

REGIONAL INFORMATION REPORT NO. 5J91-01



Preliminary Forecasts and Projections For 1991 Alaska Salmon Fisheries And Summary of the 1990 Season

Edited by:

Harold Geiger

and

Herman Savikko

February 1991

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PRELIMINARY FORECASTS AND PROJECTIONS FOR 1991 ALASKA
SALMON FISHERIES AND SUMMARY OF THE 1990 SEASON

Edited by

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and

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Regional Information Report No. 5J91-01
Alaska Department of Fish and Game
Division of Commercial Fisheries
Juneau, Alaska

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Errata

Preliminary Forecasts and Projections for 1991 Alaska Salmon Fisheries and Summary of the 1990 Season

Please note that Table 3 on page 23 of "Preliminary Forecasts and Projections for the 1991 Alaska Salmon Fisheries and Summary of the 1990 Season" the salmon totals by species for the Central Region are in error, thus making the total Alaska salmon harvests by species for 1990 also incorrect in that table. Due to errors in the spreadsheet formulas, the Southeast Alaska salmon harvests have inadvertently been added to the Central Region salmon harvests.

The correct figures for the Central Region salmon harvests are displayed in Table 5, page 25, of this document.

Additionally, after this report was published this office received updated figures for Statewide harvests. These latest totals (IN THOUSANDS) are as follows:

<u>CHINOOK</u>	<u>SOCKEYE</u>	<u>COHO</u>	<u>PINK</u>	<u>CHUM</u>	<u>TOTAL</u>
670	52,385	5,454	88,187	8,124	154,819

The Division of Commercial Fisheries hopes that this reporting error causes little confusion or concern.

Herman Savikko
Fishery Biologist/Information Officer
Alaska Department of Fish and Game
March 1991

SALMON FORECAST

EDITORS

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This report is based on information contributed by Division of Commercial Fisheries biologists located in field offices throughout the state. Area biologists, not individually identified, supplied reviews of the 1990 fishing season. Individual credit for forecast material is contained in the area forecast discussions in the Appendix.

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ABSTRACT

The 1990 Alaska salmon season resulted in the near record-breaking harvest of 153 million salmon. This was well above the preliminary harvest projection of 108.2 that was released in February of 1990. Bristol Bay sockeye salmon and Prince William Sound and Southeast pink salmon produced above average harvests, far above preseason projections. Other fisheries performed poorly. These included the Arctic-Yukon-Kuskokwim chum fisheries, and the Lower Cook Inlet, Kodiak, and Alaska Peninsula area pink salmon fisheries. The 1991 season outlook is for an extremely large, record-breaking catch. The preseason projection is for 164.3 million salmon, which includes 37.7 million sockeye salmon and 110.8 million pink salmon. After reviewing recent forecast errors we wish to caution readers that as pink salmon runs have increased, our ability to forecast pink salmon harvests has deteriorated. Although the potential exists for record pink salmon harvest in Southeast Alaska, Prince William Sound, and Kodiak, we are uncertain as to what the actual runs will produce.

KEY WORDS: Salmon, *Oncorhynchus sp.*, salmon run forecast, salmon harvest projection

OVERVIEW

The 1980s was a period of expansion for most Alaskan salmon stocks. The runs increased because of improved management, favorable environmental conditions, and reduced high-seas interceptions. In addition to improved wild runs, Prince William Sound and other areas experienced expanded hatchery production of salmon. During this period, fluctuations in run sizes became much larger, especially for pink salmon. As the runs have increased, our ability to forecast has considerably deteriorated. In 1991 we are projecting a large, record-breaking harvest of 164.3 million salmon. The current record salmon harvest to date occurred in 1989 at 153.7 million salmon. Had it not been for the Prince William Sound oil spill, the 1989 harvest would likely have been near our 1991 projection. The main feature of this 1991 projection is an expected pink salmon harvest of 111 million fish. If realized, this will be a new pink salmon harvest record.

While the best possible information and analyses have gone into the 1991 projections, we have little confidence in our outlook. Some of our evidence suggests the potential for a pink salmon run in 1991 even larger than what we are projecting. Large hatchery releases in Prince William Sound and favorable escapements and environmental conditions in the Kodiak area and in Southeast Alaska point to an exceptionally large return of pink salmon in these areas. On the other hand, an analysis of trends in catch and in our recent large errors in projecting pink salmon catches suggest that our 1991 projection is considerably too high. In the end we have only considered what we can observe about the salmon. Mostly we have observed a few aspects of the freshwater phase of their life; the fate of the salmon fry that left the streams in 1990 will be determined by unobserved conditions they encounter during their ocean migration.

For 1991 we have attempted to reconcile conflicting information on the major pink salmon runs. A detailed discussion of the salmon forecast for the total run of pink salmon in Southeast Alaska is provided in the appendix. The total run is forecast to be near 98.1 million. The Southern Southeast run is forecasted to be in the range of 15.5 to 84.9 million and the Northern Southeast run is forecasted to be in the range of 4.9 to 22.6 million pink salmon. This analysis leads us to a harvest of 67.3 million pink salmon in Southeast Alaska. However, an analysis of trends in catch and forecast errors leads to a more moderate catch projection of 28 million salmon, with the catch falling in the range of 16 to 50 million pink salmon. Considering both of these conflicting indicators, we set the Southeast pink salmon catch projection at a weighted average of 45 million fish.

The pink salmon runs for the Kodiak area and the Prince William Sound area are similarly forecasted to be extremely large. Again, we have low confidence in these catch projections. The forecast of the Kodiak pink salmon run is for 22.8 million and a forecast range from 19.28 to 27.18 million salmon. This leads to a harvest forecast of 20.53 million. An analysis of catch trends and forecast errors leads to a considerably smaller harvest projection. For this reason the Kodiak harvest projection for pink salmon was chosen to be 17 million, based on the lower end of the forecast range, as explained in the appendix.

For 1991 we have changed our forecasting methods for Bristol Bay sockeye salmon, and we will continue to work with new forecasting techniques in the coming years. The methods we used this year produced a larger forecast than methods we have used in the recent past; the recent forecasts have tended to be below the actual Bristol Bay sockeye runs. We believe the new methods will be more accurate and precise, but we caution readers that the new Bristol Bay forecast is less likely to be low.

Alaska's 1990 commercial salmon season is reviewed in this report, but final catch figures were not available at this writing. Early release of the forecast is needed to provide preliminary information to the Board of Fisheries, the fishing industry, and the public well before the next season begins.

Forecasts of runs (harvest + escapements) for major salmon fisheries and projections of the statewide commercial salmon harvest have been published yearly by the Alaska Department of Fish and Game since 1969 (Noerenberg and Seible 1969; Seible 1970-1973; Seible and Meacham 1975; Waltmeyer and Lindstrom 1976; Carson and Frohne 1977; ADF&G 1978-1984; Eggers 1985, 1986; Eggers and Dean 1987, 1988; Geiger and Savikko, 1989, 1990). In 1990 the Alaska Department of Fish and Game released formal herring forecasts for the first time. Forecasts for other fisheries, such as the shellfish fisheries, will be forthcoming as reliable methods are developed for these species.

The major fishing areas within the Southeast, Central, and Western Alaska statistical regions are shown in Figure 1. These regions and areas are used in the Department's statistical leaflet series and prior statistical reports. Also shown are the four fisheries regions (Southeast, Central, Arctic-Yukon-Kuskokwim and Westward) that comprise our current administrative boundaries.

Ages and brood years for 1991 salmon runs by species are as follows:

Species	<u>Age of Returning Salmon in Years</u>				
	2	3	4	5	6
Pink	1989				
Chum		1988	1987	1986	
Coho		1988	1987		
Sockeye			1987	1986	1985
Chinook			1987	1986	1985

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>

DEFINITION OF TERMS

Commercial Harvest:	Those fish harvested in fisheries other than sport, subsistence, and personal use fisheries, and intended to be sold. This category includes fish caught by the commercial fleet in the common property fishery and fish harvested by hatchery operators for cost recovery.
Common Property Harvest:	All fish harvested in the waters of Alaska by commercial (except cost recovery harvests), sport, subsistence, and personal use fisheries.
Cost Recovery Harvest:	Fish harvested by hatchery operators to fund the operation of the hatchery and distinct from common property fisheries.
Escapement, spawning population or brood stock:	The portion of a salmon run which is not harvested and survives to reach the spawning grounds or hatchery.
Harvest projections or harvest outlooks:	Harvest outlooks are generated for all areas of the state. These are the expected harvests, based on the formal run forecasts, historical average catches, and other relevant information. They are sometimes subjectively adjusted based on recent trends and local knowledge of the fisheries situation.
Run Forecast:	Forecasts of the run (harvests + escapement) are estimates of the fish returning in a given year based on information such as parent-year escapements, subsequent fry abundance, spring sea water temperatures, and escapement requirements. In general the run forecasts are thought to be more reliable than harvest outlooks, but they are provided only for selected areas.
Salmon Run:	The total number of salmon returning in a given year from ocean rearing areas to coastal waters.

OUTLOOK FOR THE 1991 ALASKA COMMERCIAL SALMON HARVESTS

The Alaska Department of Fish and Game does not produce formal forecasts for all salmon runs in the state, although local managers do prepare harvest outlooks or harvest projections for all areas. The harvest projections are usually based on formal forecasts, when available. In other cases historical catches and local knowledge of recent events are used to develop the harvest outlooks. These projections for the 1991 Alaska commercial salmon harvest have been organized by species, statistical region, management region, and in some cases by finer divisions. The projections are presented in Tables 1 and 2. The harvest outlooks for A-Y-K Region are developed as ranges (Appendix B.1.).

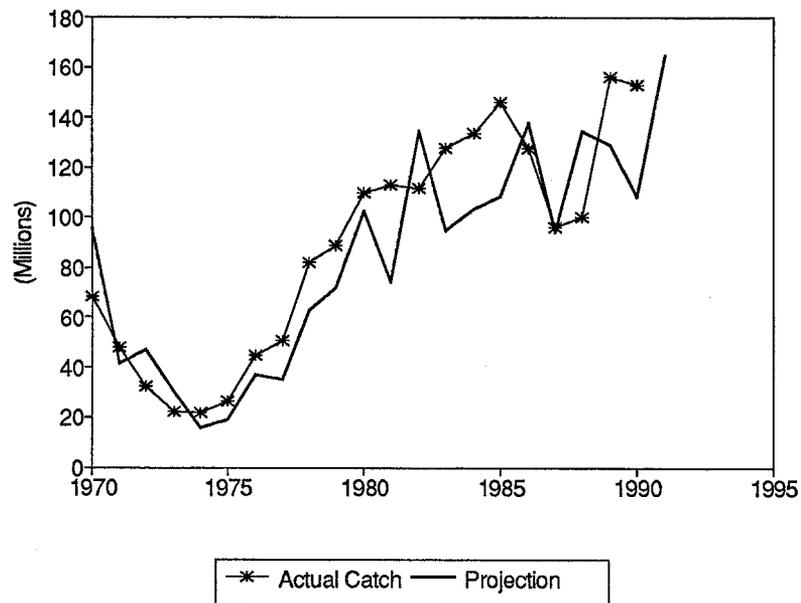


Figure 2. Catch projections and actual catches for all species of Pacific salmon in Alaska, 1970–1990. The 1991 catch projection is 164.3 million salmon.

The 1991 total statewide commercial harvest projection for Alaska is for 164.3 million salmon: 672 thousand chinook salmon, 37.7 million sockeye salmon, 4.89 million coho salmon, 110.8 million pink salmon, and 10.2 million chum salmon. The 1991 statewide projections can be seen in the context of recent (1970–1990) projections and actual catches in Figures 2–7.

Species Outlook

Chinook Salmon

Chinook salmon harvests have been relatively stable since the late 1980s, and the projections have been relatively accurate. In 1991 the projection is for 672 thousand fish. At the time of this writing the Pacific Salmon Commission had not yet set the additional hatchery catch (add-on) and catch ceiling for Southeast Alaska as established under the U.S.-Canada Treaty. This ceiling could modify the current catch projection.

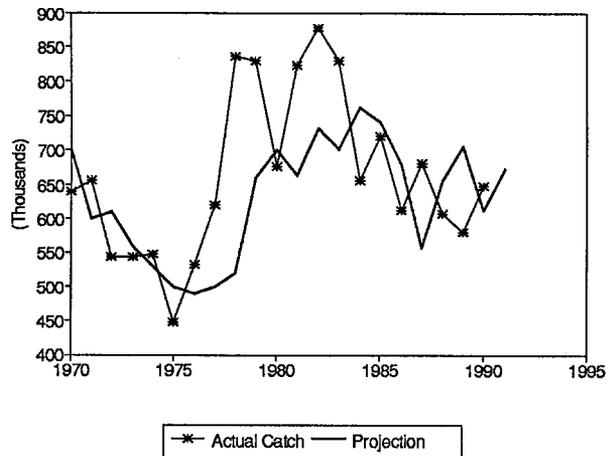


Figure 3. Catch projections and actual catches for chinook salmon in Alaska, 1970–1990. The 1991 catch projection is 672 thousand fish.

Sockeye Salmon

The sockeye salmon catch is expected to be near 37.7 million fish in 1991. This projection is near the level of catch experienced during the mid-1980s but below the high catches of the last two years. An expected drop in production from recent averages in Bristol Bay had a large effect on the projection.

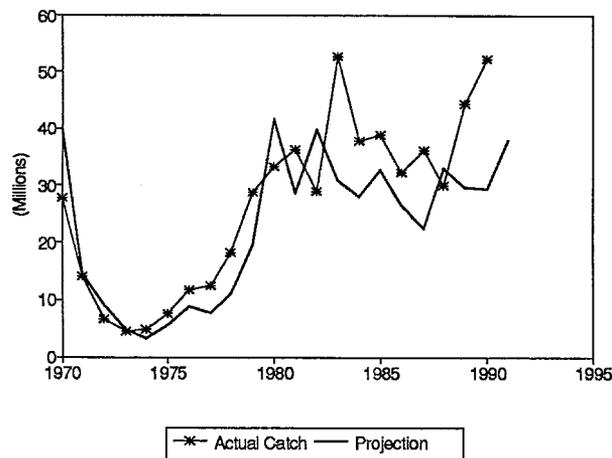


Figure 4. Catch projections and actual catches for sockeye salmon in Alaska, 1970–1990. The 1991 catch projection is 37.7 million fish.

Coho Salmon

Coho salmon harvests in the state have increased greatly since the mid-1970s. In 1975 the statewide harvest was slightly over 1 million; since 1980, harvests have been between 3.1 and 6.2 million fish. The 1991 projection is for a harvest of 4.89 million fish.

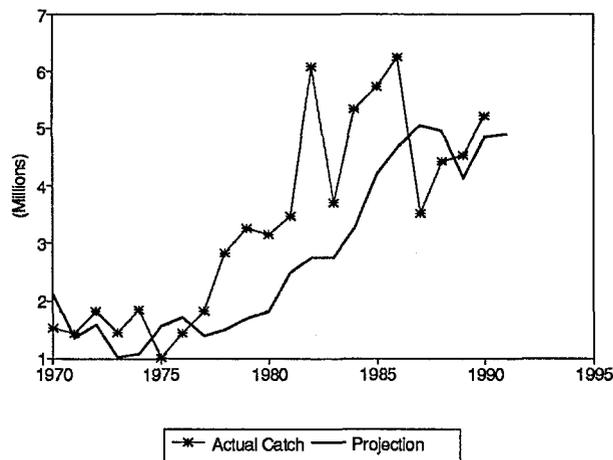


Figure 5. Catch projections and actual catches for coho salmon in Alaska, 1970–1990. The 1991 catch projection is 4.98 million fish.

Pink Salmon

In 1991 the major pink salmon producing areas are expecting large runs and extremely large harvests. The 1991 catch projection of 110.8 million fish would be a record, but there is considerable uncertainty over the projection.

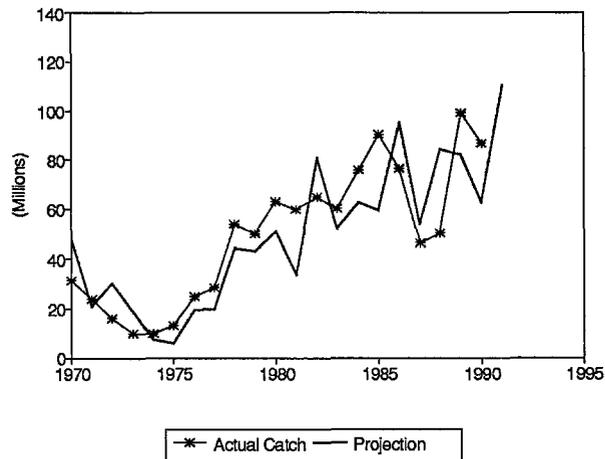


Figure 6. Catch projections and actual catches for pink salmon in Alaska, 1970–1990. The 1991 catch projection is 110.8 million fish.

Chum Salmon

On a statewide basis chum salmon catch has been fluctuating between about 7 and 15 million through the 1980s; the 1990 catch was 7.8 million. The 1991 catch projection is 10.2 million.

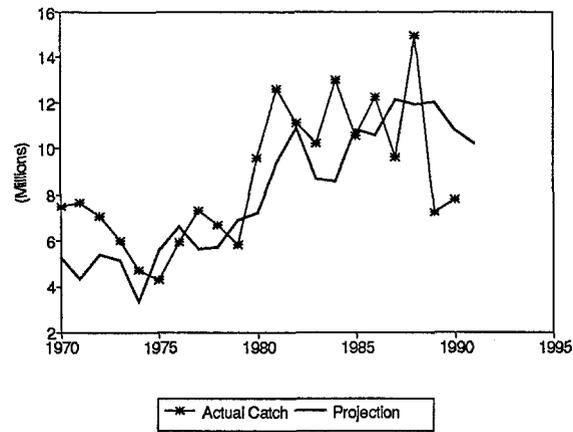


Figure 7. Catch projections and actual catches for chum salmon in Alaska, 1970–1990. The 1991 catch projection is 10.2 million fish.

Table 1. Preliminary catch projections of 1991 commercial salmon fisheries in Alaska, by fishing area and species, in units of thousands of fish.

FISHING AREA	SPECIES					
	Chinook	Sockeye	Coho	Pink	Chum	Total
Southeast Region	350 1/	1,600	2,100	45,000	2,400	51,450
Cordova Area	42	1,134	756	41,830	1,977	45,738
Upper Cook Inlet	20	3,200	400	90	500	4,210
Lower Cook Inlet	12	319	12	2,151	165	2,659
Bristol Bay Area	45	21,200	157	2	1,283	22,687
Central Region	119	25,853	1,325	44,073	3,925	75,294
Kodiak Area	15	3,190	230	17,000	805	21,240
Chignik	4	2,661	125	1,200	90	4,080
South Peninsula	5	2,600	250	3,500	1,000	7,355
North Peninsula	13	1,600	200	5	250	2,068
Aleutian Islands	0	5	0	10	0	15
Westward Region	37	10,056	805	21,715	2,145	34,758
A.Y.K. Region	166	155	664	1	1,766	2,752
TOTAL ALASKA	672	37,664	4,894	110,789	10,236	164,254

1/ The value 350 thousand is based on the 1990 harvest. The 1991 chinook salmon ceiling and add-on exception will be set by the Pacific Salmon Commission in February of 1991.

Revised January 28, 1991. Catches in thousands of fish. The projected 1991 harvests were obtained by summing harvest forecasts (Table 8) and harvest projections for remaining fisheries. Numbers may not sum to total due to rounding to nearest thousand fish.

See Tables 4,5,6, and 7 for definition of management regions.

Table 2. Preliminary catch projections for 1991 commercial salmon fisheries in Alaska, by statistical region and species, in units of thousands of fish.

Fishing Area	SPECIES					
	Chinook	Sockeye	Coho	Pink	Chum	Total
Southeast Statistical Region	350 1/	1,600	2,100	45,000	2,400	51,450
Cordova Area	42	1,134	756	41,830	1,977	45,738
Upper Cook Inlet	20	3,200	400	90	500	4,210
Lower Cook Inlet	12	319	12	2,151	165	2,659
Kodiak Area	15	3,190	230	17,000	805	21,240
Chignik	4	2,661	125	1,200	90	4,080
South Peninsula	5	2,600	250	3,500	1,000	7,355
Central Statistical Region	98	13,104	1,773	65,771	4,537	85,282
North Peninsula	13	1,600	200	5	250	2,068
Aleutian Islands	0	5	0	10	0	15
Bristol Bay Area	45	21,200	157	2	1,283	22,687
A.Y.K. Region	166	155	664	1	1,766	2,752
Western Statistical Region	224	22,960	1,021	18	3,299	27,522
TOTAL ALASKA	672	37,664	4,894	110,789	10,236	164,254

1/ The value 350 thousand is based on the 1990 harvest. The 1991 chinook salmon ceiling and add-on exception will be set by the Pacific Salmon Commission in February of 1991.

Revised January 28, 1991. Catches in thousands of fish. The projected 1991 harvests were obtained by summing harvest forecasts (Table 8) and harvest projections for remaining fisheries. Numbers may not sum to total due to rounding to nearest thousand fish.

See Tables 4,5,6, and 7 for definition of management regions.

PRELIMINARY REVIEW OF THE 1990 ALASKA COMMERCIAL SALMON SEASON

The 1990 Alaska commercial salmon season produced a harvest of nearly 153 million fish. This was well above the preliminary, preseason harvest forecast of 108.2 million salmon and makes this seasons's catch the second largest on record. The 1989 record harvest was approximately 153.7 million salmon.

Although some areas had record or near record catches, others had dismal harvests well below preseason projections. Among the bright spots this year were the sockeye harvest in Bristol Bay and pink salmon harvests in Prince William Sound and Southeast Alaska. Those fisheries that fell below expectations were chum salmon harvests in the Arctic-Yukon-Kuskokwim Region and pink salmon harvests in the Lower Cook Inlet, Kodiak, and Alaska Peninsula areas. The 1990 ex-vessel value for the commercial salmon fisheries in the state has been preliminarily estimated at approximately \$540 million. In general, prices were about the same, or slightly greater than those paid during the 1989 season. The 1990 total catch, although smaller than that of 1989, was worth more because of the increased, valuable, sockeye harvest.

Southeast Alaska and Yakutat

The total 1990 harvest of pink salmon in Southeast Alaska exceeded 31 million fish, more than three times the preseason forecast of approximately 10 million pink salmon. The purse seine fleet accounted for the majority of the pink salmon harvest, taking approximately 28 million pinks. The pink harvest was especially good in the southern Southeast Alaska districts where over 24 million pink salmon were harvested. The bumper harvest in 1990 followed the near-record harvest in 1989 of 55 million pink salmon. The purse seine harvest of over 900,000 sockeye was also exceptional; the chum (975,000) and coho (360,000) harvests were about average. Approximately 30 million salmon of all species were landed during the 1990 season by the Southeast Alaska purse seine fleet.

The Southeast Alaska drift gillnet fishery experienced an average year in 1990. The sockeye harvest of 800,000 fish was above average but slightly below the 1989 catch of over 900,000 sockeye. The drift gillnet catch of coho salmon was also above average; approximately 300,000 fish were taken. The chum harvest of 590,000 fish was similar to the 1989 season. The drift gillnet catch of chum salmon was comprised primarily of summer-run fish due to a poorer than anticipated run of fall chums. Overall, the Southeast Alaska drift gill net fishery harvested approximately 3.4 million salmon in 1990.

The summer troll fishery for chinook salmon began on July 1 and ended on July 23. The 1990 season lasted 10 days longer than in 1989 because of a 39,000-fish increase in the all-gear catch ceiling allowed by the Pacific Salmon Commission. The final summer and winter troll harvest of chinook salmon should approach 280,000 fish. A 10-day regionwide troll closure was implemented on August 13 to allow the passage of coho salmon to inside areas for gear allocation and conservation requirements. Trollers took nearly 1.4 million coho this season, about the same number taken during the 1989 season.

Set gill net fishermen in the Yakutat area enjoyed another good year. Sockeye and coho salmon comprised the major portion of the area's salmon harvest. The sockeye harvest of 344,000 was the result of good sockeye returns to the Situk and East Rivers; these rivers accounted for the major portion of the Yakutat sockeye harvest. Approximately 146,000 coho were taken by Yakutat setnetters, slightly below the 1989 harvest of 176,000 fish. Coho returns in the Yakataga District were below average.

Coho salmon catches were quite good for all user groups during the 1990 season; the preliminary total harvest is 2.2 million coho. Chum harvests were weaker than anticipated, and the preliminary catch estimate is under 2 million fish, well short of the preseason forecast of 3 million fish.

The preliminary estimate of the 1990 ex-vessel value of the commercial salmon catch in Southeast Alaska is approximately \$80 million.

Prince William Sound

The Prince William Sound Area commercial salmon harvest for 1990 amounted to an all-time record of 46.5 million fish, all species combined. This catch exceeds the previous record harvest of the 1987 season by 13 million fish. The record catch is attributed to the expanding hatchery program and excellent marine survival rates for some pink salmon stocks. Pink salmon comprised 95% of the season's harvest and were the only species to perform well in 1990. The outlook for the general purse seine fishery was for a catch of 19.8 million pink salmon and 1.4 million chum salmon. Hatchery production was anticipated to account for 87% of both the pink and chum salmon harvest.

Wild stocks of sockeye and chum salmon in the sound performed poorly. The sockeye salmon return to Coghill Lake was the lowest on record. Coho salmon returned below anticipated levels to the sound's hatcheries. In the Copper River District, coho salmon returned at 70% of the forecast level.

Recognizing that the 1989 *Exxon Valdez* oil spill had the continuing potential to impact seafood quality within Prince William Sound, the Alaska Department of Fish and Game (ADF&G) and the Department of Environmental Conservation (DEC) decided to continue the Memorandum of Understanding regarding seafood quality for the 1990 season. Prior to commercial openings in the affected areas of the sound, ADF&G conducted extensive beach surveys and collected fish which were provided to DEC for inspection. Some minor beach areas continued to pose an appreciable likelihood of fouling gear and adulterating the catch and were closed for the 1990 season. Aside from this, the lingering effects of the oil spill had little impact on the prosecution of the 1990 salmon fishery, although the effects on the runs is still unknown.

Prior to the start of the 1990 season, the Prince William Sound Salmon Harvest Task Force met numerous times to formulate a management plan the focused on improving flesh quality of the pink salmon harvest in the sound. After a great deal of public input, they agreed to a set of management recommendations that were signed-off and presented to the Commissioner, ADF&G, on June 13, 1990. Among other things, this document recommended the establishment of enlarged wild stock sanctuaries and a fishing schedule of two, 12-hour periods per week. Harvest pressure was to be exerted to a greater degree in mixed stock areas and on the early bright fish, recognizing that management risks were increased for wild stock escapement and hatchery cost recovery shortfalls.

Although late June aerial surveys revealed a strong showing of chum salmon in the Eastern and Northern Districts, the fishery that followed produced chum catches below expectations for the initial opening, and it was soon apparent that there was no strength behind the early showing. On July 2 the task force's enlarged sanctuaries were placed into effect and remained in effect for the balance of the salmon season.

Wild stock performance was quite weak during this early portion of the return, and escapement performance fell below expectations in the Eastern and Northern Districts. However, because of the outstanding return of hatchery fish to the Solomon Gulch Hatchery, nearly all of the fishing effort was concentrated in Valdez Arm and Port Valdez, and little pressure was placed on the remaining wild stock systems in these districts.

The poor wild stock performance during the early portion of the pink return was attributed to the weak escapement performance of the early-run segment of the parent year, 1988. Parent-year escapements during the August portion of the run were quite adequate, and based on the apparent high marine survival rate of the Solomon Gulch fish, it was anticipated that an improvement would be seen in the later wild production. This was indeed the case, and a dramatic improvement of wild stock pink escapements was observed during the fourth week of July.

The enlarged sanctuaries provided protection to a build up of fish in the important wild stock spawning area, which assured minimum escapements over the next week.

With hatchery cost recovery sales harvests now combined with commercial harvests, the total daily harvest in the sound during peak averaged approximately 2.0 million fish per day, exceeding the processing capacity in the management area. Although a significant volume of fish moved into the special harvest areas of the three Prince William Sound Aquaculture Association (PWSAC) hatcheries, they were unable to sell these fish because of the backlog of fish at the plants. This created a critical situation at the peak of the run.

To prevent an excessive buildup of fish at the hatcheries, a 24-hour general opening was scheduled on Monday, August 13. During this period 2.8 million pinks were taken, which again added to the processing backlog. Although PWSAC had fish to sell, there was reluctance on the part of the processors to buy them because of their commitments to their fleet. It was estimated at that time that 1.0 to 2.0 million pinks had built up in the hatchery areas, exceeding the capacity of PWSAC's harvest boats. The potential therefore existed for these fish to not be harvested in a timely manner, resulting in a decline in quality and unmarketable fish. In an effort to resolve this bottleneck in the fishery, a plan was formulated to accelerate the sales harvest of the fish in the hatchery areas. For a period of 36 hours, the special harvest areas at the three PWSAC facilities were expanded to include the hatchery subdistricts. With the seine fishery closed during this time period, PWSAC requested volunteers from the fleet to assist in the harvest of the fish in these areas. As a result of this "volunteer sales harvest", 1.6 million fish were harvested for PWSAC cost recovery by 74 commercial boats. This, coupled with the normal sales by the PWSAC contract seiners resulted in a dramatic recovery in the sales revenue shortfall.

At the close of the season 35.4 million pink salmon were harvested by the common property fishery. An additional 8.7 million were taken by the private nonprofit hatchery operators for cost recovery, setting the season's total take at 44.1 million, an all-time record harvest.

The Copper River gillnet fleet harvested about 845,000 sockeye salmon, 187,000 above the anticipated preseason forecast. In addition, they landed about 22,000 chinook and 247,000 coho salmon. Both fell below the preseason forecast projected harvests of 37,100 chinook and 295,300 coho salmon.

The outlook for the Coghill District called for an exceptionally poor return of sockeye salmon, which would not permit a targeted commercial harvest. The early chum return to the Noerenberg Hatchery was forecasted to be 340,000 fish, of which approximately 30% were needed for brood stock.

The Esther Subdistrict was opened on June 14 to a schedule of two, 24-hour fishing periods per week to target on the hatchery return of chum salmon. The balance of the Coghill District remained closed for the protection of sockeye salmon returning to Coghill Lake. The harvest of sockeye salmon during the six periods in the Esther Subdistrict amounted to 6,900 fish. Escapements at the Coghill weir were extremely poor. At the conclusion of the project the cumulative escapement of sockeye salmon amounted to only 8,500 fish, falling drastically below the goal of 55,000. This escapement and return to the Coghill Lake system is the weakest recorded since Statehood.

The final catch figures for Prince William Sound's salmon fisheries have been estimated at about 22,200 chinook, nearly 912,000 sockeye, less than 524,000 coho, 44,200,000 pink, and about 967,000 chum salmon. Although the majority resulted from common property harvests, these figures also include sales from hatchery cost recovery fisheries, fish sold under educational permits, and fish confiscated and sold because of violations.

The value of the combined commercial salmon harvest was estimated at \$68 million, including hatchery sales. The drift gillnet catch was valued at \$21.7 million, setting the average earnings for the 526 permit holders at \$41,500. The total purse seine harvest value of \$36 million set the average earnings for the 255 permit fleet at \$144,000. The set gillnet harvest was valued at \$900,000, making the average earnings for each of the 29 active permit holders approximately \$31,000.

Cook Inlet

Upper Cook Inlet

The 1990 Upper Cook Inlet salmon fishery was moderately successful, producing a catch of 5 million fish, well above average, but the lowest total since 1984. The harvest had an approximate ex-vessel value of over \$40 million, the fifth highest on record. Sockeye salmon again dominated the harvest with the catch of 3,573,000 accounting for 71% of the total salmon taken and representing 88% of the ex-vessel value. The sockeye salmon catch was both the seventh highest on record and the lowest harvest since 1984. The run developed in a manner very similar to that envisioned by the preseason outlook. Returns to nearly all systems were fair to poor, but the Kenai River return was significantly above average. The harvest strategy of allowing a limited harvest in mixed stock fisheries and dealing with the remaining Kenai-bound surplus near the upper eastside beach worked quite well. Escapement goals were satisfied in all monitored systems, except the Kasilof River, which fell short of the minimum goal by only a few thousand fish.

Drift gillnetting accounted for 64% of the harvest, slightly above the long-term average. Chum salmon returns were weak, as anticipated, the result of severe flooding in the autumn of 1986. The final harvest

will probably come in at about 360,000 fish. The 1986 fall flooding was also expected to result in a weak coho salmon return but apparently had little effect on the success of this brood year. The harvest of nearly 500,000 coho salmon was substantially above average and the fifth highest on record. With a harvest of just 550,000 pink salmon, 1990 continued to show the effects of the 1986 flooding of the Susitna River basin. Representing only about a third of the average even-year harvest, the 1990 catch was valued at \$500,000 to the fishermen. The limited fishing time in both the drift and Northern District set gillnet fisheries kept exploitation rates low, and the Yentna River escapement index was significantly improved over the parent year, although still well below average.

The pink salmon return to the Kenai River was one of the latest on record and somewhat above average in strength. The harvest of 16,000 chinook salmon in 1990 represents the lowest catch since 1984, largely due to a much-reduced harvest in the Upper Subdistrict set nets. The late run of chinook salmon to the Kenai River was substantially smaller than in the recent past. This fact, coupled with less fishing time, an offshore migratory pattern exhibited by all species of salmon, and efforts to release live chinook salmon, all served to limit the eastside setnet catch to just over 4,000 fish, the lowest catch since 1963. The directed June chinook salmon fishery in the Northern District produced a catch of 8,000 fish, well below the 12,500 quota established for this fishery. The reduced catch was apparently due to a somewhat smaller return to the Susitna River. The commercial chinook salmon harvest was valued at slightly more than \$500,000.

Lower Cook Inlet

The 1990 Lower Cook Inlet salmon fisheries fell far below preseason expectations, and only about 597,000 salmon were landed by all commercial gear groups combined. This was the lowest commercial salmon harvest since 1976 and was only 25% of the preseason forecast. Pink salmon returns, normally the dominant species both in numbers of fish and ex-vessel value, were very weak throughout Lower Cook Inlet. With less than 383,000 pink salmon taken during the 1990 season, the harvest fell far below even the lower range harvest estimate of 839,000. Midpoint projections indicated that the 1990 season would produce a harvest of over 1.8 million pink salmon. The past 30-year average pink salmon harvest is over 830,000 fish for the Lower Cook Inlet Management Area. Most of the 1990 salmon harvest was to have been hatchery produced pinks from the Tutka Bay Hatchery.

During the 1989 season, enhancement projects involving the Tutka Bay Hatchery and sockeye lake stocking accounted for 68% of that season's total harvest. However, management-area-wide enhancement projects for sockeye and pink salmon all fell far below desired levels during 1990. The biggest disappointment was the 1.4 million projected harvest from Tutka Hatchery releases. Tutka Bay and Halibut Cove Lagoon, a secondary release site for Tutka Hatchery fry, contributed only 87,500 fish this season. The Outer District produced the only other significant returns with Port Dick and Port Chatham accounting for 168,000 and 22,000 fish, respectively.

Kamishak District stocks produced just enough to secure maintenance level escapements and there was no directed fishery on pink salmon this season. In the other three districts escapement goals were achieved in all major producing streams.

Hatchery brood stock collections were in jeopardy for the better part of the season, but fisheries management strategies inseason allowed the 50 million egg take goal to finally be achieved. Biologists are still examining the data for indications pertaining to the cause of the poor returns to Lower Cook Inlet.

Despite large fry releases from lake stocking projects at Chenik and Leisure Lakes, excellent natural escapements, and lake fertilization, the Chenik Lake harvest was only about half of that expected. The weak enhanced runs combined with continued poor production from English Bay Lakes and Delight and Desire Lakes in Nuka Bay resulted in a total sockeye harvest considerably below the preseason projection of 485,000 fish (final sockeye harvest was less than half of the preseason forecast expectations). Nevertheless, sockeye comprised 75% of the total value of the fishery. The salmon harvest this season is estimated to be worth only \$1.53 million to area fishermen, far below past averages. Spawning escapements were good to excellent in all systems except English Bay Lakes for sockeye salmon.

The chinook salmon harvest of 1,570 was the fourth highest on record due to enhanced production in Halibut Cove Lagoon and Seldovia Bay. Set gillnets accounted for 87% of the catch.

The coho harvest of 3,400 was less than half the long-term average and the lowest since 1977. The catch was almost equally split between the Southern and Eastern Districts. Set gillnets harvested the bulk (68 percent) of the fish in the Southern District, while the Silver Salmon Derby in Resurrection Bay accounted for the Eastern District harvest.

Weak coho returns were anticipated in the Kamishak District as a result of severe flooding in the fall of 1986. A conservative management approach was deemed necessary, and only a portion of the Douglas River Subdistrict was opened to fishing. This action, in conjunction with the weak run and low prices, discouraged the fleet from fishing for coho salmon altogether. Although adverse weather and stream conditions in late August and September hampered aerial escapement estimates, most indicators reflected relatively poor production throughout Lower Cook Inlet.

The chum salmon harvest of 6,900 fish was the lowest on record. The catch was only 5% of the long-term average and well under the previous low of 11,300 landed in 1989. The poor returns were generally anticipated, again due to the fall flooding in 1986. Conservative fishing schedules were implemented throughout the Kamishak and Outer Districts to protect chum salmon stocks. Maintenance level escapements were achieved, but several streams were below desired levels.

Bristol Bay

The 1990 Bristol Bay commercial salmon season was a very productive one highlighted by a much greater than expected return of sockeye salmon, but a less than normal return of the other four species. The 1990 inshore sockeye salmon run, at 47.8 million fish, returned greater than forecasted by 22.3 million fish. Nearly all districts shared, to some degree, the greater than anticipated return, and all met or exceeded point escapement goals. However, a prolonged commercial fishing closure was necessary in the Togiak District to assure escapement goals would be met. The dominant age group in the run was the 5(3) component (age 2.2) from the 1985 brood year. Peak run timing appeared to be a little later than normal in the Kvichak and Egegik Districts and a little earlier in the Naknek and Ugashik Districts. The reduced size of the Egegik District as mandated by the Alaska Board of Fisheries did not appear to be overly disruptive to the fishery as the sockeye harvest in that district was the largest ever recorded. The poor performance of the Togiak sockeye run in light of strong returns to the rest of Bristol Bay remains puzzling at this point. The final commercial harvest for all districts combined was approximately 33.2 million sockeye. This was the second-largest sockeye harvest on record for Bristol Bay, trailing only the

catch of 37.4 million fish in 1983. The 1990 total sockeye salmon run was the third largest recorded over the 39 years (1952-1990) that total run data have been collected. It was approximately twice the 39-year average of 21.2 million.

The chinook salmon run to all Bristol Bay districts was disappointingly small for the fourth consecutive year. Commercial harvests were far below average in every district, with a baywide harvest of only 32,820 fish. This is the second smallest harvest recorded over the 41-year period 1950-1990. The smallest harvest occurred in 1975, when only 30,000 chinook salmon were caught. The 1990 catch was only 28% of the recent 20-year average harvest of 117,000 chinook.

Chum salmon harvests were above average in the Naknek-Kvichak and Egegik Districts, and considerably below average in the Ugashik, Nushagak, and Togiak Districts. Overall, the baywide harvest totaled about 1,008,000 fish, slightly under the 20-year average catch of 1,110,000. The extensive fishing authorized to harvest excess sockeye was responsible for relatively weak chum escapements in the Naknek-Kvichak, Egegik, and Ugashik Districts.

Pink salmon return in strength during even-numbered years in Bristol Bay. The pink salmon harvest totaled only 517,000 fish, far below the 1970-1989 even-year average catch of 1,647,000. The weakness in the Nushagak River return was the major contributor to the lack-luster pink run.

The coho salmon harvest totaled approximately 100,000 fish, well below the most recent 20-year average (1970-1989) harvest of 177,000 fish, and roughly one-third the recent 10-year (1980-1989) average of 284,000. Extremely poor returns to the Nushagak and Togiak Districts accounted for the overall reduced harvest. The Nushagak harvest of 7,000 coho salmon was only a tiny fraction of the recent 10-year average catch of 129,000 fish. Similarly the Togiak district yielded only 3,000 coho salmon in the commercial harvest compared to the 1980-1989 average of 66,000. Commercial fishing time during the coho season was reduced by emergency order at times in all districts in Bristol Bay in an effort to secure desired escapement rates.

The baywide total salmon harvest for all species in 1990 was approximately 34.8 million fish. These fish were worth an estimated \$199.9 million to the fisherman, the largest on record. This exceeds the previous high value of \$180.3 million set in 1988, when prices were nearly double those paid to commercial fishermen in 1990.

Kodiak

Kodiak area fishermen enjoyed a record catch of sockeye salmon this season, and final landings approached 5.3 million fish. This surpassed the previous record of 4.8 million sockeye established in 1901. Sockeye escapements were assured for all systems by the third week in July, except in Karluk River, where minimum escapements were assured late in the season. Although sockeye catches were excellent, the 1990 pink salmon catch, estimated at 6.0 million fish, was half of the projected 11.8 million preseason goal. Daily harvest rates inseason, combined with a less than anticipated harvest at the Kitoi Bay Hatchery, indicated that the lower end of the preseason pink salmon projection might be met. However, as catches continued to decline, even the lower end of 9 million pink salmon became impossible to reach. Minimum escapement goals were probably reached in most systems in the area.

As the 1990 season developed, it became obvious that the late chum returns were weaker than anticipated throughout the entire management area. The final chum catch for Kodiak was only 578,000 fish, well below the preseason harvest projection of 705,000. Excluding the 1989 season, which was disrupted by the *Exxon Valdez* oil spill, 1990 saw the lowest catch taken since 1985. Coho harvests should near 290,000 fish, slightly above the 1984-1988, 5-year average of 236,000 coho salmon and above preseason expectations. Additionally, 19,000 chinook salmon were commercially harvested, well above the 1984-1988 average catch of only 7,800 fish and the 1990 projected harvest of approximately 8,000.

The estimated ex-vessel value for the Kodiak Management Area commercial salmon harvest was about \$51.1 million. Unlike the 1989 Kodiak commercial salmon season with its major complications, the department did not have to make any management adjustments this year because of the oil spill in Prince William Sound.

Chignik

As was the case in Kodiak, both early and late runs of sockeye salmon to the Chignik Management Area were above average in strength. Nearly 2 million sockeye were landed this season, the best catch since 1984. This season's harvest also surpassed initial preseason projections by over 800,000 fish.

Pink salmon run strength was weaker than projected, limiting the amount of fishing time allowed in the outside districts. Although preseason projections indicated the possibility of a harvest of nearly 2.0 million pinks, the final figure reached, 514,000 fish, was only about a quarter of that number.

Unlike the Kodiak fisheries, the chum catch in the Chignik management area exceeded preseason forecast expectations by 58%. The catch of 262,000 chum salmon was also double the 1984-1988 average of 131,000 fish.

Coho catch statistics are still being compiled at this time; however, the catch should exceed 107,000 fish, well below expectations of a 1990 commercial catch of about 160,000 coho salmon. The chinook catch of about 10,000 was double the forecasted level, and the best on record. It surpassed the previous harvest record set in 1988, when about 7,000 fish were commercially harvested.

Chignik area commercial fishermen received about \$24 million total for their catch. As in Kodiak, there were no management problems this season as a result of the 1989 *Exxon Valdez* spill.

Alaska Peninsula/Aleutian Islands

South Peninsula

The 1990 South Peninsula sockeye harvest of 2.4 million fish was the seventh best catch on record. This harvest could move into sixth place when all fish tickets are entered. The catch exceeded the preseason forecast level of 2.0 million sockeye and was very near last season's 2.7 million harvest. Sockeye to chum

ratios in the South Unimak/Shumigan Islands (False Pass) fishery permitted comparatively large sockeye catches in June without exceeding the chum harvest ceiling adopted by the Alaska Board of Fisheries. That ceiling was raised to 600,000 this season, but the final June harvest reached only about 503,000 chum salmon. The Bear River sockeye run arrived late but was quite strong, and the escapement goal was exceeded despite continuous fishing up to the river mouth.

Pink salmon harvest were exceptionally poor. Preseason projections had placed the anticipated catch at approximately 8.25 million fish. However, final catches reached only about 2.8 million pink salmon. This was well below the most recent 5-year average catch of about 4.8 million.

The 1.2 million landed chum salmon fell just below both the projected harvest of 1.3 million fish and the most recent 5-year average (1885–1989) catch. South Peninsula fishermen also landed approximately 14,000 chinook and 290,000 coho salmon this year. The chinook catch was well above average, and the coho catch was about what had been projected for this season.

North Peninsula

North Peninsula fishermen did slightly better than the South Peninsula crews' sockeye harvests, exceeding the preseason forecast by about half a million fish. Like those sockeye catches in the south, final landings totalled nearly 2.4 million sockeye salmon for the North Peninsula management area. This was the best harvest since the 1986 season.

Chinook, coho and chum salmon catches fell below preseason forecast levels. Chum salmon total was about 118,000 for this season, and coho catches probably exceeded 165,000 fish. Only about 12,000 chinook salmon were landed. The pink salmon catch for the North Peninsula was projected to reach about 50,000 fish, but the actual harvest was almost ten times that, coming in at approximately 447,000 pinks.

Aleutian Islands

The Aleutian Islands commercial salmon catch totalled about 309,000 fish. The catch was comprised of about 8,000 sockeye, 300,000 pink, and 1,000 chum salmon. The pink salmon harvest was only about 60% of the anticipated catch for the season, and the number of chinook landed was 62% greater than anticipated. The ex-vessel value of the Alaska Peninsula/Aleutian Islands catch has been estimated at about \$56.3 million, slightly better than that earned in 1989.

Arctic-Yukon-Kuskokwim

Overall, runs were late and weak for chum salmon in the A-Y-K region in 1990. Less than half of the anticipated regional harvest of over 2.3 million chum was actually caught.

Lower Yukon River

Most notable among poor landings, the summer chum salmon catch on the Lower Yukon River was about 282,000 fish, only about 40% of the anticipated catch, despite the fact that preseason expectations had placed the run status at above average strength. Guideline harvest ranges for summer chum salmon were established by the Board of Fisheries in February 1990. The guideline harvest range is 251,000 to 755,000 summer chum salmon for Districts 1 and 2 combined, and 6,000 to 19,000 summer chum salmon for District 3. Management of summer chum salmon is complicated by overlapping run timing with chinook salmon. The harvest of summer chum salmon is affected by management actions applied to chinook salmon, as well as the abundance of summer chum salmon. If the summer chum salmon return is determined to be average or above average in strength, restricted mesh-size periods (six inch maximum mesh size) may be implemented prior to, or during, the chinook salmon directed fishery. A total of 99,588 summer chum salmon were harvested during unrestricted mesh-size fishing periods, and 181,830 summer chum salmon were harvested in a total of three restricted mesh-size fishing periods in Districts 1 and 2, combined. This was 60% below the recent 5-year average and the lowest catch since 1972. The summer chum season closed on June 28. Comparative test net indices indicated the 1990 summer chum salmon return was below average in abundance and similar in magnitude to returns in 1982 and 1987. Approximately 50% of the summer chum salmon return had entered the lower river by June 25 according to test fishing catch per unit of effort data. Preliminary age composition information from District 1 and 2 indicated the commercial catch was composed primarily of 5-year-old summer chums. This information suggests that the 4-year-old component of the return from the 1986 parent year was much lower than expected preseason. Four year-old fish normally comprise the greatest percentage of the run.

The fall chum season opened on July 23 in District 1, on July 26 in District 2, and on July 29 in District Y-3. The season closed during statistical week 33 (August 2-26). The fall chum catch was also poor: total harvest of about 68,000 fish, or about 39 percent below the recent 5-year average (1980-1989). The 1990 escapements seem adequate at this writing.

Chinook catch for the A-Y-K Region this season was slightly above anticipated preseason outlooks with a harvest of 188,000 fish. However, chinook catches were about 21% below the most recent 5-year average for the Lower Yukon Area, and there was a high abundance of small "jack" (precocious males) salmon in the return, quite unusual for the system. Total Lower Yukon River chinook catch was about 86,700 fish. Approximately 50% of the 1990 chinook salmon return had entered the lower river by June 18 according to lower river test fishing data.

With a harvest of only 531,000 fish, the A-Y-K coho catch total fell far short of desired levels. On the Lower Yukon, approximately 30,700 coho salmon were harvested, less than one-half that caught last season, and only about 66% of the most recent 5-year average.

A total of 679 Commercial Fishery Entry commission permit holders participated in the Lower Yukon River salmon fishery during 1990. The salmon fishery was valued at approximately \$5.7 million ex-vessel, or 26% below the 1980-1989 average.

Upper Yukon River

The Upper Yukon River fishermen experienced similarly poor chum salmon catches; about 35,000 fish were harvested. In addition, 8,300 chinook salmon were harvested; these were also used for commercial

salmon roe. Fish tickets are still being entered at the time this report was prepared, but early estimates indicate that fishermen earned about \$768,000.

Kuskokwim

On the Kuskokwim system, the preliminary catch of salmon for all four districts was about 1.3 million salmon. This is the sixth largest catch since 1913, but still about 162,000 salmon less than the previous 5-year average (1985–1989). The catch was composed of approximately 84,350 chinook, 203,000 sockeye, 520,000 chum, 16,500 pink, and 444,000 coho salmon. The record sockeye salmon catch in District W-4, Quinhagak took the other districts combined catch to the largest commercial sockeye salmon catch ever taken in the area. The total value of the Kuskokwim Area catch in 1990 was about \$4.9 million. In the Kuskokwim Bay fisheries, the chinook salmon catch was the second largest ever recorded and escapement objectives were met except in a few small systems. The sockeye and chum salmon catches was below their previous 5-year averages. Chum escapement objectives were approached or met in most systems. The coho salmon catch was the sixth largest on record, but still below the previous 5-year average. The coho salmon escapement appears to be the worst recorded since records began in 1981.

In the river districts, sockeye catches for W-4 were over 5 times the previous 5-year average, and District W-5 had the second largest harvest on record. Chinook catches in W-4 were above average, but below average in W-5. Escapements were not met in W-4, but were met in W-5 for the first time in 5 years. Similarly, chum catches in W-4 were above average escapements were below average. W-5 chum salmon figures were the opposite of W-4. Both districts had below average coho catches. The ex-vessel value of all Kuskokwim Areas fisheries totalled about \$4.9 million.

Norton Sound

Norton Sound experienced similar chum problems this season. The preliminary catch of about 65,000 fish was the second lowest harvest recorded in the last 20 years. It is also 39% below the recent five-year average (1985–1989) and 58% below the recent 10-year average (1980–1989). The low chum harvest was due primarily to the lack of market in Subdistricts 1, 2, 3, and 4. Historically, Subdistrict 2 has produced one-half of the annual chum salmon harvest. The 1990 chum catch was valued at just under \$111,000. The chinook harvest of somewhat less than 9,000 fish is slightly above the most recent 5-year average harvest of 8,400 chinook salmon. A preliminary estimate of the ex-vessel value of the chinook catch was \$170,695. The coho harvest of nearly 57,000 fish this season was much better than the five-year average catch of about 32,000 fish, the best catch since 1984 and the third highest on record. The estimated ex-vessel value for coho harvested in the area was about \$213,000. The pink harvest was negligible due to the lack of a market, however, 501 pink salmon were caught and the roe was purchased in order to test marketability.

Of the 157 Commercial Fisheries Entry Commission permits renewed, a total of 128 fishermen reported commercial catches during 1990. This is the same number that reported catches in 1989, both being the lowest number of participants since the 1977 season. Again, poor market conditions have caused some fishermen not to participate in any fisheries.

Commercial fishermen in the Norton Sound area earned approximately \$497,000 for the 1990 catch. This is the second lowest value on record since 1976 and is 16% below the recent 5-year average. This low

fishery value is attributed to the lack of competitive markets and low prices paid per pound for all salmon species. Prices paid to the fishermen averaged \$1.01 per pound for chinook, \$0.87 per pound for sockeye, \$0.50 per pound for coho, and \$0.23 per pound for chum salmon. The price for pink salmon roe was \$0.75.

Once again, chum salmon escapements in the Nome and Moses Point Subdistricts were of concern or fell short of escapement goals. The lack of chum salmon escapement in the Nome River is particularly disturbing because commercial fishing effort has almost completely dropped off and regulations continue to become more restrictive each year for sport and subsistence fishermen. During the 1990 season the chum salmon return began very slowly in the Nome River. Emergency orders were given to stop both subsistence salmon fishing for all species and sport fishing for chum salmon. Subsistence salmon fishing was later reopened after the chum salmon had passed through the legal fishing zone, but sport fishing for chum remained closed all season. Apparently ocean subsistence fishing may also have to be reduced to bring this salmon stock back to its former size.

The chum salmon return to the Kwiniuk River in the Moses Point Subdistrict was very poor, even though only three commercial chum openings occurred. In the spring of 1990, the Board of Fisheries imposed a reduced fishing schedule for the subdistrict. In the past, reduced commercial fishing had worked to rebuild the stock from a similar low level.

Kotzebue

Fishing was closed prematurely in the Kotzebue area on August 11 due to weak returns. Because of poor chum salmon escapement on the Noatak River, the commercial fishing season was limited to ten periods. A normal season runs 15 periods. Reduced fishing time and a weak four-year-old return accounted for the low 1990 harvest. Final catch statistics indicate a commercial harvest of approximately 163,000 chum salmon during 1990. This is 92,000 fish less than that taken during the 1989 season and the lowest catch in the last three years. It was also well below the most recent 5-year average harvest of 300,000 chum salmon. Preliminary estimated ex-vessel value for the 1990 season was about \$440,000 paid to 153 permit holders, the second lowest value in 17 years. Chum prices averaged about \$0.30 per pound for the entire season.

Table 3. Preliminary 1990 Alaska commercial salmon harvest by species and fishing region, in units of thousands of fish.

Fishing Area	SPECIES					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Southern Southeastern total	25	1,277	589	26,678	767	29,335
Northern Southeastern total	7	867	322	4,367	965	6,528
S.E. Hatchery Cost Recovery	27	0	122	924	376	1,449
Southeast Troll / 2	287	9	1,831	772	63	2,963
Miscellaneous	0	0	9	6	29	4
Southeastern Region Total	346	2,153	2,873	32,747	2,201	40,278
Prince William Sound Area	22	912	524	44,165	967	46,591
Lower Cook Inlet Area	2	203	3	382	7	597
Upper Cook Inlet Area	16	3,604	500	604	351	5,075
Bristol Bay Area	33	33,165	100	517	1,008	34,822
Central Region Total	73	37,884	1,127	45,668	2,333	87,085
Kodiak Area	19	5,248	294	5,984	578	12,123
Chignik	10	2,091	130	550	270	3,051
South Peninsula	14	2,367	286	2,843	1,210	6,720
North Peninsula	12	2,376	165	447	118	3,118
Aleutian Islands	0	8	0	300	1	309
Westward Region Total	55	12,090	875	10,124	2,177	25,321
Kuskokwim Area	84	204	413	16	550	1,267
Yukon Area	96	0	43	0	442	581
Norton Sound	9	0	57	1	65	132
Kotzebue Area	0	0	0	0	163	163
A-Y-K Region Total	189	204	512	16	1,221	2,143
ALASKA TOTAL	662	52,331	5,387	88,556	7,932	154,827

/1 Compiled 13 May 1991, catches in thousands of fish.

/2 Includes catch from Winter Troll Fishery (October 1, 1989 - April 14, 1990).

Table 4. Preliminary 1990 Southeastern Alaska commercial salmon harvests by species and management area, in units of thousand fish.

MANAGEMENT AREA	SPECIES					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Southern Southeastern						
Tree Point Drift Gill Net	2	85	27	559	124	796
Prince of Wales Gill Net	2	185	144	305	70	707
Gillnet Hatchery Terminal	0	0	0	1	2	3
Stikine River Gill Net	1	12	7	14	9	42
Southern Districts Seine	13	927	326	23,810	419	25,495
Annette Island Trap	0	6	0	53	0	60
Annette Island Gill Net	1	50	31	1,000	39	1,121
Blind Slough	0	0	0	0	0	0
Southern Southeastern total	18	1,265	536	25,743	662	28,224
Nothern Southeastern						
Taku-Snettisham Gill Net	3	126	63	153	143	488
Lynn Canal Gill Net	1	356	61	101	208	727
Yakutat Gill Net	1	344	137	31	6	519
Northern Districts Seine	2	36	35	3,875	550	4,497
Northern Southeastern total	6	862	296	4,159	907	6,231
S.E. Hatchery Cost Recovery	21	0	3	510	252	786
Southeast Troll 1/	287	8	1,829	772	63	2,959
SOUTHEASTERN REGION TOTAL	332	2,136	2,664	31,185	1,884	38,200

1/ Includes catch from Winter Troll Fishery (October 1, 1989 - April 14, 1990).

Compiled 11 January 1991.

Table 5. Preliminary 1990 Central Region Alaska commercial salmon harvests by species and management area, in units of thousand fish.

MANAGEMENT AREA	SPECIES					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Prince William Sound (PWS)						
Bering River	0	8	43	0	0	51
Copper River	22	845	247	2	8	1,122
P.W.S General	0	22	78	32,179	262	32,541
P.W.S. Hatcheries	0	0	14	8,733	25	8,771
Coghill District	0	12	140	2,693	312	3,158
Unakwik District	0	0	0	10	0	10
Eshamy District	0	23	1	535	359	919
PWS Misc.	0	1	0	14	2	18
PWS Total	22	912	524	44,165	967	46,590
Cook Inlet Area						
Lower Cook Inlet						
Southern District	2	83	2	177	2	265
Kamishak District	0	96	0	3	4	103
Outer District	0	17	0	190	1	208
Eastern District	0	7	2	12	0	21
Lower Cook Inlet Total	2	203	3	382	7	597
Upper Cook Inlet						
Central District	7	3,508	361	560	315	4,750
Northern District	10	96	139	44	36	325
Upper Cook Inlet Total	16	3,604	500	604	351	5,075
Cook Inlet Area Total	18	3,807	503	986	358	5,672
Bristol Bay						
Naknek-Kvichak District	4	17,127	13	448	425	18,017
Nushagak District	14	3,569	7	53	306	3,951
Egegik District	1	10,087	44	7	128	10,268
Ugashik District	2	2,144	32	0	32	2,210
Togiak District	12	237	3	9	116	377
Bristol Bay Total	33	33,165	100	517	1,008	34,822
CENTRAL REGION TOTAL	73	37,884	1,127	45,668	2,333	87,085

Compiled January 9, 1991.

Table 6. Preliminary 1990 Westward Region Alaska commercial salmon harvests by species and management area, in units of thousand fish.

MANAGEMENT AREA	SPECIES					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Kodiak Area	19	5,248	294	5,984	578	12,123
Chignik Area	9	2,094	130	550	270	3,053
South Peninsula	14	2,367	286	2,843	1,210	6,720
North Peninsula	12	2,376	165	447	118	3,118
Alaska Peninsula Total	26	4,743	451	3,290	1,328	9,838
Aleutian Islands	0	8	0	300	1	309
WESTWARD REGION TOTAL	54	12,093	875	10,124	2,177	25,323

Compiled January 9, 1991.

Table 7. Preliminary 1990 Arctic-Yukon-Kuskokwim (AYK) commercial salmon harvests by species and management area, in units of thousand fish.

MANAGEMENT AREA	SPECIES					Total
	Chinook	Sockeye	Coho	Pink	Chum	
Kuskokwim Area						
Kuskokwim River	54	85	410	3	462	1,014
Kuskokwim Bay	31	120	35	13	61	259
Kuskokwim Area Total	85	204	445	16	523	1,273
Yukon River						
Lower Yukon River	87	0	31	0	350	468
Upper Yukon River 1/	10	0	16	0	291	317
Yukon River Total	97	0	46	0	642	785
Norton Sound	9	0	57	1	65	132
Kotzebue Area	0	0	0	0	163	163
AYK REGION TOTAL	190	205	548	17	1,393	2,352

1/ On the Upper Yukon River an additional 125,798 pounds of salmon roe was sold in addition to the fish sold in the round.

Compiled January 8, 1991.

Table 8. Preliminary forecasts of salmon runs and commercial and hatchery cost recovery harvest of some Alaskan fisheries in 1991. 1/

Area	Species	Forecast Run	Escapement Goal	Forecast Harvest	Forecast Run Range	
Southern Southeast	Pinks	72.7	18.8	50.2	15.5	84.9
Northern Southeast	Pinks	24.2	12.0	12.2	16.9	34.6
S.E. Hatchery Production	Pink	1.2		0.5		
		98.1	30.8	67.3 2/		
Lynn Canal	Sockeye	0.483	0.128	0.355	0.314	0.741
Prince William Sound (PWS)	Pinks	44.33	2.50	41.83	11.23	86.70
	Chums	2.350	0.375	1.975	0.740	4.135
Hatchery	Coho	0.3389	0.0028	0.3361	0.1856	0.4921
PWS Coghill District	Sockeye	0.2378	0.0600	0.1778	0.1791	0.3697
Copper River	Sockeye	1.583	0.714	0.869	1.419	1.747
	Chinook	0.0565	0.015	0.0415	0.0466	0.0664
Upper Cook Inlet	Sockeye	4.7	1.5	3.2	3.2	7.5
Lower Cook Inlet	Pinks	2.556	0.442	2.151	1.117	7.465
Kodiak	Pinks	22.8	2.27	20.5 2/	19.3	27.2
Chignik 3/	Sockeye	3.9	0.65	3.25	3.12	4.68
Bristol Bay 4/	Sockeye	31.9	8.7	23.1	2.2	61.6
Nushagak	Chinook	0.1197	0.0750	0.0447	0.0754	0.1640

1/ Compiled January 11, 1991. Note catches in units of millions of fish.

2/ The 1991 catch projections for Southeast Alaska and Kodiak were set after considering additional information on catch and forecast error trends. The Southeast Alaska pink salmon catch is projected to be 45 million and the Kodiak pink salmon catch is projected to be 17 million.

3/ Includes intersepted Chignik bound salmon.

4/ Bristol Bay harvest includes South Peninsula quota.

Table 9. Comparison of actual and forecast 1990 salmon runs, with errors and relative errors for some major Alaskan salmon fisheries. Units are millions of fish. 1/

Area	Species	1990 Harvest	1990 Escapement	Run 2/	Forecast Harvest	Forecast Run	Error 3/	Relative Error 4/
Southern Southeast	Pinks	25.7	7.0					
Northern Southeast	Pinks	4.2	3.7					
SE Troll	Pinks	1.3	----					
Southeast Total	Pinks	31.2	10.7	41.9	9.6	20.4	-21.5	-51.3%
Prince William Sound	Pinks	44.16	1.33	45.49	26.2	28.61	-16.9	-37.1%
	Chums	0.97	0.30	1.27	1.48	1.839	0.57	45.3%
PWS Coghill District	Sockeye	0.012	0.009	0.021	0.01	0.0602	0.039	183.7%
Copper River	Sockeye	0.84	0.66	1.50	0.66	1.372	-0.13	-8.6%
	Chinook	0.029	0.011	0.040	0.0371	0.0521	0.012	29.2%
Upper Cook Inlet	Sockeye	3.60	1.50	5.10	4.3	5.80	0.70	13.7%
Lower Cook Inlet	Pinks	0.384	0.316	0.70	1.815	2.142		
Kodiak	Pinks	5.98	5.88	11.86	11.79	15.96	4.10	34.5%
Upper Station, Early	Sockeye	0.106	0.056	0.162	0.02	0.07	-0.092	-56.8%
Upper Station, Late	Sockeye	0.512	0.198	0.710	0.211	0.386	-0.324	-45.6%
Frazer	Sockeye	0.753	0.227	0.980	0.394	0.564	-0.416	-42.4%
Chignik	Sockeye	2.09	0.77	2.86	1.17	1.82	-1.04	-36.4%
Bristol Bay	Sockeye	33.2	14.6	47.8	16.0	26.7	-21.1	-44.1%
Nushagak	Chinook	0.033	0.088	0.121	0.041	0.116	-0.005	-4.1%
Total		123.8	36.6	160.5	73.7	105.9		

1/ Table updated January, 30 1991.

2/ Run is harvest plus escapement or escapement Index.

3/ Error is forecast run minus run.

4/ Relative error is error divided by run times 100%.

Table 10. Forecasted return, harvest, escapement goal, preliminary return, escapement, harvest, management error (ie, the difference between realized escapement and escapement goal), and return forecast error for major salmon fisheries where formal forecasts are made, 1970-1990, with projected and realized Alaskan commercial salmon harvests with absolute and relative error, 1970-1990. Figures are in units of thousands of fish.

Year	Forecasted		Actual (Note Figures Based on Preliminary Data)				Only Major Fisheries Where Formal Forecasts Are Made				Projected Collective Harvest of all Alaska Salmon Fisheries				Forecasted Harvest Relative to Projected Statewide Harvest
	Return	Harvest	Escapement Goal	Return	Escapement	Harvest	Management Error 1/ (thousands)	%	Forecast Error 2/ (thousands)	%	Projected Harvest	Actual Harvest	Error 3/ Error 4/	Relative Error 4/	
1970	114,347	77,080	37,267	64,653	17,271	47,382	19,996	54%	49,694	77%	95,500	68,500	27,000	39%	81%
1971	41,140	28,110	13,030	50,780	18,643	32,137	(5,613)	-43%	(9,640)	-19%	41,500	47,500	(6,000)	-13%	68%
1972	52,790	30,470	22,320	30,995	13,616	17,379	8,704	39%	21,795	70%	46,700	32,000	14,700	46%	65%
1973	38,650	18,820	19,830	21,650	10,636	11,014	9,194	46%	17,000	79%	30,000	22,300	7,700	35%	63%
1974	27,830	7,500	20,330	29,150	19,334	9,816	996	5%	(1,320)	-5%	15,600	21,900	(6,300)	-29%	48%
1975	28,740	8,435	20,305	45,937	28,496	17,441	(8,191)	-40%	(17,197)	-37%	19,900	26,200	(6,300)	-24%	42%
1976	45,202	25,702	19,500	48,940	18,860	30,080	640	3%	(3,738)	-8%	37,100	44,400	(7,300)	-16%	69%
1977	43,650	23,740	19,910	56,495	21,695	34,800	(1,785)	-9%	(12,845)	-23%	34,700	50,800	(16,100)	-32%	68%
1978	70,323	48,737	21,586	97,940	36,020	61,920	(14,434)	-67%	(27,617)	-28%	62,900	82,300	(19,400)	-24%	77%
1979	84,960	57,210	27,750	108,323	37,985	70,338	(10,235)	-37%	(23,363)	-22%	72,000	88,800	(16,800)	-19%	79%
1980	124,930	86,360	38,570	144,096	62,490	81,606	(23,920)	-62%	(19,166)	-13%	102,600	110,000	(7,400)	-7%	84%
1981	78,500	55,420	23,080	116,095	28,895	87,200	(5,815)	-25%	(37,595)	-32%	74,500	113,300	(38,800)	-34%	74%
1982	136,060	109,940	26,120	105,503	27,983	77,520	(1,863)	-7%	30,557	29%	135,000	109,100	25,900	24%	81%
1983	97,210	74,330	22,880	129,363	28,672	100,691	(5,792)	-25%	(32,153)	-25%	94,000	127,200	(33,200)	-26%	79%
1984	119,068	81,671	37,397	150,034	47,410	102,624	(10,013)	-27%	(30,966)	-21%	103,560	132,505	(28,945)	-22%	79%
1985	123,629	86,891	36,738	164,115	43,916	120,199	(7,178)	-20%	(40,486)	-25%	108,241	144,610	(36,369)	-25%	80%
1986	147,935	113,532	34,403	137,827	37,257	100,570	(2,854)	-8%	10,108	7%	138,015	127,864	10,151	8%	82%
1987	95,275	66,736	30,839	105,932	30,697	75,235	142	0%	(10,657)	-10%	94,132	95,525	(1,393)	-1%	71%
1988	135,602	101,613	34,264	87,172	24,924	62,248	9,340	27%	48,430	56%	134,996	98,575	36,421	37%	75%
1989	133,900	102,400	31,500	184,000	54,400	129,600	(22,900)	-73%	(50,100)	-27%	127,000	156,000	(29,000)	-19%	81%
1990	106,900	74,500	31,922	160,500	36,700	123,800	(4,778)	-15%	(53,600)	-33%	108,224	153,000	(44,776)	-29%	69%
1970-90															
Averages	87,935	60,914	27,121	97,119	30,757	66,362	(3,636)	(0)	(9,184)	(0)	79,818	88,209	(8,391)	(0)	
Averages without regard to sign							8,304	31%	24,721	31%			18,759	24%	

1/ Management Error is Escapement minus Escapement Goal
2/ Forecast Error is Return minus Actual Return
3/ This error is Projected Harvest minus Actual Harvest
4/ Forecast Harvest as a percent of Harvest Projection

**PRELIMINARY FORECASTS OF 1991 SALMON RUNS TO
SELECTED ALASKA FISHERIES**

The Alaska Department of Fish and Game's management program includes a number of salmon run forecast projects. Forecasted fisheries are selected using several criteria, including economic importance, feasibility, compatibility with existing programs, and management needs. For the 1991 fishing year, forecasted fisheries are:

Southern Southeast	-	pink salmon
Northern Southeast	-	pink salmon
Lynn Canal	-	sockeye salmon
Prince William Sound	-	pink, chum, hatchery coho and Coghill District sockeye salmon
Prince William Sound/ Copper River	-	sockeye and chinook salmon
Upper Cook Inlet	-	sockeye salmon
Kodiak	-	pink salmon
Chignik	-	sockeye salmon
Bristol Bay	-	sockeye and chinook salmon

A variety of information was used to make salmon run forecasts: escapement magnitudes and distribution, egg deposition, survival to intermediate life stages, high seas abundance, environmental conditions, and population age composition. A range of run possibilities are predicted for each forecast 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.

Forecast abstracts are given below; the reader is referred to the Appendix for further details. Table 8 provides a run forecast, harvest projection, and forecast ranges for all fisheries forecasted in 1991. Table 9 provides information on the accuracy of the 1990 forecast. Table 10 shows the historic performance of the statewide forecast total.

Southeast Alaska Pink Salmon

After several years of large forecast errors, an extremely large pink salmon run is forecasted for Southeast Alaska. The forecast is for 98.1 million fish. If a run materialized at near this level the harvest potential in Southeast Alaska could exceed the average harvest of all pink salmon in the entire state of Alaska during the 1980s—a period of record pink salmon production. Subtracting the escapement goal of 30.75 million from the forecasted run, leads to a catch forecast of 67.3 million.

After examining recent forecast errors and catch trends, it appears that this harvest level may be considerably too high. A time series based analysis of Southeast Alaskan harvests resulted in a projection estimate of a harvest of 28 million fish, falling in the range of 16 to 50 million pink salmon. The forecast run, minus the escapement goal, results in a forecast catch of 67.3 million pink salmon. This level of harvest may not be possible even if the run is strong enough to support it. A weighted average of these two indicators results in a projection of 45 million. This value would be a large catch, and is well within the forecast ranges of both methods. The harvest projection was set at 45 million. Although the potential definitely exists for a large run, we are very uncertain about the size of the run.

Lynn Canal Sockeye Salmon

This is the first year of a formal Lynn Canal sockeye salmon run forecast. The forecast is for an above-average run into Chilkoot Lake and a below-average run into Chilkat Lake. The Lynn Canal harvest is forecasted to be 482 thousand sockeye salmon.

Prince William Sound Pink, Chum, Coghill River Sockeye Salmon, and Hatchery Coho Salmon

Again in 1991 we are expecting a below-average wild run of pink salmon into Prince William Sound. The forecast for the hatchery run is 36.9 million pink salmon, which is more than double recent odd year hatchery run estimates. In recent years we have had extremely large forecast errors in Prince William Sound, and we are very unsure about the size of the run. The 1991 run of pink salmon will be the offspring of fish that returned into the 1989 Prince William Sound oil spill. What effect that will have on the 1991 return is impossible to know at this time.

The forecast for the chum salmon run is for an above average run of 2.35 million. This forecast is over twice the 1974-1987 average. This is based on an expected below-average wild run and additional hatchery production.

The forecast for sockeye salmon into Coghill district is for a very small run that likely will not support any directed harvest. The Main Bay Hatchery, however, is expected to provide a harvest of 163.1 thousand sockeye salmon. Hatchery production of coho salmon is expected to reach 338.9 thousand fish in 1991. The harvest of all coho in Prince William Sound is expected to be near 336.1 thousand fish.

Copper River Sockeye and Chinook Salmon

In 1991 the sockeye salmon run to Copper River is expected to be 1,583 thousand sockeye salmon, including both wild and hatchery runs. This is expected to result in a harvest of 869 thousand sockeye salmon in the Copper River fishery, an amount similar to the 1990 harvest. The chinook salmon run is expected to be 56.5 thousand fish. This is expected to result in a harvest of 41.5 thousand fish, approximately twice the 1990 harvest.

Upper Cook Inlet Sockeye Salmon

The sockeye salmon run forecast is 4.7 million, which is expected to result in a harvest of 3.2 million fish. This is 11% lower than the 1990 harvest.

Lower Cook Inlet Pink Salmon

In lower Cook Inlet, the pink salmon run is forecasted to be 2.56 million fish. This is expected to yield a harvest 2.15 million fish.

Kodiak Pink Salmon

The Kodiak pink salmon run is expected to be far above average. The run is forecast to be 22.8 million, based on a variety of information including fry sampling. The forecast run minus the escapement goal results in 20.5 million fish available for harvest. An analysis of trends in catch and recent forecast errors suggest that this number may be far too high. The catch projection was set at 17.0 million, based on the lower end of the forecast range, as explained in Appendix A.7. A harvest of this size is a near-record catch for the Kodiak area.

Bristol Bay Sockeye and Chinook Salmon

The 1991 Bristol Bay sockeye forecast is based on slightly different methods than previous forecasts. These new methods are expected to result in fewer underforecasts. The run is forecasted to be 31.9 million fish, which is expected to result in an inshore harvest of 21.2 million sockeye salmon. This would be a slight drop from recent sockeye salmon catch levels in Bristol Bay. Nushagak District chinook salmon have been in decline through the late 1980s. The 1991 forecast is for a slight increase in run size over recent levels. A run of 119.7 thousand chinook salmon is forecasted, with a forecasted harvest of 44.7 thousand.

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APPENDIX

APPENDIX A.1 SOUTHEAST ALASKA PINK SALMON

FORECAST AREA: Southeast Alaska

SPECIES: Pink Salmon

FORECAST OF THE 1991 RUN:

	Forecast Estimate <u>(millions)</u>	Forecast Range <u>(millions)</u>
NATURAL RUN COMPONENT:		
Southern Southeast		
Total Run	72.7	38.0-107.4
Escapement Goal	18.8 ¹	15.0-22.5
Harvest Estimate	50.2	15.5-84.9
Northern Southeast		
Total Run	24.2	16.9-34.6
Escapement Goal	12.0 ¹	
Harvest Estimate	12.2	4.9-22.6
SUPPLEMENTAL RUN COMPONENT:		
Southern Southeast		
Run Estimate	0.2	
Northern Southeast		
Run Estimate	1.0	
COMBINED NATURAL AND SUPPLEMENTAL RUN:		
Total Run	98.1	
Escapement Goal	30.8 ¹	
Harvest Estimate	67.3	
Harvest Projection ²	45	

¹These escapement goals are higher than previous years because we have changed from reporting an index goal to attempting to estimate the true escapement. An expansion factor of 2.5 was applied to the escapement index to convert the index to an estimate of total escapement. In addition the escapement index goal for southern Southeast Alaska was changed from a point goal of 6.0 million to a range of 6.0 to 9.0 million.

²A separate harvest projection was derived to reconcile the large forecast with expectations based on recent trends in catch and in forecast errors [Ed.].

FORECAST METHODS

Returns to the southern and northern areas of Southeast Alaska are forecast separately because of differences in migration routes and run timing. This year the total escapement, rather than an escapement index, was estimated for the return predictions by multiplying the escapement index by 2.5. The change was made to more accurately reflect spawner-recruit relationships.

The southern Southeast Alaska return forecast is based on a variance-weighted, non-linear regression using 24 years of data (1967–1990). Independent variables used in the analysis were brood year escapement index, average daily minimum air temperatures for five stations in southern Southeast Alaska during November 1 through February 28, and a total escapement index from the two previous brood years. The formula used to obtain the midpoint was:

$$\text{Return} = b_1 \text{ esc} \cdot \exp[b_2 \cdot \text{esc}^6 + b_3 \cdot \text{pesc} + b_4 \cdot \text{wtemp}]$$

where: esc = brood year escapement index
pesc = total of previous two brood year escapement indices
wtemp = average minimum winter air temperature

Multiple linear regression analysis was used to forecast pink salmon returns to northern Southeast Alaska. Independent variables in the regression were the brood year escapement index and the average weight of fry collected in Tenakee Inlet during May 16 through May 31.

FORECAST DISCUSSION

Southern Southeast Alaska: The southern Southeast Alaska forecast has been extremely inaccurate over the last 4 years, severely overestimating 1987 and 1988 returns and underestimating the returns in 1989 and 1990. The errors in 1989 and 1990 can be explained by including an additional independent variable (previous two brood year escapements) in the regression formula. The error in the 1987 prediction is understandable, because the brood year escapement index was the largest on record at the same time that winter temperatures were near record lows. No explanation has been found for the error in 1988. The possibility that overescapement caused the poor returns in 1987 and 1988 was investigated by incorporating the data into a Ricker model. However, a simple Ricker model did not significantly improve the accuracy over the linear models.

A desire to include all data between 1967 and the present into the prediction model required using the non-linear model presented above. This model is a three-parameter Ricker model in which escapement is raised to a power. This allows for differently shaped curves than the standard Ricker curve and results in a fit similar to that obtained from a linear model with return years 1987 and 1988 omitted. The mid points of the 1991 prediction differed by only 1.8 million; however, the prediction range on the linear model was unrealistically narrow (60.5–88.6 million). In addition, a plot of the residuals in the linear model revealed a missing curvilinear component to the model.

Although none of the variables used in calculating the 1991 prediction were outside of a range previously observed, all three were well above average. It should be stressed that there was no program to estimate

early marine fry abundance in southern Southeast Alaska in 1990. Consequently, there was no independent verification of the forecast. These authors realize that the upper end of the prediction range is well above any realistic expectation. It is only presented because it was what was computed as the upper bounds of the 80% prediction interval. A more realistic although subjective range would probably be the lower end of the nonlinear prediction range (38.0 million) and the upper end of the linear model (88.6 million).

The harvest estimate was computed by assuming that if the actual return is close to predicted levels, the escapement index achieved should be at or near the upper end of the escapement index goal range (9.0 million).

Northern Southeast Alaska: This was the second year that fry size data from the Tenakee Inlet early marine study was used to predict the pink salmon return to northern Southeast Alaska (Districts 109–115). The 1990 return of 9.2 million was well within the predicted range of 3.5 to 13.2 million. Two changes were made in this year's prediction model. First, fry weight rather than length was used as an independent variable. Although these two are highly correlated, using weight resulted in a higher r^2 value. Secondly, we ran the regression using the log of the return and log of the escapement index because, like southern Southeast Alaska, a plot of the residuals from a strictly linear model indicated a curvilinear component. Due to the smaller number of data points in northern Southeast ($n = 9$) a nonlinear regression was deemed inappropriate, while the log-transformed model appeared to satisfy the standard regression assumptions.

The brood year escapement index for northern Southeast Alaska of 4.5 million was slightly below the index goal of 4.8 million. The escapement distribution, however, was much better than in 1989 in that all districts, with the exception of Districts 113 and 114, met goal levels. More importantly, there were no areas of extremely weak brood year escapement levels as was the case last year in Seymour Canal. Consequently, the less conservative management required in the area should allow for increased harvesting pressure in Districts 109 and 110. It is also possible that increased harvest pressure may be possible early in the season to intercept an anticipated strong return to the Taku River.

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APPENDIX A.2 LYNN CANAL SOCKEYE SALMON

FORECAST AREA: Lynn Canal, Southeast Alaska

SPECIES: Sockeye Salmon

FORECAST OF THE 1991 RUN:

	<u>Point Estimate (thousands)</u>	<u>Forecast Range (thousands)</u>
Chilkoot Lake		
Total Run	315	216-457
Escapement Goal	63	
Harvest Estimate	252	
Chilkat Lake		
Total Run	168	63-446
Escapement Goal	65	
Harvest Estimate	103	
Lynn Canal		
Total Run	483	314-741
Escapement Goal	128	
Harvest Estimate	355	186-613

FORECAST METHODS

The Chilkoot Lake forecast is the summation of run forecasts for the early and late stocks returning to that system. A multiple linear regression generated the early stock forecast with independent variables for parent escapement, fall precipitation, and average monthly winter temperature. The late stock forecast is the sum of three parts: two linear regressions, to predict age-1.3 and age-2.3 returns, and a simple average of all other age classes. Linear regressions for both the late stock 3-ocean-age fish used both parent year escapement and the size and abundance of previous year siblings. The data set for both is relatively short, consisting of eight brood years, 1977-1984. The overall Chilkat Lake forecast was summed from results of two linear regressions, the first for age-1.3 fish and the second for age-2. fish.

Independent variables for age-1.3 fish were the abundance and length of male sibling age-1.2 fish; the

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dependent variable in the regression was the natural logarithm of the ratio of the return age-1.3 sockeye to total parent escapement.

Independent variables for age-2. fish were parent year escapement of age-2.2 fish and precipitation in subsequent winter and spring. The database for Chilkat forecasts consisted of the 10 most recent brood years.

FORECAST DISCUSSION

Chilkoot Lake.

The forecasted run of 315,000 fish for 1991 is 12% above the 1981–1990 average of 282,000 sockeye salmon. Survival in Chilkoot egg/alevin stage can be reduced by high fall rainfall, which results in scouring and sedimentation, and low winter temperatures. Measures of these variables were favorable in the parent year. The 1986 parent year escapement was 88,024 fish, or about 25,000 above the present goal. Both the abundance and size of sibling age-1.2 fish were slightly below the goal, resulting in only a slightly above average forecast for age-1.3 fish. Additionally, one length data point in the age-2.2 database contributed greatly to the age-2.3 and overall variance estimates; we chose to include that point to reflect inherent variability. We feel the 1991 run may come in slightly higher than forecast because the environmental parameters, which were favorable, were not used for the late stock forecast.

Chilkat Lake.

The forecasted run of 168,000 fish for 1991 is 13% below the average of 194,000 for 1981-1990. Survival in Chilkat Lake appears to be enhanced by precipitation in the winter and following spring. This measure was above average for the 1986 brood year. However, parent year escapements were 58,000 in 1985 and 24,000 in 1986, the lowest on record. Abundance of age-1.2 fish was above average and length of males was below average. Favorable environmental conditions with a weak parent year escapement for 5-year-old fish resulted in a below average forecast, which we believe to be a realistic picture for the 1991 Chilkat Lake run.

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NSEAK/Yakutat Sockeye Salmon

Jim Blick
Region I Biometrician

**APPENDIX A.3 PRINCE WILLIAM SOUND PINK, CHUM, AND COHO SALMON
AND COGHILL AND MAIN BAY SOCKEYE SALMON FORECASTS**

FORECAST AREA: Prince William Sound (PWS)

SPECIES: Pink Salmon

FORECAST OF THE 1991 RUN:

	Point Estimate <u>(millions)</u>	Forecast Range <u>(millions)</u>
NATURAL RUN COMPONENT:		
Total Run	7.46	2.76-20.54
Escapement Goal	1.35	
Harvest Estimate	6.11	1.36-19.19

SUPPLEMENTAL RUN COMPONENT:

VFDA - Solomon Gulch Hatchery

Total Run	3.76	0.00-8.11
Brood Stock Needs	0.30	
Sales Harvest Goal	0.80	
Common Property Harvest	2.66	0.00-7.01

VFDA - Boulder Bay Remote Release Site

Total Run	2.36	0.00-5.07
Brood Stock Needs	0.00	
Sales Harvest Goal	1.87	
Common Property Harvest	0.49	0.00-3.20

PWSAC - Armin F. Koernig Hatchery (AFK)

Total Run	6.46	2.17-10.74
Brood Stock Needs	0.21	
Sales Harvest Goal	1.63	
Common Property Harvest	4.62	0.33-8.90

PRINCE WILLIAM SOUND PINK SALMON (continued)

	Point Estimate <u>(millions)</u>	Forecast Range <u>(millions)</u>
PWSAC - Wallace H. Noerenburg Hatchery (WHN)		
Total Run	13.61	5.30-21.92
Brood Stock Needs	0.34	
Sales Harvest Goal	3.45	
Common Property Harvest	9.82	1.51-18.13
PWSAC - Cannery Creek Hatchery		
Total Run	10.68	1.06-20.30
Brood Stock Needs	0.30	
Sales Harvest Goal	1.86	
Common Property Harvest	8.52	0.00-18.14
TOTAL SUPPLEMENTAL RUN:		
Total Run	36.87	8.53-66.16
Brood Stock Needs	1.15	
Sales Harvest Goal	9.61	
Common Property Harvest	26.11	0.00-55.41
COMBINED NATURAL AND SUPPLEMENTAL RUNS:		
Total Run	44.33	11.23-86.70
Natural Escapement Goal	1.35	
Brood Stock Needs	1.15	
Sales Harvest Goal	9.61	
Common Property Harvest	32.22	0.00-74.59

FORECAST METHODS

The forecast for natural returns is based on a linear regression of the upstream component of the pre-emergent fry index versus log-transformed total returns. The pre-emergent fry index (*I*) was calculated as follows:

$$A_y = \frac{\sum F_y}{m_y^2}$$

$$I = \frac{\sum A_i}{S}$$

PRINCE WILLIAM SOUND PINK SALMON (continued)

Where: F_j = number of fry in the upstream zone of stream j ,
 m_j^2 = square meters sampled in the upstream zone of stream j ,
 S = number of index streams sampled.

The range about the natural stock forecast is an 80% confidence interval using a cross-validation method. The hatchery run forecast is the sum of hatchery-specific forecasts. For each hatchery the forecast is the product of the number of fry released times the average hatchery-specific marine survival, which is the mean marine survival for all years of production for the hatchery. The forecast range is derived from the 80% confidence interval around the mean of the marine survival estimates. The ranges of reported hatchery stock marine survivals in PWS are large, and the number of years of data is small. Therefore the 80% confidence intervals around hatchery forecasts are very large.

Unfortunately, the marine survival data reported by hatcheries are suspect. For most years in the historical data base for PWS hatcheries, marine survival estimates are probably little more than best guesses. Total returns were estimated as the sum of hatchery terminal area harvests and brood stock divided by an educated guess of the exploitation rate on all stocks in the common PWS property fisheries. The accuracy of these estimates are unknown and there are no associated measurements of precision. Since 1987 some run estimates are based on coded-wire tag recovery data. Confidence in this data is greater, but there are only 3 years of observations for each facility.

The projected broodstock needs for each facility are fairly accurate. The sales harvest numbers are only preliminary and may vary depending on changes in projected operating costs, the final value for the 1990 sales harvests, the revenue generated for hatcheries from a 2% assessment on area salmon harvests for 1990, and the projected prices for 1991.

The escapement, brood stock, and sales harvest requirements are treated as constants and the confidence interval for the common property harvest is the same as for the total return.

FORECAST DISCUSSION

The projected 7.46 million wild stock pink salmon return in 1991 is below the average odd year run of 9.97 million fish. Traditionally, the upstream portion of the fry index, used for the odd year forecast, has been given more weight than the index from the intertidal areas (75% versus 25%). The current historical pre-emergent fry data set for odd brood years appears to forecast as well or better when based solely on the upstream data. The 1990 upstream index was below average. Though not included in the 1991 forecast, the indices for the intertidal areas were also below average. Marine temperatures in the spring of 1990 were mild, but the correlation between March and April air temperatures in the year of emergence and subsequent odd year returns is poor. Therefore, there is no reason to suspect that a mild spring in 1990 will positively affect marine survival of the emergent fry from the 1989 brood year.

The point estimate of 36.9 million fish returning to hatcheries in 1991 is by far the largest forecasted run of hatchery fish in PWS since the inception of the hatchery program and is almost double the recent odd year average hatchery run. The increase in hatchery returns is primarily a function of expanded

production at the WHN and Cannery Creek hatcheries. The 1991 forecast is based on hatchery-specific marine survival data rather than the blanket 5.3% survival figure used to forecast the odd year return in 1989. The 5.7% mean marine survival rate for AFK in odd years is based on 7 years of data, and the confidence bounds are reasonable narrow (4.85% to 5.30%). There are only two years of data for WHN hatchery, and the variance was unrealistically high. As a compromise, WHN data were pooled with 7 years of data from AFK to calculate reasonable confidence bounds around the WHN forecast. The success of odd year returns to the Solomon Gulch and Cannery Creek hatcheries has varied. Though the average marine survivals are good (5.0% and 7.4%, respectively), the variances around these means are large. The survival rate for the remote fry release at Boulder Bay was excellent in 1990, but the odd year database is limited to a small return in 1989. Marine survival data for Solomon Gulch releases will be used to forecast these returns until more years of data are available. There were no releases of pink fry in Main Bay in 1990; hence, there will be no pink returns to that facility in 1991.

FORECAST AREA: Prince William Sound

SPECIES: Chum Salmon

FORECAST OF THE 1991 RUN:

	Point Estimate <u>(thousands)</u>	Forecast Range <u>(thousands)</u>
NATURAL RUN COMPONENT:		
Total Run	505.0	284.9-895.3
Natural Escapement Goal	225.5	
Harvest	279.5	59.4-669.8
SUPPLEMENTAL RUN COMPONENT:		
VFDA - Solomon Gulch Hatchery		
Total Run	48.3	11.9-84.8
Brood Stock Needs	25.0	
Sales Harvest Goal	0.0	
Common Property Harvest	23.3	0.0-59.8
PWSAC - Wallace H. Noerenburg Hatchery (Early Stock)		
Total Run	1,305.2	321.4-2,288.9
Brood Stock Needs	115.0	
Sales Harvest Goal	0.0	
Common Property Harvest	1,190.2	206.4-2,173.9
PWSAC - Wallace H. Noerenburg Hatchery (Late Stock)		
Total Run	96.7	23.8-169.6
Brood Stock Needs	10.3	
Sales Harvest Goal	20.8	
Common Property Harvest	65.6	97.8-696.8
ADF&G/F.R.E.D. Division - Main Bay Hatchery		
Total Return	397.3	97.8-696.8
Brood Stock Needs	0.0	
Sales Harvest Goal	0.0	
Common Property Harvest	397.3	97.8-696.8

PRINCE WILLIAM SOUND CHUM SALMON (continued)

	Point Estimate <u>(thousands)</u>	Forecast Range <u>(thousands)</u>
TOTAL SUPPLEMENTAL RUN:		
Total Return	1,847.5	454.9–3,240.1
Brood Stock Needs	150.3	
Sales Harvest Goal	20.8	
Common Property Harvest	1,676.4	283.8–3,240.0

COMBINED NATURAL AND SUPPLEMENTAL RUNS:

Total Return	2,352.5	739.8–4,135.4
Natural Escapement Goal	225.5	
Brood Stock Needs	150.3	
Sales Harvest Goal	20.8	
Common Property Harvest	1,955.9	343.2–3,738.8

FORECAST METHODS

The natural stock forecast is the pooled results of three separate regressions in which the returns of 3- and 4-year-old fish are predicted from pink returns from the same brood year, and 5-year-old fish are predicted from sibling 4-year-old returns in 1989. To generate a forecast interval, the returns for years 1974 through 1990 were predicted by hindcasting using a cross-validation procedure with these same models.

The hatchery returns for 1991 are projected from fry releases in 1987, 1988, and 1989, an estimated marine survival of 2.28%, and average age composition data for natural chum returns from brood years 1978 through 1985. The marine survival rate is based on 5 years of fry release and adult return data from the ADF&G Main Bay hatchery. This is the only hatchery for which formal quantitative methods (coded-wire tagging results) were used to estimate the portion of the adult returns intercepted in the commercial harvest, hence the only one with reliable total return estimates.

FORECAST DISCUSSION

The forecast for natural chum returns in 1991 is only 50% of the 1974 to 1990 average. The low forecast is due to poor returns of pink salmon from the 1987 and 1988 brood years. These regressions may seem suspect as they are based on "siblings" of another species; they are, however, corroborated by similar predictions based on regressions between chum salmon sibling age groups. Intraspecies models for sibling age groups have been used to forecast in some prior years. The intraspecies models (i.e., chum salmon sibling models) explain less variability in returns of 3-year-old and 4-year-old chum salmon than the interspecific (i.e., chum and pink salmon) models.

Despite a wild stock forecast almost 290,000 fish below average, the overall harvest of chums in 1991 should exceed the 1974–1989 average by almost 1 million fish because of full production levels from the area hatcheries. The Main Bay hatchery, which previously produced chum salmon, has discontinued that species. Large fry releases at that facility in 1987 will still produce a respectable return of almost 400,000 five-year-old fish in 1991. In the absence of brood stock requirements, these returns can be fully

PRINCE WILLIAM SOUND CHUM SALMON (continued)

exploited. The WHN facility is now nearing peak production for chum salmon. The total return in 1991 may exceed 1.4 million fish for the early and late runs combined. From these returns the stock with early run timing could contribute approximately 1.2 million fish to the common property fisheries, and the late stock could contribute approximately 97,000 fish. The relatively small 48,000 fish return to Solomon Gulch will contribute approximately 23,000 fish to the common property fisheries.

There is a strong possibility that hatchery returns in 1991 may be in the lower end of the forecast range and well below the point estimate of 1.85 million. Age composition data from the commercial and sales harvests in 1990 and trends in the wild stock forecast suggest that the forecast for chum returns to PWS hatcheries based on average marine survival data may be too high. Poor returns of 3 and 4-year-old fish in 1990 may indicate poor marine survival for the 1986 and 1987 brood years for hatchery stocks as well as for wild stocks.

FORECAST AREA: Prince William Sound

SPECIES: Sockeye Salmon

FORECAST OF THE 1991 RUN:

	Point Estimate <u>(thousands)</u>	Forecast Range <u>(thousands)</u>
NATURAL RUN COMPONENT - Coghill Lake:		
Total Run	64.7	23.3-179.3
Natural Escapement Goal	50.0	
Harvest	14.7	0.0-129.3

SUPPLEMENTAL RUN COMPONENT:

ADF&G/F.R.E.D. Division - Main Bay Hatchery

Total Run	173.1	155.8-190.4
Brood Stock Needs	10.0	
Sales Harvest Goal	0.0	
Common Property Harvest	163.1	145.8-180.4

COMBINED NATURAL AND SUPPLEMENTAL PRODUCTION:

Total Run	237.8	179.1-369.7
Natural Escapement Goal	50.0	
Hatchery Brood Stock	10.0	
Sales Harvest Goal	0.0	
Common Property Harvest	177.8	13.7-159.4

FORECAST METHODS

The forecast for the Coghill Lake returns is the pooled result of 4 separate regressions. The returns of 4-year-old fish (age 1.2) are predicted from a regression of the log of the returns per spawner of fish aged 1.2 versus the brood year escapement. The returns of 5-year-old fish (age 1.3) are predicted from a sibling model using returns of fish aged 1.2 from the prior year. The mean return at age is used to predict 5-year-old fish (age 2.2). The 6-year-old fish (age 2.3) are predicted using a sibling model using the fish aged 2.2 from the prior year.

Although catch and escapement at age data exist for the Coghill sockeye returns from as far back as 1962, escapement data prior to the installation of the full weir in 1974 are unreliable. Escapement and catch at age data in the regressions are from 1974 to the present. To calculate a forecast range, the returns for

COGHILL DISTRICT SOCKEYE SALMON (continued)

years 1979 through 1988 were predicted by hindcasting, and the range was developed using a cross-validation procedure with these same models.

The forecast for Main Bay Hatchery returns is based on a marine survival rate of 20% for smolt releases in 1988 and 1989. The 1991 returns of 4- and 5-year-old fish will be the first significant adult returns to the Main Bay facility. The majority of the returns, 117,000 fish, are anticipated to be 4-year-old fish from the 1989 smolt release; the remainder will be a modest return of 56,000 five year-old fish from the 1988 smolt release. The only historic data for the Main Bay sockeye salmon facility is from the small return of 4-year-old fish in 1990. The 20% survival rate used for the 1991 forecast is only a best guess based on data from other areas. In the absence of any historic data, the forecast range is the estimated return for 18% and 22% (returns expected at $\pm 10\%$ of marine survival used for point estimate).

FORECAST DISCUSSION

The forecasted total return of approximately 64,700 sockeye salmon to Coghill Lake in 1991 is the second lowest forecast on record. Only the 1990 forecast was lower. Given the 50–60,000 fish escapement goal for Coghill Lake and the likelihood that several thousand Coghill Lake sockeye will be intercepted in the fisheries directed at early returns of chum salmon to the WHN and Main Bay hatcheries, it is unlikely there will be any directed fishery for sockeye salmon in the Coghill District in 1991.

The poor forecast is largely due to the extremely poor returns of 3- and 4 year-old fish in 1990 and may actually be too optimistic. The majority (70%) of returns to Coghill have historically been 5-year-old fish aged 1.3. The returns of 4-year-old fish in 1990 were among the lowest ever recorded; this bodes poorly for 5-year-old returns aged 1.3 in 1991. Traditionally, a sibling model has been used for predicting 4-year-olds from 3-year-olds in the prior year, but due to the total absence of 3-year-olds from the fishery in 1990, this model had to be abandoned for the less reliable model which regresses the log of the returns per spawner against the brood year escapement. Given the total absence of 3-year-old siblings in 1990, it is likely that the forecast for 4-year-old fish is too high.

The brood stock needs shown in the forecast summary are for the Main Bay Hatchery, which has been converted from a chum salmon hatchery to a sockeye salmon hatchery.

PWS SOCKEYE SALMON HARVEST PROJECTION OUTSIDE THE COGHILL DISTRICT

1991 Harvest Projection

	Point Estimate (thousands)	Forecast Range (thousands)
Common Property Harvest	86.5	13.7–159.4

COGHILL DISTRICT SOCKEYE SALMON (continued)

Harvest Projection Methods

The harvest projection is the mean of purse seine and gill net catches in PWS exclusive of the Coghill District since 1968. The 80% confidence interval is the 80% confidence interval around the mean.

Harvest Projection Discussion

The Eshamy Lake stock is by far the largest single contributor to the harvest of sockeye salmon outside the Coghill District. Many of these fish have historically been intercepted incidentally in the purse seine fishery in the Southwest District. The extent of these interceptions is unknown; hence, total return estimates have not been possible despite the fact that the escapement has been enumerated through a weir since 1939. In recent years, age, sex and size data has been systematically collected for the escapement to Eshamy Lake, the catch in the Eshamy District, and the incidental mixed stock catches in the Southwest District. We are now in a position to estimate the Eshamy Lake stock contribution in the mixed stock catches based on age composition and catch timing data. Catch composition data, escapement data, and catch and escapement age composition data can be used to construct brood tables. In a few years it may be possible to forecast these returns separately.

The overall harvest projection for sockeye salmon may be too high. The two stocks which contribute to the Unakwik District fishery are small relative to the Eshamy stock but are important minor contributors to the incidental sockeye catch; they have historically mimicked the Coghill stock in run performance. In light of the disastrous projection for the latter in 1991, the Unakwik District catches are also apt to be below average in 1991.

FORECAST AREA: Prince William Sound

SPECIES: Coho Salmon

FORECAST OF THE 1991 PWS COHO SALMON HATCHERY RUN AND NATURAL STOCK CATCH PROJECTION

	Point Estimate <u>(thousands)</u>	Forecast Range <u>(thousands)</u>
SUPPLEMENTAL RUN COMPONENT:		
VFDA - Solomon Gulch Hatchery		
Total Run	46.6	26.8-66.4
Brood Stock Needs	1.5	
Sales Harvest Goal	0.0	
Common Property Harvest	45.1	25.3-64.9
PWSAC - Wallace H. Noerenburg Hatchery		
Total Run	292.3	158.8-425.7
Brood Stock Needs	1.3	
Sales Harvest Goal	0.0	
Common Property Harvest	291.0	157.5-424.4
TOTAL SUPPLEMENTAL RUN:		
Total Run	338.9	185.6-492.1
Brood Stock Needs	2.8	
Sales Harvest Goal	0.0	
Common Property Harvest	336.1	182.6-489.3

FORECAST METHODS

The point estimates are the product of the number of smolt released from each facility in 1989 and the average marine survival for each facility. The forecast range is based on the 80% confidence interval about the mean of marine survival.

FORECAST DISCUSSION

The mean marine survival rates for Solomon Gulch and WHN Hatcheries are 5.9% and 11.7% respectively. The validity of these rates is unknown. Although the former is based on only 5 years of data and the latter on only 4 years of data, the variance is small. The natural stock run in PWS is small

and in recent years fisheries have been confined to a large degree to hatchery terminal areas. Total return estimates for hatchery stocks, hence marine survival estimates, are probably fairly reliable.

1991 Natural Stock Harvest Projection

	Point Estimate <u>(thousands)</u>	Forecast Range <u>(thousands)</u>
Common Property Harvest	8.2	0.0–21.3

Harvest Projection Methods

The harvest projection is the mean of the historical coho salmon harvest in PWS from 1968 to 1984. In years subsequent to 1984 there has been hatchery production of coho salmon in PWS, and the natural component of the catch has not been known. The harvest projection range is the 80% confidence interval about the 1968–1984 harvest mean.

FORECAST AREA: Prince William Sound Copper/Bering River

SPECIES: Coho Salmon

	Point Estimate <u>(thousands)</u>	Forecast Range <u>(thousands)</u>
Common Property Harvest		
Copper River District	291.6	124.3–415.4
Bering River District	120.3	0.0–224.9
Copper/Bering Total	411.9	124.3–640.3

Harvest Projection Method

The harvest projection is the mean performance of the fishery in the last 12 years, and the forecast ranges are the 80% confidence intervals about the mean.

Harvest Projection Discussion

For lack of a better method, the harvest projection of 411,900 fish for the combined Copper and Bering River Districts is based on the mean performance of the fishery from 1978 to 1989. The historical database for catch includes all years since statehood; but the fishery has changed, and data from more recent years is probably more representative of what to expect in 1991.

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The possibility of predicting total runs of Copper and Bering River coho salmon using forecast models which incorporate growing escapement catch-age composition databases should be investigated in future years. Escapement estimates are based solely on aerial surveys; since 1981 these surveys have been fairly systematic and reliable. A systematic sampling program for catch-age composition data has been in place since 1982. After one or two more years we will have a sufficiently long time series of age composition to generate brood tables.

Sam Sharr
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Cordova

**APPENDIX A.4 PRINCE WILLIAM SOUND --
COPPER RIVER SOCKEYE AND CHINOOK SALMON**

FORECAST AREA: Prince William Sound/Copper River

SPECIES: Sockeye Salmon

FORECAST OF 1991 RUN:

	Point Estimate <u>(thousands)</u>	Forecast Range <u>(thousands)</u>
NATURAL RUN COMPONENT:		
Total Run	1,360.0	1,196.0–1,524.0
Escapement Goal	614.0	
Harvest Estimate	746.0	657.0–837.0

SUPPLEMENTAL RUN COMPONENT:

Gulkana Hatchery

Total Run	223.0	178.0–267.0
Brood Stock and Stream Escapement	100.0	
Harvest Estimate	123.0	88.0–137.0

TOTAL RUN:

Total Run	1,583.0	1,419.0–1,747.0
Escapement and Brood Stock	714.0	
Harvest Estimate	869.0	779.0–959.0

FORECAST METHODS

Natural Production: The 1991 sockeye salmon forecast used historical return-per-spawner data and parent year escapement weighted by age class (4-, 5- and 6-year-olds) for the Copper River Delta and Upper Copper River independently. The 1991 predicted return is influenced heavily by the 1986 brood year for the Copper River Delta and the Upper Copper River.

Supplemental Production: The 1991 supplemental return will result from production from Gulkana Hatchery. Applying FRED Division standard survival assumptions to brood years 1986 and 1987, I expect an adult return of 222,700. A harvest level of 55% would contribute 112,500 salmon to the commercial catch.

FORECAST DISCUSSION

Natural Production: The 1991 run experienced relatively mild winter conditions, particularly on the Copper River Delta during the freshwater life history stage. These conditions should result in above average returns per spawner, although the average parent year escapements were below average in 1986 and 1987 and

Appendix A.4 (2 of 2)

above average in 1985. Upper Copper River escapements were near average in all 3 years. Thus generally mild conditions and good distribution should yield above average returns. The forecast will be low if environmental conditions continue to produce above average survival rates. Additionally, moderate fry densities should increase the return per spawner. Supplemental Production: Facility production data and conditions suggest a wide variation in survival. However, as future data is collected, predictions will become more reliable.

FORECAST AREA: Prince William Sound/Copper River

SPECIES: Chinook Salmon

FORECAST OF THE 1991 RUN:

	<u>Point Estimate (thousands)</u>	<u>Forecast Range (thousands)</u>
NATURAL RUN COMPONENT:		
Total Run	56.5	46.6-66.4
Escapement Goal	15.0	
Harvest Estimate	41.5	31.1-51.9

FORECAST METHODS

The 1991 chinook salmon forecast used historical aerial index and age composition data from the 4-, 5-, 6- and 7-year-old age classes. Weighted index figures are combined to create a single index of abundance which, for lack of information, is compared to the historical average escapement index. The forecast return is then based on the estimated return per spawner without regard to climate conditions or distribution of spawners.

FORECAST DISCUSSION

During the past 7 years, chinook salmon returns to the Copper River have been consistently above previous averages and have established several of the top catches on record. Escapements have also been maintained at high levels. Only a failure of the 1986 or 1987 brood years, or unexpected extra production from the 1985 brood year, could seriously affect the forecasted return. No unusual climate conditions or other events were observed during any of the brood years involved. A chinook salmon harvest of 41,500 fish appears to be a good estimate.

Kenneth Roberson
Research Biologist
Glennallen

APPENDIX A.5 UPPER COOK INLET SOCKEYE SALMON

FORECAST AREA: Upper Cook Inlet

SPECIES: Sockeye Salmon

FORECAST OF 1991 RUN:

	Point Estimate <u>(millions)</u>	Forecast Range <u>(millions)</u>
NATURAL RUN COMPONENT:		
Total Run	4.7	3.2-7.5
Escapement Goal	1.5	
Harvest Estimate	3.2	1.7-6.0

FORECAST METHODS

The major sockeye salmon systems in Upper Cook Inlet are the Kenai, Kasilof, Susitna, Crescent, Chakachatna/McArthur, Big Rivers, and Fish Creek.

Historical harvest data for Upper Cook Inlet were subjected to a Box Jenkins ARIMA modeling procedure. This time series approach appears to provide a better forecast tool than the classic escapement-return relationships used previously. Data on fry and smolt production in the Kenai and Kasilof Rivers were used to subjectively evaluate the model outputs.

FORECAST DISCUSSION

In 1990 the forecasted harvest using the Box Jenkins ARIMA model was 4.3 million fish. Actual harvest was 3.6 million fish or 84% of the forecast. The 1991 harvest forecast is 3.2 million fish, 11% lower than the 1990 harvest. Biological data on fry and smolt production in the Kenai and Kasilof Rivers suggest that the actual harvest will be lower than forecast. However, an insufficient number of years of fry and smolt data make formal forecasting using these data scientifically questionable.

Kenneth E. Tarbox
Research Project Leader
Upper Cook Inlet

APPENDIX A.6 LOWER COOK INLET PINK SALMON

FORECAST AREA: Lower Cook Inlet

SPECIES: Pink Salmon

FORECAST OF THE 1991 RUN:

	Point Estimate <u>(thousands)</u>	Forecast Range <u>(thousands)</u>
NATURAL RUN COMPONENT:		
Total Run:	1,366	337-5,865
Escapement goal ¹	372	275-470
Harvest Estimate ²	1,031	179-5,399
SUPPLEMENTAL RUN COMPONENT:		
Total Run	1,190	780-1,600
Brood Stock	70	70-70
Harvest Estimate	1,120	710-1,530
TOTAL AREA RUN:		
Total Run	2,556	1,117-7,465
Brood Stock and Estimate	442	345-540
Harvest Estimate ³	2,151	889-6,929

¹Escapement goals for those systems forecasted is 372,000. The total Lower Cook Inlet pink salmon escapement goal, including systems without a formal forecast, is 489,000.

²Port Graham and Rocky Bay runs are forecasted to be 37,000 fish below their escapement goals. Therefore, the harvest of 1,031,000 plus the escapement goal of 372,000 minus the escapement shortfall of 37,000 will add up to the forecast run.

³Additional harvest may be expected in systems without a forecast.

FORECAST METHODS

The 1991 forecast of pink salmon runs to the Lower Cook Inlet Management area was derived from log-log regressions of returns on escapements based on data from 1960 to 1989. The 1991 harvest estimate was obtained by subtracting the escapement goal from the forecast run by individual bays and river

systems. The sum of the harvest estimates for the individual bays and river systems was the total Lower Cook Inlet harvest estimate.

FORECAST DISCUSSION

The models used to prepare the forecast of Lower Cook Inlet pink salmon natural production have performed poorly in simulation tests, suggesting a 62% chance that the 1991 run will be less than or equal to the forecast. The natural production models were used for the first time last year. Nine of the actual runs were within the 80% confidence interval, two fell below, and one was above. There was an extremely large error in the Ursus and Rocky Cove system forecast. The 1990 natural run forecast was 49% greater than the actual run, and the 1990 forecast for the supplemental stocks was also greater than the actual run.

Pink salmon escapements in 1989 were uneven throughout Lower Cook Inlet. Barabara Creek, Port Graham, Windy Creek Right, Rocky River, Island Creek, South Nuka Island Creek, Aialik Lagoon, Resurrection Bay, Big and Little Kamishak Rivers, and Amakdedori Creek did not meet their escapement goals; Port Chatham and Brown's Peak Creek, on the other hand, received the highest escapements on record.

In the Southern District the harvests for 1991 are projected to be 71,000 in Humpy Creek, 290,000 in Halibut Cove Lagoon, 830,000 in Tutka Lagoon, 19,000 in Seldovia, and zero in Port Graham. Additional harvests are expected in China Poot Bay and the Barabara Creek area.

In the Outer District the harvests for 1991 are projected to be 1,000 in Dogfish Bay, 20,000 in Port Chatham, 5,000 in Windy Bay, zero in Rocky Bay, 250,000 in Port Dick, and 75,000 in the Desire Lake area of Nuka Bay.

In the Eastern District, the harvest for 1991 is projected to be 4,000 in Resurrection Bay.

In the Kamishak Bay District, the harvests for 1991 are projected to be 477,000 in Bruin Bay and 108,000 in Ursus and Rocky Coves.

Henry Yuen
C.F. Research Biologist

Nick Dudiak
F.R.E.D. Area Biologist
Lower Cook Inlet Management Area

APPENDIX A.7 KODIAK PINK SALMON

FORECAST AREA: Kodiak

SPECIES: Pink Salmon

FORECAST OF THE 1991 RUN:

	Point Estimate <u>(millions)</u>	Forecast Range <u>(millions)</u>
 NATURAL RUN COMPONENT:		
Total Run	19.7	18.2-21.1
Escapement Goal ¹	2.0	
Harvest Estimate	17.7	16.2-19.1
 SUPPLEMENTAL RUN COMPONENT: ²		
Hatchery Run	3.1	1.08-6.06
Escapement Goal	0.27	
Harvest Estimate	2.83	0.81-5.81
 TOTAL RUN:		
Total Run	22.8	19.3-27.2
Escapement Goal ¹	2.27	
Harvest Estimate	20.53 ³	17.0-24.9

¹With the exception of hatchery production, all escapement values represent indexed escapement.

²Hatchery production forecast is for Kitoi Bay Hatchery and was prepared by Tim Joyce. See Afognak District for additional description.

³An analysis of recent catches and forecast errors suggests that the harvest will be less than the forecast run minus the escapement goal. The harvest projection was set at 17 million [*Ed.*].

FORECAST METHODS

The 1991 pink salmon natural return forecast for Kodiak's natural return was determined as follows. A point estimate for the total return was calculated from a linear regression analysis of the past 25 years of pre-emergent data. Variables used in the analysis were the indexed live fry densities and the combined March-April "departure from the norm" ambient air temperatures taken in Kodiak. The upper and lower ranges are the 80% confidence intervals.

Average survival rates from 1978-1990 were used to compute the Kitoi Bay hatchery pink return point estimate. The low range estimate was calculated by using the average survival rate of the lowest 4 years and the high range was calculated by using the average survival rate of the highest 4 years.

FORECAST DISCUSSION

Pre-emergent fry sampling in the spring of 1990 indicated fair to excellent overwinter survival from the brood year escapement in 1989. In this year the vast majority of pink salmon returning to the Kodiak Management Area escaped the fishery because of extensive commercial fishery closures as a result of the 1989 *Exxon Valdez* oil spill.

Sampling resulted in an unweighted live fry index of 275.01 live fry/m², the highest on record for an odd year return. Sampling conditions during March and April 1990 were generally good. Both unusually high live fry density and moderate spring conditions were the main factors resulting in the record high 1991 pink salmon forecast. However, for planning purposes, actual harvest expectations may approach the lower end of the range at 17 million fish and may not exceed the point estimate of 20.5 million fish. Pink salmon returned in 1990 at lower than expected levels and at near record low average weights from Lower Cook Inlet to the Alaska Peninsula, including the Kodiak and Chignik Management Areas. If the marine conditions which may have affected the 1990 pink salmon returns have not improved, the 1991 return may also be lower than expected.

Afognak District: The pre-emergent fry index for the Afognak District is above average; fry production from Portage Creek and Little Waterfall was less than expected. Due to excellent early marine conditions, a total of 1.1 million pink salmon are expected to return. An escapement goal of 150,000 pink salmon leaves 950,000 available for harvesting.

Afognak District Supplemental Production: The Kitoi Bay Hatchery total pink salmon return point estimate is 3.1 million fish from a release of 84 million reared fry and 960,000 emergent fry; 270,000 pink salmon are needed for escapement and brood stock requirements, leaving 2.83 million available for harvesting. According to Hatchery Manager, Tim Joyce, a higher return should not be expected due to egg-to-fry survival problems and additional survival difficulties after release.

Westside District: Overall, live fry densities for this district were one of the highest on record due mainly to the exceptionally high level of live fry sampled in the Uyak River. Live fry indexes were lower than expected in the Terror and Uganik Rivers, which appeared to have scouring damage from flooding conditions in the fall of 1989. Due to the high numbers of pink salmon which spawned in areas less prone to scouring combined with the excellent early marine rearing conditions, 4.5 million pinks are expected to return to this district. The escapement goal is 400,000, leaving 4.1 million pink salmon available for harvesting.

Alitak District: Although some scouring and freezing damage was evident in all streams sampled, live fry densities for the Alitak district were excellent. As a result of the high fry densities and the very favorable early marine conditions, 6.5 million pinks are expected to return to this district. The escapement goal is 400,000, leaving 6.1 million pink salmon available for harvesting.

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General District: The overall live fry densities for this district is one of the highest on record. Damage from freezing and scouring was evident in most streams sampled. Barling, Kiliuda, and Buskin Rivers had lower than expected fry densities. Excellent early marine conditions combined with the overall excellent fry index should result in 5.7 million pinks returning to this district. The escapement goal is 650,000, leaving 5.05 million pink salmon available for harvesting.

Mainland District: Twelve streams were sampled between Kukak and Wide Bay, and appeared to have suffered scouring and freezing damage. Based on good overall fry densities and very good early marine conditions, 1.9 million pinks are expected to return to this district; 400,000 pink salmon are required for escapement, leaving 1.5 million available for harvesting.

David Prokopowich
Acting Area Management Biologist
Kodiak Management Area

APPENDIX A.8 CHIGNIK SOCKEYE SALMON

FORECAST AREA: Chignik Management Area

SPECIES: Sockeye Salmon

FORECAST OF THE 1991 RUN:

	Point Estimate <u>(thousand)</u>	Forecast Range <u>(thousand)</u>
Early Run (Black Lake stocks)		
Run Estimate:	2,763	2,340–3,180
Escapement Goal:	400	
Harvest Estimate:	2,363	
Late Run (Chignik Lake stocks)		
Run Estimate:	1,140	910–1,370
Escapement Goal:	250	
Harvest Estimate:	890	
Total Chignik Run		
Run Estimate:	3,900	3,120–4,680
Escapement Goal:	650	
Harvest Estimate:	3,250	
(Including interceptions)		

FORECAST METHODS

The estimated run to Black Lake is the sum of the predicted returns of two and 3-ocean sockeye; the Chignik Lake returns were calculated using all contributing age classes.

The Black Lake forecast is based on the historical relationship between run size and other predictors which include the prior year total return of age-1.2 fish, the average length of prior year age-1.2 male fish, and the parent year escapement. These variables provided the framework for the multiple linear regression model used to predict the 1991 return. The Chignik Lake forecast has historically been quite inaccurate. The forecast for 1991 was derived using an average return per spawner for each age class represented in the return.

FORECAST DISCUSSION

Early Run

The estimated run of Black Lake sockeye salmon in 1991 is 2.76 million fish. This is approximately 1.2 million fish more than the 1980–89 average run of 1.57 million. The 1986 parent year escapement was 566,100 fish, 166,100 above the 400,000 fish escapement goal. The estimated return of 335,200 age-1.2 fish in 1990 was twice the 10 year average of 160,000. The 1990 1.2 return was only 53,000 less than the 1983 1.2 return of 388 thousand which preceded the record run of 3.84 million in 1984.

Late Run

The estimated run of second run sockeye salmon in 1991 is 1.14 million fish, 40,000 more than the 1980–89 average of 1.10 million fish. The second run forecast has not predicted actual returns well. The 1985 parent year escapement of 369,200 fish was 119,200 above the 250,000 desired escapement goal. The average return per spawner for each contributing age class was used to forecast the run, and it is anticipated that the actual return will fall within the prediction bounds.

Mike Thompson
Area Management Biologist
Chignik Area

Dave Owen
Assistant Area Biologist
Chignik Area

APPENDIX A.9 BRISTOL BAY SOCKEYE SALMON

FORECAST AREA: Bristol Bay

SPECIES: Sockeye Salmon

FORECAST OF THE 1991 RUN:

	Point Estimate (millions)	Forecast Range (millions)
Total Run:	31.9	2.2-61.6
Escapement Goal:	8.7	7.6-12.1
South Peninsula Quota:	1.9	
Inshore Harvest:	21.2	0-47.6

Forecasted sockeye harvests for inshore Bristol Bay fishing districts are as follows: Naknek-Kvichak, 8.9 million; Egegik, 7.2 million; Ugashik, 2.8 million; Nushagak, 2.1 million; and Togiak, 0.2 million.

FORECAST METHODS

The 1991 Bristol Bay forecast is the sum of individual predictions for nine river systems: Kvichak, Branch, Naknek, Egegik, Ugashik, Wood, Igushik, Nuyakuk, and Togiak; and four age classes: age-1.2, 1.3, 2.2, and 2.3 sockeye salmon. Predictions for each age class returning to a river system were calculated by averaging the results from three simple linear regression models based on the relationship between returns and either spawners, siblings, or smolt. Results from each regression model were excluded from final forecast calculations if the slope of the line was not significantly different from zero ($p < 0.25$) or if the independent variable was outside the range of past data. The mean return of an age class to a specific river system was used to predict returns when none of the models could be used.

Data used for the 1991 forecast of sockeye returns were similar to those used for the 1989-1990 predictions. Production data from only recent years (1978-1990) were used to predict returns for systems on the eastside of Bristol Bay (Kvichak, Branch, Naknek, Egegik, and Ugashik Rivers); data from all available years (1956-1990) were used for systems on the westside of Bristol Bay (Wood, Igushik, Nuyakuk, and Togiak Rivers). Because the number of returning adults produced from each spawner has shown a dramatic increase for eastside systems since 1978, we thought that the use of recent data would provide more accurate and less biased predictions of run size. To estimate and compare the forecasting errors between the use of recent versus all data, predictions were made for seven past years (1984-1990). For eastside Bristol Bay predictions taken collectively, these results indicated that the use of the more recent data would increase accuracy (mean absolute percent error, 1984-1990: 24.9% using recent data, 42.4% using all data) and decrease bias (mean percent error, 1984-1990: -18.1% using recent data, -42.4% using all data). However, using the recent data for westside predictions resulted in large over-forecasting errors which reduced accuracy (mean absolute percent error, 1984-1990: 66.2% using recent data, 18.3% using all data) and increased bias (mean percent error, 1984-1990: 64.7% using recent data, -16.1% using all data).

Although use of the recent years reduced prediction errors for eastside rivers during the years 1984 to 1990, this method would nonetheless have under forecasted eastside returns in 5 out of 7 years. To further

correct this under-forecasting tendency, we increased the 1991 eastside forecast by the 1984–1990 average prediction error (30.38%). The average prediction error for years 1984–1990 was used because we were able to hindcast only those years using recent years. We also investigated trends in the prediction errors based on all years with regression and time series analysis. Both methods produced 1991 forecasts for eastside systems similar to that obtained by applying the 1984–1990 average prediction error. Therefore, we decided to use the simpler approach: average error corrections.

The mean squared error of the total run forecast was calculated from total run predictions made for 1987–1990 and was based on the same methods used for the 1991 forecast: use of recent years for eastside systems corrected by previous year's average error rate and the use of all years for westside systems. The mean square error was then used to estimate the standard error and 80% confidence bounds.

FORECAST DISCUSSION

Based on the method described above, 31.9 million sockeye salmon are expected to return to Bristol Bay in 1991. A run of this size would be 10% greater than the previous 20-year mean (29.0 million; range, 3.5–66.3 million), but 12% less than the previous 10-year mean (36.3 million; range, 24.0–48.9 million). Runs are expected to exceed spawning escapement goals for all systems.

The inshore harvest is expected to be 21.2 million sockeye salmon. A harvest of this size would be 33% greater than the previous 20-year mean (15.9 million; range, 0.7–37.3 million) but 9% less than the previous 10-year mean (23.4 million; range, 13.9–37.3 million). An additional 1.9 million Bristol Bay sockeye salmon will 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 harvest of 23.1 million).

Although out-of-range data were not used in calculations, they suggest how actual runs may deviate from the preseason forecast. A record 72.5 million age-I smolt migrated to sea during 1989, and a large number of age-1.2 sockeye salmon returned to Egegik River in 1990. This could result in a higher than forecasted return of age-1.2 and age-1.3 sockeye salmon to Egegik River. Additionally, a record number of age-I smolt migrated to sea in 1988 from Ugashik River. This could result in larger than expected returns of age-1.3 sockeye salmon to Ugashik River in 1991, although returns of 4-year-olds to Ugashik River in 1990 from the record smolt outmigration in 1988 were low. Low numbers of age-I smolt migrated to sea from Nuyakuk River in 1989. This could result in lower than forecasted returns of age-1.2 sockeye salmon to Nuyakuk River in 1991.

Beverly A. Cross
Research Project Leader

Barry L. Stratton
Research Biologist
Linda K. Brannian
Regional Biometrician

APPENDIX A.10 BRISTOL BAY NUSHAGAK DISTRICT CHINOOK SALMON

FORECAST AREA: Bristol Bay, Nushagak District

SPECIES: Chinook Salmon

FORECAST OF THE 1991 RUN:

	Point Estimate (thousands)	Forecast Range (thousands)
Total Run:	119.7	75.4-164.0
Escapement Goal:	75.0	
Projected Harvest:	44.7	0.4-89.0

FORECAST METHODS

The 1991 forecast of the chinook salmon run to Nushagak District is the sum of individual predictions for five age classes (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-1.3 returns for 1991 based on age-1.2 returns in 1990). However, predictions from regression models were used only if the slope of the line was significantly different from zero ($p < 0.25$) and the independent variable was within the range of past data. If these criteria were not met, the geometric mean return of an age class was used to predict returns.

Regression models were used to predict returns of two age classes: 1.3 and 1.4. Geometric means were used for the remaining three age classes (1.1, 1.2, and 1.5). In addition, the 1991 total forecast was adjusted to account for over-forecasting errors that have occurred for the past 7 years. The 1991 prediction based on sibling regression models and geometric means was reduced by the 1984-1990 average forecast error (-19.75%). The average forecast error from 1984-1990 was used because the number of chinook salmon returning to Nushagak River has declined dramatically since 1984. A cross-validation procedure was used to estimate the mean squared error of 1984-1990 total run predictions calculated with the same methods as used in 1991. The mean square error was then used to estimate the standard error and 80% confidence bounds.

FORECAST DISCUSSION

The age structure of the 1991 forecasted run is 0.5 thousand age-1.1, 18.6 thousand age-1.2, 47.1 thousand age-1.3, 47.1 thousand age-1.4, and 6.4 thousand age-1.5 chinook salmon. The 1991 forecasted run of 119.7 thousand chinook salmon is 28% less than the long term (1966-1990) mean run of 165.3 thousand but 11% greater than the most recent 5 year (1986-1990) mean run of 108.0 thousand. The projected harvest of 44.7 thousand chinook salmon is 47% less than the long term mean harvest of 84.7 thousand but 5% greater than the most recent 5 year mean harvest of 42.6 thousand. The chinook salmon return to Nushagak District has been in decline since 1984. Possible causes for this trend are being investigated.

Beverly Cross
Research Project Leader

APPENDIX B HARVEST OUTLOOK FOR THE A-Y-K REGION

Yukon Area

Salmon run projections for the Yukon River based on the 1991 season are based on a qualitative evaluation of brood year escapements and survival. The 1991 chinook salmon run is anticipated to be average to below average in strength, and the projected harvest range is 83,000 to 98,000. Assuming average survival, the Yukon River summer chum salmon run for 1991 will be below average in magnitude, and the commercial harvest is expected to be 400,000 to 600,000, near the lower end of the guideline harvest range. An average to above average run of fall chum salmon is anticipated in 1991, and the commercial harvest is projected to range from 197,000 to 259,000. Parent year escapements were average to above average; therefore, an average to above average harvest of 55,000 to 90,000 coho salmon is expected for 1991.

Norton Sound

Harvest projections for the 1991 commercial salmon season are based on qualitative assessments of brood year return strength, subjective determinations of egg survival and juvenile fish, and projected markets for the various subdistricts. In recent years, fishermen in up to half the subdistricts have been unable to find buyers for their catch. Chinook escapements for the primary parent years were slightly above average. Assuming normal survival, the 1991 return should be average, and harvests should range from 8,000 to 10,000. Pink salmon have small returns during odd-numbered years, and no market is anticipated for them; commercial sales are expected to be insignificant. Brood years for the chum salmon return had below average escapement. The chum salmon return is expected to be below average. If the lack of buyers continues, the catch is expected to fall between 50,000 and 100,000 chum. Coho salmon returns are expected to be near normal, roughly 20,000 to 40,000.

Kotzebue Sound

The outlook for the 1991 chum salmon season is based on the returning age classes during the 1990 season. During the 1991 season the 4-year-old age component of the run is expected to be well below average as is the 5-year-old component. 3-year-olds are expected to be near normal. The harvest is expected to fall within the range of 75,000 to 175,000.

	SPECIES					
Management Area	King	Sockeye	Coho	Pink	Chum	Fall Chum
Kuskokwim: ¹						
Kuskokwim River	19-56	41-137	222-660	0.1-0.5	199-1380	
Kuskokwim Bay	16-42	13-120	35-206	0.03-0.11	13-83	
Kuskokwim Total	35-98	54-257	257-866	0.6-0.61	212-1463	
Yukon	83-98	0	55-90	0	400-600	197-259
Norton Sound	8-10	0	20-40	0	50-100	
Kotzebue	0	0	0	0	75-175	

¹Kuskokwim projections are based on recent average harvests, except for pink salmon, which are based on recent odd year harvests.

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