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**Run Forecasts and Harvest Projections
for 1999 Alaska Salmon Fisheries and Review of the 1998 Season**

Edited by

Harold J. Geiger

and

Deborah Hart

May 1999

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EXECUTIVE SUMMARY

The Alaska Department of Fish and Game is expecting 1999 commercial salmon harvests to be similar to 1998's levels. The 1999 commercial catch all-species projection of 148 million is distributed as 0.613 million chinook, 29.0 million sockeye, 5.86 million coho, 92.8 million pink, and 19.4 million chum salmon. Table 1 shows specific projection numbers by species and fishing area. In some cases the projections are based on formal run forecasts, using information on previous spawning level, the environment, and other factors. In other cases, the catch projections are simply recent average catch levels. With two or three exceptions, such as the Southeast chinook troll fishery and South Peninsula June Fishery chum catch, Alaskan salmon management will be based on actual observed salmon run strength. Alaska managers have the primary goal of maintaining spawning population sizes – not to reach preseason catch projections.

At this time last year, department biologists were expecting an all-species commercial catch of 146 million for the 1998 season. As it turned out, the overall catch of sockeye salmon was about 40% lower than expected, but statewide catches of pink salmon were about 20% higher than expected, and the all-species total reached 151 million salmon. Notably, pink salmon catches were far above expectations in Kodiak. Although statewide chum salmon catches were above expectation, and chum salmon catches in Southeast were far above expectation, other areas failed to produce at expected levels. For example, runs of Western Alaska chum salmon, Yukon River chinook salmon, and Bristol Bay sockeye salmon were well below expectations. We suspect that ocean conditions have changed and that unusually poor ocean survivals were to blame. Table 2 shows 1998 harvest numbers by species and fishing area, in units of fish harvested, and Table 3 provides this information in units of pounds harvested.

The exvessel value of the commercial harvest continued on its long downward trend. The preliminary estimate for the total value of Alaska's 1998 harvest is \$259 million – below the estimates of \$296 for 1997, \$378 for 1996, \$466 for 1995, and \$489 for 1994.

In both 1997 and 1998, the Bristol Bay sockeye salmon run was considerably less than the forecasted levels. The 1997 forecast was for a return of 35.8 million, with an in-Bay catch of 24.8 million. The actual run in 1997 was 20.1 million, with an in-Bay catch of 12.3 million. The forecast for 1998 was for a run of 32.1 million and an in-Bay catch of 20.6 million. The actual run in 1998 was 19.3 million, with an in-Bay catch of 10.0 million. We suspect that unfavorable climatic and oceanographic conditions reduced marine survival since parent-year escapements were at levels that had produced large runs in the past. The 13.8 million sockeye salmon harvest forecasted for Bristol Bay in 1999 should be used with caution since the climatic/oceanographic conditions that influence survivals are poorly understood and measured.

For 1999, biologists in Southeast Alaska are again expecting a *strong* run of pink salmon with catches in the range of 31 to 51 million. A run of 32.7 million pink salmon with a commercial catch of just over 29.9 million is being forecasted by biologists in Prince William Sound. The forecast for the Copper River sockeye salmon run is 2.2 million, with a catch of 1.5 million. The Upper Cook Inlet forecast of sockeye salmon is for a run of 3.5 million, with a harvest of 2.0 million. Kodiak area biologists are forecasting a run of 11.8 million pink salmon, with a catch of 9.5 million.

Look for inseason harvest information, postseason statistics, and other information about salmon in Alaska on the World Wide Web at <http://www.cf.adfg.state.ak.us/>.

INTRODUCTION

The Alaska Department of Fish and Game's (ADF&G) four major fishery management regions (Southeast, Central, Arctic-Yukon-Kuskokwim, and Westward) are shown in Figure 1. These regions supersede any references to the department's former statistical regions.

Forecasts of runs (catch + escapement) for major salmon fisheries and projections of the statewide commercial salmon harvest have been published every year by ADF&G since 1969 (ADF&G 1969–1973, 1975–1983; Eggers 1985, 1986; Eggers and Dean 1987, 1988; Geiger and Savikko, 1989–1993; Geiger and Simpson 1994, 1995; and Geiger and Frenette 1996–1997; Geiger et. al. 1997; Hart et. al. 1998). Though the department does not produce formal run size forecasts for all salmon runs in the state, local salmon biologists prepare harvest projections or harvest outlooks for all areas. Projections are based on formal forecasts, when available; when the formal forecasts are not available, local biologists use average historical catches and local knowledge of recent events to develop these outlooks. Projections for the 1999 Alaska commercial salmon harvest, by species and area, are found in Table 1. Harvest outlooks for the Arctic-Yukon-Kuskokwim Region are developed as ranges; these ranges are listed in Appendix B. Trends in total statewide salmon harvests and catch projections in numbers of fish, by species, are found in Figures 2–6. Tables 2–7 provide detailed information on the 1998 harvest.

This report contains a detailed review of Alaska's 1998 commercial salmon season. We normally release it before final catch figures are available to provide preliminary information to the Board of Fisheries, the fishing industry, and the public.

Predominate ages and brood years for 1999 salmon runs, by species, are as follows:

Species	Age of Returning Salmon in Years				
	2	3	4	5	6
Pink	1997				
Chum		1996	1995	1994	
Coho		1996	1995		
Sockeye			1995	1994	1993
Chinook			1995	1994	1993

The common and scientific names for Alaska's Pacific salmon species are as follows:

<u>Common (and Vernacular) Names</u>	<u>Scientific Name</u>
chinook (king)	<i>Oncorhynchus tshawytscha</i>
sockeye (red)	<i>Oncorhynchus nerka</i>
coho (silver)	<i>Oncorhynchus kisutch</i>
pink (humpy, humpback)	<i>Oncorhynchus gorbuscha</i>
chum (dog)	<i>Oncorhynchus keta</i>

DEFINITIONS OF TERMS

<i>Biological escapement goal</i>	The number of salmon in a particular stock that ADF&G has determined should be allowed to escape the fishery to spawn to achieve the maximum yield (human use). This determination is based on biological information about the fish stock in question. (Also see <i>optimum escapement goal</i> .)
<i>Commercial harvest</i>	Harvests of fish that are used for commercial purposes. This includes fish caught by the commercial common property fishery (see below) and by hatchery operators for cost recovery; it excludes sport, subsistence, and personal use harvests.
<i>Commercial common property harvest</i>	Harvests taken by traditional, competitive commercial fisheries (gillnet, purse seine, and troll), as opposed to commercial harvests resulting from hatchery cost recovery, fishing derbies, and sale of confiscated fish.
<i>Common property harvest</i>	Harvests taken by the commercial common property fisheries (see above), as well as the sport, subsistence, and personal use fisheries. This category excludes hatchery cost recovery harvests.
<i>Cost recovery harvest</i>	Harvests of salmon by hatchery operators in specially designated areas to fund the operation of hatcheries and other enhancement activities.
<i>Enhancement of runs</i>	Hatcheries and other means of artificial propagation to create salmon runs or make existing salmon runs larger. Enhancement includes remote fish stocking, fertilization of lakes, and other techniques.
<i>Escapement, spawning population, or broodstock</i>	The portion of a salmon run that is not harvested and survives to reach the spawning grounds or hatchery.
<i>Harvest projections or harvest outlooks</i>	Harvest outlooks are the best available estimates of upcoming harvest levels. Prepared by local biologists, outlooks are based on formal run forecasts, when available. At other times outlooks are based on historical average catches, subjectively adjusted based on recent trends and local knowledge.
<i>Optimum escapement goal</i>	The number of salmon in a particular stock that should be allowed to spawn to achieve sustainable runs based on biological needs of the stock, as well as consideration of social and allocative needs.

Run forecast

Forecasts of a run (harvest + escapement) are estimates of the fish that will return in a given year based on such information as parent-year escapements, subsequent fry abundance, and spring seawater temperatures. Run forecasts are generally thought to be more reliable than harvest outlooks, but run forecasts are provided only for selected areas.

Salmon run

The total number of mature salmon returning in a given year from ocean-rearing areas to coastal waters.

PRELIMINARY REVIEW OF THE 1998 ALASKA COMMERCIAL SALMON FISHERIES

Southeast and Yakutat

The 1998 Southeast Alaskan commercial salmon harvest, including hatchery cost recovery, totaled 62.6 million fish. This was the ninth highest harvest on record, the sixth highest since 1941, and just over the 10-year average of 58.6 million. Highlights of the 1998 season were a record pink return in the Sitka area and a generally strong harvest and escapement of pink salmon throughout the region, a near record harvest of 15.6 million chum salmon driven by large hatchery returns, a respectable 2.91 million coho harvest, and lagging sockeye and chinook runs to several systems. With few exceptions, Southeast Alaska's salmon stocks are in excellent condition. Nine of the 12 largest harvests in the 121-year history of the Southeast Alaskan commercial salmon fisheries have occurred since 1985.

The exvessel value of this year's salmon harvest was about \$71 million. This is about the same exvessel value as in 1996 and 1997. Even though the exvessel values were similar, in these two years the all-species harvests were a record 86.7 million, and a modest 45.5 million, respectively. Calculated in 1997 adjusted dollars, these were the lowest exvessel values since 1984.

The 1998 pink salmon harvest of 42.6 million was the 14th highest in history and close to the 45.6 million 1988–1997 average. Hatcheries probably contributed about 3 million of these fish. Seine fishermen harvested a near record 5.6 million pink salmon in District 113 and relatively few salmon in District 104. The actual regionwide harvest was consistent with the department's preseason forecast for a "strong" harvest in the 36 to 50 million fish range. The 1998 return was from the highest escapement on record and the harvest was four times the 1987 and 1988 harvests which had similarly high brood year escapements. This should temper concerns that overescapement was a primary reason for the poor returns in 1987 and 1988. Escapements in 1998 were above the 1990s average in the Sitka (+82%), Ketchikan (+24%), and Juneau (+14%) management areas and equal to the 1990s average in the Petersburg management area.

The 15.6 million chum salmon harvested in 1998 was just shy of the record 15.8 million chum salmon harvested in 1996. The District 102 fall chum salmon harvest of 0.56 million was over twice the 1994 record. The 5 highest chum salmon harvests in the 121-year history of the fishery have occurred during the last 5 years. Hatchery returns account for the majority of the harvest in recent years. Wild-stock escapements were generally good throughout the region.

The 1998 sockeye salmon harvest of 1.38 million was well below the 1988–1997 average of 2.1 million. Harvests lagged below the 1988–1978 averages in the Yakutat area set gillnet fisheries, in all drift gillnet fisheries except Tree Point (District 101), and in most seine fisheries except those near Sitka. Sockeye salmon escapements in Southeast Alaska were below recent-year averages in most systems.

This year's coho salmon harvest of 2.91 million fish was the ninth highest in history, equal to the recent 10-year average, and a million more than last year's harvest. The 0.2 million harvest of coho salmon in the Yakutat area set gillnet fisheries was 19% below the recent 10-year average. Escapement goals were met or exceeded in the four wild coded-wire-tagged indicator stocks. In addition, surveys and estimates for other systems indicated that escapements were exceptionally strong on the outer coast north of Sitka to west of Yakutat. Escapements to most other systems in the region were near or above recent averages.

The commercial chinook salmon catch, of 231 thousand for the 1998 accounting year (October 1, 1987 to September 30, 1998), was about 25 thousand below the 1988–1997 average. The 1998 fishery was managed based on U.S. and Canadian bilateral estimates of chinook salmon abundance and the U.S. Letter of Agreement. Of the 10 systems with established escapement goals, 5 had escapements above or within goals (Situk, King Salmon, Andrew Creek, Alsek, and Unuk) and 5 had escapements below goals (Taku, Stikine, Chickamin, Blossom, and Keta).

Prince William Sound

The 1998 Prince William Sound Area commercial salmon harvest of 31.9 million fish was the sixth highest on record. The harvest was comprised of 28.7 million pink, 1.71 million sockeye, 1.27 million chum, 195,000 coho, and 70,900 chinook salmon. The majority of the catch, 22.4 million fish, was from the common property harvest, and 9.5 million fish were sold for hatchery cost recovery (exclusive of post egg-take roe sales).

The estimated value of the combined commercial salmon harvest is \$36.8 million, including hatchery sales. During the 1998 season, 522 drift gillnet permit holders fished. The drift gillnet catch is valued at \$18.2 million, setting the average earnings at \$34.9 thousand. The set gillnet catch is valued at \$195 thousand, setting the average earnings of the 16 participating permits at \$12.2 thousand. The seine fishery was worth \$9.77 million for an average ex-vessel value of \$65.6 thousand for the 149 permit holders that participated this year. Revenue generated for hatchery operations was approximately \$8.58 million.

The total commercial pink salmon harvest of 28.7 million fish was the regions sixth largest harvest and it exceeded the preseason harvest forecast of 23.3 million fish. Prince William Sound Aquaculture Corporation and Valdez Fishery Development Association harvested 8.82 million pink salmon for cost recovery. Statewide, the strong pink salmon return and harvest resulted in processors ending their Prince William Sound operations earlier than normal and an estimated 2 to 4 million surplus pink salmon went unharvested in 1998.

Wild-stock pink salmon escapement goals were met or exceeded in the Eastern, Northern and Southeastern, Southwestern and Montague Districts in 1998. In the Coghill, Northwestern and Eshamy Districts, wild-stock escapements were performing reasonably well early in the season. However poor weather during late August and early September prevented many aerial surveys from being flown during peak-escapement periods. It appears that escapement goals were not met in the Coghill and Northwestern Districts. Similar to 1997, sampling of pink salmon otoliths (to look for a hatchery mark) in the spawning populations of the Southwest and portions of the Eastern districts showed high levels of straying of hatchery pink salmon into wild populations.

For all gear types, the total chum salmon harvest of 1.27 million fish was slightly higher than the recent 10-year average of 1.19 million fish. The Prince William Sound area chum salmon harvest was comprised mostly of hatchery-produced chum salmon returning to the Noerenberg Hatchery, Solomon Gulch Hatchery and the Port Chalmers remote release site at Montague Island. Based upon the aerial surveys, wild-stock chum salmon escapements appeared to fall short of individual district escapement goals. However, factors such as the loss of peak surveys due to poor weather and the difficulty of accurately counting chum salmon mixed in with large volumes of pink salmon tended to obscure the chum salmon escapement estimates. In general, it appears that the Eastern, Northern and Southeastern Districts exceeded their respective chum salmon escapement goals, while other districts experienced moderate escapement shortfalls.

Copper River District

The 1998 sockeye salmon harvest of 1.34 million was the fourth largest on record, but less than the forecast of 1.9 million. The harvest of 68,800 chinook salmon was the largest harvest on record. The inriver goal of 617,000 salmon past Miles Lake sonar was exceeded with an estimated 867,000 salmon passing the sonar site. The sockeye salmon aerial escapement index for the Copper River Delta systems was slightly below the index goal.

Bering River District

The cumulative Bering River sockeye harvest was 8,440 fish, less than half the preseason projection and the lowest since 1990. The observed escapement index for the Bering River systems was 15% below the goal. The first commercial fishing period for coho salmon in the Bering River District occurred on August 17. Low catch and escapement numbers resulted in the fishery being managed conservatively. The total coho salmon harvest was 12,300 fish – well below the preseason projection of 139,000 fish. Escapements into the Bering River/Controller Bay systems were somewhat stronger than in the Copper River delta.

Eshamy District

The 1998 forecast of the return to Main Bay Hatchery was 187,000 sockeye salmon. Because this hatchery maintains several broodlines, the forecast was distributed as 5,000 Eyak stock, 153,000 Coghill stock and 29,000 Eshamy stock. The Eshamy wild-stock return was forecast to be 64,000 sockeye salmon, of which 35,000 were needed for escapement and 29,000 would be available for a common property harvest. With Prince William Sound Aquaculture Corporation's revenue goal of \$900,000 from Main Bay Hatchery, and a projected weak return on non-wild stocks, and going into the season with no funding for a weir project to assess escapement, it looked unlikely that an Eshamy District commercial fishery would occur. Prince William Sound Aquaculture Corporation completed cost recovery harvesting on July 25, harvesting a total of 111 thousand sockeye salmon for their corporate escapement. The waters of the Main Bay Subdistrict opened to commercial fishing soon after. It is not known if Eshamy Lake met its escapement goal. There was no directed fishery on Eshamy wild stocks and only the Main Bay Subdistrict was open to commercial fishing in August and September. The total common property harvest of sockeye was 124 thousand fish with the drift fleet harvesting 80% of the total.

Cook Inlet

Upper Cook Inlet

The harvest of 2.03 million salmon in 1998 represents the lowest catch in twenty years and was only about half of the long-term average for this fishery. The approximate exvessel value of the harvest was only \$9.3 million, the poorest since 1975 and less than 20% of the average annual value over the last 10 years.

The harvest of 1.22 million sockeye salmon represents the poorest catch since 1979. This catch is only about half of the long-term average and about a quarter of the average of the past 10 years. The catch fell well short of the forecast harvest of 2.5 million. The exvessel value of the sockeye salmon catch was about \$8.3 million, or 89% of the exvessel value of the fishery for all salmon species. Prices paid for sockeye salmon were relatively stable throughout the season with very little upward trend following the shortfall in Bristol Bay. The average price per pound of \$1.15 was the same value

observed for the past 3 years. The distribution of the harvest between drift (49.3%) and set gillnet gear (50.7%) differed somewhat from the average (56% drift).

Initially, management attempted a strategy in the sockeye salmon fishery similar to the successfully one from prior years. This consisted of a restricted drift fishery to permit adequate passage of fish northward and planned use of the east side setnets and drift gear confined to the eastern 3-mile corridor to deal with resulting surpluses of Kenai and Kasilof River stocks. In mid-July, when the run was judged to be below average, management initiated a long series of restrictions. The restrictions were successful in securing adequate escapement levels in the Kenai and the Yentna, but the restrictions hindered the fishery's ability to fully harvest Kasilof River surpluses. Escapement into Kasilof was above the desired escapement range. Early season restrictions to limit the harvest of Crescent River sockeye produced adequate escapement into the Crescent River.

The 1998 harvest of 96 thousand chum salmon was the poorest on record and continues the trend of extremely poor harvests of this species. The extreme management measures taken to produce greater escapement of sockeye salmon were the primary reason for the poor catch while the freshwater abundance throughout the Susitna River drainage was considerably better than commercial catches might have indicated. The chum salmon return to Chinitna Bay was poor to fair and essentially unexploited as the local set gillnet fishery was largely inactive due to low prices. Fishermen were paid only \$.20 per pound for chum salmon, producing an exvessel value of \$141,000 or just 1.5% of the overall salmon fishery value.

In Cook Inlet, pink salmon are numerous only in even-numbered years. The 1998 pink salmon return showed a dramatic increase in strength over recent even-year runs. While the harvest totaled just 552 thousand, a very mediocre catch for an even year, it was double the 1996 harvest despite the extremely prolonged closures during the peak of the major returns. Pink salmon were very abundant throughout the Susitna River drainage (more than a half million were counted through the Deshka River weir, alone) and abundance in the Kenai River appeared to be the highest in many years. The price per pound of \$.12 resulted in an exvessel value of \$223 thousand or 2.4% of the overall value of the salmon fishery.

The harvest of 160 thousand coho salmon was nearly half the long-term average. The \$450 thousand exvessel value of the catch represented 4.8% of the overall value of the fishery. As with the other species, the extremely reduced commercial fishery resulting from the poor sockeye salmon returns was the primary factor in the low harvest. Based on freshwater abundance in many of the monitored sites, overall coho salmon run strength was mediocre although improved over the very poor return of the previous year.

The 1998 harvest of 8.33 thousand chinook salmon was well below the long-term average and was valued at \$229 thousand. Chinook salmon made up 2.5% of the exvessel value of the commercial salmon fishery. The directed chinook salmon fishery in the Northern District was limited to the first 2 of 4 scheduled periods to aid in rebuilding a number of stocks where escapement levels had been below desired levels in recent years. The resulting catch of 2,340 fish was only about a third of the average for this fishery but an improvement over the previous two years. Freshwater abundance in most Northern District streams was significantly improved over 1997, with escapement objectives achieved in virtually all tributaries. The Central District eastside setnet catch of 4,990 chinook salmon was the smallest since 1991, again due largely to the very limited fishing time.

Overall run strength of late-run Kenai River chinook salmon was about average. While final numbers have not yet been generated, the spawning escapement was well in excess of the goal of 22,300 fish.

Lower Cook Inlet

The 1998 Lower Cook Inlet salmon harvest of 1.76 million fish was the seventh highest on record, surpassing both the most recent 10- and 20-year averages. The catch produced an exvessel value of approximately \$2.0 million, about 17% less than that of the 1997 season. The 1998 harvest of chinook salmon, not normally a commercially important species in Lower Cook Inlet, was the lowest catch since 1986 at 1,100 fish. This was less than the long-term average of 1,340 and well below the record high harvest of 2,300 fish taken in 1995. The sockeye salmon harvest of 284,000 fish was the fourth highest during the last 20 years, but fell short of the preseason catch projection by about 16%. Despite accounting for only 16% of the Lower Cook Inlet salmon harvest in numbers of fish, sockeye salmon provided over 60% of the exvessel value of the entire salmon fishery during 1998. The commercial harvest of 15,700 coho salmon in 1998 represented the second highest total for this species during the 1990s, slightly exceeding the 20-year average. Returns of pink salmon, the dominant species in numbers of commercially harvested fish in Lower Cook Inlet, fell below preseason expectations in 1998, with an overall harvest of 1.45 million fish. Still, this number is about 16% greater than the most recent 20-year average and represents the seventh highest catch on record.

Pink salmon production from Tutka Hatchery, operated by Cook Inlet Aquaculture Association (CIAA), did not meet expectations, yet the harvest of pink salmon returning to the facility comprised over 80% of the all-species catch. The estimated hatchery return, including escapement, brood stock, and commercially harvested fish, was 1.47 million pink salmon, about 40% less than the preseason projection of 2.46 million fish, and the fourth highest return on record for the facility. About 793 million pink salmon were used for Tutka Hatchery cost recovery.

Almost 60% of the sockeye salmon harvest in both numbers of fish and exvessel value was attributed to lake stocking and fertilization projects at Leisure and Hazel Lakes in the Southern District, Kirschner and Bruin Lakes in the Kamishak Bay District, and Bear and Grouse Lakes in the Eastern District. Another enhancement project, undertaken by Chugach Regional Resources Commission (CRRC) and Port Graham Hatchery Corporation (PGHC) at English Bay Lakes in the Southern District, provided a harvestable surplus of sockeye salmon for both subsistence and commercial set gillnet fishermen in Port Graham Subdistrict. However, as has been the case since hatchery programs were taken over by private non-profit agencies in Lower Cook Inlet, a significant portion of the salmon harvest was used as hatchery cost recovery to recoup expenses incurred by the various stocking and enhancement projects throughout the management area. One-half of the total salmon harvest was taken by Cook Inlet Aquaculture Association and Port Graham Hatchery Corporation to support the sockeye salmon lake stocking programs and Tutka Hatchery operations. This cost recovery, equated to approximately 37% of the exvessel value of the Lower Cook Inlet salmon fishery.

Bristol Bay

With the exception of chinook salmon, commercial salmon catches were depressed in Bristol Bay in 1999. The inshore run of sockeye salmon totaled approximately 18.4 million fish and was the lowest inshore return in the last 20 years. It was approximately 39% less than the preseason forecast of 30.2 million fish. With the exception of the Nushagak District, all of the other Districts, including Naknek/Kvichak, Egegik, and Ugashik, and Togiak sustained runs that were less than forecast. The commercial harvest of 9.99 million sockeye salmon was the lowest catch in the Bay since 1978. The total escapement was approximately 8.4 million sockeye salmon. The commercial chinook salmon harvest of approximately 126,000 fish was 10% above the recent 20-year average harvest of 117,100, and it was the third largest catch recorded in the last 10 years. The chum salmon harvest totaled approximately 391,000 fish and was well below the 1978 - 1997 average harvest of 1.2 million. It was the second lowest catch in that same time frame. The pink salmon harvest of about 25,000 fish was the smallest even-year harvest on record and was well below the recent 20-year average of 1.5 million. The coho salmon

harvest of approximately 125,000 fish was 39% below the 20-year average of 206,000 fish, but it was the sixth largest harvest in 10 years.

As stated earlier, sockeye salmon runs to the Naknek, Kvichak, Egegik, Ugashik, and Togiak Districts were less than anticipated. Except for the Nushagak River, escapement midrange goals were met or exceeded in all areas. The Nushagak River escapement of 458,000 sockeye salmon was 16.6% under its midrange objective of 550,000. The Naknek-Kvichak District sockeye salmon harvest of 2.55 million fish was the second smallest harvest for that district since the late 1970s. The Egegik District sockeye salmon harvest of 3.56 million fish was the smallest harvest for that district since 1982. Likewise, the Ugashik District sockeye salmon harvest of approximately 730 thousand sockeye salmon was the smallest since 1979. The Nushagak District harvest, of 2.96 million sockeye salmon, was about 20% below the 20-year average catch, and the Togiak District sockeye salmon harvest of approximately 190,000 fish was about 58% below the 20-year average of 454,500.

Inshore run abundance developed slowly. Through July 3, the Egegik sockeye salmon run was the only one showing strength. Through July 1, the Egegik tower count was 340 thousand while Nushagak was 155 thousand and Naknek and Kvichak were at 80, and 32 thousand, respectively. On July 2 Naknek escapement picked up considerably and by July 7, 68% of its midrange objective goal had been achieved. By July 7, with the exception of the Ugashik District, all Bristol Bay districts were fishing. Peak harvests occurred on July 7 and July 13 when 1.3 and 1.1 million sockeye salmon were landed. The timing of this year's inshore run appears to have been 2 days later than usual with the midpoint of the run occurring on July 8. Bay-wide, sockeye salmon averaged 5.73 pounds.

The chinook salmon harvests in all Bristol Bay districts except Nushagak were below average. However, since Nushagak is the largest stock, the total Chinook salmon catch was approximately 10% above the 10-year average. Chinook salmon escapement indices were above average in the Naknek-Kvichak, Egegik and Ugashik Districts. The escapement goal of 75,000 in the Nushagak River was exceeded and the goals of 10,000 in the Togiak River and 5,000 in the Naknek River were achieved.

The total Bristol Bay chum salmon harvest of 391 thousand fish was well below the recent 20-year average of 1.2 million. All of the districts produced harvests below their 1978–1997 averages. Escapements ranged from average in Togiak to below average in Kvichak, Egegik and Ugashik Rivers.

Pink salmon return in strength to Bristol Bay only during even-numbered years. The 1998 run produced a commercial harvest of only 25,000, but this catch level was influenced by the lack of processor interest in purchasing pink salmon. Pink salmon escapement counts were below average in most areas. The Togiak River count of 121,000 pink salmon was average.

Coho salmon runs to most of the districts in Bristol Bay had some strength in 1998. The Bay-wide coho salmon harvest of approximately 125,000 fish was 38% below the 1978–1997 average of 200,000 fish. The Nushagak harvest of 22,000, though below average, was the largest harvest in that fishery in 6 years. The Togiak harvest of 58,000 was the third largest harvest in 10 years. The rest of the districts sustained coho salmon harvests that were below average.

Kuskokwim

The total 1998 commercial salmon harvest for the Kuskokwim Area was 755 thousand fish. The area-wide chinook salmon harvest of 44 thousand fish was 18% below the recent 10-year average of 54 thousand fish. The area-wide sockeye salmon harvest of 129 thousand fish was below average. Area-wide, fishermen harvested 267 thousand chum salmon – 49% below the recent 10-year average of

524 thousand fish. Chinook and sockeye salmon harvests, taken incidentally during the chum salmon fishery, were well below average because of the reduced fishing time. The area-wide chinook salmon catch was 44 thousand. The area-wide coho salmon harvest was 312 thousand, the second lowest harvest since 1983 and 51% below the recent 10-year average of 632 thousand fish. Although overall fishing time during the season was well below average due to critically low chum and coho salmon returns, fishing time in the Kuskokwim Bay Districts, Quinhagak and Goodnews Bay, was about average.

In the Kuskokwim River, fishing time was very limited. The Kuskokwim River chum salmon harvest was 54% below the recent 10-year average. Chinook and sockeye salmon harvests, taken incidentally during the chum salmon fishery, were well below average because of the reduced fishing time. The Kuskokwim River coho salmon harvest was 61% below the recent 10-year average and the second lowest since 1983, with 1997 being lower.

The Quinhagak District opened on June 15 and commercial fishing occurred on a regular schedule due to strong chinook and coho salmon harvests. The chinook salmon harvest was 15% above the recent 10-year average. The sockeye salmon harvest was 32% below the recent 10-year average. The incidental chum salmon harvest was 16% below the recent 10-year average. The below-average sockeye and chum salmon harvests are largely due to the below-average fishing effort in the Quinhagak District in June and July. The coho salmon harvest was 28% above the recent 10-year average.

The Goodnews Bay District was opened in late June to provide for a directed harvest of sockeye salmon, yet protect earlier running chinook salmon. The chinook salmon harvest was 37% above the recent 10-year average and the Middle Fork Goodnews River escapement goal of 3,500 fish was achieved. The sockeye salmon harvest was 32% below the recent 10-year average. However, sockeye salmon escapement was excellent and the Middle Fork Goodnews River escapement goal of 25 thousand fish was achieved. The incidental chum salmon harvest was 20% below the recent 10-year average although the Middle Fork Goodnews River escapement goal of 15 thousand fish was met. As in the Quinhagak District, below-average harvests of sockeye and chum salmon were due largely to below-average fishing effort in July. The coho salmon harvest was 10% below the recent 10-year average.

Only 707 of the 832 Kuskokwim Area permit holders participated in the commercial fishery in 1998. The exvessel value of the harvest was \$1.6 million, 67% below the recent 10-year average of \$4.9 million. The average exvessel earnings for each permit holder was \$2.3 thousand, well below the recent 10-year average value of \$6.1 thousand.

Yukon Area

The 1998 Yukon Area commercial harvest was 73 thousand salmon. Sales were composed of 44 thousand chinook salmon and 29 thousand summer chum salmon. Less than 500 pounds of chinook and summer chum salmon roe were sold. The ex-vessel value of the Yukon Area commercial salmon fishery was an estimated \$2 million, which was 64% below the recent 5-year average of \$5.6 million.

The 1998 chinook salmon harvest was 59% below the recent 5-year average of 107 thousand fish and the lowest harvest since 1952. The 1998 chinook salmon run was unexpectedly poor, particularly in light of the relative stability of harvests over the past 20 years. Chinook salmon escapements were below recent 5-year averages throughout the drainage, with minimum escapement goals achieved in only 3 of 8 surveyed tributaries.

The 1998 summer chum salmon harvest was well below the recent 5-year average of 426 thousand fish and the lowest harvest since 1968. No commercial harvest of fall chum or coho salmon was allowed in 1998. The recent 5-year average harvests are 91 thousand fall chum salmon and 29 thousand coho salmon. Where observations were made, chum salmon escapements to selected tributaries in 1998 were below levels observed in most other years. No summer chum salmon populations in monitored tributaries met minimum escapement goals; estimates ranged from 27% below to 81% below recent-year averages.

Lower Yukon Area fishermen harvested 42 thousand chinook salmon and 28 thousand summer chum salmon in the round. No salmon were sold in District 3. The estimated average price paid per pound in the Lower Yukon Area was \$2.51 for chinook salmon and \$0.14 for summer chum salmon. The ex-vessel value of the Lower Yukon Area commercial fishery was \$1.94 million. The average income for the 643 Lower Yukon Area fishermen that participated in the 1998 commercial fishery was \$3.0 thousand.

Upper Yukon Area fishermen harvested 2 thousand chinook salmon and 1 thousand summer chum salmon. The estimated average price paid per pound in the Upper Yukon Area for fish in the round was \$0.95 for chinook salmon and \$0.17 for summer chum salmon. Less than 500 pounds of chinook and summer chum salmon roe were sold by Upper Yukon Area fishermen. The estimated average price paid per pound was \$2.00 for chinook salmon roe and \$1.90 for summer chum salmon roe. The ex-vessel value of the Upper Yukon Area commercial fishery was \$0.02 million. The average income for the 28 Upper Yukon Area fishermen that participated in the 1998 commercial fishery was \$0.6 thousand.

Fall chum salmon enter the Yukon River beginning in mid-July. As the 1998 run materialized, the department adjusted its estimate of run size, and correspondingly adjusted its estimate of allowable harvest. By early August, managers estimated that the 1998 fall chum salmon return would be far below the preseason projection and likely below 600,000 fall chum salmon. By late August, managers realized that the run would probably be below 450,000 salmon, and subsistence salmon fishing restrictions became necessary. After the vast majority of fall chum salmon had migrated through the traditional fishing areas, subsistence salmon fishing restrictions were removed to provide fishing opportunities on later-running coho salmon as well as other non-salmon species such as whitefish. Although subsistence fishing restrictions were implemented in 1998, no fall chum salmon escapement goals were met.

Yukon River coho salmon have a slightly later, but overlapping, run timing with that of fall chum salmon. However, fall chum salmon are the primary species of management concern during the fall season. There are no commercial guideline harvest ranges established for coho salmon. Currently, commercial harvest of coho salmon is a function of the timing, frequency, and duration of periods established for the more numerous fall chum salmon. In 1998, there were no directed fall chum salmon commercial fishing periods.

Norton Sound

The commercial salmon harvest totaled 641 thousand fish, distributed as 7 thousand chinook, 30 thousand coho, 588 thousand pink, and 16 thousand chum salmon. A record low of 82 permit holders participated in the fishery and collectively received \$359 thousand for their harvest. The chinook salmon harvest was 9% below the previous 5-year average. The coho salmon harvest was the lowest since 1987, and 50% below the previous 5-year average. The pink salmon harvest was second highest on record following the 1994 harvest of 982 thousand fish. The Norton Sound chum salmon commercial harvest was 49% below the 5-year average. This low chum salmon harvest was due to a low harvestable surplus of fish in the northern subdistricts and poor markets in the southern subdistricts.

The Norton Sound salmon fishery has 201 limited entry salmon permits, of which 82 were actually fished during the 1998 season. The number of participating fishermen this season was 27% below the previous 5-year average. There has been a drop in effort in recent years primarily due to poor market conditions.

Two primary salmon buyers operated in Norton Sound during the 1998 season. The average price paid per pound was \$0.74 for chinook, \$0.29 for coho, \$0.14 for pink, and \$0.09 for chum salmon.

Kotzebue

During 1998, the commercial salmon harvest in the Kotzebue District consisted of 56 thousand chum salmon. The harvest was the lowest on record since 1968. There were 45 permits fished this year. The last 3 years represent the fewest number of participants since the late 1960s. Because of the low salmon prices, fishermen concentrated their efforts close to Kotzebue (Statistical Area 331-01) to minimize the costs of fuel and oil. All but a few of the fish were harvested from this statistical area.

The average price paid per pound for chum salmon was \$0.15. The total exvessel value was \$71 thousand to Kotzebue area fishermen with an average of \$1.6 thousand for each participating permit holder.

Kodiak

The 1998 Kodiak commercial salmon fishery was unusual in that the pink salmon return was about four times greater than expected. This larger-than-expected catch resulted in all major buyers instituting some type of daily harvest limits on their respective "fleets" in August. The 1998 chinook salmon harvest, of 17,300 fish, is below the last 10-year average (1987–1997, excluding 1989) harvest of 20,800. The largest chinook salmon harvest on record (42,000 fish) occurred in 1993. The 1998 sockeye salmon harvest, of 3.62 million fish, although better than expected this year, was still less than the last 10-year average harvest of 3.9 million. The highest sockeye salmon harvest on record (5.7 million fish) occurred in 1991. This year's sockeye salmon harvest included an estimated 260,000 fish produced by supplemental and enhancement projects sponsored by the Kodiak Regional Aquaculture Association. The 1998 coho salmon harvest, of 425,000 fish, was the highest on record, mainly because of the supplemental production from Kitoi Bay Hatchery estimated at 137,000 fish. The 10-year average harvest is 289,000 coho salmon. The 1998 pink salmon harvest of 22.1 million fish set a new even-year record. The previous high of 17.3 million was set in 1980. The recent 10-year average catch of pink salmon is 14.5 million fish, with the last 5 even-year harvests averaging only 7.1 million pink salmon. The all-time record harvest of 42.8 million fish occurred in 1995. Included in this year's harvest are approximately 6.3 million pink salmon that were caught near the Kitoi Bay Hatchery. The 1998 chum salmon harvest, of 316,000 fish, was the lowest since 1975, when less than 100,000 fish were caught, and well below the last 10-year average harvest of 831,000 fish. Approximately 38,000 chum salmon were caught near Kitoi Bay Hatchery. The highest chum harvest on record occurred in 1970 when 1.54 million fish were caught.

The estimated exvessel value of the 1998 fishery was approximately \$30 million. This is about \$11 million more than for 1997, but still well below the most recent 10-year average (1987–1997 – excluding 1989, the year of the *Exxon Valdez* oil spill) average of \$43 million. Average earnings, by gear type and permit fished, are estimated at \$103,000 for purse seine, \$43,700 for set gillnet, and \$3,900 for beach seine. Final exvessel values will not be available until final price adjustments are made in accordance with the contracts signed between major buyers and permit holders. Of the 611 eligible permit holders, only 390 participated. Participation consisted of a total of 2 beach seine, 171

set gillnet, and 217 purse seine permit holders. Purse seine effort was the lowest on record since limited entry has been in effect. This continues a decreasing trend in participation, which began in 1996. Throughout the season 13 different buyers operated 14 processing plants (all of which were shorebased).

Salmon counting weirs operated on 12 different spawning systems, encompassing all major chinook and sockeye salmon systems, from late May to late September. Aerial surveys and, to a lesser degree, foot surveys were used to estimate escapements into most pink, chum, coho, and minor sockeye salmon systems.

A total of 24,700 chinook salmon were estimated as escapement through weirs into the Ayakulik, Karluk, and Dog Salmon rivers; this exceeded the combined escapement goal of 11,100 to 19,300 fish. Escapement counts were 10,200 chinook salmon into the Karluk River and 14,000 chinook salmon into the Ayakulik River. An additional 290 chinook salmon entered Dog Salmon river.

Sockeye salmon escapements, overall, were excellent with 1.78 million fish counted as escapement. Approximately 1.66 million sockeye salmon (93% of the total escapement estimate) were counted into systems with fish weirs. The overall escapement goal for sockeye salmon is the range of 1.4 to 2.0 million fish.

Pink salmon escapement levels and geographical distribution were excellent.

Chum salmon escapement estimates varied considerably depending on location. The large numbers of pink salmon and poor visibility in some major mainland chum salmon systems obscured escapement estimates. Overall, chum salmon production for the Kodiak area was at relatively low levels.

Area wide, coho salmon escapements were excellent.

Chignik

In 1998, for all salmon species, the harvests were smaller than preseason catch projections, and below the 10-year averages for each species. The catch of sockeye salmon was 1.05 million – nearly equal to the preseason projection of 1.07 million. The catch of chinook salmon was 4,400, compared to the preseason projection of 7,000. The harvest of pink salmon was about 777 thousand, compared to the preseason projection of 1.10 million. And, the chum salmon harvest was 129 thousand, compared to the preseason projection of 270 thousand.

The Chignik commercial salmon season was characterized by a below-average sockeye salmon run to Black Lake and a slightly below-average sockeye salmon run to Chignik Lake. On June 16, a strike postponed the sockeye salmon fishery. For approximately the next 2 weeks, the fishery was extended in 24-hour increments as the strike continued. On June 29 the strike was settled between fishers and processors and commercial fishing began.

Approximately 61% of the commercial catches (for all salmon species combined) were from Chignik Bay and Central Districts. Approximately 59% of the sockeye salmon were caught in Chignik Bay while 27% were caught in the Central District.

Escapement was estimated by video weir counts on the Chignik River and by aerial surveys for all other streams. For all species, except perhaps coho salmon, escapement met or exceeded escapement goals. Goals for coho salmon are not established; their late fall run timing are incompatible with escapement estimation because of bad weather, turbidity, and budget constraints. Preliminary

postseason analysis resulted in sockeye salmon escapement estimates of 411,000 sockeye salmon to Black Lake and 279,000 to Chignik Lake.

Preliminary analysis of aerial survey data indicates that the Chignik area-wide pink salmon and chum salmon escapement goals were met.

Alaska Peninsula – Aleutian Islands

South Peninsula

For 1998, the total South Peninsula chinook salmon catch was 4,800, less than the preseason projection of 10,000 and approximately 45% of the 10-year average. The sockeye salmon catch, of 2.17 million, was less than the preseason projection of 2.46 million and 87% of the 10-year average. For coho salmon, the catch of 154 thousand was also less than the preseason projection, of 255 thousand, and only 49% of the 1988–1997 average. On the other hand, the pink salmon harvest of 8.04 million exceeded the preseason projection of 6.80 million and the 10-year average catch of 7.75 million. Finally, the total South Peninsula chum salmon catch was 712 thousand, only 53% of the 1988–1997 average, and well below the preseason projection of 1.60 million.

The June Fishery. June fishery harvests for sockeye salmon were 975 thousand at South Unimak and 314 thousand for the Shumagin Islands, for a total South Peninsula June sockeye salmon catch of 1.29 million – only 69% of the combined June fishery sockeye salmon guideline of 1.86 million. Total chum salmon catches in the South Unimak-Shumagin Islands June fishery were 246,000 – well below the Guideline Harvest Level range of 350,000-400,000.

The department conducted test fisheries at South Unimak and in the Shumagin Islands to determine when the sockeye-to-chum ratios were high enough to allow a fishery. One purse seine vessel was used to test fish in the Shumagin Islands and 3 purse seine vessels were used at South Unimak (one at Cape Pankof and two at Cape Lutke). The Shumagin Islands June 9, 10, and 11 test fisheries resulted in sockeye-to-chum ratios of 1.4, 1.3, and 1.2, respectively, while at South Unimak June 9, 10, and 11 ratios were 1.5, 1.0, and 2.0, respectively. These ratios were not high enough to allow a commercial test fishery prior to June 13.

A 6-hour fishing period (16 hours for set gillnet) beginning at 8:00 a.m. on June 13 was announced for both fisheries. However, all of the seiners and approximately 80% of the set gillnetters went on strike for higher prices. As the fishery progressed, more set gillnetters went fishing. At 8:00 p.m. on June 17, the seiners and the balance of the set gillnetters went fishing. Reports from the fishing grounds indicated that sockeye-to-chum ratios were very good and fishing time in both fisheries was extended.

The Southeastern District Mainland fishery. Total salmon harvests for the Southern District Mainland fishery, through October 31, were 477 chinook, 279,000 sockeye, 24,000 coho, 950,000 pink, and 69,700 chum salmon. The early Chignik River sockeye salmon run was weak, and the late run was slightly below average. Consequently only a single 33 hour commercial fishing period was permitted prior to July 25 targeting Chignik stocks in the Southeastern District Mainland.

The Northwest Stepovak Section is managed on the basis of local stocks beginning July 1. In 1998, the Orzinski Lake sockeye salmon escapement was 25,000 – greater than the escapement goal of 20,000 adult salmon. During July, extensive fishing time was allowed inside Orzinski Bay to harvest Orzinski Lake salmon. Approximately 28,500 sockeye salmon were caught in Orzinski Bay from July 3 through July 25.

The balance of the Southern District Mainland remained closed to commercial salmon fishing until July 20, when Chignik sockeye salmon catches and escapement requirements were achieved. During the July 20-21 fishing period, about 83,000 sockeye salmon were caught in the Southern District Mainland, including an estimated 67,000 fish that were considered Chignik bound, 7.8% of the total Chignik bound sockeye salmon harvest through July 25. In the Southern District Mainland, landings were reported during 13 days from July 26 through August 10. During August 11 through 31, no commercial salmon fishing was allowed in the Southern District Mainland to insure that the pink and chum salmon escapements were achieved.

The Remainder of South Peninsula Post-June Fishery. Harvests through October, excluding the Southern District Mainland, included 1,620 chinook, 603,000 sockeye, 130,000 coho (but only 42,000 of those during the 60,000-cap period), 6.62 million pink, and 396,000 chum salmon. The Alaska Board of Fisheries had made a number of changes to the regulations effective for the 1998 season; among those were set commercial fishing periods and a cap of coho salmon harvests of 60,000 in non-terminal areas between July 22 and July 31. Test fishing in the Shumagin Islands during early July indicated a very low abundance of immature salmon, therefore, the first commercial fishing period opened early on July 6.

The South Peninsula sockeye salmon escapement of 85,000 fish was within the range of the escapement goal. The South Peninsula indexed total pink salmon escapement was the third highest on record and above the upper end of the escapement goal. The South Peninsula indexed chum salmon escapement was the third highest on record and also above the upper end of the escapement goal. No explicit goals exist for chinook and coho salmon along the South Peninsula.

North Peninsula

The harvest of all species was well below the 1988 - 1997 average. The North Peninsula is predominantly a sockeye salmon fishery, although directed chinook, chum, and coho salmon fisheries occur in some areas. During even years, pink salmon fisheries occur if market conditions warrant. The chinook salmon harvest of 5,900 was below the preseason projection of 10,000 and only 45% of the previous 10-year average. The sockeye salmon harvest of 1.09 million was below the preseason projection of 2.10 million and only 44% of the previous 10-year average; it was the lowest harvest since 1978. The coho salmon harvest of 135 thousand 73% of the previous 10-year average. The pink harvest of 34,800 was 32% of the previous 10-year average. The chum salmon harvest of 69,500 was 35% of the previous 10-year average. The 1998 North Alaska Peninsula commercial salmon fishery started on June 1 and ended on September 27, for a total of 119 days. A total of 267 permit holders (of which 67 permits were Area T permit holders) participated in North Peninsula commercial salmon fisheries during 1998.

Overall, sockeye salmon runs were weak in 1998, although escapement goals were met or exceeded. Indexed escapements of chinook salmon in the North Peninsula were all within or above goals. Indexed chum salmon escapements were above the goal range.

That portion of the North Peninsula harvest taken by Area T fishermen in the Cinder River and Inner Port Heiden sections was 1,400 chinook, 3,400 sockeye, 56,200 coho, 1,500 pink, and 600 chum salmon.

Aleutian Islands and Atka-Amlia Islands Areas

In 1998, no salmon were commercially harvested in the Aleutian Islands and Atka-Amlia Islands areas.

Pink salmon escapements were generally poor or fair in major Unalaska streams. Exceptions were revealed during an aerial survey on August 11, which indicated that Pumicestone and Kismaliuk streams in the Kashega Bay Section were receiving strong pink salmon escapements. Summer Bay and Humpy Cove systems, located in Unalaska Bay had good escapements.

A weir was placed at the outlet of Summer Bay Lake in response to an oil spill from the freighter Kuroshima during the previous winter. A total of 2,641 sockeye salmon were counted through the weir, a considerably higher count than expected.

**PRELIMINARY FORECASTS OF 1999 SALMON RUNS
TO SELECTED ALASKA FISHERIES**

ADF&G prepares forecasts for salmon runs that affect major fisheries around the state. Salmon runs to be forecasted are selected using several criteria, including economic importance, feasibility, compatibility with existing programs, and management needs. For the 1999 fishing year, forecast fisheries are as follows:

Southeast	—	pink salmon
Prince William Sound	—	pink, chum, sockeye, coho, and chinook salmon
Copper River	—	sockeye and chinook salmon
Copper and Bering Rivers	—	coho salmon
Upper Cook Inlet	—	sockeye salmon
Lower Cook Inlet	—	pink salmon
Kodiak	—	pink salmon
Upper Station Lakes	—	sockeye salmon
Frazer Lake	—	sockeye salmon
Ayakulik River (early and late)	—	sockeye salmon
Spiridon Lake	—	sockeye salmon
Karluk Lake (early and late)	—	sockeye salmon
Chignik	—	sockeye salmon
Bristol Bay	—	sockeye and chinook salmon
Alaska Peninsula, Bear Lake	—	sockeye salmon
Alaska Peninsula, Nelson River	—	sockeye salmon

A variety of information was used to make salmon run forecasts. In most cases the principal indicator of future abundance is the escapement magnitudes of parental stocks. Other information that might have been considered includes spawning stock distribution, egg deposition, survival to intermediate life stages, environmental conditions, and historical age composition. A range of run possibilities are predicted for each forecasted fishery. In general, based on past experience, the actual run can be expected to fall within the range (between the lower and upper limits) less than half the time. Please see the appendices for further details.

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Table 1. Preliminary projections of 1999 Alaska commercial salmon harvests, by fishing area and species, in thousands of fish.

Fishing Area	Species					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Southeast Region	242 ^a	2,170 ^a	3,430 ^a	41,000 ^b	13,000 ^a	59,800
Prince William Sound						
<i>Common Property</i>	53	1,550	575	19,600	2,410	24,200
<i>Cost Recovery</i>	0	135	16	10,300	530	11,000
Upper Cook Inlet	16	2,000	300	75	200	2,590
Lower Cook Inlet	1	391	15	3,400	10	3,820
Bristol Bay	150	13,800	100	0	680	14,700
Central Region	220	17,900	1,000	33,400	3,830	56,300
Kodiak Area	20	3,500	350	9,500	500	13,900
Chignik	4	1,330	185	925	185	2,630
South Peninsula	10	2,100	250	8,000	750	11,100
North Peninsula	10	1,800	150	15	150	2,130
Aleutian Islands	0	0	0	0	0	0
Westward Region	44	8,730	935	18,400	1,590	29,700
AYK Region	107	155	493	2	963	1,720
Statewide Total	613	29,000	5,860	92,800	19,400	148,000

Columns and rows do not total exactly due to rounding.

^a Average harvest for the five-year period, 1994–1998.

^b Midpoint of the 31-51 million forecast range.

Modified December, 1998

Table 2. Preliminary 1998 Alaska commercial salmon harvests, by fishing area and species, in thousands of fish.

Fishing Area	Species					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Southeast Region	230 ^a	1,370	2,900	42,500	15,500	62,500
Prince William Sound	71	1,710	195	28,700	1,270	31,900
Upper Cook Inlet	8	1,220	160	552	96	2,030
Lower Cook Inlet	1	284	16	1,450	5	1,760
Bristol Bay	126	9,990	125	25	391	10,700
Central Region	206	13,200	496	30,700	1,760	46,400
Kodiak Area	17	3,620	425	22,100	316	26,500
Chignik	4	1,050	130	777	129	2,090
South Peninsula	5	2,170	154	8,040	712	11,100
North Peninsula	6	1,090	135	35	70	1,340
Aleutian Islands	0	0	0	0	0	0
Westward Region	32	7,930	844	31,000	1,230	41,000
AYK Region	95	129	342	591	368	1,530
Total Alaska	563	22,600	4,580	105,000	18,900	151,000

Missing data indicates no harvest, and zeros indicate harvest activity but <1,000. Columns and rows do not total exactly due to rounding.

^a Total commercial harvest of chinook salmon for the October 1, 1997 to September 30, 1998 catch accounting period.

Modified December, 1998

Table 3. Preliminary 1998 Alaska commercial salmon harvests, by fishing area and species, in thousands of pounds.

Fishing Area	Species					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Southeast Region	3,950	8,270	22,500	147,000	138,000	320,000
Prince William Sound	1,590	10,400	1,670	105,000	10,400	129,000
Upper Cook Inlet	181	6,690	1,100	2,090	695	10,800
Lower Cook Inlet	14	1,290	120	4,540	35	6,000
Bristol Bay	2,230	57,200	1,050	85	2,500	63,000
Central Region	4,020	75,600	3,940	112,000	13,600	209,000
Kodiak Area	249	17,500	3,590	81,700	2,460	105,000
Chignik	67	6,440	1,050	2,590	918	11,100
South Peninsula	75	12,500	1,110	28,300	5,040	47,000
North Peninsula	89	6,080	1,090	126	497	7,890
Aleutian Islands	0	0	0	0	0	0
Westward Region	480	42,500	6,840	113,000	8,920	171,000
AYK Region	1,690	1,000	2,630	1,830	2,830	9,980
Total Alaska	10,100	127,000	35,900	374,000	163,000	710,000

Missing data indicates no harvest, and zeros indicate harvest activity but <1,000. Columns and rows do not total exactly due to rounding.

Modified December, 1998

Table 4. Preliminary 1998 Southeastern Region commercial salmon harvests, by fishing area and species, in thousands of fish.

Fishing Area	SPECIES					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Tree Point Drift Gillnet	1	161	60	650	524	1,400
Prince of Wales Gillnet	1	113	273	503	332	1,220
Stikine River Gillnet	0	22	19	39	41	122
Southern Districts Seine	7	623	301	21,700	3,150	25,800
Annette Island Fisheries	0	17	9	837	159	1,020
Southern Southeast Total	10	935	663	23,700	4,200	29,500
Taku-Snettisham Gillnet	1	70	29	168	296	564
Lynn Canal Gillnet	1	124	26	24	89	263
Yakutat Set Net	3	77	196	86	1	364
Northern Districts Seine	0	100	149	15,600	1,870	17,700
Northern Southeast Total	5	371	400	15,900	2,260	18,900
Southeast Troll ^a	192	6	1,640	261	118	2,220
Hatchery Terminal Area Fisheries						
Gillnet	3	12	5	105	644	769
Seine	7	10	14	1,140	4,360	5,530
Private Hatchery Fishery	15	35	186	1,400	3,950	5,590
Miscellaneous ^b	1	6	3	51	27	89
SOUTHEAST REGION	231	1,380	2,910	42,600	15,600	62,600

^a Includes chinook salmon caught by troll gear from October 1, 1997 to September 30, 1998.

^b Includes salmon that were confiscated, sport fish derbies, or commercial test fisheries.

Missing data indicates no harvest and zeros indicate harvest activity but less than 500.

Columns and rows might not total exactly due to rounding

Revised: Nov. 23, 1998

Table 5. Preliminary 1998 Central Region commercial salmon harvests, by fishing area and species, in thousands of fish.

Fishing Area	SPECIES					
	Chinook	Sockeye	Coho	Pink	Chum	Total
Purse Seine						
Eastern	0	7	30	2,230	108	2,380
Northern	0	3	5	5,040	57	5,110
Coghill	0	2	2	2,850	22	2,880
Southwestern ^[b]	0	7	13	8,430	4	8,450
Montegue ^[a]	0	1	0	430	205	637
Southeastern	0	1	0	350	5	356
Drift Gillnet						
Bering River ^[b]	0	8	12	0	0	21
Copper River ^{[a], [b]}	69	1,340	108	21	5	1,540
Unakwik	0	14	0	2	1	16
Coghill	1	59	3	384	347	794
Eshamy	0	98	0	101	0	200
Set Gillnet						
Eshamy	0	26	0	34	0	60
Hatchery ^[c]						
	1	148	20	8,830	519	9,520
Misc. PWS ^[d]						
	0	0	0	0	0	1
Prince William Sound						
	71	1,710	195	28,700	1,270	31,900
Southern District						
	1	196	5	1,310	4	1,520
Kamishak District						
		28		2	0	30
Outer District						
		16	0	102	1	119
Eastern District						
	0	44	11	39	0	94
Lower Cook Inlet						
	1	284	16	1,450	5	1,760
Central District						
	6	1,160	126	540	91	1,920
Northern District						
	2	61	34	12	5	114
Upper Cook Inlet						
	8	1,220	160	552	96	2,030
Naknek-Kvichak						
	3	2,550	2	11	48	2,610
Nushagak District						
	108	2,960	22	7	239	3,340
Egegik District						
	1	3,560	30	1	26	3,620
Ugashik District						
	0	730	13	0	10	753
Togiak District						
	14	190	58	6	68	336
Bristol Bay Total						
	126	9,990	125	25	391	10,700
CENTRAL REGION						
	206	13,200	496	30,700	1,760	46,400

^[a] Totals include discarded sockeye, coho, pink and chum salmon.

^[b] Does not include salmon taken for home use as reported on fish tickets.

^[c] Hatchery sales for operating expenses. Includes meal production/roe salvage sales, processor discards.

Excludes post egg-take roe sales at hatcheries.

^[d] Some of these fish were donations landed by Coghill District and Copper River District drift gillnet permit holders.

Missing data indicates no harvest and zeros indicate harvest activity but less than 1,000.

Columns and rows do not total exactly due to rounding

Revised: December, 1998

Table 6. Preliminary 1998 Westward Region commercial salmon harvests, by fishing area and species, in thousands of fish.

Fishing Area	SPECIES					
	Chinook	Sockeye	Coho	Pink	Chum	Total
Kodiak Area	17	3,620	425	22,100	316	26,500
Chignik Areas	4	1,050	130	777	129	2,090
South Peninsula	5	2,170	154	8,040	712	11,100
North Peninsula	6	1,090	135	35	70	1,340
Alaska Peninsula Total	11	3,260	289	8,080	782	12,400
Aleutian Islands	0	0	0	0	0	0
WESTWARD REGION	32	7,930	844	31,000	1,230	41,000

Missing data indicates no harvest and zeros indicate harvest activity but less than 1,000.

Columns and rows do not total exactly due to rounding

Revised: December, 1998

Table 7. Preliminary 1998 Arctic-Yukon-Kuskokwim Region commercial salmon harvests, by fishing area and species, in thousands of fish.

Fishing Area	SPECIES					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Kuskokwim River	17	61	210	0	208	496
Kuskokwim Bay	27	68	102	3	59	259
Kuskokwim Area Total	44	129	312	3	267	755
Lower Yukon River	42				28	70
Upper Yukon River ¹	2				1	3
Yukon River Total¹	44				29	73
Norton Sound	7	0	30	588	16	641
Kotzebue Area	0				56	56
AYK REGION	95	129	342	591	368	1,530

¹ The Upper Yukon River catch includes the estimated harvest to produce roe sold.

Missing data indicates no harvest and zeros indicate harvest activity but less than 1,000.

Columns and rows do not total exactly due to rounding

Revised: December, 1998

Table 8. Comparison of actual and forecast 1998 salmon runs, with errors and relative errors for some major Alaskan salmon fisheries, in millions of fish.

Area	Species	1998	1998	1998 Harvest	Forecast Run	Forecast Harvest	Error 2/ Error 3/	Relative Error 3/
		Estimated Run 1/	Escape- ment					
Southeast Total	Pinks	82.78	40.38	42.40	73.20	43.00	-9.58	-11.6%
Prince William Sound	Pinks	31.01	2.35	28.66	26.00	23.30	-5.01	-16.2%
	Chums	1.66	0.39	1.27	1.40	1.04	-0.26	-15.5%
	Sockeye	0.34	0.04	0.30	0.32	0.25	-0.02	-5.6%
	Coho	nd	nd	0.07	0.11	0.11	nd	nd
	Chinook	0.002	0	0.002	nd	nd	nd	nd
Copper River	Sockeye	2.30	0.95	1.34	2.74	2.14	0.45	19.4%
	Chinook	nd	nd	0.07	nd	0.05	nd	nd
Upper Cook Inlet	Sockeye	2.91	1.69	1.22	4.00	2.50	1.09	37.4%
Lower Cook Inlet	Pinks	2.38	0.91	1.47	3.11	0.32	0.73	30.8%
Kodiak	Pinks	29.15	7.09	22.06	10.80	6.30	-18.35	-62.9%
Upper Station, Early	Sockeye	0.11	0.03	0.08	0.10	0.05	-0.02	-13.3%
Upper Station, Late	Sockeye	0.36	0.17	0.19	0.42	0.27	0.06	17.1%
Frazer	Sockeye	0.61	0.25	0.36	0.54	0.40	-0.07	-11.1%
Ayakulik	Sockeye	1.45	0.43	1.02	0.71	0.41	-0.74	-50.9%
Karluk, Early	Sockeye	0.37	0.25	0.12	0.41	0.21	0.04	10.6%
Karluk, Late	Sockeye	0.69	0.39	0.30	0.59	0.19	-0.10	-14.0%
Chignik	Sockeye	1.94	0.70	1.24	2.00	1.35	0.06	3.1%
Bristol Bay	Sockeye	19.61	8.40	11.21	32.10	22.80	12.49	63.7%
Nushagak	Chinook	0.24	0.11	0.13	0.16	0.08	-0.08	-34.0%
Total		177.9	64.4	113.5	158.7	104.8		

Updated March, 1999.

1/ Run is harvest plus Escapement

2/ Error is Forecast Run minus Run

3/ Relative Error is Error divided by Run times 100%

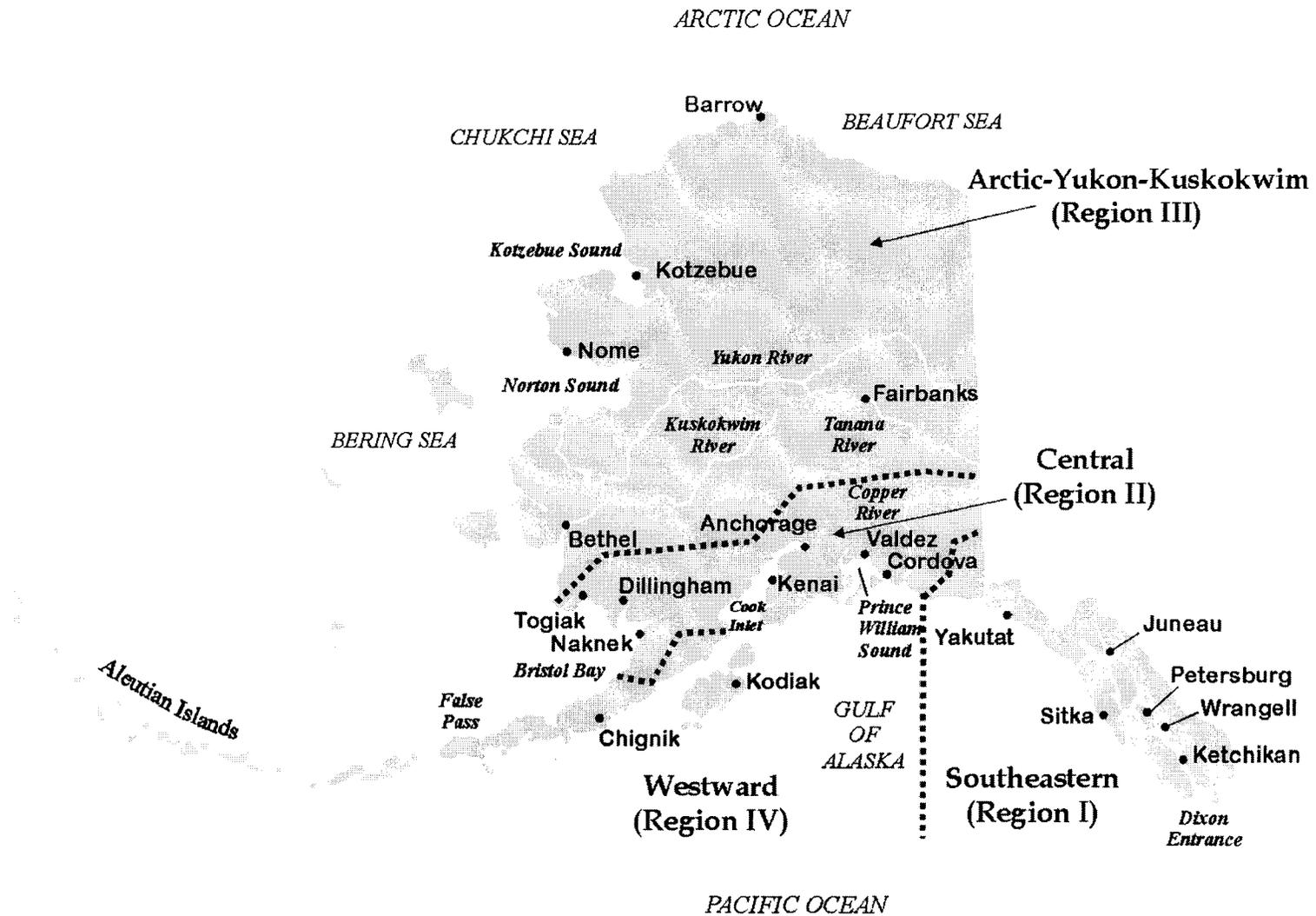


Figure 1. The four fishery management regions (Southeast, Central, Arctic-Yukon-Kuskokwim, and Westward) of the Alaska Department of Fish and Game, Division of Commercial Fisheries.

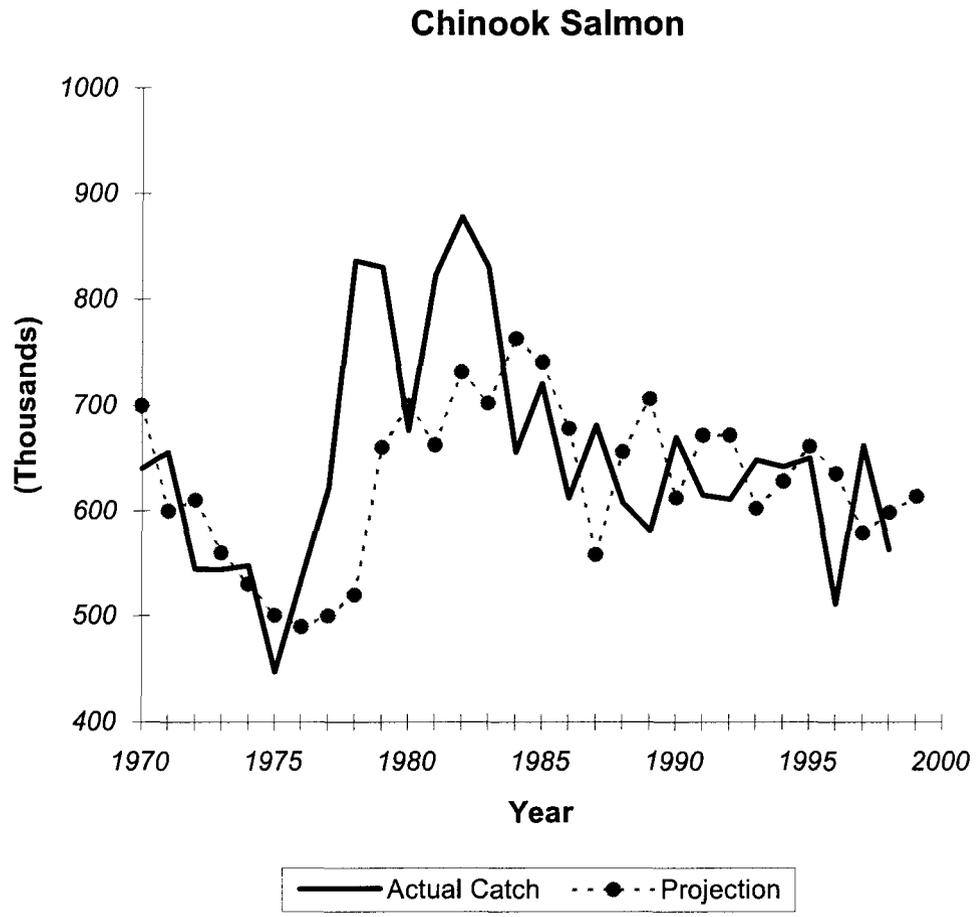


Figure 2. Relationship between actual catch and projected catch, in thousands, for Alaska chinook salmon from 1970 to 1998, with the 1999 projection.

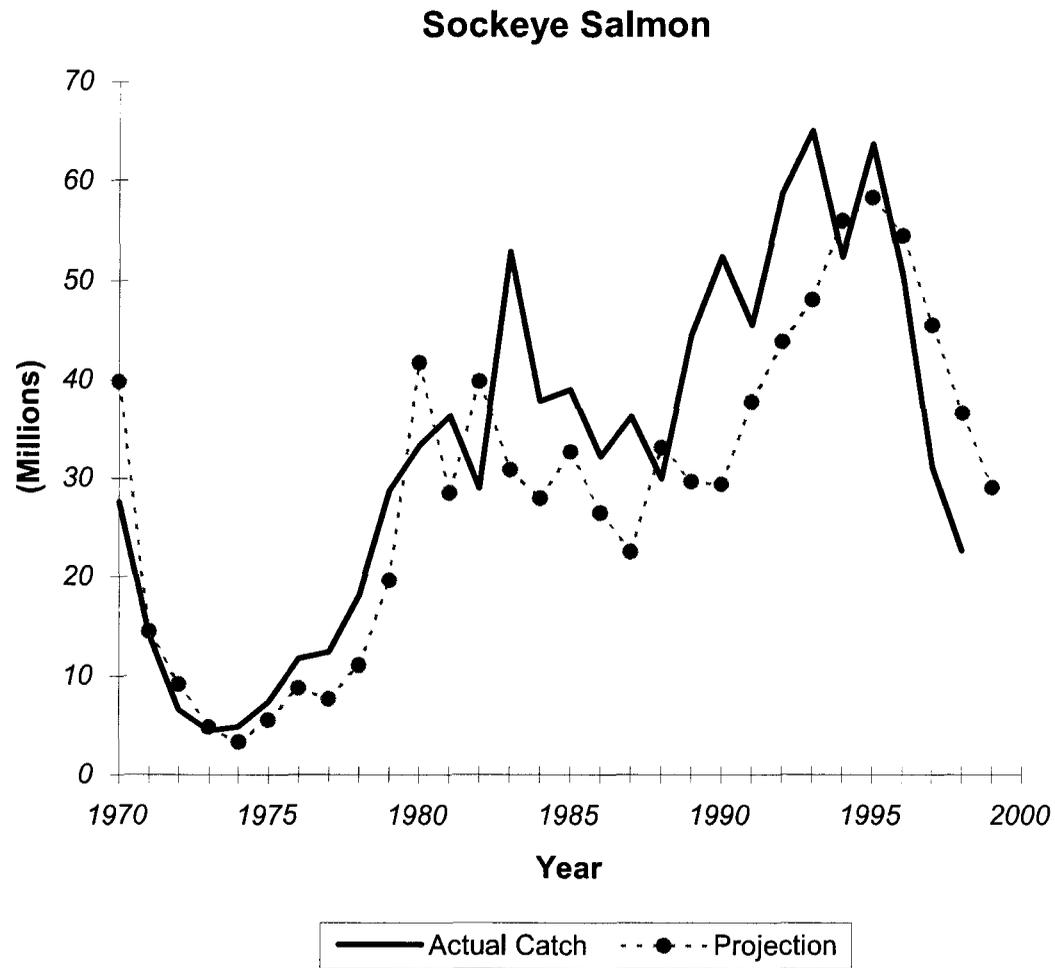


Figure 3. Relationship between actual catch and projected catch, in millions, for Alaska sockeye salmon from 1970 to 1998, with the 1999 projection.

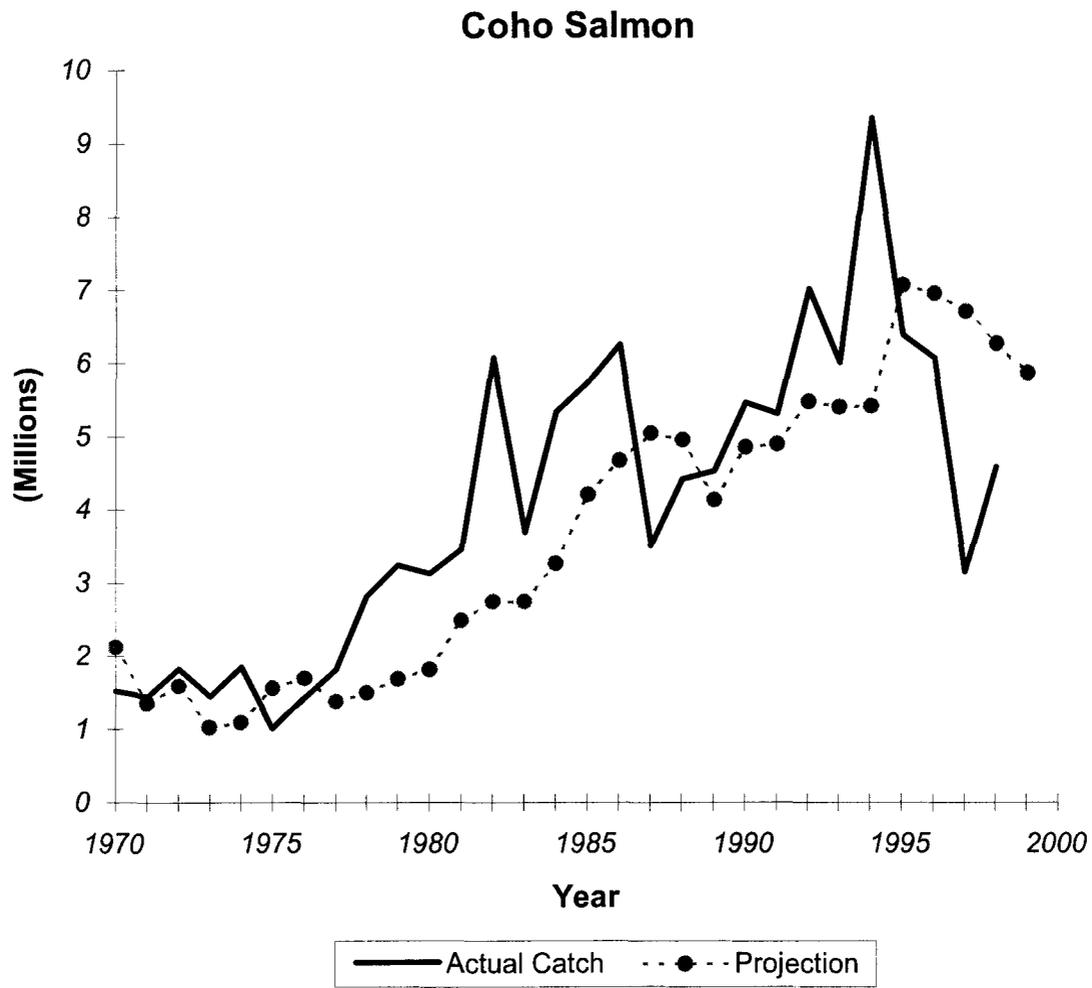


Figure 4. Relationship between actual catch and projected catch, in millions, for Alaska coho salmon from 1970 to 1998, with the 1999 projection.

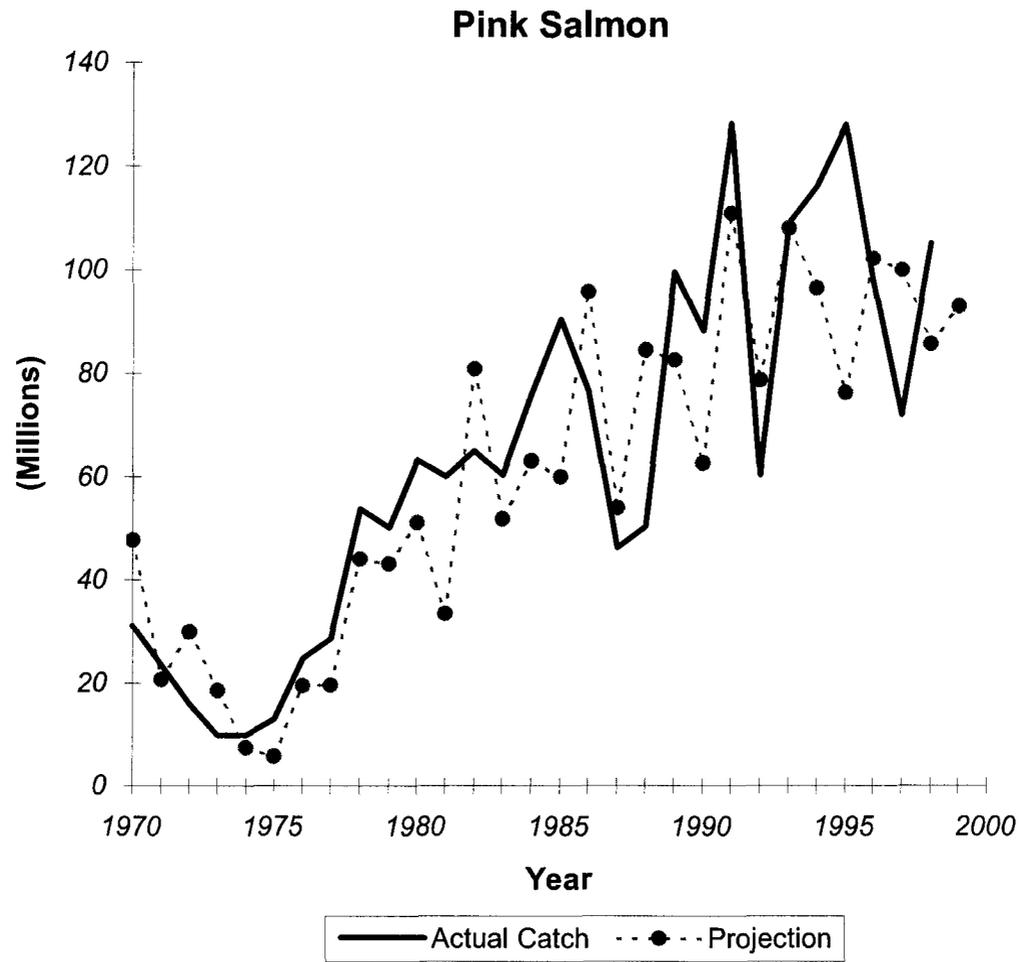


Figure 5. Relationship between actual catch and projected catch, in millions, for Alaska pink salmon from 1970 to 1998, with the 1999 projection.

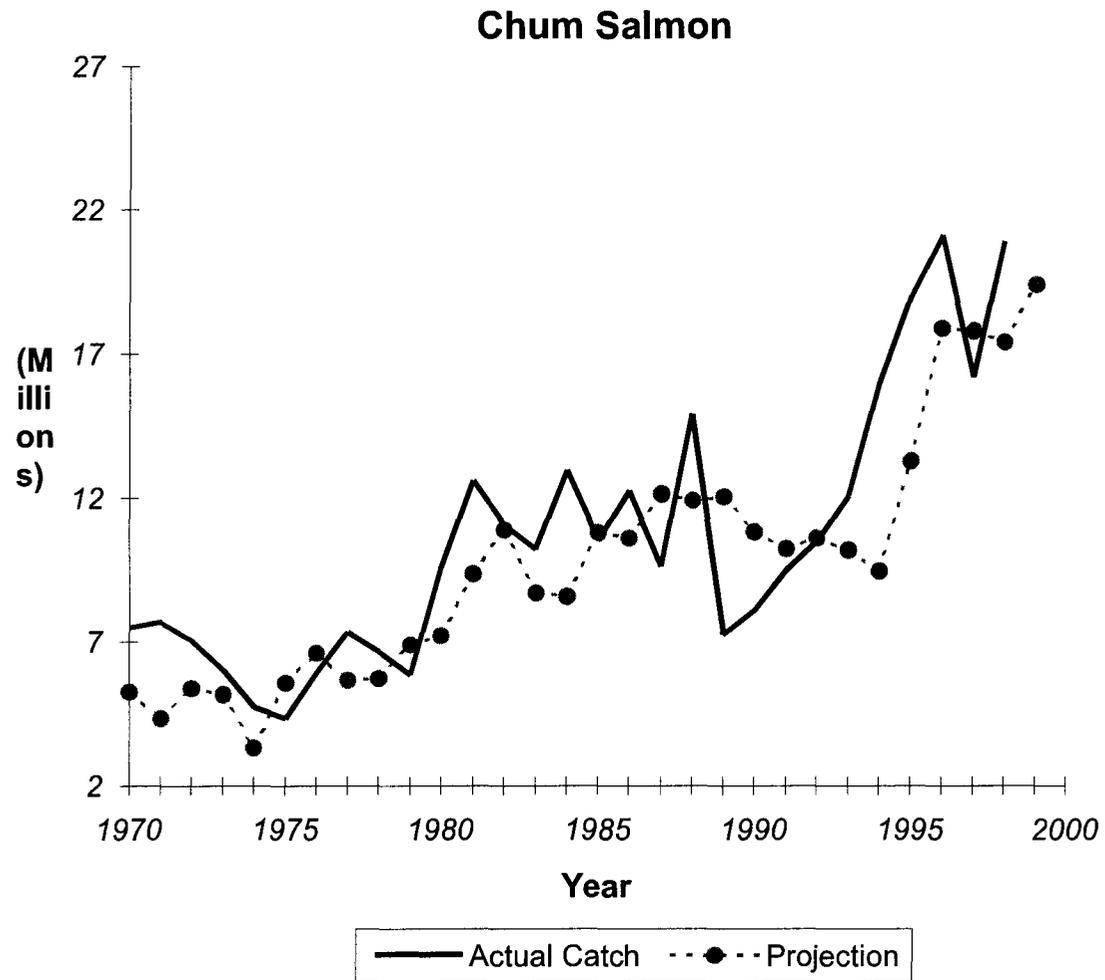


Figure 6. Relationship between actual catch and projected catch, in millions, for Alaska chum salmon from 1970 to 1998, with the 1999 projection.

Appendix

Forecast Area: Southeast Alaska
Species: Pink Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (millions)
• Natural Production	
Natural Run	66.0 to 80.0
Escapement Goal	26.0 to 34.0 ^a
Commercial Common Property Harvest	31.0 to 51.0
• Hatchery and Supplemental Production	
Hatchery Run	1.7
Broodstock Needs	0.2
Commercial Common Property Harvest ^b	1.5
• Total Production	
Total Run	67.7 to 81.7
Escapement Goal	26.2 to 34.2
Commercial Common Property Harvest ^b	31.0 to 51.0

^a An expansion factor of 2.5 was applied to the escapement index to convert the index to an estimate of total escapement.

^b Includes commercial common property and hatchery cost recovery harvests.

Introduction

Data relevant to estimating the magnitude of Southeast Alaska's pink salmon are no longer collected. Consequently, we make predictions based solely on formal statistical models. Information available from other sources (National Oceanic and Atmospheric Administration temperature and precipitation data, management escapement data, and management and fleet field observations) allows us to provide an estimate that we believe is more informative than a simple historic average. Predictions made since 1992 have been a subjective combination of statistical forecast models, historic average harvests, and expert opinion.

Forecast Methods

This year's prediction is based on selecting one of five different harvest magnitude categories calculated from the 1960–1998 harvest quintiles.

Category	Range
Disaster	10 Million or less
Weak	11 to 14 Million
Average	15 to 30 Million
Strong	31 to 51 Million
Excellent	More than 51 Million

Category selection was made by subjective weighting of the following information:

1. The 1997 brood escapement index for the Southeast Alaska region totaled 36.2 million and was the fourth highest since 1960. The escapement index for southern Southeast (16.4 million) ranked eighth highest and the northern Southeast index (19.8 million) was the highest observed since the index program was initiated in 1960.
2. A strong positive linear relationship exists between brood year escapement indices and harvests up to a brood year index of approximately 40 million. Three statistical models (Ricker spawner - recruit, "generalized" Ricker, and Loess smooth) all produced estimates for a region-wide harvest of 36 to 50 million fish (**STRONG** category). Separate models for northern inside, northern outside, and southern stock groups also summed to a harvest in the **STRONG** category.
3. The winter temperature (average minimum daily air temperature November 1 through February 28) of 0.7°C was the third highest since 1960 and was well above the study period average of 1.7°C. Thus, winter weather conditions did not signal significant causes of mortality for the 1999 return.
4. Early marine fry surveys were discontinued in 1997. Therefore this information was not available for forecast assessment.

Forecast Discussion

Based on a subjective evaluation of the above points, we believe that the 1999 harvest will be **STRONG**. The escapements in most areas of Southeast were at or above desired levels in 1997. Outside district 113 had an extremely high escapement index that was approximately 1.75 times higher than any previous index. Outside District 113 has had three very high escapements for the past three years (1996–1998). The returns to this area could be the only poor returns in 1999 if overescapement is an issue. However, the 1998 returns were from the highest escapement to that time in 1996 and produced the largest returns to date. More work is needed on spawner-recruit productivity for this area of Southeast Alaska.

The number of fry released from pink hatcheries in Southeast Alaska was not available at the time this report was prepared. Hatchery production was estimated by assuming a 90% survival from green eggs to fry, and a 2% survival from release to return (95,837,000 green eggs x 0.90 survival to fry stage x 0.02 survival to return = 1.7 million adults returning). The Burnett Inlet hatchery is now operated by Southern Southeast Regional Aquaculture Association and all pink salmon production ceased in 1996.

Tim Zadina
Fishery Biologist
Ketchikan

Jim Blick
Biometrician
Juneau

<p>Forecast Area: Prince William Sound</p> <p>Species: Pink Salmon</p>
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Preliminary Forecast of 1999 Run	Forecast Estimate (millions)	Forecast Range (millions)
• Natural Production		
<i>Prince William Sound General Districts</i>		
Total Run	6.6	1.4–11.9
Escapement Goal	1.4	
Harvest Estimate	5.2	0.0–10.5
• Hatchery and Supplemental Production		
<i>VFDA^a — Solomon Gulch Hatchery</i>		
Hatchery Run	6.5	5.5–10.8
Brood Stock Needs	0.5	
Cost Recovery Needs ^b	4.3	3.8–5.1
Limited Entry Harvest	1.7	0.0–6.5
Historical Survival for Odd Years: Range = 1.3%–9.9%; Mean = 4.2%		
<i>PWSAC^c — Cannery Creek Hatchery</i>		
Hatchery Run	6.6	5.2–8.0
Brood Stock Needs	0.3	
Cost Recovery Needs	2.0	1.8–2.4
Limited Entry Harvest	4.3	2.5–5.9
Historical Survival for Odd Years: Range = 0.5%–8.3%; Mean = 4.8%		
<i>PWSAC^c — A. F. Koernig Hatchery</i>		
Hatchery Run	5.2	4.0–6.4
Brood Stock Needs	0.3	
Cost Recovery Needs	2.0	1.8–2.4
Limited Entry Harvest	2.9	1.3–4.3
Historical Survival for Odd Years: Range = 0.9%–10.3%; Mean = 4.9%		
<i>PWSAC^c — W. H. Noerenberg Hatchery</i>		
Hatchery Run	7.8	2.0–9.0
Brood Stock Needs	0.3	
Cost Recovery Needs	2.0	1.8–2.4
Limited Entry Harvest	5.5	0.0–6.9
Historical Survival for Odd Years: Range = 0.9%–8.7%; Mean = 3.7%		
• Total Production		
Run Estimate	32.9	17.9–46.6
Natural Escapement Goal	1.4	
Broodstock Needs	1.4	
Cost Recovery Needs	10.3	5.4–7.2
Limited Entry Harvest	19.8	3.8–34.6

^a VFDA is an abbreviation for Valdez Fisheries Development Association.

^b VFDA sales are based upon fixed revenue needs. The lower and upper bounds are based upon variations in salmon weight and price per pound.

^c PWSAC is an abbreviation for Prince William Sound Aquaculture Corporation.

Forecast Methods

The predicted natural run of pink salmon is the mean total run of natural production for 1989–1998. This differs markedly from previous predictions that used linear regressions of adult production on brood year escapement for indicator spawning streams.

The forecast for the total hatchery run is the sum of individual hatchery forecasts. The forecast for each hatchery is the product of the number of fry released and historic mean marine survival rate at each hatchery subjectively adjusted for plankton abundance, degree days, and hatchery manager's observations of site-specific parameters (e.g. predator abundance, fry growth rates, and fry condition at time of release). The 80% confidence interval around the forecast is derived from the confidence interval around the mean of the marine survival data. The exception to the confidence interval calculation is W. H. Noerenberg Hatchery where the highest survival rate recorded was used as the upper confidence interval.

Projected brood stock needs will not change unless State permitted changes occur in hatchery programs. Projected brood stock needs for each facility are based on the expected number of eggs retrievable from each female and the expected percentage of females in the brood stock.

All cost recovery harvest estimates are preliminary. Cost recovery harvests for the Prince William Sound Aquaculture Corporation are based on a revenue goal of \$3.8 million using a base price of \$0.18/lb and a 3.5 lb average size for the returning adult pink salmon. The range was calculated using prices of \$0.15/lb and \$0.20/lb as the lower and upper bounds of the run forecast minus the brood stock goal. Actual Prince William Sound Aquaculture Corporation cost recovery harvests will depend on the actual run realized by each facility. The Valdez Fisheries Development Association projected cost recovery harvest is based on a revenue goal of \$2.7 million. The upper and lower bounds of the Valdez Fisheries Development Association cost recovery harvest are based on the same assumptions about pink salmon weight and price as used for the Prince William Sound Aquaculture Corporation return.

Forecast Discussion

Previous forecasts for odd year runs employed surveys of pre-emergent eggs and juveniles, or linear regressions of adult production on brood year escapement for indicator spawning streams. Surveys of pre-emergent eggs and juveniles are no longer conducted and the information is not available for forecasting. Because R^2 values for regressions of the logarithm of return per spawner on parent year escapements were extremely low (0.0007), calculations of natural pink salmon runs using these data were deemed inappropriate and produced estimates no better than the recent average. The previous 10-year period was chosen for calculation of average return, because reliable estimates of natural and hatchery contributions are only available for that time period.

The release of 542 million pink salmon from hatcheries in Prince William Sound in 1998 was about average for the last 10 years. Marine survival estimates for each hatchery have been calculated since 1987 using coded-wire tag recoveries and have most likely underestimated hatchery production. Mean odd-year survival was used to initially calculate the estimated run, but these estimates were often adjusted to account for subjective observations on growing conditions and fry health. In the case of W. H. Noerenberg Hatchery, the highest zooplankton levels ever recorded at that facility were measured this season during the pink salmon fry release. In addition, over 30% of the fry released were composed of large fed fry released later in the spring. Because two previous releases of large fed fry resulted in very high survivals (up to 28%), record high zooplankton levels could result in even greater survival of fry. The midpoint forecast generated by the model was adjusted upward beyond the model's calculated upper 80% confidence interval. Effects of predators are extremely difficult to quantify and can greatly affect the survival of juvenile pink salmon; therefore our forecast does not explicitly account for

predation. Another factor that could affect forecast accuracy is the current La Niña climatic event. We do not know what effect this may have on the 1999 run. Future enhancements to forecasting accuracy may come from work nearing completion on a number of *Exxon Valdez* oil spill (EVOS) Trustee Council funded projects. Most promising are project components within the Sound Ecosystem Assessment (SEA) study which incorporate smolt size, ocean temperatures, plankton abundance, and growth rate in bioenergetic models to estimate pink salmon ocean survival.

The midpoint forecast for a 1999 hatchery return of 32.9 million pink salmon to Prince William Sound would be the fourth largest hatchery run achieved. All hatcheries are expected to produce similar numbers of returning adult salmon. A large plankton bloom on the western side of Prince William Sound is expected to produce above average survivals for the W. H. Noerenberg and A. F. Koernig hatcheries.

Tim Joyce
Fishery Biologist III
Area Resource Development Biologist
Cordova

John Wilcock
Fishery Biologist III
Prince William Sound Research Project Leader
Cordova

Forecast Area: Prince William Sound Species: Chum Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (millions)	Forecast Range (millions)
• Natural Production		
<i>Prince William Sound General Districts</i>		
Total Run	0.61	0.29–1.38
Escapement Goal	0.23	
Harvest Estimate	0.39	0.07–1.16
• Hatchery and Supplemental Production		
<i>VFDA^a — Solomon Gulch Hatchery</i>		
Hatchery Run	0.01	0.00–0.02
Brood Stock Needs	0.00	
Cost Recovery Needs	0.00	
Limited Entry Harvest	0.01	0.00–0.02
<i>PWSAC^b — W. H. Noerenberg Hatchery (Onsite Returns)</i>		
Hatchery Run	2.4	1.8–2.9
Broodstock Needs	0.14	
Cost Recovery Needs ^c	0.53	0.41–0.74
Limited Entry Harvest	1.7	0.92–2.35
<i>PWSAC^b — W. H. Noerenberg Hatchery (Port Chalmers Remote Returns)</i>		
Hatchery Run	0.31	0.13–0.45
Broodstock Needs	0.00	
Cost Recovery Needs ^c	0.00	
Limited Entry Harvest	0.31	0.13–0.45
<i>PWSAC^a— A.F. Koerning Hatchery (Onsite Returns)</i>		
Hatchery Run	0.003	0.001–0.005
Brood Stock Needs	0.0	
Cost Recovery Needs ^b	0.003	0.001–0.005
Limited Entry Harvest	0.00	0.00–0.00
• Total Production		
Run Estimate	3.24	2.22–4.76
Natural Escapement Goal	0.23	
Broodstock Needs	0.14	
Cost Recovery Needs	0.53	0.41–0.74
Limited Entry Harvest	2.44	1.59–3.65

^a VFDA is an abbreviation for Valdez Fisheries Development Association.

^b PWSAC is an abbreviation for Prince William Sound Aquaculture Corporation.

^c Chum salmon cost recovery is pooled with the sockeye salmon cost recovery at Main Bay Hatchery to provide a to provide a revenue goal of \$2.5 million.

Forecast Methods

The forecast of natural chum salmon production is calculated as the total of estimates for four age classes. Returns of 3-year-old chum salmon are predicted from pink salmon returns from corresponding brood years. Returns of 4- and 5-year-old chum salmon are predicted from returns of 3- and 4-year-old chum salmon from the same brood year (i.e. siblings one year younger than the age class being predicted). The return of 6-year-old chum salmon are predicted as the mean return of that age class in prior years.

The forecast of the total hatchery run is the sum of individual hatchery forecasts. The forecast for each hatchery is the product of the number of fry released and their historical mean marine survival rate adjusted for past sibling returns. Hatchery runs for all age classes except age 4 are calculated from fry releases made during 1993–1997 multiplied by a mean marine survival of 1.26%. Mean survival for all released fry is based on eight years of fry release and adult return data from W. H. Noerenberg Hatchery. The average age composition of returning adults from 1993 to 1997 hatchery releases is assumed to be the same as the average age composition observed for previous chum returns during 1983–1998. However, this assumption may no longer be valid since hatchery rearing practices were altered in 1995. This has resulted in released fry about 2.5 times larger in body size than those from earlier years. The adjustment to the total forecast is based on sibling information. The Solomon Gulch 1999 adult run is expected to be composed solely of 5- and 6-year-old adults from very small chum salmon releases in 1993 and 1994. A. F. Koernig Hatchery run is expected to be composed of only 3-year-old chum salmon returning from releases in 1996, but no historical survival data are available for releases at this site. Port Chalmers chum salmon run is expected to be composed of all adult-age salmon for the first time in 1999, but again no survival data is available for releases at this site. W. H. Noerenberg Hatchery historical survivals are used to forecast Solomon Gulch, A. F. Koernig, and Port Chalmers runs. The forecast for the W. H. Noerenberg Hatchery run is based on sibling relationships, and far exceeds the upper confidence interval calculated from average survivals. A record 3-year-old component returned to the W. H. Noerenberg Hatchery in 1998 from fry that were released at over twice the average body size of historical releases. Large size at release could shift adult returns to earlier age classes, as well as significantly increase overall survival. A record return of 4-year-old chum salmon is highly likely, but the current forecasting model does not compensate for changes in rearing practices.

Projected brood stock needs for each facility were based on expected number of eggs produced from each female and expected proportion of females in the brood stock. Brood stock needs will not change unless hatchery program changes occur. The projected sales harvest for PWSAC is based on a revenue goal of \$2.3 million for species other than pink salmon. PWSAC expects to achieve this revenue goal primarily from hatchery sales of sockeye and chum salmon. The forecasted sockeye salmon run would be insufficient to provide half of the total non-pink salmon revenue goal. Therefore additional chum salmon will be sold to compensate for any short fall in sockeye salmon sales. A revenue goal of \$1.49 million for W. H. Noerenberg Hatchery chum salmon was based on an estimated price of \$0.35/lb and average adult weight of 8 lb. Under these assumptions, the corporation would require sales of about 30% of the total chum salmon return produced by PWSAC. Nearly all hatchery sales harvest will occur at the W. H. Noerenberg Hatchery site. Less than 4,000 chum salmon are expected to return to the A. F. Koernig Hatchery in 1999 from releases in 1997, providing only a minor contribution to the total cost recovery goal. The Solomon Gulch Hatchery does not have a directed cost recovery fishery for their chum salmon run.

Forecast Discussion

Our ability to accurately forecast natural chum salmon is limited by the small amount of data available to calculate survivals and examine sibling relationships. Additionally, estimates of wild stock contributions to harvests are not available for recent years due to elimination of the coded -wire tag recovery program for this species. Finally, age data from escapements are unavailable for most areas of Prince William Sound. Lack of information is reflected in the wide forecast for the natural chum salmon forecast. If forecast is realized, it would be twice the size of the 1998 run and 28% greater than the average run for the period 1988–1998.

If the forecast for W. H. Noerenberg Hatchery chum salmon is realized, it would be the largest run produced by that facility. The sibling relationship used to produce the 6-year-old chum salmon forecast estimated an average return for that age class, but the 6-year-old component typically contributes only 3% to the total run. Age-5 chum salmon generally contribute about 40% to the run, but previous returns of age-3 and -4 siblings in 1997 and 1998 produced actual returns only about 66% of those predicted. As a result, the midpoint forecast for the 5-year-old age class return was reduced to compensate for the weakness in this brood year. The 4-year-old component, which generally contributes about 53% of returns, is expected to produce a record run of that age group based on the number of 3-year-old chum salmon that returned in 1998. The 1995 brood year produced about 5 times the predicted number of 3-year-old adults in 1998, which was about 3 times greater than the previous record run for that age group. While production of larger fry due to changes in rearing strategy is the most likely cause for the large increase in 1995 brood year returns, favorable environmental conditions may also have contributed to the greater than expected production of 3-year-old chum salmon.

Returns from Port Chalmers remote releases of chum salmon fry from W. H. Noerenberg Hatchery are expected to exceed the 1998 run with the addition of another returning brood year. The Port Chalmers run is expected to be 310,000 adults, and will be comprised of 3-, 4-, 5- and 6-year-old chum salmon. Together, the W. H. Noerenberg Hatchery onsite and Port Chalmers remote returns are expected to produce over 2.7 million adult chum salmon.

The Solomon Gulch facility is expected to have a much reduced chum salmon run in 1999. This facility no longer releases chum salmon fry, and runs from their largest releases have already returned.

The A. F. Koernig Hatchery started releasing chum salmon fry in 1997. All returning adults are expected to be sold for cost recovery because only 3-year-old chum salmon will return in 1999, and the run should end prior to commencement of commercial fishing by the purse seine fleet in that area.

Our ability to accurately forecast chum salmon runs is limited because little data is available and recent changes in hatchery practices appear to have greatly altered survival. The midpoint forecast based on sibling relationships falls outside the upper end of the 80% confidence intervals calculated from average survivals, primarily due to the extremely high survival of the 1995 brood year.

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Forecast Area: Prince William Sound
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Natural Production		
<i>Prince William Sound — Coghill Lake</i>		
Total Run	72.8	21.3–255.4
Escapement Goal	25.0	
Harvest Estimate	47.8	0.0–230.4
<i>Prince William Sound — Eshamy Lake</i>		
Total Run	38.4	30.8–45.9
Escapement Goal	40.0	
Harvest Estimate	0.0	0.0–5.9
<i>Prince William Sound — Unakwik District</i>		
Harvest Estimate	10.8	8.3–13.4
• Hatchery and Supplemental Production		
<i>PWSAC^a — Main Bay Hatchery (Eyak Stock Onsite Returns)</i>		
Hatchery Run	8.6	7.7–9.6
Brood Stock Needs	0.0	
Cost Recovery Needs	8.6	7.7–9.6
Limited Entry Harvest	0.0	
<i>^a — Main Bay Hatchery (Coghill Stock Onsite Returns)</i>		
Hatchery Run	19.6	18.8–20.3
Brood Stock Needs	10.5	
Cost Recovery Needs	9.1	8.3–9.8
Limited Entry Harvest	0.0	
<i>PWSAC^a — Main Bay Hatchery (Coghill Stock Marsha Bay Lake Remote Returns)^c</i>		
Hatchery Run	6.5	5.8–7.3
Brood Stock Needs	0.0	
Cost Recovery Needs ^b	6.5	5.8–7.3
Limited Entry Harvest	0.0	
<i>PWSAC^a — Main Bay Hatchery (Eshamy Stock Onsite Returns)</i>		
Hatchery Run	110.9	106.9–115.5
Brood Stock Needs	0.0	
Cost Recovery Needs ^b	110.9	106.9–115.5
Limited Entry Harvest	0.0	0.00–0.00
• Total Production		
Run Estimate	259.1	191.9–457.8
Natural Escapement Goal	65.0	
Brood Stock Needs	10.5	
Cost Recovery Needs ^b	135.1	128.7–142.2
Limited Entry Harvest	58.6	8.3–249.7

- ^a PWSAC is an abbreviation for Prince William Sound Aquaculture Corporation.
- ^b Any hatchery surplus would be harvested from Coghill stock production.
- ^c Sockeye salmon returning from the release of 1996 brood year pre-smolt into Marsha Bay Lake on Knight Island.
- ^d Cost recovery figures are derived from a revenue goal of \$1.25 million using a price of \$1.00/lb and an average size of 6 lb.

Forecast Methods

The forecast of the natural sockeye salmon run to Coghill Lake is the total of estimates for five age classes. Linear regression models using logarithm-transformed data are used to predict runs for four age classes: age-1.2, -1.3, -2.2, and -2.3 sockeye salmon. The run of each of these four age classes is predicted from the relationship between returns of that age class and returns of the age class one year younger from the same brood year. For example, the model used to predict the run of age -2.2 sockeye salmon in 1999 used the run of age-2.1 sockeye salmon in 1998 as the input parameter. Finally, the predicted run of a fifth age class, age-1.1 sockeye salmon, is calculated as the mean return of that age class in past years. Although catch and escapement numbers, as well as age composition data, are available for Coghill sockeye salmon runs since 1962, escapement numbers prior to installation of a full weir in 1974 are considered to be unreliable. Therefore, only data collected since 1974 are used to estimate model parameters, and calculate individual age class forecasts.

The forecast of the natural run to Eshamy Lake is the mean of low-run years in the 4-year cycle observed for this stock. Eshamy Lake generally has a cycle of one strong brood year that contributes to runs in two return years followed by two years of small runs. Eshamy Lake escapements have been enumerated at a weir since 1950 for all but two years: 1987 and 1998. Commercial catches are available for the same period, but age composition data are available only for some years since 1962. Escapement numbers and age composition data were not collected in 1987 and 1998. Only available data collected since 1968, excluding 1987 and 1998, were used to calculate the mean run used for the forecast and the forecast range.

Main Bay Hatchery, operated by Prince William Sound Aquaculture Corporation, is the only hatchery producing sockeye salmon within Prince William Sound. Three sockeye salmon stocks (Coghill, Eshamy, and Eyak Lake stocks) are used, and forecasts are made for each stock returning to the facility (onsite returns) as well as to remote release sites (remote returns).

The forecast of the Eyak Lake sockeye salmon onsite return is based on age-specific marine survivals (0.24% for 3-year-old and 3.0% for 4-year-old sockeye salmon) for hatchery releases in brood years 1990, 1991, 1993 and 1994. Survival estimates are based on fry releases, catch contribution estimates from coded-wire tag recoveries, and brood stock data. Most marine survival estimates were calculated from adults returning from releases of age-0 sockeye salmon, but adults returning in 1999 from brood year 1995 and later are from age-1 smolt releases. Since survival data were not available from multiple brood years, coefficients of variation for age specific survival estimates, based on Coghill Lake hatchery stock returns from brood years 1987 through 1991, were used to approximate confidence intervals around Eyak Lake age specific forecasts. It is expected that all returning Eyak sockeye salmon will be used for cost recovery. This stock is being phased out of hatchery production.

The forecast of the Coghill sockeye salmon stock onsite return is based on age specific mean marine survival of hatchery returns from brood years 1987 through 1992 (0.73% for 3-year-old, 7.35% for 4-

year-old, and 2.44% for 5-year-old sockeye salmon). Survival estimates are based on fry releases, catch contribution estimates from coded-wire tag recoveries, and brood stock data. Since only limited data were available from multiple brood years, age specific survival estimates were calculated separately for 24 separate release groups within four complete brood years. Means of these estimates were then used to forecast 3-, 4-, and 5-year-old returns, and the variance about each mean was used to estimate associated confidence intervals. It is expected that over half of the Coghill stock return to Main Bay Hatchery will be used for brood stock, leaving approximately 9,000 adults for common property harvest

Coghill stock remote smolt releases have been discontinued, and no further adult returns are expected from prior releases. Adult return forecasts from stockings of Main Bay Hatchery pre-smolt into Coghill Lake are included in the wild stock forecast section.

The forecast of Coghill stock remote returns to Marsha Bay Lake, Knight Island, is based on the estimated proportion of 5-year-old sockeye salmon in a previous return from a 1991 release of smolt. Five-year-old sockeye salmon are returning in 1999 from a smolt release in 1995; no further returns from the 1991 release are anticipated. It is expected that all returning Eyak sockeye salmon will be used for cost recovery.

The forecast of the late-run Eshamy sockeye salmon onsite return is based on age-specific mean marine survival from three complete brood year cycles of hatchery production (0.25% for 3-year-old, and 11.01% for 4-year-old, and 0.05% for 5-year-old sockeye salmon). Coefficients of variation for age-specific survival estimates from Coghill stock hatchery returns were used to estimate confidence intervals about forecasts of late-run Eshamy stock onsite returns. It is expected that all returning Eshamy sockeye salmon will be harvested for cost recovery.

Projected brood stock needs for each facility were based on the expected number of eggs produced from each female and the expected percentage of females in the brood stock. Brood stock needs will not change unless hatchery program changes occur. PWSAC cost recovery needs for sockeye salmon are based on a revenue goal of \$2.5 million for species other than pink salmon. This revenue goal was divided between chum salmon and sockeye salmon produced in hatcheries. The sockeye salmon portion of the revenue goal was expected to be \$1.25 million. The midpoint estimate of the number of sockeye salmon adults needed to achieve this cost recovery goal was calculated using an expected price of \$1.00/lb and an average adult weight of 6 lb. The upper and lower bounds of the cost recovery midpoint estimate were calculated using estimated prices of \$1.10/lb and \$0.90/lb. The midpoint forecast of hatchery returns suggests an insufficient number of adults will return to meet the original cost recovery goal. As a result a revised sockeye salmon revenue goal of \$0.8 million was used. As a result, PWSAC will probably have to harvest additional chum salmon to make up for the shortfall in sockeye salmon returns.

Forecast Discussion

The natural Coghill sockeye salmon run appears to be recovering after a period of poor runs in the first half of this decade, which appear to be due in part to limnological conditions in Coghill Lake. The biological escapement goal for this system was lowered to allow plankton populations to recover, and fertilizers were added to the lake in a cooperative project with the US Forest Service to improve the forage base for rearing sockeye salmon juveniles. Returns in 1996, 1997, and 1998 appear to mark the resumption of higher production levels, and are expected to continue in 1999. Biological escapement goals for Coghill Lake natural run were met in 1998 for the fifth time since 1990. The forecast for the natural run to Coghill Lake in 1999 of approximately 72.8 thousand sockeye salmon would be larger than four of the last eight years, but would still be only one third of the 1962–1997 average run of 190,000 sockeye salmon for this system.

The forecast for natural stocks was generated using sibling regression models, similar to projections in previous years. However, sibling relationships do not account for the return of presmolts released into Coghill Lake in 1994 and 1995. Few sockeye salmon returned in 1998 from these releases, but insufficient data are available to evaluate survival or typical age at maturity. Estimated smolt emigration numbers for 1995–1997 suggests the 1999 run could be somewhat greater than the point estimate from sibling models. If smolt estimates are accurate, the forecast of 72.8 thousand wild Coghill sockeye salmon is likely to underestimate the total run of wild and enhanced adults.

The forecast for the natural run of sockeye salmon to Eshamy Lake is about half of the 1968–1997 average run of 67.0 thousand adults. The 1995 spawning escapement was one of the latest escapements on record, but many adults matured completely in salt water before entering Eshamy Lake. Resulting spawning success was thought to have been very low. In addition, the Eshamy Lake natural stock appears to exhibit a four-year cycle of peak abundance, and the 1999 run should be the smallest one year between peak years. Mean size of runs for this point in the cycle for the period 1968–1997 is 32.0 thousand sockeye salmon.

The Eshamy Lake natural stock is the largest natural stock contributor to commercial harvests of sockeye salmon in Prince William Sound outside of the Coghill District. The Eshamy Lake natural run has historically contributed to a substantial incidental harvest by the purse seine fishery in the Southwest District. Although escapements into Eshamy River have been counted at a weir for 50 years, collection of age, sex and size data has only been recently instituted for the escapement, the Eshamy District directed harvest, and the Southwest District incidental harvest. These data were used to construct brood tables for this run, which, in turn, were used to calculate the 1997 and 1998 forecasts. Contributions to commercial harvests in western Prince William Sound of sockeye salmon produced by the Main Bay Hatchery have been estimated by recovery of coded-wire tags. However, not all harvests can be adequately estimated, increasing uncertainty of total run estimates for all wild and enhanced sockeye salmon stocks in western Prince William Sound. Age composition data and weir counts were not collected in 1987 and 1998 due to budget shortfalls, and future funding of tag recovery and Eshamy weir projects is uncertain. Loss of this data will reduce the Eshamy forecast to a harvest projection based on the mean of past harvests.

The Main Bay Hatchery onsite run of Eyak stock will be small in 1998. The run will consist of 3- and 4-year-old sockeye salmon from brood years 1995 and 1996. Returns from both brood years were released as age-1 smolt. A water pipeline break during the winter of 1995–1996 caused high mortality of much of the production for brood years 1995 and 1996, greatly reducing the number of juveniles released and expected number of returning adults.

The onsite hatchery return of Coghill stock in 1999 is expected to be less than the 1998 run. The forecast of 5-year-old sockeye salmon has been greatly reduced since most of that year class was released in January 1996 following the pipeline failure. The 4-year-old age class dominates the hatchery return of this stock, but just over 200,000 smolt were released. No 3-year-old sockeye salmon are expected to return because no Coghill stock smolt were released in 1998. This stock is being reintroduced to the Main Bay Hatchery and will replace all other stocks currently at that facility.

Remote release of Coghill hatchery stock in the Coghill system to supplement natural production ended with stocking of pre-smolt in 1995. Returns of Coghill system remote releases in 1999 will consist solely of adults released into Coghill Lake as pre-smolt in brood year 1995. Pre-smolt to adult survival data are not available because these returns will be the first from that stocking strategy. Stocked pre-smolt were not included in the natural production forecast. Smolt were counted at a weir on the Coghill River during emigration, but contribution estimates for enhanced and natural stocks were not available for all years.

Prince William Sound Aquaculture Corporation harvested returns from 1992 remote releases of Coghill hatchery stock pre-smolt into Marsha Bay Lake for cost recovery needs in 1995 and 1996. The 1999 forecast return is composed entirely of 5-year-old sockeye salmon stocked into the lake as presmolts in November of 1995. The forecast is based entirely on predicted return of 5-year-old adults from returns of the 1992 stocking.

The onsite hatchery return of Eshamy stock is expected to be composed almost entirely of 4-year-old sockeye salmon. The forecast is based on expected survival of smolt released in 1997, and is expected to be greater than the 1998 return because of the larger number of smolt released. The accuracy of this forecast is very uncertain since there have been only two complete brood year returns for this hatchery stock.

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Forecast Area: Prince William Sound
Species: Coho Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Hatchery and Supplemental Production		
<i>VFDA</i> ^a — <i>Solomon Gulch Hatchery</i>		
Hatchery Run	130.6	106.5–154.6
Brood Stock Needs	1.5	
Cost Recovery Needs	16.0	
Common Property Harvest ^b	113.1	89.0–137.1
Historical Survival: Range = 0.9%–14.5%; Mean = 7.4%		
<i>PWSAC</i> ^c — <i>W. H. Noerenberg Hatchery (Onsite Releases)</i>		
Hatchery Run	16.0	12.5–19.6
Brood Stock Needs	1.0	
Cost Recovery Needs	0.0	0.0–0.0
Common Property Harvest	15.0	11.5–18.6
Historical Survival: Range = 3.0%–14.3%; Mean = 7.4%		
<i>PWSAC</i> ^c — <i>W. H. Noerenberg Hatchery (Remote Releases)</i> ^d		
Hatchery Run	15.0	11.7–18.3
Brood Stock Needs	0.0	
Cost Recovery Needs	0.0	
Common Property Harvest ^b	15.0	11.7–18.3
• Total Hatchery Production		
Run Estimate	161.6	130.7–192.5
Brood Stock Needs	2.5	
Cost Recovery Needs	16.0	16.0
Limited Entry Harvest	143.1	112.2–174.0

^a VFDA is an abbreviation for Valdez Fisheries Development Association.

^b Includes recreational fishing harvest.

^c PWSAC is an abbreviation for Prince William Sound Aquaculture Corporation.

^d Includes remote releases at Whittier, Chenega, and Cordova.

Forecast Methods

Harvest projections for natural coho salmon in Prince William Sound have typically been estimated from the mean of historic annual harvests of this species. In recent years, commercial harvests have targeted primarily hatchery returns, and no stock contribution estimates are available to assess natural production. Estimates of sport harvests, which do target natural coho salmon runs, are not available until the following summer. For these reasons, no projection is estimated for natural production of this species for 1999.

The forecast for each hatchery return is the product of the number of smolt released from each facility in 1998 and mean marine survival achieved for each facility (7.4% for Solomon Gulch Hatchery and

7.4% for W. H. Noerenberg Hatchery). Forecast ranges are based on 80% confidence intervals about mean survivals.

Forecast Discussion

Coho smolt releases from the Solomon Gulch Hatchery and the W. H. Noerenberg Hatchery in 1998 exceeded those of the previous year. Recent improvements in fish culture practices at W. H. Noerenberg Hatchery resulted in production of fewer, but larger and more vigorous, smolt. Family tracking to reduce the incidence of bacterial kidney transmission has been accomplished for one generation. Marine survival estimates for coho salmon hatchery stocks were based on the assumption that all harvest taken in the vicinity of each hatchery is comprised of production from that hatchery. Survival estimates could be overly optimistic if hatchery and natural runs mix in harvest areas. Return estimates to remote stocking locations in Whittier and Cordova are based on hatchery survival estimates since little information is available on actual sport harvest of these stockings. No direct cost recovery harvest is anticipated at the W. H. Noerenberg Hatchery because the run expected is small. However some revenue could be generated from coho salmon incidentally captured during the pink salmon cost recovery harvest.

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Forecast Area: Copper River
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (millions)	Forecast Range (millions)
• Natural Production		
Total Run	1.47	0.90–2.46
Escapement Goal	0.48	
Common Property Harvest	0.98	0.49–1.50
• Hatchery and Supplemental Production		
<i>PWSAC^a — Gulkana Hatchery</i>		
Hatchery Run	0.89	0.53–1.24
Brood Stock Needs	0.02	
Supplemental Escapement ^b	0.27	
Common Property Harvest	0.60	0.29–0.90
• Total Production		
Run Estimate	2.36	1.43–3.70
Natural Escapement Goal	0.48	
Brood Stock Needs	0.02	
Supplemental Escapement ^b	0.27	
Common Property Harvest	1.59	0.78–2.40

^a PWSAC is an abbreviation for Prince William Sound Aquaculture Corporation.

^b Includes harvests from commercial, subsistence, personal use and sport fisheries.

^c Hatchery production that will not be harvested to ensure natural escapement into the Upper Copper River is achieved, since natural stocks cannot sustain the higher exploitation levels of hatchery stocks.

^d Includes remote releases at Whittier, Chenega and Cordova.

Forecast Methods

The forecast of the natural run of sockeye salmon to the Copper River is the total of estimates for six age classes. Linear regression models using logarithm-transformed data were used to predict runs for three age classes: age-1.2, -1.3, -2.2 sockeye salmon. The run of each of these three age classes was predicted from the relationship between returns of that age class and returns of the age class one year younger from the same brood year. For example, the model used to predict the run of age -2.2 sockeye salmon in 1999 used the run of age-2.1 sockeye salmon in 1998 as the input parameter. Finally, predicted runs of age-1.1, -2.3 and -0.3 sockeye salmon were calculated as the mean return of those age classes in past years. Forecast methods for 1999 are similar to forecast methods used in 1998, but differ substantially from earlier methods. Prior to 1998, forecasts were calculated as the product of historical mean return-per-spawner values and parent year escapements weighted by age class (4-, 5-, and 6-year old sockeye salmon). Mean return-per-spawner values were estimated from linear regressions of adult production on brood year escapements.

Supplemental production from Gulkana Hatchery remote releases to Crosswind and Summit Lakes was predicted using smolt-to-adult survival estimates based on coded-wire tag recoveries in harvests and enumerated adult escapements. Survival of juveniles released into Paxson Lake was assumed to

lie between values estimated for Crosswind and Summit Lake. Average proportion of 1996–1998 runs harvested (70.5%) was used to project total harvest of Gulkana Hatchery stocks in 1999.

Forecast Discussion

Forecasts prior to 1998 relied on the relationship between number of spawners and subsequent returns, using return-per-spawner values for parent year abundance similar to that of the dominant age class (age 5) of the year for which the forecast was developed. Recent Copper River sockeye salmon runs have exceeded all previously documented runs, although escapements has been only slightly above average. High return-per-spawner values for the two most successful brood years on record (1991 and 1992) reflect this apparent increased productivity. Because average return-per-spawner values do not reflect recent increased production, and because returns are still incomplete from the most recent brood years, linear regressions of brood year sibling returns were used to produce the 1998 and 1999 forecasts. Linear regressions of sibling returns were not used prior to these years because age composition data for some escapements and harvests were not available. Additionally, reliable estimates of survival and contributions from supplemental production for individual brood years have only recently become available through coded wire tag recoveries in harvest and escapements. Although historic estimates of Gulkana Hatchery production are thought to be inaccurate, improved contribution estimates for 1997 and 1998 indicated large contributions from supplemental production and provided smolt-to-adult survival estimates for Crosswind Lake releases that exceeded 30%.

The 1999 run will be composed primarily of returns from the 1995 and 1994 brood years. Five-year-old sockeye salmon from the 1994 brood year are expected to dominate Copper River Delta and Upper Copper River runs. Recent record large runs suggest that conditions have been unusually favorable for these stocks. The 1998 run, although still above average, may signal a return to more typical production levels for this system. If realized, the forecast for the 1999 total run will still be 17% above the 1983–1998 average. However a 1.47 million natural run would still be slightly below average runs documented prior to substantial supplemental production, while a 0.89 million Gulkana Hatchery run would be nearly double that observed for recent years.

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Forecast Area: Copper River
Species: Chinook Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
<ul style="list-style-type: none"> • Harvest Projection for Natural Run Copper River District 	53.0	32.2–73.9

Forecast Methods

The harvest projection for the 1999 chinook salmon run to the Copper River area is the average limited entry commercial fishery harvest for 1994–1998.

Forecast Discussion

During the past 15 years, chinook salmon runs to the Copper River have tended to be above average, and several catch records have been set. Total harvests in all Copper River fisheries (commercial, subsistence, personal use, and sport) since 1995 have exceeded all documented annual harvests since 1890. Escapements appear to have been maintained at high levels, and conditions generally appear to favor continued good production. Because aerial surveys to estimate escapement were not conducted in the Upper Copper River in 1993, and surveys in 1992 and 1995 were made under poor conditions, it is no longer possible to forecast chinook total run abundance using previous methods requiring spawning escapements to approximate total run size. However, forecasting performance based on this method was poor, and, all but two of the predictions made during 1985–1997 were less than actual runs.

John Wilcock
 Fishery Biologist III
 Prince William Sound Research Project Leader
 Cordova

Forecast Area: Copper and Bering Rivers
Species: Coho Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Harvest Projection for Natural Run		
Copper River District	304.2	64.4–825.1
Bering River District	127.5	0.0–281.0

Forecast Method

The harvest projection for the 1999 run of coho salmon to the Copper and Bering River areas is the average limited entry commercial fishery harvest for 1981–1998.

Forecast Discussion

Both the 1997 and 1998 runs of coho salmon to the Copper and Bering River areas were well below the 1980–1996 average, and commercial fishery harvests were restricted in both years. Although aerial survey information did not indicate parental escapements for either of these years were unusually low, these runs followed years in which the second (1994) and third (1995) largest commercial fishery harvests were taken. Winters with extremely low temperatures and little snow cover, and summers with either near-drought or high water conditions have occurred regularly since 1990. The occurrence of extremely high and low brood year returns during this period may help identify environmental factors affecting freshwater survival of coho salmon juveniles that may be used to improve forecast accuracy. Forecasting accuracy may also be improved with information obtained jointly, since 1994, by the department and U.S. Forest Service on climatic factors and coho salmon survival from eggs deposited in spawning channels.

John Wilcock
 Fishery Biologist III
 Prince William Sound Research Project Leader
 Cordova

Forecast Area: Upper Cook Inlet
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (millions)	Forecast Range (millions)
• Natural Production		
Total Run	3.5	0.0–7.2
Escapement Goal	1.5	
Harvest Estimate	2.0	

Forecast Methods

The major sockeye salmon systems in Upper Cook Inlet are the Kenai, Kasilof, Susitna and Crescent Rivers, Packers Creek and Fish Creek. Spawner, sibling, and fry data, if available, were examined for each system. Forecasts for all systems and age classes, except Kenai age -1.3 sockeye salmon, were made from two models: one using the relationship between adult returns and spawners and the other the relationship between adult returns and siblings. A model using the relationship between adult returns and fall fry was used for Kenai River age-1.3 sockeye salmon. In most cases sibling relationships were used. The forecast range for the total forecasted run was calculated using the squared deviations between past forecasts and actual runs as the forecast variance (mean square error).

Forecast Discussion

The total run to Upper Cook Inlet in 1998 was 2.9 million sockeye salmon, while the preseason forecast was 4.0 million. The run of age-1.3 sockeye salmon to Upper Cook Inlet was about 0.8 million less than expected, while the run of age-1.2 sockeye salmon to Fish Creek was about 0.2 million less than expected. The 1999 forecasted harvest would be the 5th lowest in the last 20 years and half the average for the last 10 years.

The forecasts for Crescent River, Packer Creek, and Fish Creek are highly uncertain since models fit the data relatively poorly. The Kenai River sockeye salmon forecast is also uncertain since models based on different relationships supplied different predictions. A difference of 1.2 million sockeye salmon exists between results of the sibling and fall fry models for Kenai River age-1.3 sockeye salmon. The sibling model predicts a run of 2.1 million age-1.3 adults while the fall fry model predicts a run of only 0.9 million. This smaller estimate, based on fall fry, was used for the 1999 forecast since marine survival has been less than expected for the last two years, future marine survival conditions are unknown, and the sibling model overestimated the 1998 age-1.3 run. Forecasted runs to individual freshwater systems are as follows:

System	Run	Escapement Goal
Crescent River	162,000	50,000-100,000
Fish Creek	38,000	50,000
Kasilof River	660,000	150,000-250,000
Kenai River	1,649,000	330,000-600,000
Packers Creek	102,000	15,000-25,000
Susitna River	452,000	200,000
Minor System	459,000	N/A

Kenneth E. Tarbox
Research Project Leader
Upper Cook Inlet

Forecast Area: Lower Cook Inlet
Species: Pink Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Natural Production		
Total Run	1,095	255–4,803
Escapement ^a	369	191–478
Commercial Harvest ^b	727	64–4,325
• Supplemental Production		
Total Run	3,220	1,560–4,880
Brood Stock	155	
Commercial Harvest ^b	3,065	
• Total Production		
Total Run	4,315	1,815–9,683
Brood Stock and Escapement ^f	524	
Commercial Harvest ^b	3,792	

^a Escapement values include an escapement goal shortfall of 14 thousand fish for systems with a forecast in 1999.

^b Commercial Harvest = Total Run – Escapement/Brood Stock. Commercial harvests of supplemental production include both common property and cost recovery harvests. Additional harvests may be expected in systems not included within the forecast.

Forecast Methods

The forecast of wild pink salmon returns to 11 harvest areas in the Lower Cook Inlet Management area was based on spawner-return regressions and Ricker spawner-recruit analysis using 25 to 37 years of observations. The forecast range about the forecast of natural production was developed using cross-validation methods. Projected harvest from natural production was obtained by subtracting both escapement goals and escapement shortfalls from the overall forecast. Forecast range of supplemental production in Tutka Bay was based on ocean survival rates of 1.7% to 5.4%. Projected harvest from supplemental production was obtained by subtracting broodstock goals from the supplemental production forecast.

Forecast Discussion

The natural production forecast model was tested using cross-validation methods. The model correctly predicted 35 out of 37 changes in direction of annual run size. Accordingly, we have some confidence that the 1999 total return will continue the cycle of more fish returning in odd-numbered years. In contrast, Resurrection Bay system runs are unusual in that they typically exhibit a weak odd-year cycle. We have been less successful in correctly predicting the actual size of these runs, although forecasts have usually fallen within the forecast range. For example, in 1997, the last odd-numbered year, 9 of the 11 systems for which a forecast was made had runs within the forecast range. If realized, a natural run of 1.1 million pink salmon would be 50% greater than the median run size of 732 thousand fish for odd-years between 1963 and 1997. The pink salmon escapement goal is 383 thousand

for systems with a forecast; but a combined escapement shortfall of 14 thousand fish is expected. The resulting escapement forecast is 369 thousand pink salmon.

In the Southern District, projected pink salmon harvests are 26.2 thousand fish in Seldovia and 73.6 thousand fish at Humpy Creek. No harvest is expected in Port Graham, which did not achieve its escapement goal in 1997. Supplemental production of pink salmon in the Southern District has contributed from 24% to 90% of the total Lower Cook Inlet commercial harvest in recent years. The Tutka Hatchery released 90 million fry in 1998. Assuming an ocean survival rate of 3.6%, about 3.2 million pink salmon are expected to return to Tutka Bay and Lagoon in 1999 (Tutka Hatchery Annual Management Plan, 1998). Because cost recovery requirements are dependent upon inseason fish prices, the allocation of supplemental production salmon returns between common property and cost recovery fisheries cannot be determined at this time.

In the Outer District, harvests are projected to be 83.8 thousand pink salmon in Windy Bay, 250.6 thousand in Port Dick, and 47.7 thousand for Nuka Island. No harvests are anticipated in Port Chatham or Rocky Bay. In the Eastern District, a harvestable surplus of 16.2 thousand pink salmon is projected for Resurrection Bay. This would be the largest odd-year harvest in the Eastern District since 1985. In the Kamishak Bay District, a harvestable surplus of 175 thousand fish is projected in Bruin Bay, and 53.4 thousand fish in Ursus and Rocky Coves. If realized, this would be the second largest odd-year harvest on record for Bruin Bay.

Edward O. Otis
Lower Cook Inlet Research Biologist
Homer

Wes Bucher
Area Finfish Management Biologist
Homer

Forecast Area: Kodiak
Species: Pink Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (millions)	Forecast Range (millions)
• Natural Production		
Natural Run	9.1	7.4–10.8
Escapement Goal ^a	2.0	2.0
Commercial Common Property Harvest	7.1	5.4–8.8
• Hatchery Production ^b		
Hatchery Run	2.7	1.9–5.8
Brood Stock Needs	0.3	0.3
Commercial Common Property Harvest	2.4	1.6–5.5
• Total Production		
Total Run	11.8	9.3–16.6
Brood Stock and Escapement	2.3	2.3
Commercial Common Property Harvest	9.5	7.0–14.3

^a Midpoint indexed escapement goal.

^b Hatchery forecast was prepared by the Kitoi Bay Hatchery Manager.

Forecast Methods

The forecast for the 1999 natural pink salmon run to the Kodiak management area was calculated based on a Ricker analysis using the most recent 12 odd-years (1971–1997) of escapement data and assuming an additive error. Data for 1993 and 1995, however, were not included due to the anomalously high returns for those years. Past forecasts were calculated from a multiple linear regression model utilizing pre-emergent fry data; however, 1997 was the last year of that data gathering program, necessitating a new forecast method. Prediction intervals were calculated using a bootstrap of the parameter estimates.

The forecast for the 1999 Kitoi Bay Hatchery pink salmon run was developed using survival rates from the 1979–1997 odd numbered brood years. The range estimates were calculated using the average survival rate of the two lowest and two highest odd-year returns.

Forecast Discussion

The 1999 natural run forecast is about 8 million fish less than the most recent odd-year forecast of 16.8 million, and about 2 million fish less than the actual 1997 run of 11.5 million fish. Our confidence in this forecast is poor due to the error realized in the 1997 forecast. Similarly, this is a new model and there are no onsite stream observations, as collected in past years during pre-emergent sampling. Confidence in the hatchery forecast is good due to the condition of the released fry and the favorable environmental conditions.

Returns in 1999 originate from the 1997 brood year escapement of 2.41 million pink salmon. This escapement is above the minimum Kodiak management area escapement goal of 2.0 million but below the recent 5 odd-year average escapement of 5.8 million pink salmon. During the fall, weather conditions in the Kodiak management area were good, with moderate rain causing little flooding of streams. Early spring conditions in 1998 were favorable for outmigration and rearing in the nearshore ocean environment. Ambient air temperatures, as measured in Kodiak, were near average in March and April. Spring plankton production, as noted by the Kitoi Bay Hatchery Manager in Kitoi and Izhut Bays, was better than average at the time of release of hatchery -produced fry and outmigration of wild pink salmon fry. Hatchery release fry were also noted to be in good condition.

If this run is realized it will be slightly less than the recent 10 -year average odd-year run of 9.4 million fish (excluding 1993 and 1995) and considerably smaller than the recent 1993 and 1995 returns.

Nick Sagalkin
Finfish Research Biologist
Kodiak

Andy Hall
Kodiak Regional Aquaculture Assoc.
Kodiak

Forecast Area: Kodiak, Upper Station (Early Run)

Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	145	87–203
Escapement Goal	50	50–75
Harvest Estimate	95	

Forecast Methods

The 1999 Upper Station early run forecast was estimated using simple linear regression models employing recent brood year sibling relationships for each major age class for the years 1981–1995. In constructing and evaluating the regression models, standard regression diagnostic procedures were considered and applied where appropriate (e.g., removal of outliers and transformations). The age-0.3 sibling relationship was not significant ($P > 0.25$); therefore, median return was used as the forecast estimate. Minor age classes (ages -0.1, -0.2, -1.1, -2.1, -0.4, -3.1, -1.4, -3.2, -3.3, and -2.4) were estimated by summing across brood years and taking the median (1981–1991). The variances for the median forecasts were calculated assuming the distribution of the mean. The total run forecast was calculated by summing individual age class estimates along with the estimate for the minor age classes. The variances associated with individual and pooled minor age classes were summed to calculate the forecast range.

Forecast Discussion

The 1999 forecast is approximately 47 thousand greater than 1998 forecast (98 thousand) and about 32 thousand fish greater than the actual 1998 run of 113 thousand fish. While the 1998 run fell within 10% of the forecast, individual age class predictions were fair to poor, therefore our confidence in this forecast is fair. The 1999 run should be composed of approximately 67% 5-year-old fish and 11% 6-year-old fish. If this run is realized it will be greater than the recent 10-year average run of 129 thousand fish.

The projected harvest of 95 thousand fish is based on achievement of the lower bound of the escapement goal range of 50-75 thousand. The dominant age classes in the run should be 1.3 (29%) and 2.2 (38%).

Nick Sagalkin
Finfish Research Biologist
Kodiak

Forecast Area: Kodiak, Upper Station (Late Run)
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	528	233–822
Escapement Goal	150	150–200
Harvest Estimate	378	

Forecast Methods

The 1999 Upper Station late run forecast was estimated using simple linear regression models employing recent brood year sibling relationships and age-specific return on brood year escapement level for the major age classes for the years 1981–1995. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were considered and applied where appropriate (e.g., removal of outliers and transformations). Age 0.3 and 1.2 fish were forecasted from their brood year escapement, while the remaining age classes were forecasted from sibling relationships. Age-1.3 and -2.2 fish were both forecasted from age-1.2 fish. The age-0.3 sibling relationship was not significant ($P>0.25$); therefore, median return was used as the forecast estimate. Minor age classes (ages-0.1, -1.1, -2.1, -3.1, -0.4, -1.4, -3.2, -3.3, and -2.4) were estimated by summing them across brood years and taking the median (1981–1991). The variances for the median forecasts were calculated assuming the distribution of the mean. The total run forecast was calculated by summing individual and aggregate age class estimates. The variances associated with individual and pooled minor age classes were summed to calculate the forecast range.

Forecast Discussion

The 1999 forecast is about 111 thousand fish more than the 1998 forecast (417 thousand) and about 172 thousand fish more than the actual 1998 run of 356 thousand fish. While the 1998 run fell within 15% of the forecast, individual age class predictions were fair to poor, therefore our confidence in this forecast is fair. The 1999 run should be composed of approximately 35% 4-year-old fish and 48% 5-year-old fish. If this run is realized it will be approximately 90% of the recent ten-year average run of 586 thousand fish.

The projected harvest of 378 thousand fish is based on achievement of the lower bound of the escapement goal range of 150-200 thousand. The dominant age classes in the run should be 2.2 (39%) and 0.3 (18%).

Nick Sagalkin
 Finfish Research Biologist
 Kodiak

Forecast Area: Kodiak, Frazer Lake (Dog Salmon)

Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	522	283–761
Escapement Goal	140	140–200
Harvest Estimate	382	

Forecast Methods

The 1999 Frazer Lake (Dog Salmon River) forecast was estimated using simple linear regression models employing recent brood year sibling relationships for the major age classes for the years 1981–1995. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were considered and applied where appropriate (e.g., removal of outliers and transformations). The age-3.2 sibling relationship was not significant ($P > 0.25$); therefore, median return was used as the forecast estimate. Minor age classes (ages -0.2, -0.3, -2.1, -3.1, -1.4, -2.4, and -3.4) were estimated by summing them across brood years and taking the median (1981–1991). The variances for the median forecasts were calculated assuming the distribution of the mean. The total run forecast was calculated by summing individual age class estimates along with the estimate for the minor age class. The variances associated with individual and pooled minor age classes were summed to calculate the forecast range.

Forecast Discussion

The 1999 forecast is about 17 thousand fish less than the 1998 forecast (539 thousand) and about 84 thousand fish less than the actual 1998 run of 606 thousand fish. While the 1998 run fell within 15% of the forecast, individual age class predictions were fair to poor, therefore our confidence in this forecast is fair. In addition, age-2. smolt outmigration estimates from 1994 were the lowest since 1988. The 1999 run should be composed of approximately 58% 5-year-old fish and 30% 6-year-old fish. If this run is realized it will be approximately 67% of the recent 10-year average run of 782 thousand fish.

The projected harvest of 382 thousand fish is based on achievement of the lower bound of the escapement goal range of 140-200 thousand. The dominant age classes in the run should be 2.2 (51%) and 2.3 (28%).

Nick Sagalkin
Finfish Research Biologist
Kodiak

Forecast Area: Kodiak, Ayakulik (Red River)
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	1,382	834–1,929
Escapement Goal	300	200–300
Harvest Estimate	1,082	

Forecast Methods

The 1999 Ayakulik (Red River) forecast was primarily estimated using simple linear regression models utilizing recent brood year sibling relationships for four major age classes for the years 1982 – 1995. Ages -1.2, -1.3, and -2.3 were predicted from ages -1.1, -1.2 and -2.2 siblings, respectively. A sibling regression model was also employed to estimate the age -2.2 component of the run from returns of age -1.2 sockeye salmon. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Prediction estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Other age classes were estimated by summing all minor age class returns by brood year (1982–1994) and calculating the pooled median contribution. The total run forecast was calculated by summing individual and pooled age class estimates. When the median return by age class was used, the variance calculated from the mean distribution was applied to the estimate. The variances associated with individual and pooled age class estimates were summed to calculate the forecast range.

Forecast Discussion

The 1999 forecast is about 672 thousand fish greater than the 1998 forecast of 710 thousand, and about 64 thousand fish less than the actual 1998 run of 1,446 thousand fish. Our confidence in this forecast is fair. The 1999 run should be composed of approximately 75% 5-year-old fish (1994 brood year). The estimated age -1.2 return to Ayakulik in 1998 was stronger than expected suggesting favorable 1994 brood year conditions. If realized, this run will be about 409 thousand fish greater than the recent 10-year average run of 973 thousand fish as well as the third largest run in 20 years (1979–1998). Based on historic run estimates, it is reasonable to assume that the actual run may not exceed the point estimate but rather fall between the lower bound and point estimate.

The projected harvest of 1,082 thousand fish is based on achievement of the upper bound of the escapement goal range of 200-300 thousand. The dominant age classes in the run should be age -1.3 (42%) and -2.2 (32%).

Patricia Nelson
 Finfish Research Biologist
 Kodiak

Forecast Area: Kodiak, Spiridon Lake
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	214	129-300
Escapement Goal		
Harvest Estimate	214	129-300

Forecast Methods

The 1999 Spiridon Lake forecast was based on: 1) 1996–1998 smolt outmigration estimates; 2) 1995–1998 average adult age composition from terminal harvests; and 3) average, low, and high observed smolt-to-adult survival for 1991–1993. Smolt-to-adult survival has averaged 28.5%, ranging from 18.4% to 43.8%, for fry stocking years 1991–1993. A smolt-to-adult survival of 25% (a lower range of 15%, and upper range of 35%) was used for forecasting the 1999 run. Lastly, the 1995–1998 terminal harvest area sockeye catch, on average, was composed of 9.9% 1-ocean fish, 87.4% 2-ocean fish, and 2.5% 3-ocean fish. These proportions were used for forecasting the 1999 run.

Forecast Discussion

A barrier falls prevents escapement into Spiridon Lake; thus, sockeye salmon fry stocking is intended to provide only harvest of returning adults. The forecast for 1999 was predicated upon the marine age-at-return remaining similar to previous years (predominantly 2-ocean). However, Saltery Lake sockeye, which were stocked in 1995, are predominantly 3-ocean (~75%). The 1999 run is predicted to be about 41,000 fish less than forecast for the 1998 run (255,000). The predominant age class is expected to be 1.2 fish. The majority of the run is projected to be the result of late-run Upper Station Lake stock fry releases; returning 5-year-old fish (age 1.3 and 2.2) will be from Saltery Lake stock releases in 1995. The run timing should be similar to the 1998 run, approximately 3 weeks earlier than in 1994 - 1997. The run is expected to begin in late June, early July and end by mid September. The run will be bimodal: Saltery Lake stock returns peaking in mid to late July and late-run Upper Station stock returns peaking early to mid August. The mid-August peak (age 1.2 fish) should be substantially larger than the July peak.

Steve Honnold
Area Development Biologist
Kodiak

Forecast Area: Kodiak, Karluk Lake (Early Run)
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	357	154–560
Escapement Goal	200	150–250
Harvest Estimate	157	

Forecast Methods

The 1999 Karluk River early run forecast was primarily estimated using simple linear regression models using recent brood year sibling relationships for 6 major age classes for 1979–1995. Ages -1.3, -2.2, -3.2, and -3.3 were predicted from ages -1.2, -2.1, -3.1, and -3.2 siblings respectively. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Prediction estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Following non-significant regression results, the median brood year return by age class was used to estimate the age -1.2 and -2.3 components of the run. Other age classes were estimated by summing all minor age class returns by brood year (1982–1991) and calculating the pooled median contribution. The total run forecast was calculated by summing individual and pooled age class estimates. When the median return by age class was used, the variance calculated from the mean distribution was applied to the estimate. The variances associated with individual and pooled age class estimates were summed to calculate the forecast range.

Forecast Discussion

The 1999 forecast is about 51 thousand fish less than the 1998 forecast of 408 thousand, and about 12 thousand fish less than the actual 1998 run of 369 thousand fish. While the 1998 run fell within 10% of the forecast, individual age class predictions were fair to poor, therefore our confidence in this forecast is fair. The 1999 run should be composed of approximately 44% 5-year-old fish and 42% 6-year-old fish. If realized, this run will be less than the recent 10-year average run of 437 thousand fish.

The projected harvest of 157 thousand fish is based on achievement of the midpoint of the escapement goal range of 150-250 thousand. The dominant age classes in the run should be age -2.2 (38%) and -2.3 (29%).

Patricia Nelson
 Finfish Research Biologist
 Kodiak

Forecast Area: Kodiak, Karluk Lake (Late Run)**Species: Sockeye Salmon**

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	1,032	534–1,530
Escapement Goal	400	400–550
Harvest Estimate	632	

Forecast Methods

The 1999 Karluk River late run forecast was primarily estimated using simple linear regression models using recent brood year sibling relationships for 6 major age classes for 1979–1995. Ages-1.3, and -2.3 were predicted from ages-1.2, and -2.2 siblings respectively. Sibling regression models were also employed to estimate the age-2.2 component of the run from returns of age-1.2 sockeye salmon last year. Similarly the age-3.2 component of the run was predicted from last year's returns of age-2.2 sockeye salmon. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Prediction estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Following non-significant regression results, the median brood year return by age class was used to estimate the age-1.2 and -3.3 components of the run. Other age classes were estimated by summing all minor age class returns by brood year (1982–1991) and calculating the pooled median contribution. The total run forecast was calculated by summing individual and pooled age class estimates. When the median return by age class was used, the variance calculated from the mean distribution was applied to the estimate. The variances associated with individual and pooled age class estimates were summed to calculate the forecast range.

Forecast Discussion

The 1999 forecast is about 441 thousand fish greater than the 1998 forecast of 591 thousand, and about 345 thousand fish more than the actual 1998 run of 687 thousand fish. While the 1998 run fell within 10% of the forecast, individual age class predictions were fair to poor, therefore our confidence in this forecast is fair. The 1999 run should be composed of approximately 55% 5-year-old fish and 37% 6-year-old fish. If this run is realized it will be larger than the recent ten-year average run of 911 thousand fish. The Karluk late run has not reached this level since 1992 and has only exceeded this level three times since 1985. Therefore, it is reasonable to assume that the actual run may not exceed the point estimate but rather fall between the lower bound and point estimate.

The projected harvest of 632 thousand fish is based on achievement of the lower bound of the escapement goal range of 400-550 thousand. This run should be primarily age 2.2-fish (53%) followed by age-3.2 (21%) and -2.3 (17%) fish.

Patricia Nelson
Finfish Research Biologist
Kodiak

Forecast Area: Chignik
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
<i>Early Run (Black Lake)</i>		
Total Run	1,049	
Escapement	400	
Commercial Common Property Harvest	649	
<i>Late Run (Chignik Lake)</i>		
Total Run	1,285	
Escapement	250	
Commercial Common Property Harvest	1,035	
<i>Total Chignik Area Run</i>		
Total Run	2,334	1,704–2,964
Escapement	650	
Commercial Common Property Harvest ^a	1,684	

^a Includes portion of harvest by the Southeastern District Mainland and Cape Igvak Fisheries

Forecast Methods

Black Lake and Chignik Lake

The 1999 run forecast for Chignik and Black lakes was based on the combined runs to these lakes using simple linear and polynomial regressions of sibling relationships, analysis of outlier data points, and medians. Predictions for major age classes were based on the values that had negative residuals since brood year 1970, under the assumption that poor returns (1997 and 1998) for sockeye runs are more likely to be followed by poor returns. Age class 1.3 was based on a polynomial relationship with age class 1.2, and age class 2.3 was based on a linear relationship with age class 2.2. Predictions for age classes 1.2 and 2.2 were calculated from the 1997 smolt emigration data, applying mean survival from smolt 1994 and 1995. Minor age classes were estimated from the median of their aggregate contributions from brood years since 1970. Forecast ranges were calculated by combining the variance of individual and aggregate age class estimates.

To allocate the total run to the early or late components, similar analyses were performed separately for each lake and percentages of each lake's contribution to the total run were then calculated.

Forecast Discussion

The 1999 sockeye salmon run to the Chignik lakes is expected to be 2.3 million fish, which is 0.4 million fish more than last year's total run of 1.9 million. The run and catch estimates are lower than the last 20 years' averages of 2.6 and 1.9 million fish, respectively. The two runs are expected to have similar numbers of fish returning, with the Black Lake early run being slightly smaller (45% of total run) than the Chignik Lake late run (55% of total run). The Black Lake run is expected to be 0.3 million sockeye higher than the 1998 run to this lake, and the Chignik Lake run will be similar to

last year. Although these estimates are above last year's run, they are within the range of the last 10 years.

Studies during winter 1996 in the lakes indicate that fry abundance was average. This observation, together with low numbers of smolt trapped in 1996 in the Chignik River, suggests a conservative approach to estimate returns for age classes 1.3 and 2.3. However, some local observers have indicated seeing smolt schooling in readiness to leave Chignik Lake in early spring, before the traps were installed in the river on the first of May, 1996. These observations are partly supported by the 1998 return of ages 1.2 and 2.2 in larger numbers than our smolt estimates can justify. Therefore, age classes 1.3 and 2.3 are based on sibling relationships rather than on smolt counts.

The major age classes comprising the Chignik Lakes runs are 1.3 and 2.3. The sibling 1.2 -1.3 regression explained 89% of the variability, and the estimate for the age class 1.3 in 1999 is 0.8 million for both lakes combined. The regression estimate for age -2.3 explained 65% of the variability and is expected to be 1.0 million. Minor age classes (1.2 and 2.2) are expected to contribute about 0.46 million fish to the total run. 1997 smolt emigration from the Chignik system was excellent and, while the age-1.2 return is not expected to be strong, the prediction for the age -2.2 return in 1999 is above average. Confidence in this forecast is fair.

Alicia Pérez-Fuentetaja
Finfish Research Biologist
Peninsula/Aleutians

Forecast Area: Bristol Bay
Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (millions)	Forecast Range (millions)
• Total Production		
Total Run Estimate	26.2	9.0–43.4
Escapement Goal	11.1	
South Peninsula Quota	1.3	
Commercial Common Property Harvest (Inshore) ^a	13.8	

^a Forecasted sockeye salmon harvests for inshore Bristol Bay fishing districts are as follows: Naknek-Kvichak = 7.4 million; Egegik = 2.5 million; Ugashik = 0.6 million; Nushagak = 3.1 million; and Togiak = 0.2 million.

Forecast Methods

The 1999 Bristol Bay forecast is the sum of individual predictions for nine river systems (Kvichak, Branch, Naknek, Egegik, Ugashik, Wood, Igushik, Nushagak-Mulchatna, and Togiak) and four age classes (age-1.2, -1.3, -2.2, and -2.3 sockeye salmon). In addition to these four major age classes, a prediction was also made for age-0 sockeye salmon returning to Nushagak-Mulchatna River because of their relative importance to that system. Predictions for each age class returning to a river system were calculated by averaging results from simple linear regression models based on the relationship between adult returns and either spawners or siblings. Also, regression models based on the relationship between returns and smolt were examined for Kvichak, Egegik, and Ugashik Rivers. Results from a regression model were excluded from final forecast calculations if the slope of the line was not significantly different from zero ($P < 0.25$). The mean return of an age class to a specific river system was used to predict returns when no model results were used.

We analyzed production data obtained from three time periods: 1) 1956–1977, referred to as Old; 2) 1956–1998, referred to as All; and, 3) 1978–1998, referred to as New. From 1978 through 1995, the number of returning adults produced from each spawner showed a dramatic increase for most river systems in Bristol Bay. Consequently, the New data series was used to predict runs returning in those years. However, in the past two years (1997–1998) we observed a decrease in return-per-spawner ratios. We looked at production relationships from an earlier time period because, if salmon runs in 1997 and 1998 were indications of a long-term production shift, predictive relationships for 1999 might be better represented by the Old data series. Nushagak-Mulchatna predictions were based on data from a shorter time interval, 1980–1998, since these were the only available production data. Predictions of the 1999 total Bristol Bay sockeye salmon run from each of the three time series were: 21 million from Old data; 30 million from All data; and 33 million from New data.

We examined potential forecast performance by hindcasting estimates for the 1994–1998 sockeye salmon runs using the three data time series. We selected the data time series to be used for the 1999 prediction of each river system based on performance and trends of hindcasts. Predictions used for the

1999 forecast were based on Old data (1956-77) for Egegik, Ugashik, and Togiak; All data (1956-98) for Kvichak, Branch, Naknek, and Igushik; and New data (1978–1998) for Wood River.

Mean squared error of the total run forecast was calculated using deviations of actual runs from published run predictions made for 1988 through 1998. Run predictions for 1988 to 1998 were based on similar methods used for the 1999 forecast; while those prior to 1988 were based on other data sets and combinations of models. Mean squared error was used to estimate the forecast range of the total run forecast.

Forecast Discussion

A total of 26.2 million sockeye salmon are expected to return to Bristol Bay in 1999. This prediction is 35% less than the previous 20-year mean (40.4 million; range, 19.6 million to 66.3 million), and 39% less than the previous 10-year mean (43.3 million; range, 19.6 million to 62.7 million). Runs are expected to exceed spawning escapement goals for all systems.

Inshore harvest is expected to be 13.8 million sockeye salmon. A harvest of this size would be 46% less than the previous 20-year mean harvest of 25.4 million (range, 9.9 million to 44.2 million) and 53% less than the previous 10-year mean of 29.1 million (range, 9.9 million to 44.2 million). An additional 1.3 million Bristol Bay sockeye salmon can be harvested during June in the Shumagin Islands and South Unimak fisheries under the current Alaska Board of Fisheries management plan (8.3% of the total projected 15.1 million harvest).

There is great uncertainty in the prediction for the 1999 Bristol Bay sockeye salmon run (80% C.I. is 9.0 million to 43.4 million). We do not know why production for the past two years has been so low and whether this decreased production will persist. We will continue to discuss Bristol Bay salmon production with other scientists and search for new information that might decrease the uncertainty in predictions (e.g. adding environmental factors to predictive models). However, it is unlikely we will be able to do so prior to the 1999 season.

Beverly Cross
Research Project Biologist
Anchorage

Forecast Area: Bristol Bay, Nushagak District

Species: Chinook Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	214	161–267
Inriver Run Escapement Goal ^a	75	
Commercial Common Property Harvest	139	

^a The Nushagak inriver goal is 75.0 thousand chinook salmon, which provides for a biological escapement goal of 65.0 thousand spawners and an additional harvest of 10.0 thousand chinook salmon by upriver subsistence and sport fisheries.

Forecast Methods

The 1999 chinook salmon forecast for Nushagak District is the sum of individual predictions for five age classes (age-1.1, -1.2, -1.3, -1.4, and -1.5). The prediction for each age class was first calculated from a simple linear regression model based on the relationship between sibling returns in succeeding years (e.g., age-1.4 returns for 1999 based on age-1.3 returns in 1998). Regression models were based on natural logarithm-transformed data. Predictions from regression models were only used if the slope of the line was significantly different from zero ($p < 0.25$). If this criteria was not met, the mean return of an age class was used to predict 1999 returns.

Regression models were used to predict age-1.3, -1.4, and -1.5 returns. Mean returns were used to predict age-1.1 and -1.2 returns. The mean squared error mean squared error of the total run forecast was calculated from deviations of actual runs from hindcasts for 1984 to 1998. Hindcasts were based on the same methods used for the 1999 forecast. The mean squared error was then used to estimate the forecast range.

Forecast Discussion

The age composition of the 1999 forecasted run is 0.4% (0.8 thousand) age 1.1, 12.4% (26.6 thousand) age 1.2, 23.9% (51.2 thousand) age 1.3, 60.4% (129.5 thousand) age 1.4, and 2.9% (6.3 thousand) age 1.5. The 1999 forecasted run of 214 thousand chinook salmon is 14% more than the previous 20-year mean run of 188 thousand, and 36% greater than the most recent 10-year mean run of 158 thousand. The projected harvest of 139 thousand chinook salmon is 53% more than the previous 20-year mean harvest of 91 thousand and 74% greater than the most recent 10-year mean harvest of 72 thousand

Beverly Cross
Research Project Biologist
Anchorage

Forecast Area: Alaska Peninsula, Bear Lake (Late Run)

Species: Sockeye Salmon

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	472	379-566
Escapement Goal	100	80-115
Commercial Common Property Harvest	372	

Forecast Methods

The 1999 forecast for Bear Lake late run was based on simple linear regressions of sibling relationships, analysis of outlier data points, and medians. For sibling relationships, predictions were based on the values that had negative residuals, under the assumption that poor returns for sockeye runs are more likely to be followed by poor returns. The age -2.2 return was estimated from sibling age-2.1 using the years that had negative residuals during the last 14 years. The same approach was used for age class 2.3 estimated from age -2.2. The sibling relationship between age classes 1.2 and 1.3 was not significant ($P > 0.25$), and did not improve using negative residuals, therefore, the median since brood year 1980 was used. The minor age class estimates have been based on the median from the last 15 brood years. The forecast ranges were calculated using combined variances from each individual age class estimate.

Forecast Discussion

The 1999 sockeye salmon late run to Bear Lake is forecast to be 472 thousand fish, which is 100 thousand fish more than in 1997 and a similar number of fish as in 1998. The forecast for 1999 is comparable to the last two years' runs, since it is based on a conservative analysis of the data. Because the 1999 run will be mostly composed of ages -2.2 and -2.3, which had high regression coefficients and low error terms, the confidence on this estimate is fair.

The projected harvest of 372 thousand fish is based on achievement of near the middle of the escapement goal range of 80-115 thousand. Contribution of age class 2.2 (285 thousand sockeye) to the run is expected to be twice the contribution of age class 2.3 (130 thousand sockeye).

Alicia Pérez-Fuentetaja
Finfish Research Biologist
Peninsula/Aleutians

Forecast Area: Alaska Peninsula, Nelson River**Species: Sockeye**

Preliminary Forecast of 1999 Run	Forecast Estimate (thousands)	Forecast Range (thousands)
• Total Production		
Total Run Estimate	540	393–687
Escapement Goal	150	100–150
Commercial Common Property Harvest	390	

Forecast Methods

The 1999 forecast for Nelson River was based on significant ($P < 0.25$) simple linear regressions of sibling relationships, analysis of outlier data points, and medians. Linear regressions of sibling relationships were used to estimate age classes 1.3 and 2.3 from age classes 1.2 and 2.2, respectively. Age class 2.2 was estimated from age-2.1 using the years that had negative residuals since 1982, under the assumption that, for age class 2.2, 1999 will follow the same trend as 1997–1998 (which had negative residuals). Prediction of age-1.2 was estimated from the median annual contribution since brood year 1980. Likewise, the minor age classes were estimated from the median of their aggregate contributions since brood year 1980. The forecast ranges were calculated using combined variances from each individual and aggregate age-class estimate.

Forecast Discussion

The 1999 sockeye salmon run to Nelson River is expected to be 540 thousand fish, larger than the actual 1998 run of 321 thousand fish. The run will be mostly composed of ages 2.2 and 2.3, however, the sibling relationship for age class 2.3 had high variability. Age class 2.2 had a much better prediction estimate and it is expected to be strong next year. Contribution of age class 2.2 (322 thousand sockeye) to the run is expected to be 4 times higher than the contribution of age class 2.3 (75 thousand sockeye). Age class 1.3 is expected to be similar to age class 2.3 with a run of about 82 thousand fish.

The projected harvest of 390 thousand fish is based on achievement of the upper end of the escapement goal range of 100-150 thousand fish. Parallel analyses of the data using polynomial regression yielded a more conservative estimate of 430 thousand (397 thousand – 463 thousand) for the total run. Because of the high variability associated to some of the major age-class calculations, confidence in this forecast is moderate, and the run is expected to be between the lower prediction limit (393 thousand) and the mean (540 thousand).

Alicia Pérez-Fuentetaja
Finfish Research Biologist
Penninsula/Aleutians

Forecast Area: Arctic-Yukon-Kuskokwim

Commercial Harvest Outlook for the Arctic-Yukon-Kuskokwim Region in 1999

The Alaska Department of Fish and Game does not produce formal run forecasts for any salmon runs in the Arctic-Yukon-Kuskokwim (AYK) Region. Salmon run outlooks in the AYK Region are qualitative in nature due to the lack of adequate information with which to develop more rigorous forecasts. Consequently, the commercial harvest outlooks for the AYK region are qualitative and typically based upon available parent year spawning escapement indicators, age composition information, and the likely level of commercial harvest that can be expected to be available from such indicators, given the fishery management plans in place. However, in some cases, the commercial harvest outlook has simply been the range of historical harvest levels. While the commercial harvest outlooks provide for a general level of expectation, the fisheries are managed based upon inseason assessments of the actual runs.

In the AYK region, as in some other areas of the state, salmon production has decreased notably for many stocks. Causes for the loss of productivity will be the focal point of discussions of fisheries scientists over the winter, but to date it is unknown whether the decline in productivity can be expected to continue or not. The commercial harvest outlooks for 1999 try to qualitatively take recent decreased abundance trends into account. Additionally, declining salmon markets, particularly for chum salmon flesh since 1994 and salmon roe in 1997, have had a major impact on the commercial fisheries in the AYK Region. A continuation of these market trends in 1999 could further reduce harvests in some areas, or lower exvessel value. In most cases, market conditions have not been accounted for in the harvest outlooks.

For 1999, the commercial harvest outlook by management area in the AYK Region consists of 26 to 73 thousand chinook, 110 to 200 thousand sockeye, 155 to 610 thousand coho, 1 to 2 thousand pink, and 250 to 590 thousand chum salmon for the Kuskokwim Area (Kuskokwim Bay and Kuskokwim River combined); 25 to 75 thousand chinook, 0 to 100 thousand coho, 25 to 300 thousand summer chum, and 0 to 300 thousand fall chum salmon for the Yukon River; 6 to 8 thousand chinook, 50 to 70 thousand coho, and 20 to 40 thousand chum salmon for Norton Sound; and 150 to 250 thousand chum salmon for Kotzebue Sound.

Commercial salmon harvest outlook for the AYK Region, 1999, in thousands of fish.

Management Area	SPECIES					
	Chinook	Sockeye	Coho	Pink	Chum	Fall Chum
Kuskokwim	26-73	110-200	155-610	1-2	250-590	
Yukon	25-75		0-100		25-300	0-300
Norton Sound	6-8		50-70		20-40	
Kotzebue Sound					150-250	

South Peninsula June Fishery Chum Salmon Guideline Harvest Level

Background

In 1998, the Alaska Board of Fisheries replaced the chum salmon cap in the South Peninsula June fishery, with a “floating” guideline harvest range. This range of chum harvest is now determined annually by two factors: a forecast of an index of summer chum salmon harvest in western Alaska, and a check to see if the department has any “management concerns” for summer chum salmon in this area. The level of the forecast index in relation to the 33rd and 66th percentiles of the historic series determines the range. For a forecast less than the 33rd percentile, the range covers 350,000 to 450,000 chum salmon. Between the 33rd and the 66th percentile, the range covers 450,000 to 550,000 chum salmon. Above the 66th percentile, the range covers 550,000 to 650,000 chum salmon. If the department identifies a “management concern” for summer chum salmon within the Arctic -Yukon-Kuskokwim Region, the department must manage the June fishery for the low end of the guideline harvest range (e.g., 350,000 to 400,000 for the first range). A “management concern” means a chronic inability to meet escapement objectives, despite the use of specific management measures. The term “chronic” refers to the continuing or anticipated inability to meet escapement objectives over a four - year period, which is generally equivalent to a life cycle or generation of chum salmon.

The 1999 June Fishery Guideline Harvest Level

The 1999 forecast for the catch index is 1.05 million summer chum salmon. This catch, if realized, will be in the bottom third of the index series, and therefore restricts the guideline harvest level to 350,000 to 450,000 chum salmon. Because the department has identified conservation concerns for summer chum salmon in seven systems in the A -Y-K area (six in Norton Sound, and one on the Yukon River), this further restricts the guideline harvest level to 350,000 to 400,000 chum salmon in the June fishery.

Forecast Methods

The catch index is made up of commercial and subsistence catches of summer chum salmon in the Yukon River, (including the subsistence harvest, Yukon area personal use summer chum salmon, and Yukon area test fish given away for subsistence purposes, and excluding sport-caught chum salmon) and commercial chum harvests in the Kuskokwim area, in Norton Sound, and in the Kotzebue area. To produce the forecast for next year’s value of this series, I generated a statistical regression relationship that predicts this index series by its value from the previous year. The resulting forecast equation is given by

$$\text{forecast} = 744 \text{ thousand} + (0.537) \text{ last year's catch}.$$

To understand the mechanics of the forecast, it helps to notice that because the mean of both the independent and dependent variables are nearly the same, the above equation can be approximately written as a weighted average of the long-term average and the previous year’s value of the index. In other words,

$$\text{forecast} \approx (1 - \text{regression coefficient}) \text{ long-term average} + (\text{regression coefficient}) \text{ last year's catch}.$$

The weights are approximately given by the regression coefficient, 0.537, and one minus the regression coefficient. The series began in 1970, and the long-term average is near 1.6 million.

Forecast Discussion

The regression relationship that underlies the forecast is weak. Since the 1998 forecast, I have looked into incorporating oceanographic information; I have not found any oceanographic time series that adequately summarize environmental effects on western Alaskan salmon. As poor as the regression relationship is, it remains the best objective forecasting tool I could find. The current method provides a stable forecast that will not fluctuate wildly from year to year, and unfortunately, it will always miss sudden drops or increases in production. Except when the previous year's catch is very high or very low, this method will lead to the middle guideline harvest level (450,000 to 550,000).

To the extent this forecasting tool works, it is based only on the general tendency of catch to remain near the same level from one year to the next. In 1997 and 1998 catches were quite small. The low catch in 1998 caused the forecast to be pulled far away from the long-term average, and brought the forecast below the 33rd percentile of the historic values in the index series.

Hal Geiger
Principal Salmon Biometrician
Juneau

Forecast Errors**Species: Pink and Sockeye Salmon****An exploration of forecast errors in selected major runs of Alaska pink and sockeye salmon**

Looking for obvious patterns, we have graphed forecast errors together with estimated run size, for four major pink and four major sockeye salmon producing systems in Alaska (Forecast Error Figures 1-7). Our hypothesis is that forecast errors reflect environmental or ocean-climate processes in addition to such things as changes in forecasting methods and hatchery enhancement. Even though large-scale hatchery contributions may mask structural changes in recruitment patterns, for pink and sockeye salmon these effects are largely restricted to Prince William Sound.

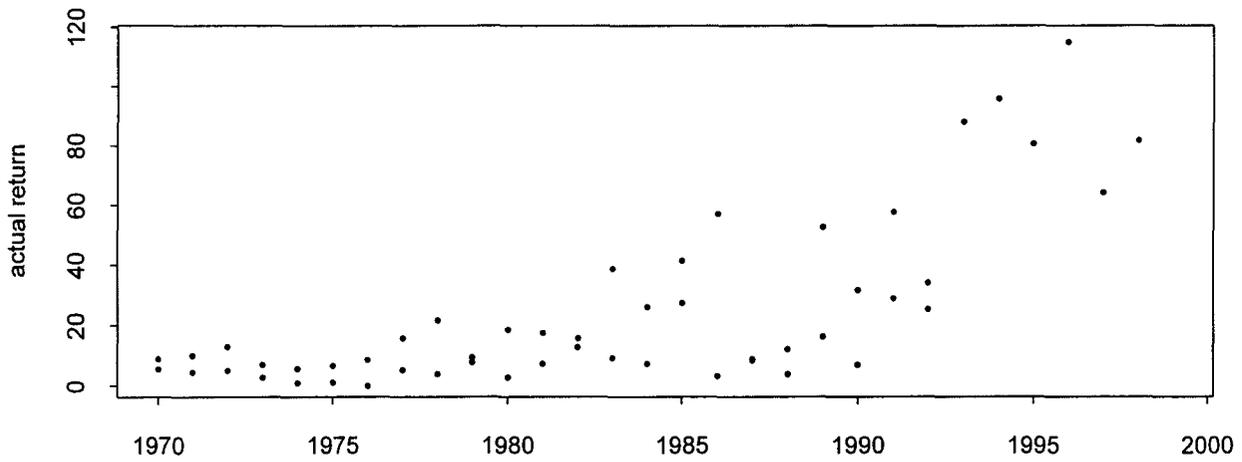
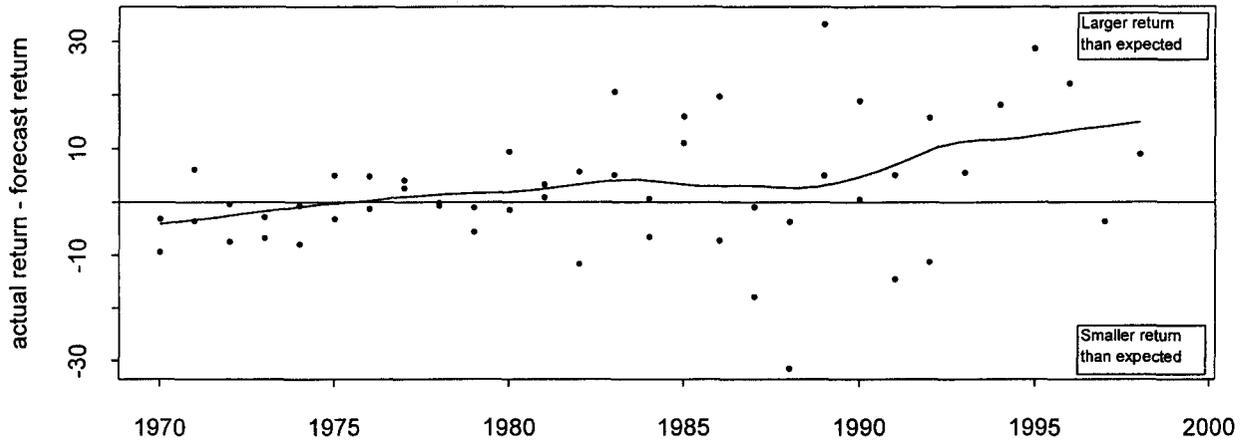
In Bristol Bay, sockeye salmon run sizes were consistently under-estimated from the middle 1970s to late 1980s. Upper Cook Inlet also experienced stronger sockeye returns than expected over a similar period. Forecast methods for Bristol Bay were changed in 1991, when an adjustment for a consistent under-forecast bias was added. Sockeye salmon in Bristol Bay and Upper Cook Inlet share a nearly linear trend from under- to over-forecasting during about 1990 to the present, however. Chignik sockeye forecasts share this increasing trend toward over-forecasting, but do so over a longer period. On the other hand, with the exception of 1998, Copper River shows an opposite trend. Copper River returns have increased steadily since the middle 1980s and forecasts have not kept up.

Statewide, pink salmon runs increased after the middle 1970s. Forecast errors started to increase in the mid-1980s. Increased variability in forecast, beginning in the early 1980s may have been exacerbated by the introduction of microcomputers into fisheries management. These microcomputers may have encouraged the use of over-parameterized forecast models. Under-forecasts in pink salmon production was especially pronounced in Prince William Sound after 1985, coinciding with a period of increasing hatchery production.

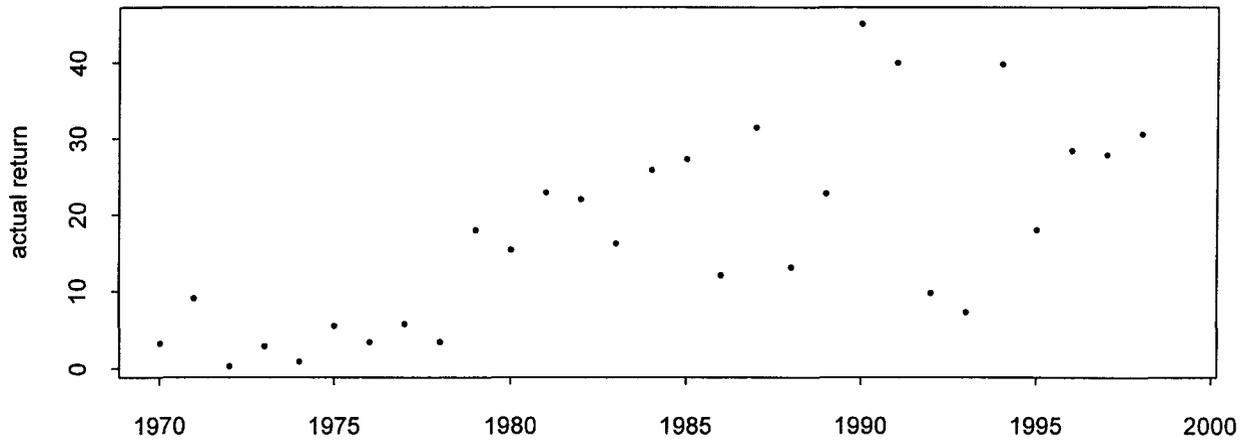
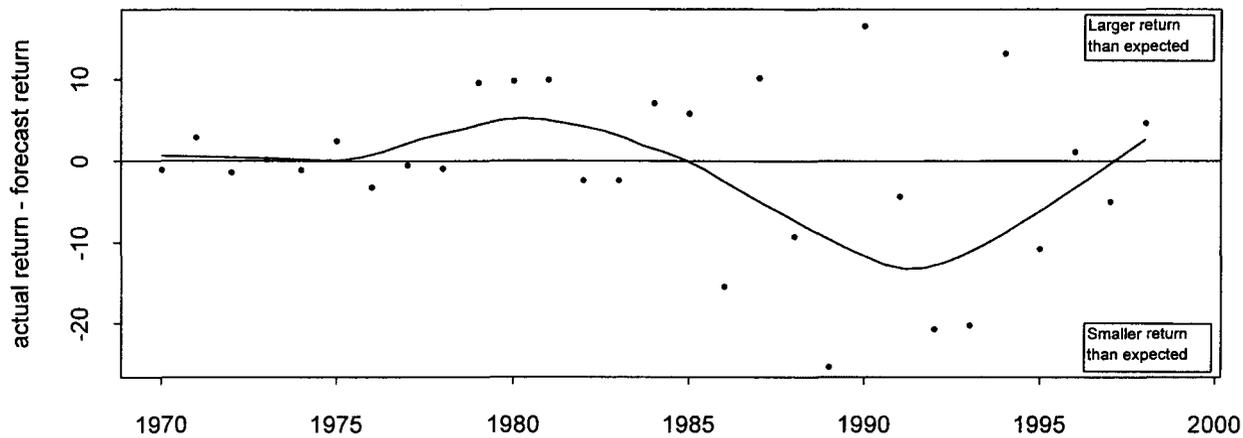
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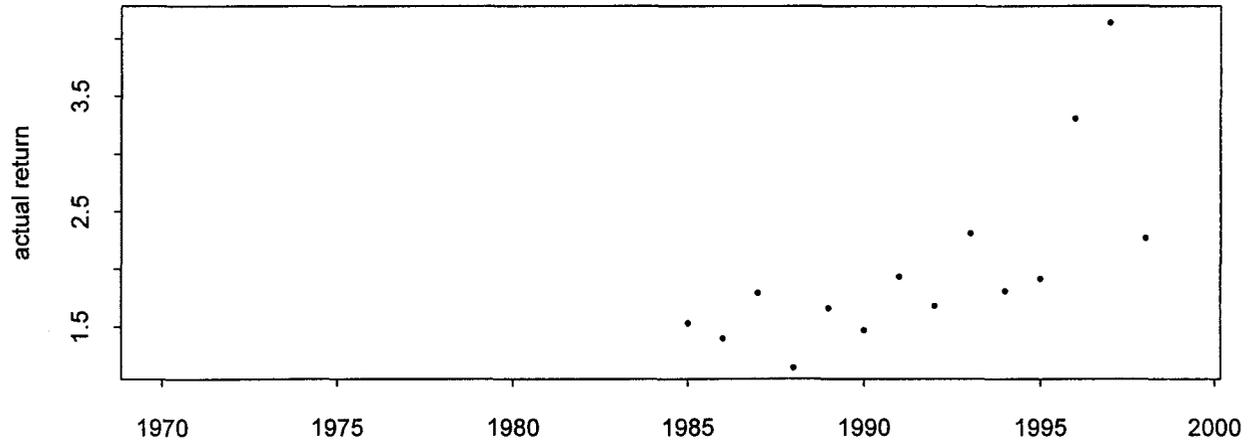
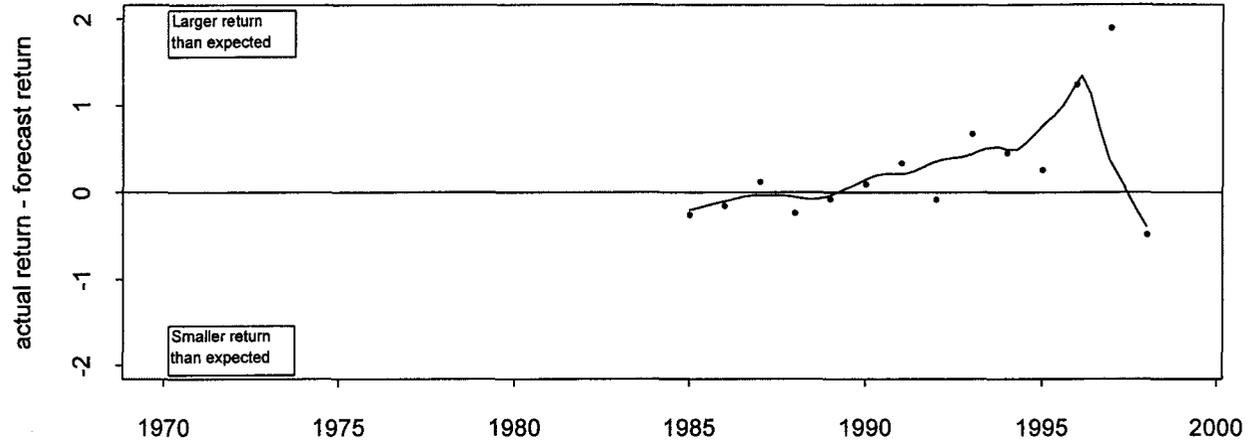
Pink Salmon Forecast Error - Southeast



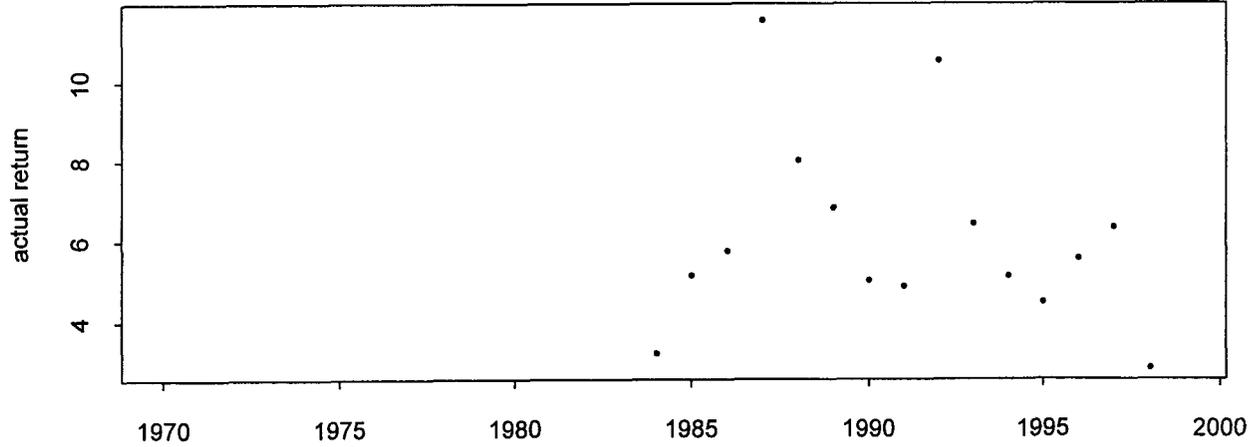
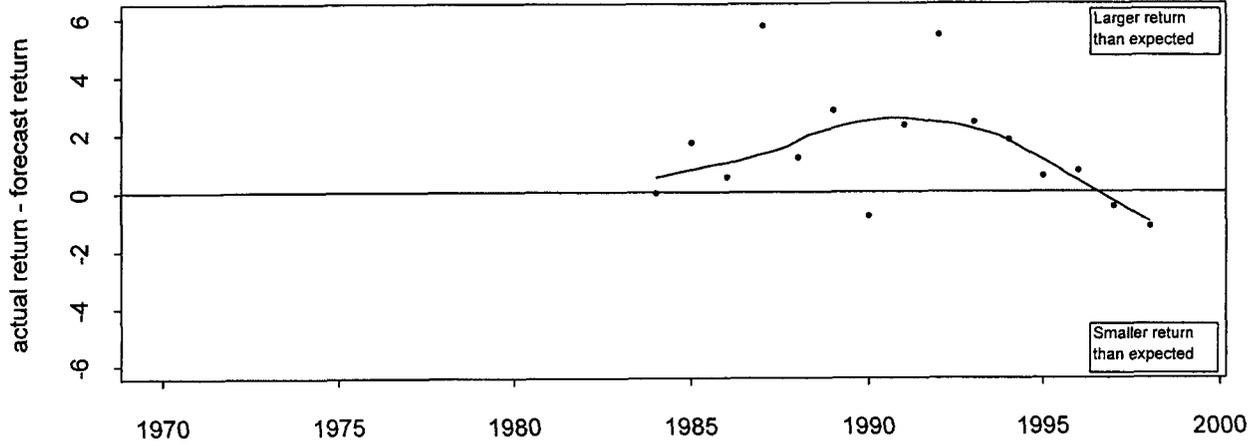
Pink Salmon Forecast Error - Prince William Sound



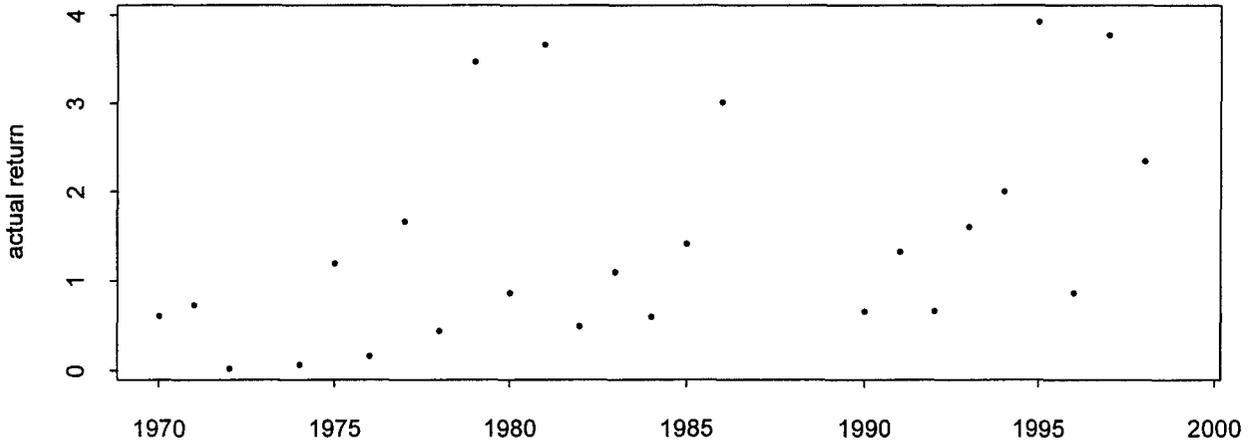
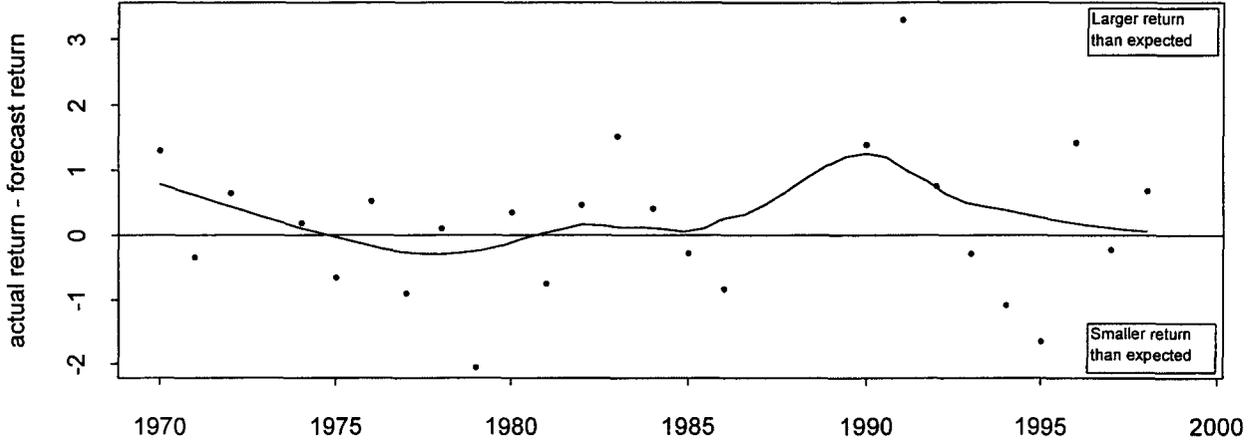
Sockeye Salmon Forecast Error - Copper River



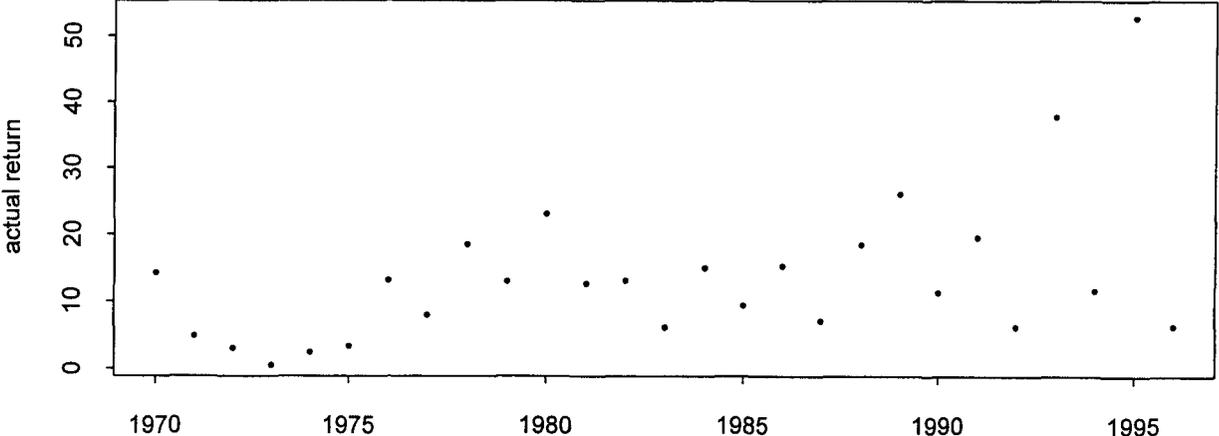
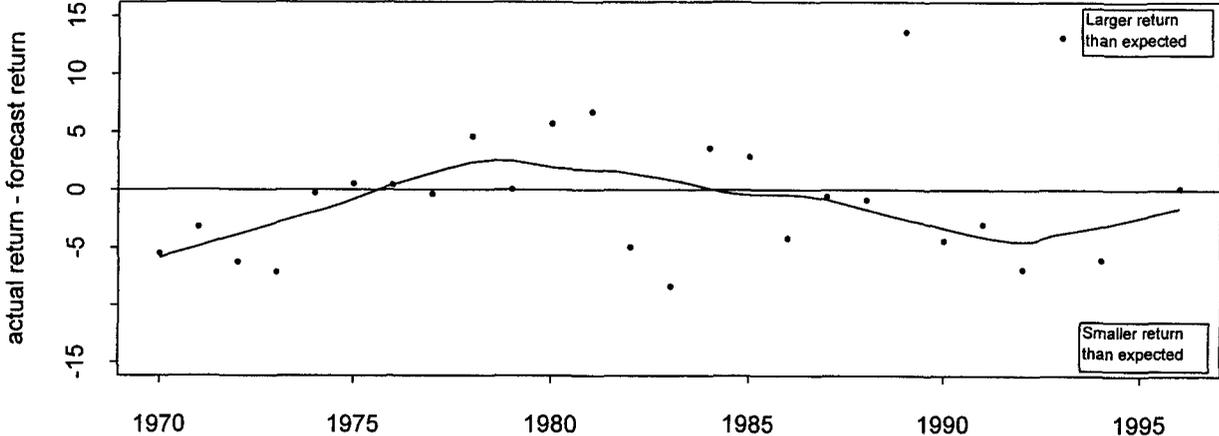
Sockeye Salmon Forecast Error - Upper Cook Inlet



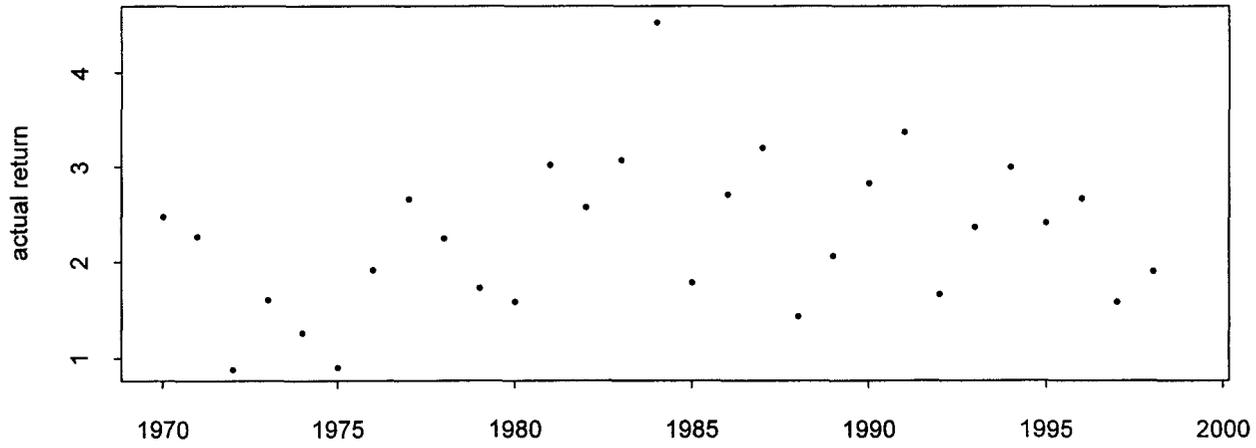
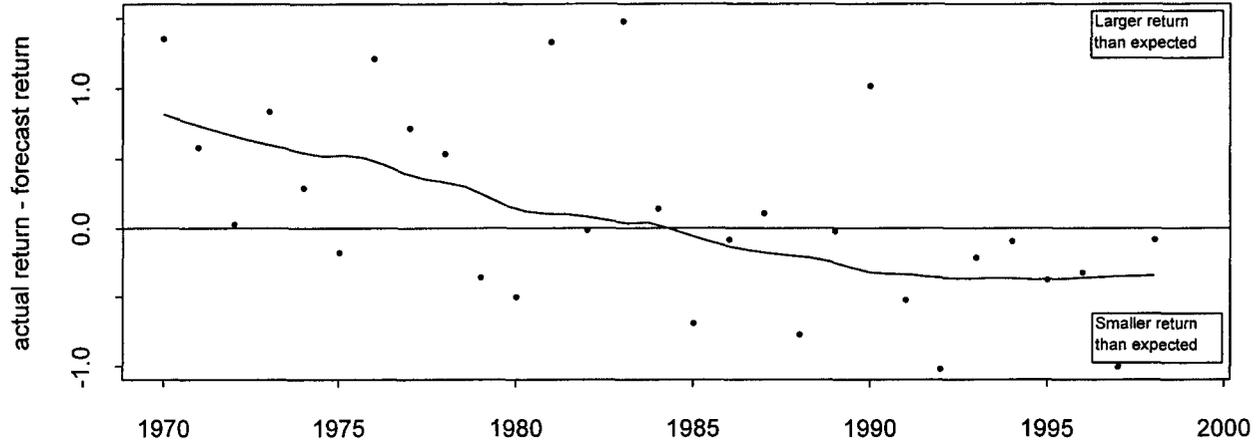
Pink Salmon Forecast Error - Lower Cook Inlet



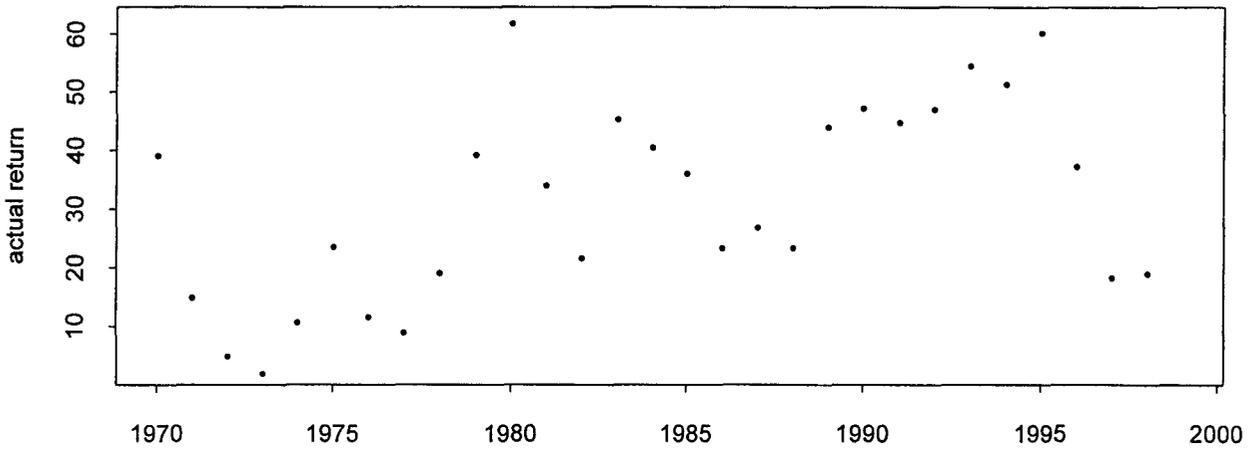
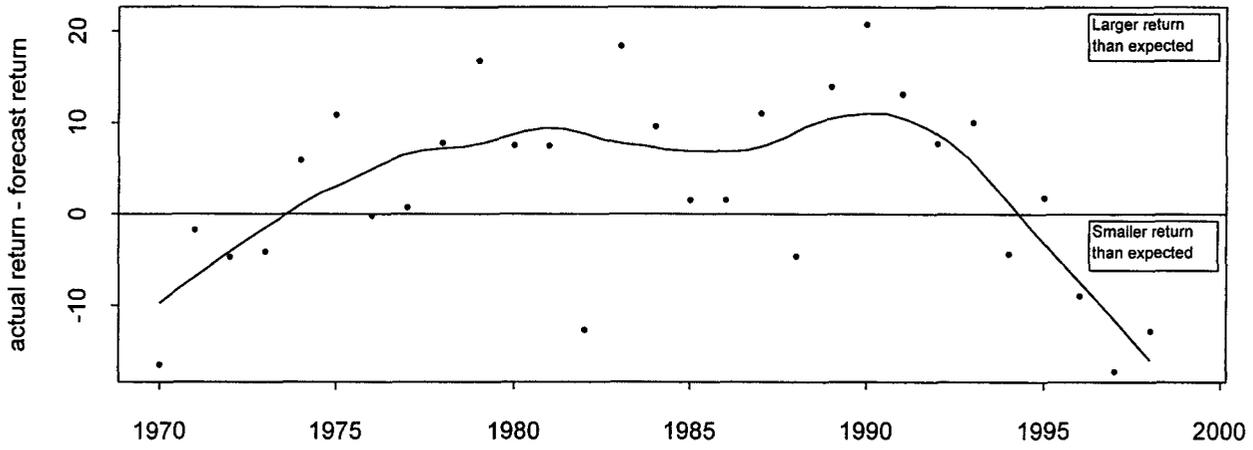
Pink Salmon Forecast Error - Kodiak



Sockeye Salmon Forecast Error - Chignik



Sockeye Salmon Forecast Error - Bristol Bay



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