 17,800 to 35,700 spawners, which represents a range about the previous BEG of 22,300 spawners. The previous BEG represents the number of spawners needed to maintain mean runs of 66,900 chinook salmon, assuming an average recruitment of three adults per spawner. Recruitment from only nine brood years is available for examination (Table 8). Good production (2.3 returns per spawner) and yield (24,500 chinook salmon) was obtained at the smallest spawning escapement in the data set (19,600 spawners), while poor production (1.0 returns per spawner) and no yield was obtained at the largest escapement (48,000 spawners). Production has generally been good (1.1 to 2.4 returns per spawner) and always above replacement (yields ranging from 4,700 to 40,100 chinook salmon; average yield, 25,100 chinook salmon) for the seven other escapements within the data set (21,700 to 35,500 spawners). Too few data points were available to reliably fit either stock-recruitment models or to use Markov models. While the best production was obtained at an escapement of 27,700 spawners, the department set the BEG range around the previous BEG point estimate of 23,300 spawners (S_{msy}) using Eggers (1993) recommendation of $0.8S_{msy}$ to $1.6S_{msy}$. This range is similar to the actual range of escapements that have produced good yields (19,600 to 35,500 spawners). Returns over the next three to four years will come from escapements near (33,900 to 34,000 spawners), or just above (38,500 spawners), the upper end of the BEG range.

The department will provide advice on the OEG and action points contained within regulatory management plans in an oral report to the board. Examination of past performance indicated the department is unable to accurately project final run size in relation to current action points (i.e. existing action points are too close together in relation to inseason forecasting accuracy).

Ninilchik River

The department changed the BEG from a single escapement level of 830 spawners to a range of 500 to 900 spawners. The previous BEG was calculated as the mean of aerial survey counts adjusted with data from supplemental foot counts for a 24 year period (1966-1969 and 1972-1991). Since foot surveys are no longer conducted, the BEG was recalculated using only aerial survey counts from helicopters obtained during the period 1976-1997 (15 years:1976-1979, 1981-1984, 1986-1989, 1991, 1994, and 1996; Table 9). The median survey count for these years was 552 spawners, and the mean count was 578 spawners. The BEG range was calculated as the 40^{th} to 80^{th} percentile values, rounded to the nearest 50 spawners, of these aerial survey counts. The 40^{th} percentile was chosen as the lower end of the range since it was the lowest percentile, in increments of 10, that contained 400 or more spawners. Aerial survey counts greater than 400 spawners have consistently been associated with inriver harvests of 600 to 1,500 chinook salmon prior to 1993 as well as during 1994 and 1996. Surveys within the 15 years used have exceeded 500 spawners nine times.

Willow and Deception Creeks

The department divided the original Willow Creek drainage chinook salmon BEG of 1,750 spawners into separate BEG's of 1,350 spawners for Willow Creek and 400 spawners for Deception Creek, a major tributary within the drainage. Separate BEG's will help avoid situations in which a large hatchery run to Deception Creek could account for a large portion of the drainage escapement and thus falsely suggest that adequate numbers of wild spawners were distributed throughout the drainage. Only chinook salmon returning to Deception Creek are used as hatchery brood stock to enhance the run to this drainage, and, since 1996, all hatchery-produced juveniles are released in Deception Creek, approximately 4 miles above its confluence with Willow Creek.. The enhanced component of the Deception Creek escapement has averaged about 42% since 1986, but only contributes about 8% to the main Willow Creek escapement. Beginning with progeny of the 1996 brood year, all hatchery-reared chinook salmon juveniles released into this system have been marked by insertion of a coded wire tag and removal of the adipose fin. Although unmarked hatchery-reared chinook salmon from previous broods will continue to return to Deception Creek through 2001, only adults having an adipose fin have been used as brood stock for propagation of chinook salmon stocked into the Willow Creek drainage since 1997. It is hoped this practice will maintain wild stock traits and fitness.

Coho Salmon

All seven existing UCI coho salmon BEG's were reviewed, and a modification was adopted for one stock: Little Susitna River (Table 2).

Little Susitna River

The department increased the BEG from a single escapement level of 7,500 spawners to a range of 9,600 to 19,200 spawners. The previous BEG was a value close to the average escapement count (7,195) for nine years (1978, 1981-1983, 1985, and 1987-1990) using a mix of aerial (1978, 1981-1983, 1985 and 1987) and weir (1986, and 1988-1990) counts. This system was enhanced during 1988-1996 through stocking of smolt. The BEG was recalculated using data from nine brood years (1986-1994; Table 10). All escapement estimates except the one used for 1987 were weir counts. An expanded (doubled) aerial survey count from a helicopter was used as the 1987 escapement estimate since the weir count, based on a shortened season, was less than the unexpanded aerial count that year. To estimate production for these nine brood years, hatchery production was removed, commercial harvests of wild coho salmon were estimated using the mean exploitation rate of hatchery-produced coho salmon during 1993-1996 (0.55), and the age composition of all runs was assumed to be 33% age-3 and 67% age-4 coho salmon. Spawning escapements during this nine year period ranged from 9,700 to 29,300 coho salmon, and returns were always above replacement (range, 1.8 to 9.1 returns per spawner). The greatest yield (77,600 coho salmon) was obtained for an escapements of 10,900 spawners, but yields in excess of 60,000 coho salmon have been obtained for escapements of 8,400 (67,900 coho salmon), and 16,100 (64,700 coho salmon) spawners. Although the number of data points is very limited, Ricker stock-recruitment models fit to these data produced BEG estimates of about 12,000 spawners. The department set the BEG as a range around 12,000 spawners (S_{msy}), using Eggers' (1993) recommendation of 0.8S_{msy} to 1.6S_{msy}.

Sockeye Salmon

All eight existing Upper Cook Inlet sockeye salmon BEG's were reviewed, and modifications were adopted for two stocks: Crescent and Kenai River sockeye salmon (Table 3). The department discussed setting a BEG for Hidden Lake sockeye salmon, but deferred consideration until an enhancement project review and evaluation is completed.

Crescent River

The department decreased the BEG from a range of 50,000 to 100,000 spawners to a range of 25,000 to 50,000 spawners, and intends to manage this run so that annual spawning escapements of about 30,000 are achieved. The BEG was decreased because there appears to be a decline in the rearing capacity of Crescent Lake for sockeye salmon juveniles. The density of cyclopoid copepods, the key food of sockeye salmon juveniles, has sharply declined, and the euphotic zone of the lake has decreased due to increased water turbidity. For the 21 years of stock and recruitment data examined (1972-1992), spawning escapements have ranged from 28,000 (1974) to 128,000 (1985) sockeye salmon (Table 11). Beginning with the 1984 brood year, adult returns have been close to or below replacement levels (average, 0.9 returns per spawner), and yields have been low or unavailable (ranging from 0 to 26,000 sockeye salmon; average, 5,000 sockeye salmon). During this period, five spawning escapements were within (1986, 1988-1990, and 1992), two were above (1985 and 1987) and one was below (1991) the former BEG range. Prior to the 1985 brood year, spawning escapements ranged from 28,000 (1974) to 118,000 (1984) sockeye salmon (average, 62,000 sockeye salmon), production was always at or above replacement levels (ranging from 1.0 to 5.3 returns per spawner; average, 3.0 recruits per spawner), and yields were generally good (ranging from 1,000 to 185,000 sockeye salmon; average, 108,000 sockeye salmon). Ricker stock-recruitment models fit to the data indicated a downward shift in productivity (estimated by the α parameter) beginning with the 1985 brood year. If funding is available, monitoring of Crescent Lake will be continued so that future productivity changes can be identified. It is possible that sockeye productivity will increase once lake turbidity decreases. Production from both the 1991 and 1992 brood years (escapements of 44,000 and 58,000 spawners) was slightly above replacement levels (1.2 and 1.4 returns per spawner), and returns to date from the 1993 brood year (37,000 spawners) are also above replacement (1.5 returns per spawner). Two of these escapements (1991 and 1993) are within and one (1992) is slightly above the newly adopted BEG range.

Kenai River

The department increased the BEG from a range of 300,000 to 570,000 spawners to a range of 500,000 to 800,000 spawners. 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. Analyses done for this report, however, were based on Upper Cook Inlet sockeye salmon production data revised by 1) estimating and removing Hidden Lake enhanced sockeye salmon from escapements and harvests, and 2) altering stock contribution estimates to commercial harvests based on assumptions of which stocks were present in various harvest areas.

While there is good contrast in the data, with recruitment information from spawning escapements ranging from 52,000 (1969) to about 1,334,000 (1987 and 1989) sockeye salmon, only 26 years of complete stock and recruitment data are available (1968 to 1993 brood years; Table 12). Over half of the data (15 brood years) has been obtained from spawning escapements between about 200,000 to 570,000 spawners. Examination of these data indicated that 1) spawning escapements below 300,000 sockeye salmon have never produced yields greater than 865,000 sockeye salmon (mean yield, 624,000 sockeye salmon); 2) the three greatest yields (in excess of 800,000 sockeye salmon) have been obtained at spawning escapements of 557,0000, 566,000, and 1,333,000 sockeye salmon (1982, 1983, and 1987 brood years); 3) the four smallest return-per-spawner values in the data set (2.5, 2.9, 3.0, and 1.5) occurred within the last six years of the data series (1988, 1989, 1990, and 1993 brood years).

The stock-recruitment model which best fit the data includes a brood year interaction term based on a one-year lag. This model produced a BEG estimate of 731,000 spawners (95% confidence interval, 584,000 to 1,238,000). The occurrence of brood year interaction at the time of freshwater residency was first hypothesized during *Exxon Valdez* Oil Spill Trustee Council studies on Kenai River sockeye salmon (Schmidt 1994; Schmidt and Tarbox 1996 and 1993). Results indicated potential density dependent effects resulting from successive escapements in excess of 900,000 spawners. The mechanism causing these effects appears to be competition for a single prey item, cyclopoid copepods, by successive cohorts of sockeye salmon juveniles (Schmidt and Tarbox 1995). The greatest return-per-spawner value for these three large escapements (7.2) was obtained for the first one in this series (1,333,000 spawners). The succeeding two large escapements (839,000 and 1,334,000 spawners), as well as a much smaller one (439,000 spawners) that followed the last large escapement, produced three of the lowest return-per-spawner values on record (2.5, 2.9 and 3.0, respectively). Process control analysis indicated these return-per-spawner values were much lower than expected from past production history of this system (S. Carlson, ADF&G, Soldotna, personal communication).

Markov models, constructed with overlapping intervals of either 150,000 or 200,000 spawners, showed greatest average yield was obtained at about 553,000 spawners.

A population simulation model, based on brood year interaction, was also used to examine Kenai River sockeye salmon production (Carlson, Tarbox and Bue 1999). Simulation results indicated that escapements maintained within a range of 500,000 to 800,000 spawners sustained high yields and had a low probability (about once every 20 years) of producing poor runs with annual harvests less than 1,000,000 sockeye salmon. While a range of 500,000 to 800,000 spawners was adopted as the BEG for this stock, it is the intent of department to achieve, on average, an escapement of about 600,000 spawners. This level of spawning escapement is about mid-way between BEG estimates obtained from the stock-recruitment model incorporating brood year interaction (731,000 spawners) and the Markov model (553,000 spawners). The department also intends, as long as funding is available, to continue monitoring Skilak and Kenai lakes to track changes in freshwater production and survival of juveniles.

The population simulation model was also used to examine effects of harvest strategy (fixed escapement, harvest rate, etc.) and implementation error (ability of department to achieve escapement goals) on run size and yield (Carlson, Tarbox, and Bue 1999). Results showed that, with current regulations and management tools, the department has been unable to effectively control escapement. This has resulted in spawning escapements which have been well above the previous BEG range of 300 to 570,000 spawners, and which would have been at or above the upper limit of the newly adopted BEG range of 500,000 to 800,000, for 10 of the last 18 years.

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Table 1. Escapement goals and estimation methods for chinook salmon stocks, Upper Cook Inlet, 1999. Revised biological goals and altered estimation methods are shown in bold type and underlined.

Stock	Biological Goal	Optimal Goal	Inriver Goal	Estimation Method
Alexander Creek	2,700			Aerial Survey
Anchor River	**1,050-2,200**			**Aerial 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
Deception Creek	**400**			Aerial Survey
Deep Creek	**400-950**			**Aerial Survey**
Deshka River	**17,500**			**Weir**
Eagle River - South Fork	300			Foot Survey
Goose Creek	350			Aerial Survey
Kenai River Early-Run	**7,200-14,400**	9,000		Hydroacoustics
Kenai River Late-Run	**17,800-35,700**	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	**500-900**			**Aerial 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	**1,350**			Aerial Survey

Table 2. Escapement goals and estimation methods for coho salmon stocks in Upper Cook Inlet, 1999. Revised biological goals and altered estimation methods are shown in bold type and underlined.

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
<u>Little</u> <u>Susitna</u> <u>River</u>	**<u>9,600-19,200</u>**	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, 1999. Revised biological goals and altered estimation methods are shown in bold type and underlined.

Stock	Biological Goal	Optimal Goal	Inriver Goal	Estimation Method
<u>Crescent</u> <u>River</u>	**<u>25,000</u> <u>to</u> <u>50,000</u>**			Hydroacoustics
Fish Creek (Knik Arm)	50,000	50,000		Weir
Kasilof River	150,000 to 250,000			Hydroacoustics
<u>Kenai</u> <u>River</u>	**<u>500,000</u> <u>to</u> 80<u>0,000</u>**		550,000 to 850,000	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. Anchor River chinook salmon spawning escapement and inriver harvest, 1976-1998. Spawning escapements are unexpanded aerial survey counts from helicopters. All numbers were rounded to the nearest 50 chinook salmon.

Year	Spawning Escapement	Inriver Harvest
1976	2,150	850
1977	3,600	1,100
1978	2,200	2,100
1979	1,350	1,900
1980	N/A.	N/A.
1981	1,050	1,000
1982	1,450	650
1983	1,050	1,200
1984	1,100	850
1985	N/A.	N/A.
1986	2,300	1,000
1987	2,500	700
1988	1,450	850
1989	950	550
1990	N/A.	N/A.
1991	600	1,000
1992	N/A.	N/A.
1993	N/A.	N/A.
1994	850	2,500
1995	N/A.	N/A.
1996	300	2,450
1997	500	1,700
1998	800	N/A.

Table 5. Deep Creek chinook salmon spawning escapement and inriver harvest, 1976-1998. Spawning escapements are unexpanded aerial survey counts from helicopters. All numbers were rounded to the nearest 50 chinook salmon.

Year	Spawning Escapement	Inriver Harvest
1976	1,100	200
1977	850	400
1978	600	800
1979	750	700
1980	N/A.	N/A.
1981	450	500
1982	1,000	700
1983	550	1,000
1984	400	600
1985	N/A.	N/A.
1986	1,000	900
1987	950	600
1988	400	650
1989	550	750
1990	N/A.	N/A.
1991	300	1,550
1992	N/A.	N/A.
1993	N/A.	N/A.
1994	350	2,400
1995	300	1,150
1996	200	1,750
1997	150	1,350
1998	700	N/A.

Table 6. Deshka River chinook salmon production, 1974-1998 brood years. Spawning escapements are either expanded (doubled) aerial survey counts (1976-1994, and 1998) or weir counts (1995-1997). All numbers were rounded to the nearest 100 chinook salmon.

Brood Year	Spawning Escapement	Total Return	Return Per Spawner	Yield (Total Return minus Spawning Escapement)
1974	10,500	54,500	5.2	44,000
1975	9,500	32,500	3.4	23,000
1976	43,500	38,500	0.9	0
1977	79,500	34,500	0.4	0
1978	49,500	39,500	0.8	0
1979	55,000	46,000	0.8	0
1980	30,000	44,000	1.5	14,000
1981	30,000	37,000	1.2	7,000
1982	32,000	65,500	2.0	33,500
1983	38,500	37,500	1.0	0
1984	34,000	35,000	1.0	1,000
1985	36,500	44,500	1.2	8,000
1986	42,000	27,000	0.6	0
1987	30,000	18,000	0.6	0
1988	38,500	16,000	0.4	0
1989	30,000	12,000	0.4	0
1990	36,500	6,000	0.2	0
1991	16,000	16,000	1.0	0
1992	15,600	41,000	2.6	25,400
1993	11,500	N/A.	N/A.	N/A.
1994	5,500	N/A.	N/A.	N/A.
1995	10,000	N/A.	N/A.	N/A.
1996	14,500	N/A.	N/A.	N/A.
1997	35,500	N/A.	N/A.	N/A.
1998	31,500	N/A.	N/A.	N/A.

Table 7. Kenai River Early Run chinook salmon production, 1985-1998 brood years. Total return data includes inriver recreational harvest, eastside set gillnet commercial harvest, and estimated spawning escapement, but not marine recreational fishery harvest. All numbers were rounded to the nearest 100 chinook salmon.

Brood Year	Spawning Escapement	Total Return	Return Per Spawner	Yield (Total Return minus Spawning Escapement)
1985	8,000	11,200	1.4	3,200
1986	19,200	9,900	0.5	0
1987	12,000	18,300	1.5	6,300
1988	7,800	19,700	2.5	11,900
1989	10,600	19,600	1.9	9,000
1990	8,700	20,400	2.3	11,700
1991	9,900	17,400	1.8	7,500
1992	8,600	11,300	1.3	2,700
1993	12,000	N/A.	N/A.	N/A.
1994	12,600	N/A.	N/A.	N/A.
1995	11,200	N/A.	N/A.	N/A.
1996	17,300	N/A.	N/A.	N/A.
1997	8,200	N/A.	N/A.	N/A.
1998	8,200	N/A.	N/A.	N/A.

Table 8. Kenai River Late Run chinook salmon production, 1984-1998 brood years. Total return data includes inriver recreational harvest, eastside set gillnet commercial harvest, and estimated spawning escapement, but not marine recreational fishery harvest. All numbers were rounded to the nearest 100 chinook salmon.

Brood Year	Spawning Escapement	Total Return	Return Per Spawner	Yield (Total Return minus Spawning Escapement)
1984	31,800	36,500	1.1	4,700
1985	21,700	40,400	1.9	18,700
1986	48,000	46,900	1.0	0
1987	35,500	63,700	1.8	28,200
1988	34,000	72,400	2.1	38,400
1989	19,600	44,100	2.3	24,500
1990	27,100	50,000	1.8	22,900
1991	27,700	67,800	2.4	40,100
1992	23,300	46,300	2.0	23,000
1993	34,000	N/A.	N/A.	N/A.
1994	38,500	N/A.	N/A.	N/A.
1995	33,900	N/A.	N/A.	N/A.
1996	33,900	N/A.	N/A.	N/A.
1997	28,700	N/A.	N/A.	N/A.
1998	28,400	N/A.	N/A.	N/A.

Table 9. Ninilchik River chinook salmon spawning escapement and inriver harvest, 1976-1998. Spawning escapements are unexpanded aerial survey counts from helicopters. All numbers were rounded to nearest 50 chinook salmon.

Year	Spawning Escapement	Inriver Harvest
1976	950	650
1977	1,150	1,150
1978	700	1,450
1979	850	1,500
1980	N/A.	N/A.
1981	550	1,350
1982	950	1,100
1983	450	800
1984	350	550
1985	N/A.	N/A.
1986	300	350
1987	500	1,100
1988	550	800
1989	300	750
1990	N/A.	N/A.
1991	600	750
1992	N/A.	N/A.
1993	N/A.	N/A.
1994	250	1,700
1995	N/A.	N/A.
1996	150	1,450
1997	N/A.	N/A.
1998	300	N/A.

Table 10. Little Susitna River coho salmon production, 1986-1998 brood years. Spawning escapements for 1986, 1988-1998 are counts at a weir. The spawning escapement estimate for 1987 is an expanded (doubled) aerial survey count from a helicopter. All numbers were rounded to the nearest 100 coho salmon.

Brood Year	Spawning Escapement	Total Return	Return Per Spawner	Yield (Total Return minus Spawning Escapement)
1986	7,000	32,500	4.6	25,500
1987	9,700	67,700	7.0	58,000
1988	16,100	80,800	5.0	64,700
1989	8,400	76,300	9.1	67,900
1990	10,900	88,500	8.1	77,600
1991	29,300	67,900	2.3	38,600
1992	19,500	61,200	3.1	41,700
1993	25,600	47,300	1.8	21,700
1994	23,500	52,000	2.2	28,500
1995	11,100	N/A.	N/A.	N/A.
1996	16,300	N/A.	N/A.	N/A.
1997	9,900	N/A.	N/A.	N/A.
1998	15,200	N/A.	N/A.	N/A.

Table 11. Crescent River sockeye salmon production, 1968-1998 brood years. All numbers were rounded to the nearest 1,000 sockeye salmon.

Brood Year	Spawning Escapement	Total Return	Return Per Spawner	Yield (Total Return minus Spawning Escapement)
1972	62,000	161,000	2.6	99,000
1973	29,000	122,000	4.2	93,000
1974	28,000	114,000	4.1	86,000
1975	41,000	216,000	5.3	175,000
1976	51,000	52,000	1.0	1,000
1977	87,000	99,000	1.1	12,000
1978	74,000	244,000	3.3	170,000
1979	86,000	245,000	2.8	159,000
1980	90,000	275,000	3.1	185,000
1981	41,000	162,000	4.0	121,000
1982	58,000	167,000	2.9	109,000
1983	92,000	181,000	2.0	89,000
1984	118,000	113,000	1.0	0
1985	128,000	53,000	0.4	0
1986	95,000	89,000	0.9	0
1987	118,000	64,000	0.5	0
1988	57,000	50,000	0.9	0
1989	71,000	80,000	1.1	9,000
1990	52,000	41,000	0.8	0
1991	44,000	54,000	1.2	10,000
1992	58,000	84,000	1.4	26,000
1993	37,000	N/A.	N/A.	N/A.
1994	30,000	N/A.	N/A.	N/A.
1995	52,000	N/A.	N/A.	N/A.
1996	28,000	N/A.	N/A.	N/A.
1997	70,000	N/A.	N/A.	N/A.
1998	62,000	N/A.	N/A.	N/A.

Table 12. Kenai River sockeye salmon production, 1968-1998 brood years. Total return includes Russian River late run sockeye salmon harvested in commercial and personal use fisheries, but does not include Hidden Lake hatchery-produced sockeye salmon. All numbers were rounded to the nearest 1,000 sockeye salmon.

Brood Year	Spawning Escapement	Total Return	Return Per Spawner	Yield (Total Return minus Spawning Escapement)
1968	82,000	916,000	11.2	834,000
1969	52,000	409,000	7.9	357,000
1970	72,000	520,000	7.2	448,000
1971	289,000	863,000	3.0	574,000
1972	302,000	2,186,000	7.2	1,884,000
1973	358,000	1,995,000	5.6	1,637,000
1974	144,000	665,000	4.6	521,000
1975	129,000	895,000	7.0	766,000
1976	353,000	1,187,000	3.4	834,000
1977	664,000	2,811,000	4.2	2,147,000
1978	350,000	3,451,000	9.9	3,101,000
1979	246,000	1,111,000	4.5	865,000
1980	398,000	2,346,000	5.9	1,948,000
1981	359,000	2,268,000	6.3	1,909,000
1982	566,000	8,930,000	15.8	8,364,000
1983	557,000	8,697,000	15.6	8,140,000
1984	310,000	3,252,000	10.5	2,942,000
1985	396,000	2,446,000	5.7	2,050,000
1986	400,000	1,741,000	4.4	1,341,000
1987	1,333,000	9,531,000	7.2	8,198,000
1988	839,000	2,120,000	2.5	1,281,000
1989	1,334,000	3,898,000	2.9	2,564,000
1990	439,000	1,334,000	3.0	895,000
1991	376,000	3,926,000	10.4	3,550,000
1992	752,000	3,463,000	4.6	2,711,000
1993	670,000	977,000	1.5	307,000
1994	895,000	N/A.	N/A.	N/A.
1995	521,000	N/A.	N/A.	N/A.
1996	553,000	N/A.	N/A.	N/A.
1997	868,000	N/A.	N/A.	N/A.
1998	646,000	N/A.	N/A.	N/A.

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
Acting Director, Division of Commercial Fisheries — Date

Norval Netsch — 10/16/92

Norval Netsch
Director, Sport Fish Division — Date

Jeff Koenings — 10/16/92

Jeff Koenings
Director, FRED Division — Date

C Meacham — 10-16-92

Charles P. Meacham
Deputy Commissioner, Alaska Department of Fish and Game — Date

Carl L. Rosier — 10/21/92

Carl L. Rosier
Commissioner, Alaska Department of Fish and Game — Date

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