MEMORANDUM

TO: Council, SSC and AP Members

FROM: Chris Oliver
Acting Executive Director

ESTIMATED TIME
2 HOURS

DATE: January 28, 2002

SUBJECT: Salmon Bycatch

ACTION REQUIRED

Review discussion paper on salmon bycatch.

BACKGROUND

In October, the Council requested that staff bring forward information regarding salmon bycatch implications resulting from the 2002 Steller sea lion measures. In addition, last February, the Council reviewed a preliminary data analysis on salmon bycatch in Gulf of Alaska trawl fisheries. The Council requested that staff provide additional information at a future meeting to assist with evaluating the need for management measures to control salmon bycatch in Gulf of Alaska fisheries. Staff has prepared a paper to address these and other issues regarding salmon bycatch in Alaska groundfish fisheries (Item C-9(a)).

[Note: this manuscript is being prepared for publication in Alaska Fishery Research Bulletin]

# An Overview of Salmon Bycatch in Alaska Groundfish Fisheries

by
David Witherell[1], David Ackley[2], and Cathy Coon[1]

Abstract - Chinook salmon *Oncorhynchus tschawtscha* and chum salmon *O. keta* are caught incidentally in Alaska groundfish fisheries, primarily in the walleye pollock *Theragra chalcogramma* trawl fishery. On average 1990-2001, 37,500 chinook salmon and 69,000 other salmon species (> 95% are chum salmon) were caught annually in Bering Sea groundfish trawl fisheries and 21,000 chinook salmon and 20,500 other salmon were caught annually in Gulf of Alaska trawl fisheries. In 1999 and 2000, chinook salmon bycatch was reduced in the Bering Sea, but increased in the Gulf of Alaska. Chum salmon bycatch has remained relatively stable in recent years. Bycatch is primarily juvenile salmon that are one or two years away from returning to the river of origin as adults. The origin of salmon taken as bycatch includes rivers in western Alaska, central and southeast Alaska, Asia, and British Columbia. Analysis indicates that a Bering Sea trawl fisheries bycatch level of 30,000 chinook salmon equates to about 14,580 adult chinook salmon from western Alaska. Similarly, a bycatch of 60,000 chum salmon in Bering Sea trawl fisheries equates to about 13,120 adult chum salmon from western Alaska. We estimated that, on average, salmon bycatch in BSAI trawl fisheries reduced the western Alaska chum salmon run by less than 0.22%, and reduced the western Alaska chinook salmon run by less than 2.6%. Impacts of salmon bycatch from GOA trawl fisheries cannot be estimated at this time. No significant changes in salmon bycatch are expected in 2002.

## Introduction

Pacific salmon, including pink salmon (*O. gorbuscha*), sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), chum salmon, and chinook salmon support large commercial, recreational, and subsistence fisheries throughout Alaska. Salmon are also taken incidentally as bycatch in commercial groundfish fisheries.

Chinook salmon and chum salmon runs in western Alaska, and sockeye salmon runs in Bristol Bay, began to decline in 1997. By 2000, salmon returns throughout the Yukon and Kuskokwim River drainages and the entirety of Norton Sound were less than 50% of the 20-year average. These run declines resulted in severe constraints on commercial, sport, and subsistence harvest. In 2000, the Alaska governor declared that an emergency disaster existed in the area, which resulted in a request for federal disaster relief funds, and a request to fisheries managers to re-examine any and all factors that may have contributed to the decline.

This paper reviews available information regarding salmon taken incidentally in U.S. North Pacific groundfish fisheries of the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) areas. Our objective is to provide the reader with basic information on salmon bycatch (amount caught, species composition, timing and location of bycatch), and to provide estimates on the impacts of bycatch on salmon stocks of western Alaska. We also review existing management measures to control salmon bycatch, and provide estimates of salmon bycatch for 2002 as a result of new fishery management measures designed to protect Steller sea lions.

## Bycatch Amounts

Pacific salmon bycatch is estimated through the National Marine Fisheries Service (NMFS) observer program and is normally classified into the two major groups of chinook salmon and other salmon. In both the BSAI and GOA groundfish fisheries, about 95 % of other salmon bycatch is chum salmon (Table 1). Bycatch of coho, pink, and sockeye salmon is relatively rare.

[1]Staff, North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage AK, 99516.

[2]National Marine Fisheries Service, P.O. Box 21668, Juneau, AK, 99802

Table 1. Catch of Pacific salmon in North Pacific groundfish trawl fisheries, by management area and species, 1990-2001.

**Bering Sea and Aleutian Islands Area**

| Year | Chinook | Chum | Coho | Sockeye | Pink |
|---|---|---|---|---|---|
| 1990 | 14,085 | 16,202 | 153 | 30 | 31 |
| 1991 | 48,873 | 29,706 | 396 | 79 | 79 |
| 1992 | 41,955 | 40,090 | 1,266 | 14 | 80 |
| 1993 | 45,964 | 242,895 | 321 | 22 | 8 |
| 1994 | 44,380 | 95,978 | 231 | 20 | 202 |
| 1995 | 23,079 | 20,901 | 858 | 0 | 21 |
| 1996 | 63,205 | 77,771 | 218 | 5 | 1 |
| 1997 | 50,218 | 67,349 | 114 | 3 | 69 |
| 1998 | 58,966 | 69,237 | (combined with chum) | | |
| 1999 | 12,924 | 46,295 | (combined with chum) | | |
| 2000 | 7,470 | 57,600 | (combined with chum) | | |
| 2001 | 37,742 | 57,169 | (combined with chum) | | |

**Gulf of Alaska Area**

| Year | Chinook | Chum | Coho | Sockeye | Pink |
|---|---|---|---|---|---|
| 1990 | 16,913 | 2,541 | 1,482 | 85 | 64 |
| 1991 | 38,894 | 13,713 | 1,129 | 51 | 57 |
| 1992 | 20,462 | 17,727 | 86 | 33 | 0 |
| 1993 | 24,465 | 55,268 | 306 | 15 | 799 |
| 1994 | 13,973 | 40,033 | 46 | 103 | 331 |
| 1995 | 14,647 | 64,067 | 668 | 41 | 16 |
| 1996 | 15,761 | 3,969 | 194 | 2 | 11 |
| 1997 | 15,119 | 3,349 | 41 | 7 | 23 |
| 1998 | 16,941 | 13,539 | (combined with chum) | | |
| 1999 | 30,600 | 7,529 | (combined with chum) | | |
| 2000 | 26,706 | 10,996 | (combined with chum) | | |

Bycatch of salmon has fluctuated through the years. On average 1990-2001, 37,500 chinook salmon and 68,600 chum salmon were bycaught annually in BSAI groundfish fisheries, and 21,000 chinook salmon and 20,500 chum salmon in GOA groundfish fisheries (Table 1). Much lower chinook salmon bycatch was recorded in 1999 and 2000 BSAI groundfish fisheries, but increased to 38,000 salmon in 2001. Chum salmon bycatch in the BSAI has been fairly consistant over the last few years. In the GOA, chinook salmon and chum salmon bycatch has fluctuated in recent years. Reductions in BSAI chinook salmon bycatch are likely to be attributable, in part, to changes in salmon abundance, reduction in salmon bycatch limits, regulatory changes (particularly those associated with Steller sea lion *Eumeopias jubatus* protection measures), bycatch avoidance measures by the fleet, and changes in fishery operations due to the formation of cooperatives allowed under the American Fisheries Act of 1998.

Table 2. Incidental take of salmon in North Pacific trawl fisheries, by area and target fishery, 2000 and 2001.

**Bering Sea and Aleutian Islands Area**

| | Chinook salmon | | Other salmon | |
|---|---|---|---|---|
| Fishery | 2000 | 2001 | 2000 | 2001 |
| Pollock | 3,968 | 30,130 | 56,715 | 52,690 |
| Pacific cod | 2,688 | 3,529 | 128 | 1,835 |
| Flatfish | 462 | 2,702 | 108 | 1,044 |
| Other targets | 278 | 1,1381 | 460 | 1,600 |
| Total | 7,470 | 37,742 | 57,600 | 57,169 |

**Gulf of Alaska Area**

| | Chinook salmon | | Other salmon | |
|---|---|---|---|---|
| Fishery | 2000 | 2001 | 2000 | 2001 |
| Pollock | 18,413 | 9,421 | 7,450 | 2,741 |
| Pacific cod | 2,747 | 2,796 | 0 | 677 |
| Flatfish | 4,386 | 2,295 | 2,979 | 1,857 |
| Other targets | 1,160 | 434 | 567 | 720 |
| Total | 26,706 | 14,946 | 10,996 | 5,995 |

Nearly all (>99%) salmon bycatch is attributable to trawl fisheries, with most taken in the walleye pollock trawl fishery and to a lesser extent trawl fisheries for Pacific cod *Gadus macrocephalus*, and other target species (Table 2). The amount of chinook salmon taken in the 2000 BSAI pollock fishery was unusually low, primarily due to a U.S. District Court order, which closed all Steller sea lion critical habitat (including the offshore foraging areas) to trawling from August 8 through December 14, 2000. This injuction prevented the pollock fishery from being prosecuted in the Bering Sea Steller sea lion foraging area, which historically had the highest chinook salmon bycatch rates.

The average size of salmon taken as bycatch in 1993 Bering Sea trawl fisheries was 2.1 kg (56 cm fork length) for chum salmon and 2.9 kg (58 cm fork length) for chinook salmon (NPFMC 1995a, 1995b). The chinook salmon are generally one to two years away from returning to their streams of origin to spawn (Myers and Rogers 1988).

### Timing and Location of Bycatch

Chinook salmon are taken as bycatch in trawl fisheries occurring at depths of 100 m to 200 m. In the Bering Sea, chinook salmon are taken throughout the area, whereas in the GOA, bycatch appears to occur in more discrete locations (Figures 1 and 2). The lower observer coverage in

the GOA trawl fisheries limits the amount of data available for interpretation. However, it appears that the highest bycatch in the GOA occurs along the outer margins of Portlock Bank. In the Bering Sea, areas of high bycatch rates, or 'hotspots', can occur in any location, not just within the eastern section of the Chinook Salmon Savings Area. No chinook salmon were bycaught in the western section of the Chinook Salmon Savings Area in 2000 and 2001 due to the closure of the Aleutian Islands pollock fishery during those years.

The locations where chum salmon are taken as bycatch closely mirror bycatch locations for chinook salmon (Figures 3 and 4). This is not surprising, as both chum salmon and chinook salmon are bycaught by fisheries in similar proportions, with the exception of the Pacific cod fishery that incurs chinook salmon bycatch but not many chum salmon (Table 2). The Chum Salmon Savings Area encompasses nearly all the 'hotspot' areas of chum salmon bycatch in the Bering Sea. Bycatch locations of chum salmon in the GOA is similar to chinook bycatch locations, except that almost no chum salmon were taken in Shelikof Strait.

The timing of salmon bycatch in the Bering Sea follows a predictable pattern (Figures 5-6). For 2000 and 2001, chinook bycatch occurred during the period of October through April (weeks 1-16, 40-52). Chum salmon bycatch was taken during the months of July through October (weeks 26-44). Our results are consistent with temporal analysis of BSAI salmon bycatch taken in the mid-1990s (NPFMC 1995a, 1995b, 1999).

In the GOA, salmon bycatch does not appear to occur in discrete time periods. In 2000 and 2001, both chinook and chum salmon were taken in every week the groundfish fishery was prosecuted (Figures 7-8). Bycatch of chinook salmon was higher in the winter, and bycatch of chum salmon was higher in the summer. The salmon bycatch spike seen in weeks 32 and 33 of the 2000 fishery was due to increased bycatch in the pollock fishery, which was forced to fish outside of Steller sea lion critical habitat, per order of the U.S. District Court.

**Stream of Origin of Bycatch**

Information on the origins of chinook salmon caught incidentally in BSAI fisheries comes from scale pattern analysis and genetic information. Scale sample analysis of chinook salmon bycatch in 1979-1982 foreign and joint venture trawl fisheries indicated about 60% of the chinook salmon bycatch originated from western Alaska, 17 % from south central Alaska, 14% from Asia, and 9% from southeast Alaska and Canada (Myers and Rogers 1988). These results should be interpreted with some caution, however, as the information comes from fisheries that were prosecuted over 20 years ago; many changes in groundfish fisheries and salmon stocks have since occurred. Genetic baseline data are being collected from western Alaska chinook stocks to allow for improved estimates in the future (A. Gharrett, University of Alaska Fairbanks, personal communication).

More recent studies have examined the stock composition of chum salmon taken as bycatch in BSAI fisheries. Wilmot et al. (1998) and Kondzela et al. (1999, as cited in NMFS 2001a) examined allele frequencies of chum salmon taken in 1994-1996 summer and fall BSAI pollock trawl fisheries. They found that, on average, about 27% of the chum salmon bycatch originated from western Alaska, 5% from south central Alaska, 38% from Asia, 12% from southeast Alaska and 18% from Canada and Washington. The regional composition varied slightly from year to year. Scale pattern analysis of 1994 bycatch data resulted in a regional composition as follows: 18.6% from western and central Alaska, 49.7% from Asia, 28.6% from southeast Alaska and Canada, and 3.1% from Washington. (Patton et al. 1998)

To date, no studies have examined the stock composition of salmon bycatch from GOA trawl fisheries. However, genetic stock identification techniques have been applied to chum salmon samples taken by research gillnets in the high seas (Urawa et al. 2000). Results indicate that Alaska stocks were common in the eastern-central GOA (15% western Alaska, 25% Alaska peninsula and Kodiak, 28% Southeast Alaska, 18% from

Canada), and Asian chum salmon were predominant in the western GOA (25% Japan, 53% Russia, 13% western Alaska, 10% elsewhere).

### Status of Western Alaska Stocks

Stocks of western Alaska chinook salmon and chum salmon are at low levels, as shown by the

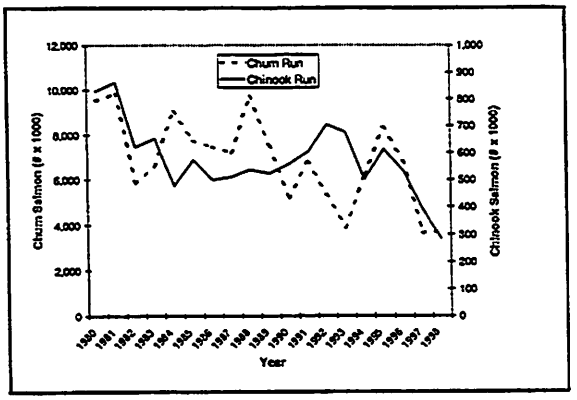


**Figure 9. Minimum run size estimates for western Alaska chinook and chum salmon stocks, 1982-2000. Data provided by Doug Eggers, ADF&G.**

minimum run size estimates in Figure 9. This figure includes all available data (commercial, subsistence, sport, and personal use catch, plus escapement estimates if available). Because escapement estimates are not available for all populations, these estimates are incomplete (D. Eggers, ADF&G, personal communication). The figure does not include populations of chum salmon in the Subdistrict 2, 4-6 of the Norton Sound area, Yukon River summer run chum salmon above the Anvik River, several important spawning populations of Yukon River chinook salmon in the lower and middle river tributaries, or any spawning population estimate for chum salmon or chinook salmon in the Kuskokwim Area (i.e., the Kuskom River, Kanectoc River drainage, the Kanectoc River, and Goodnews River). Therefore, the actual run size of chum salmon and chinook salmon to western Alaska is likely substantially higher than is shown in Figure 9.

### Impacts of Bycatch to Western Alaska Salmon

Because of the poor returns of chinook salmon and chum salmon to western Alaska rivers in recent years, it is useful to consider the impacts of incidental bycatch from trawl fisheries on these stocks. To estimate impacts of bycatch on salmon stocks, we adjusted bycatch numbers to account for mortality associated with age at incidental capture. Thus, we can express bycatch as adult equivalents. Myers and Rogers (1988) had estimated that 56% of the chinook included in their analysis were age 1.2 fish and that 26% of the chinook were age 1.3 (years in fresh water, years in salt water). If we assume that all bycatch is age 1.2 or 1.3, then the numbers are adjusted accordingly such that 68.3% are age 1.2 and 31.7% are age 1.3. Annual at-sea natural mortality rates between ages 1.2 and 1.3 were set at 20%, and the natural mortality rate over the year between ages 1.3 and 1.4 was set at 10% (Pacific Salmon Commission 1988). The returns would occur over a number of years. Of the 1.2 age fish, some will return the next year (with a 20% mortality) and some in 2 years with a 10% mortality. Some of the 1.3 age fish will return the same year and some in another year at 10% mortality (NPFMC 1995b).

Based on Myers and Rogers (1988) estimate that 60% of the chinook salmon bycatch originated in western Alaskan systems, a BSAI trawl bycatch of 30,000 juvenile chinook salmon (1998-2001 rounded average) would be comprised of about 18,000 fish from western Alaska. Further, according to Meyers and Rogers (1988), within the western Alaska component of intercepted chinook salmon, 17% were from the Yukon, and 29% were from Bristol Bay. Since the available age at return information is primarily from the Yukon and Bristol Bay systems, it was assumed for purposes of this paper that all bycaught western Alaska chinook salmon were from these two systems only. Adjusting the percentages resulted in 37% of the western Alaska chinook salmon from the Yukon and 63% from Bristol Bay.

Using fairly general assumptions based on chinook salmon return information to the Yukon River (Brannian 1990) and Bristol Bay (the Nushagak drainage, Minard et al. 1992), and

assuming that all fish return as age 1.3 or 1.4, a rough approximation was be made that 30% and 43% of chinook salmon return to the Yukon and Nushagak systems as age 1.3, respectively, and approximately 70% and 57% as age 1.4 to the Yukon and Nushagak, respectively.

Bycatch in a year would be expected to impact chinook salmon returns to western Alaska over at least a two year period. For instance, fish intercepted as age 1.2 would have contributed to the following year system returns as 1.3 fish or in the next year as 1.4 fish. As seen above, bycatch amounts can vary from year to year, however, to gauge bycatch impacts on western Alaska chinook salmon a constant bycatch amount of 30,000 chinook salmon was assumed. Given the above natural mortality rates and age proportions (NPFMC 1995a), and assuming that the majority of intercepted fish were ages 1.2 and 1.3 and that the majority of returns to western Alaska systems were ages 1.3 and 1.4, we have calculated that approximately 14,580 chinook would have been removed as adult equivalents. Details of the calculation method are provided in Table 3. For comparison, an adult equivalent bycatch of 14,580 adult chinook salmon equates to about 2.6% of a minimum run size estimate for western Alaska.

The same age-specific information for chum salmon was not available for this paper, however, the impacts are believed to be smaller due to the larger population size and lower bycatch composition from western Alaska. Based on composition studies of Wilmot et al. (1998) and Kondzela et al. (1999, as cited in NMFS 2001a), about 27% of the chum salmon bycatch in BSAI trawl fisheries originates in western Alaskan systems. Applying this percentage to an average BSAI trawl bycatch of 60,000 juvenile chum salmon (1998-2001 rounded average) would be comprised of about 16,200 fish from western Alaska. If we assume the same mortality as calculated for chinook salmon, this would equate to about 13,120 mature chum salmon from western Alaska. For comparison, an adult equivalent bycatch of 13,120 adult chum salmon equates to about 0.22% of a 6 million chum salmon minimum run size estimate for western Alaska .

It is not known at this time what proportion, if any, of the chinook salmon or chum salmon taken in GOA trawl fisheries originate from western Alaska. Hence, we are unable to estimate the impacts of GOA bycatch on western Alaska salmon stocks.

**Bycatch Control Measures**

Salmon are listed as a prohibited species in the groundfish fishery management plans, meaning that they cannot be retained and sold. However, regulations implemented in 1994 prohibited the discard of salmon taken as bycatch in BSAI groundfish trawl fisheries until the number of salmon has been determined by a NMFS certified observer. Subsequent regulations allowed for voluntary retention and processing of salmon for donation to foodbanks.

The North Pacific Fishery Management Council (NPFMC) has taken measures over the years to control the bycatch of salmon in trawl fisheries (Witherell and Pautzke 1997). Several bycatch "hotspot" areas have been closed to trawl fishing if too many salmon are encountered. Beginning in 1994, the Chum Salmon Savings Area has been closed to all trawling from August 1 through August 31. Additionally, the area remains closed if a bycatch limit of 42,000 chum salmon is taken within the catcher vessel operational area. Although more than 42,000 chum salmon were taken over the course of a year from 1995 through 2001, additional closures had not been triggered because the bycatch limit was not attained within the area prior to the accounting period (August 15 to October 14).

From 1996 through 1999, regulations were in place to prohibit trawling in the Chinook Salmon Savings Areas through April 15 if and when a bycatch limit of 48,000 chinook salmon was attained in the BSAI trawl fisheries. More than 48,000 chinook salmon were taken as bycatch annually from 1996 through 1998, but closures were not triggered because bycatch limits were not exceeded before April 15.

In 1999, the NPFMC adopted Amendment 58 to the BSAI Groundfish Fishery Management Plan to

reduce the amount of chinook salmon allowed to be taken as bycatch in BSAI trawl fisheries (NPFMC 1999). Specifically, the amendment did the following: (1) incrementally reduced the chinook salmon bycatch limit from 48,000 to 29,000 chinook salmon over a 4-year period, (2) implemented year-round accounting of chinook salmon bycatch in the pollock fishery, beginning on January 1 of each year, (3) revised the boundaries of the Chinook Salmon Savings Areas, and (4) set more restrictive closure dates. In the event the limit is triggered before April 15, the Chinook Salmon Savings Area closes immediately. The closure would be removed on April 16, but would be reinitiated September 1 and continue through the end of the year. If the limit were reached after April 15, but before September 1, then the areas would close on September 1. If the limit were reached after September 1, the areas would close immediately through the end of the year. The bycatch limit for 2002 BSAI pollock fisheries was 33,000 chinook salmon.

**Management Update for 2002**

In October 2001, the NPFMC adopted a new suite of fishery management measures for pollock, Pacific cod, and Atka mackerel *Pleurogrammus monopterygius* fisheries, to minimize any potential competition for prey with the endangered western stock of Steller sea lions. These management measures, which were implemented in January 2002, included fishery and gear specific closed areas around Steller sea lion rookeries and haulouts, and seasonal apportionments of the total allowable catch limits for pollock, Pacific cod, and Atka mackerel.

The effects of Steller sea lion measures on salmon bycatch were analyzed in the Supplemental Environmental Impact Statement (SEIS) prepared for the Steller sea lion protection measures (NMFS 2001b). The expected changes in bycatch levels were estimated by comparing bycatch rates in closed areas with the bycatch rates of the remaining open areas. Relative to a 1997-1999 average baseline catch of 33,500 chinook salmon and 55,500 other salmon for BSAI trawl fisheries, adoption of the preferred management measures was projected to result in similar bycatch amounts of about 30,000 chinook salmon (10% decrease) and 59,300 other salmon (7% increase). In the GOA, the SEIS examined changes relative to baseline bycatches of about 20,800 chinook salmon and 7,600 other salmon. Adoption of the preferred management measures was projected to result in similar bycatch amounts of about 22,000 chinook salmon (6% increase) and 6,900 other salmon (9% decrease) in GOA trawl fisheries. The SEIS concluded that changes of this magnitude would not be practically detectable in the range of bycatch levels experienced in recent years, and therefore the management measures adopted to protect Steller seal lions would have insignificant impacts on salmon bycatch.

**Discussion**

Our analysis agrees with the conclusion of Patton et al. (1998); chum salmon bycatch in BSAI groundfish fisheries has negligible impacts on western Alaska salmon runs. Our analysis indicates that a bycatch of 60,000 juvenile chum salmon in BSAI trawl fisheries would amount to an adult equivalent bycatch of 13,120 western Alaska chum salmon. As shown in Figure 9, the minimum average run size for western Alaska, was about 6 million chum salmon. Using these data, the bycatch of chum salmon, as measured by adult equivalents, would equate to about 0.22% of the western Alaska chum salmon run. Note that the actual impacts would be lower, as many populations of chum salmon (including populations from the Yukon River and Kuskokwim River) are not included in the run size estimates.

Bycatch of chinook salmon in BSAI groundfish fisheries may be a bigger concern to managers, but the impact to western Alaska stocks also appears to be relatively small. Our analysis indicates that a bycatch of 30,000 juvenile chinook salmon in BSAI trawl fisheries would amount to an adult equivalent bycatch of 14,580 western Alaska chinook salmon. For comparison, an adult equivalent bycatch of 14,580 adult chinook salmon equates to about 2.6% of a 550,000 fish minimum run size estimate for western Alaska.

Actual impacts of bycatch are likely much lower than 2.6% for two reasons. First, many populations of chinook salmon from western Alaska have not been included in run size estimates. Second, the stock composition study of chinook salmon bycatch (Meyers and Rogers 1988) was based on data collected over 20 years ago during foreign and joint venture fisheries, at a time when western Alaska chinook salmon were much more abundant. Application of those stock composition estimates would likely overestimate the contribution of western Alaska chinook salmon.

The impacts of groundfish fisheries on western Alaska salmon bycatch are consistent with the levels established for the bycatch of other prohibited species. For example, the prohibited species catch limits for 1998 equated to 0.1% of the red king crab *Paralithodes camtschaticus* population, 0.1% of the *Chionoecetes opilio* population, 1.8% of the *C. bairdi* population, 1% of the herring *Clupea pallasi* biomass, and 1.3% of the halibut *Hippoglossus stenolepis* biomass (Witherell et al. 2000).

Measures to control salmon bycatch were developed to address allocation concerns from competing users of the salmon resources. Managers have attempted to create a balance by developing regulations that allow maximum groundfish catches with a minimum of bycatch. Clearly, the costs of forgoing the groundfish trawl fishery to eliminate salmon bycatch would result in significant costs at the national, state, and community level. The BSAI groundfish trawl fisheries generates about $300 million exvessel value annually (Hiatt et al. 2001), whereas forgone chinook salmon bycatch from trawl fisheries (14,580 adult equivalents with average fish weight of 7.3 kg, worth $3.30/kg; ADF&G data) and chum salmon bycatch (approximately 13,120 adult equivalents with average fish weight of 3.6 kg, worth $0.66/kg; ADF&G data) originating from Alaska would have a total exvessel value of about $382,000. The trawl fisheries also generate millions of dollars in State of Alaska fish taxes, and provides direct and indirect employment to thousands of Alaskans. The relative economic impacts of salmon bycatch to subsistence and recreational users has not been estimated.

To date, no regulations have been implemented to control salmon bycatch in the GOA trawl fisheries. There are several reasons for this. First, salmon bycatch has historically been much lower in GOA fisheries, and thus has been of lower concern to managers. Chinook salmon bycatch is about 50% less in GOA trawl fisheries as compared to BSAI trawl fisheries, and chum salmon bycatch in GOA trawl fisheries is about one tenth of the BSAI trawl fisheries. Second, trawl vessels in the GOA are generally smaller in size, and thus generally carry observers only 30% the time. Much of the salmon bycatch is not observed and enumerated until it is delivered to a shoreside processor. This would make it somewhat more difficult for the GOA fleet to monitor bycatch "hotspots" like the BSAI trawl fleet. Lastly, there have not been any studies to date on the origins of salmon taken as bycatch in GOA trawl fisheries, and thus the impact on Alaska salmon stocks and other salmon stocks remains speculative.

**Acknowledgements**

We thank D. Eggers for providing salmon run estimates for western Alaska and helpful comments, and C. Pautzke and C. Oliver for their reviews. The National Marine Fisheries Service Observer Program provided observer data, and M. Furuness provided salmon bycatch data.

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ble 3. Adult equivalent bycatch of chinook salmon from western Alaska stocks taken in BSAI trawl fisheries, based on average annual bycatch amounts, adjusted for proportion from western Alaska, age composition, and natural mortality.

| | Percent | Survival Rate | Number of fish |
|---|---|---|---|
| Assumed annual bycatch: | | | 30,000 |
| Western Alaska component of intercepted chinook | 60.0% | | 18,000 |
| | | | |
| Yukon River component of western Alaska chinook | 37.0% | | 6,652 |
| Age 1.2 | 68.3% | | 4,543 |
| Age 1.3 | 31.7% | | 2,109 |
| | | | |
| Age 1.2 returning next year as 1.3 | 30% | 80% | 1,090 |
| Age 1.2 returning 2 years later as 1.4 (uses both survival rates) | 70% | 90% | 2,290 |
| Age 1.3 returning same year | 30% | 100% | 633 |
| Age 1.3 returning next year as 1.4 | 70% | 90% | 1,329 |
| Total annual contribution to Yukon river from intercepted chinook salmon | | | 5,342 |
| | | | |
| Nushagak River component (Bristol Bay) of western Alaska chinook | 63.0% | | 11,348 |
| Age 1.2 | 68.3% | | 7,750 |
| Age 1.3 | 31.7% | | 3,598 |
| | | | |
| Age 1.2 returning next year as 1.3 | 43% | 80% | 2,666 |
| Age 1.2 returning 2 years later as 1.4 (uses both survival rates) | 57% | 90% | 3,181 |
| Age 1.3 returning same year | 43% | 100% | 1,547 |
| Age 1.3 returning next year as 1.4 | 57% | 90% | 1,846 |
| Total annual contribution to Nushagak river (Bristol Bay) from intercepted chinook salmon | | | 9,239 |
| | | | |
| **Total annual contribution to western Alaska from intercepted chinook salmon** | | | **14,581** |

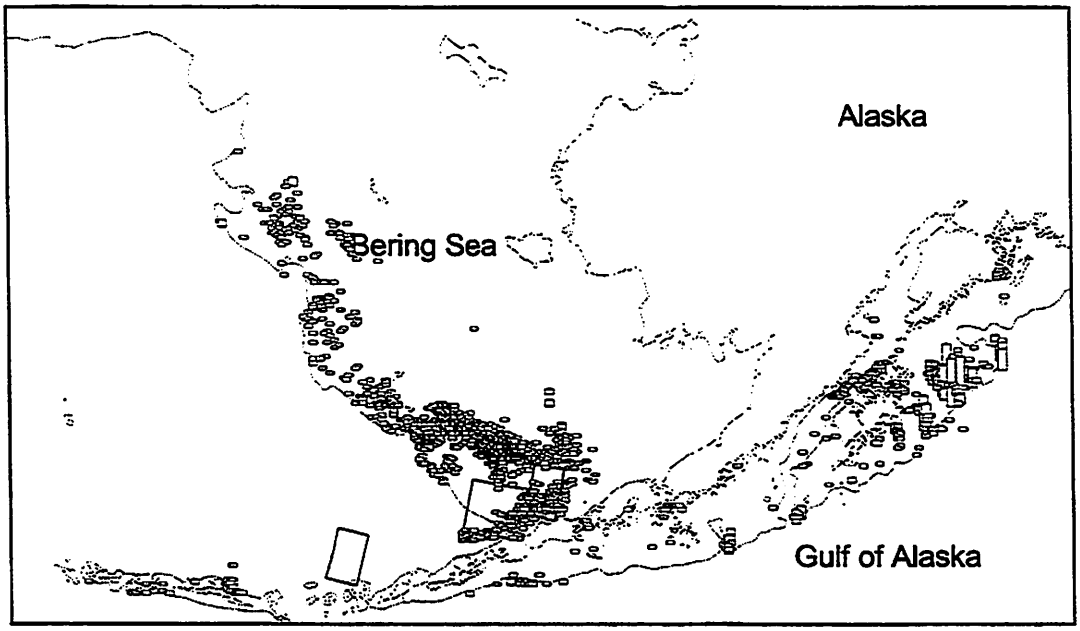


**Figure 1.** Locations of chinook salmon bycatch in trawl fisheries, hauls summed by 25km$^2$, 2000. Bar height indicates relative number observed. The 200 m depth contour and the Chinook Salmon Savings Areas are also shown.

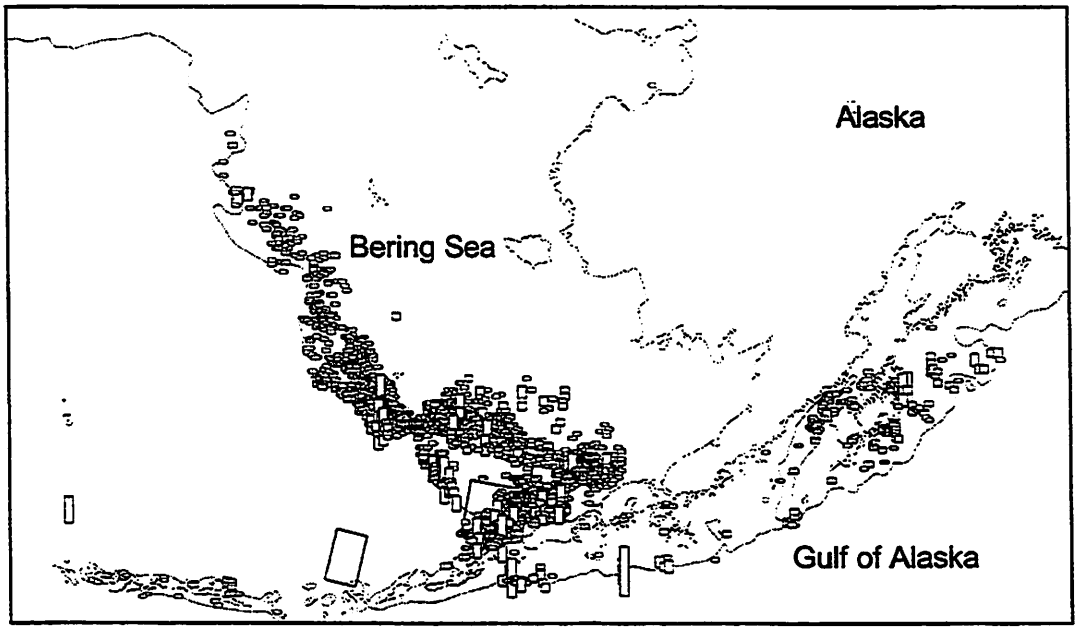


**Figure 2.** Locations of chinook salmon bycatch in trawl fisheries, hauls summed by 25km$^2$, 2001. Bar height indicates relative number observed. The 200 m contour and the Chinook Salmon Savings Areas are also shown.

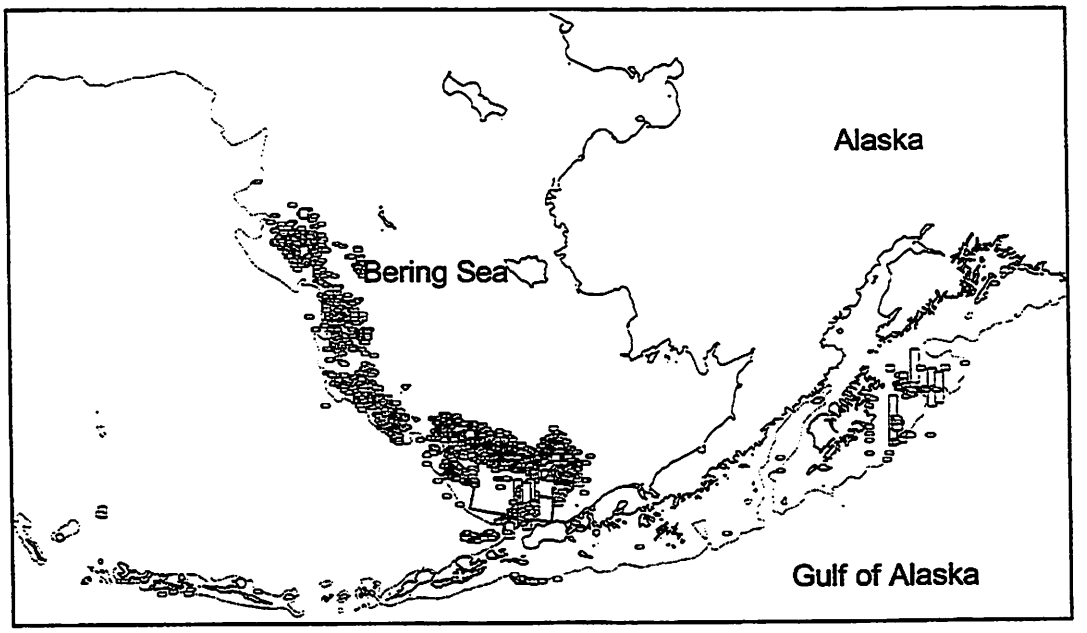


**Figure 3.** Locations of chum salmon bycatch in trawl fisheries, hauls summed by 25km$^2$, 2000. Bar height indicates relative number observed. The 200 m depth contour and the Chum Savings Area are also shown.

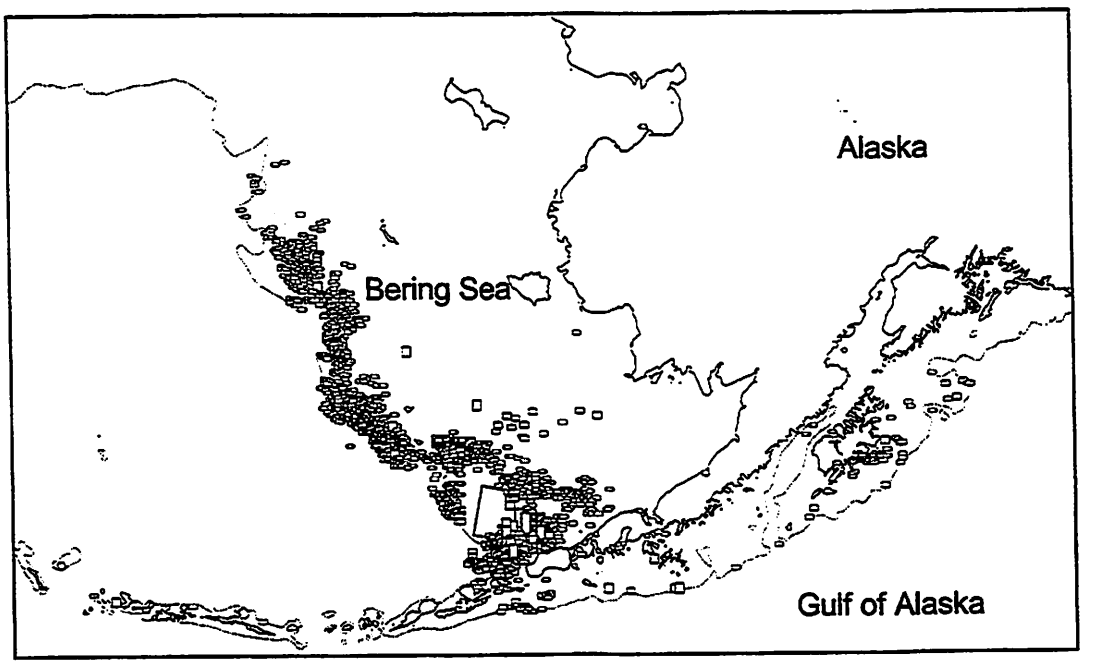


**Figure 4.** Locations of chum salmon bycatch in trawl fisheries, hauls summed by 25km$^2$, 2001. Bar height indicates relative number observed. The 200m depth contour and the Chum Salmon Savings Area are also shown.

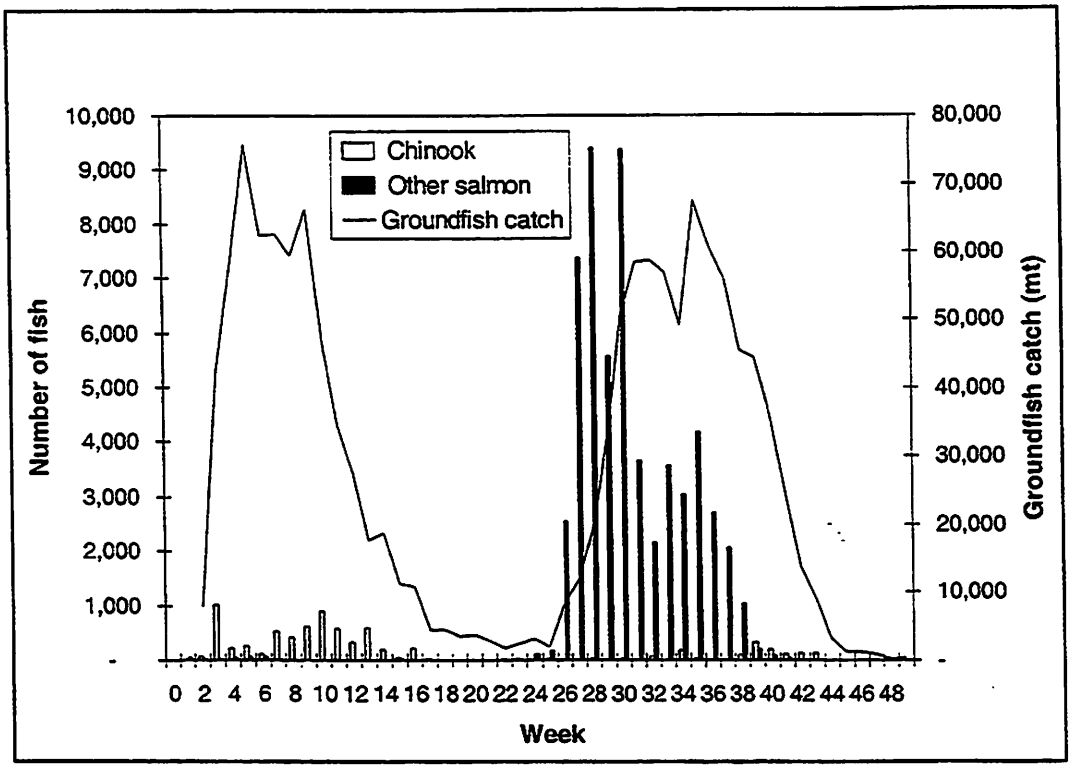


Figure 5. Bycatch of chinook salmon and "other salmon" ( chum salmon) in BSAI trawl fisheries, by week, 2000.

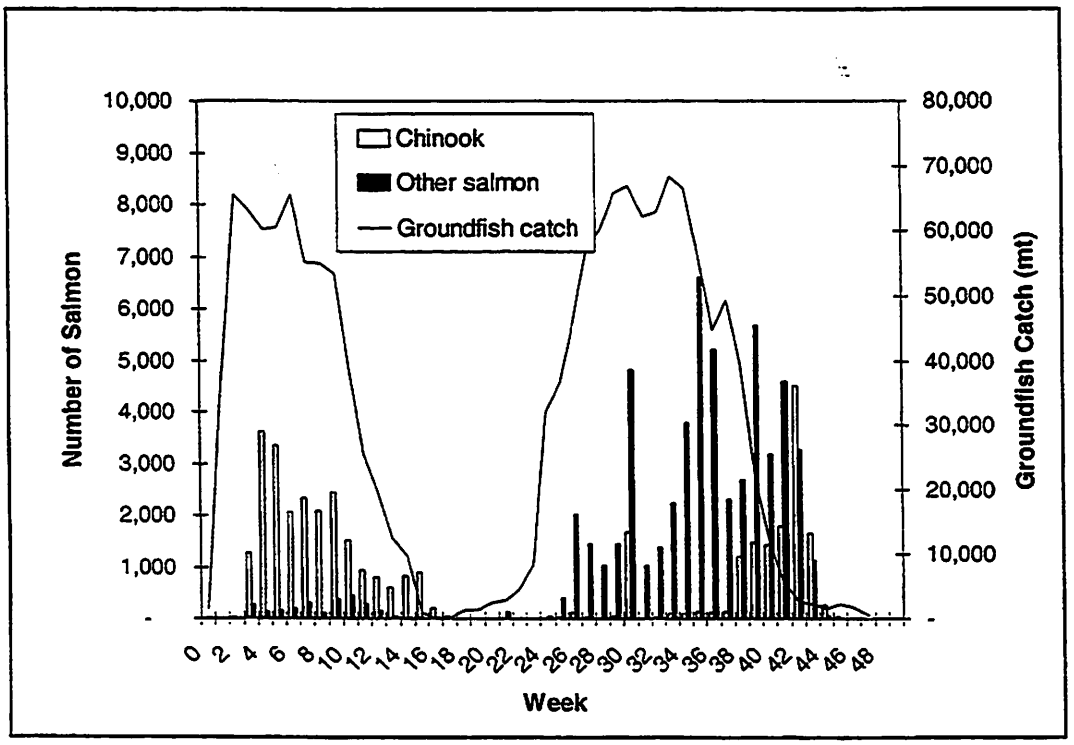


Figure 6. Bycatch of chinook and "other salmon" (chum salmon) in BSAI trawl fisheries, by week, 2001.

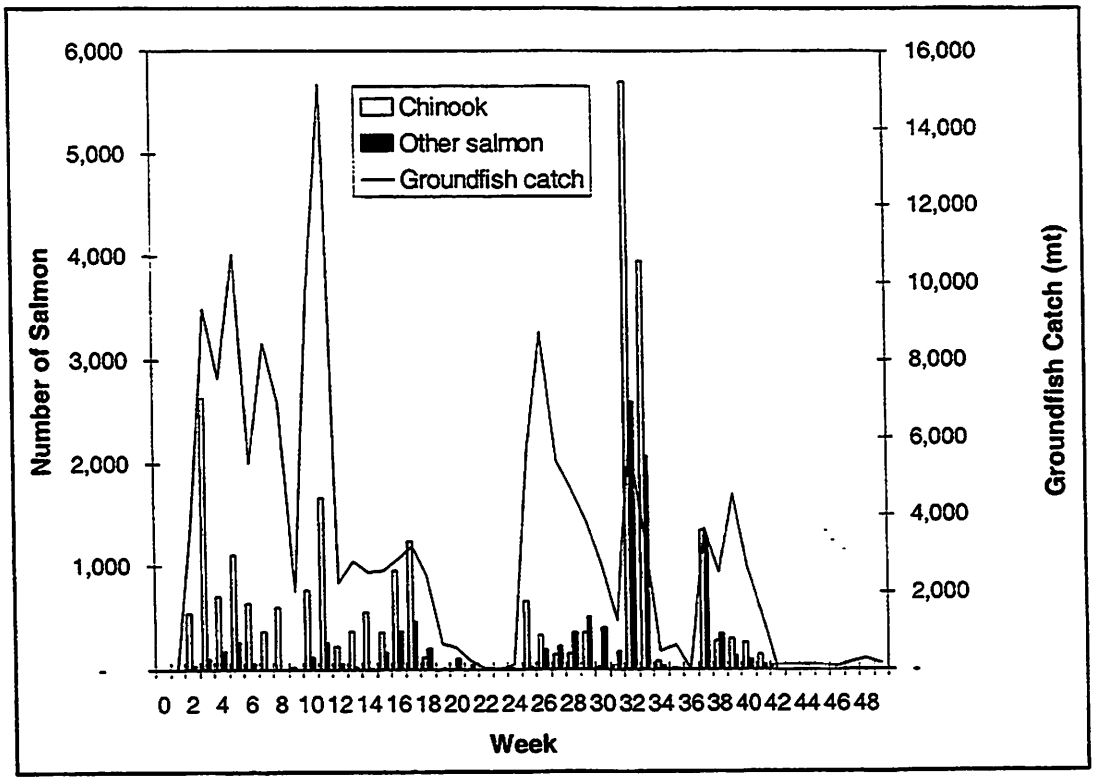


Figure 7. Bycatch of chinook and "other salmon" (chum salmon) in GOA trawl fisheries, by week, 2000.

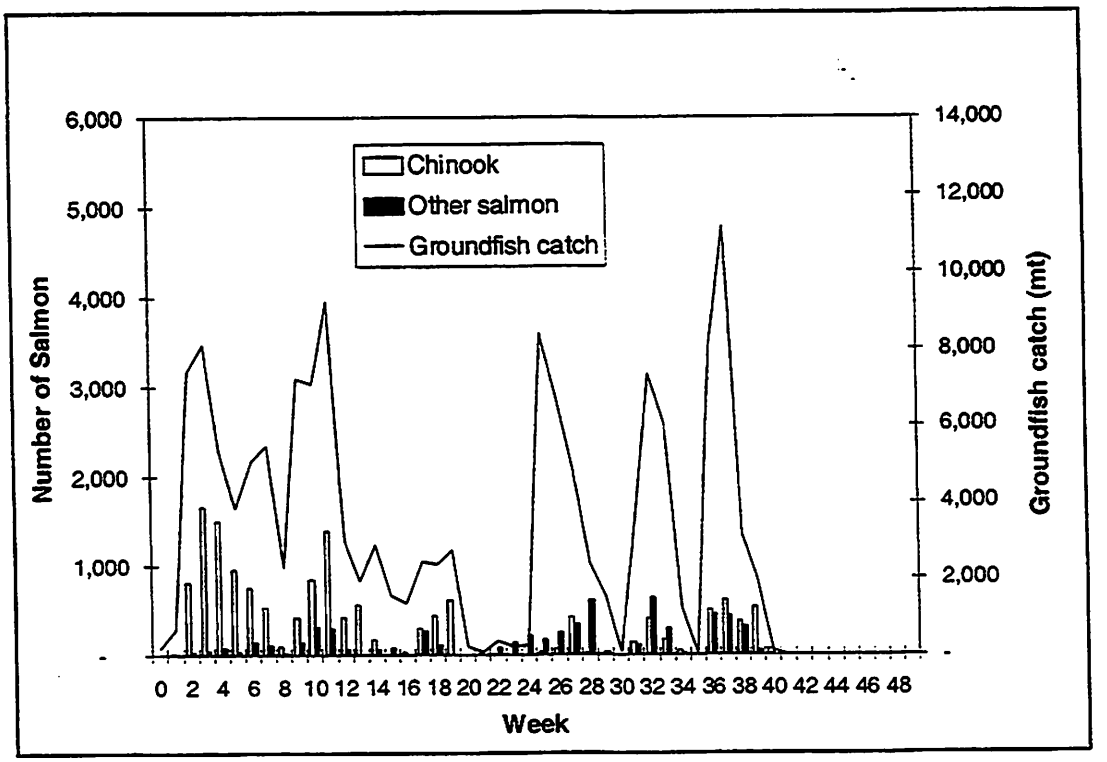


Figure 8. Bycatch of chinook salmon and "other salmon" (chum salmon) in GOA trawl fisheries, by week, 2001.

*Alaska Marine Conservation Council*
Box 101145 • Anchorage, Alaska 99510
(907) 277-5357 • (fax) 277-5975
amcc@akmarine.org • www.akmarine.org

February 11, 2002

North Pacific Fishery Management Council
Agenda Item C-9
**Salmon Bycatch**

Recommendations:

- AMCC recommends that the 42,000 Chum bycatch limit, the savings area, and the accounting period be reconsidered. And a program similar to the Chinook Salmon Savings Area be implemented, that ratchets the PSC cap down over time.
    - The Chum bycatch limit has been exceeded each year since its implementation, but is only applicable to the cap if caught during the accounting period (August 15 to October 14).
    - The savings area accounts for most "hotspots" but based on current data, could be refined and potentially encompass all bycatch hotspots.

- Additionally, we recommend that genetic sampling be conducted on Chinook and Chum salmon by-caught in both the GOA and BSAI groundfish fisheries, to have better and more recent information on the salmon's stream of origin.
    - Little information in know about the stream of origin of salmon by-caught in the Gulf of Alaska
    - The information used to assess stream of origin for Chinook in the Bering Sea is over 20 years old.

- We recommend that PSC limits and savings areas be considered for the Gulf of Alaska and that steps are taken to reduce salmon bycatch, not just maintain historical averages.
    - There are presently no PSC caps or savings areas in the Gulf
    - Salmon bycatch in Gulf of Alaska:
        On average 1990 – 2001: *21,000* Chinook & *20,500* Chum
        1999: *30,600* Chinook & *7,529* Chum
        2000: *26,706* Chinook & *10,996* Chum

- Finally, we recommend that if the Council can't take up these issues all at once, that you develop an implementation timeline to address these issues for both the GOA and Bering Sea.