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BSA 21b

ENVIRONMENTAL ASSESSMENT/REGULATORY IMPACT REVIEW/

FINAL REGULATORY FLEXIBILITY ANALYSIS

FOR

Proposed Alternatives to
Limit Chinook Salmon Bycatch
in the Bering Sea Trawl Fisheries:
Amendment 21b

TO THE FISHERY MANAGEMENT PLAN FOR

THE GROUNDFISH FISHERY OF THE

BERING SEA AND ALEUTIAN ISLANDS AREA

Prepared by the staffs of the

Alaska Department of Fish and Game
Alaska Commercial Fisheries Entry Commission

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TABLE OF CONTENTS

1.0 Introduction

The groundfish fisheries in the Exclusive Economic Zone (EEZ) [between 3 and 200 miles offshore] off Alaska are managed under the Fishery Management Plan for the Groundfish Fishery of the Gulf of Alaska (GOA FMP) and the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area (BSAI FMP). Both fishery management plans were prepared by the North Pacific Fishery Management Council (Council) under the Magnuson Fishery Conservation and Management Act (Magnuson Act). The GOA FMP was approved by the Secretary of Commerce and became effective in 1978, and the BSAI FMP became effective in 1982.

Actions taken to amend fishery management plans or implement other regulations governing the groundfish fisheries must meet the requirements of Federal laws and regulations. In addition to the Magnuson Act, the most important of these are the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), Executive Order (E.O.) 12866, and the Regulatory Flexibility Act (RFA).

NEPA, E.O. 12866 and the RFA require a description of the purpose and need for the proposed action and a description of alternative actions which may address the problem. Section 1 includes this information as well as biological, social, cultural, and economic background information. Section 2 addresses the requirements of NEPA to consider biological and environmental impacts of the alternatives, including impacts on endangered species and marine mammals. Section 3 is the Regulatory Impact Review, which addresses the impact of the alternatives and trade-offs in terms of costs and benefits. Section 4 contains the Final Regulatory Flexibility Analysis, which examined the impacts of the alternatives on small businesses.

1.1 Purpose of and Need for the Proposed Action

Because groundfish fisheries use non-selective harvesting techniques, incidental catches (bycatch) occur in the these fisheries. Salmon, crab, halibut, and herring are considered prohibited species in the groundfish fisheries, and must be discarded. A conflict occurs when bycatch is thought to impact measurably the resources available to another fishery. Bycatch management attempts to balance the effects of various fisheries on each other. This is particularly contentious because fishermen value these alternative uses of bycatch species, in this case chinook salmon, very differently, depending on the fishery they pursue.

Recent amendments to the BSAI FMP have established various methods of managing halibut, crab and herring bycatch (Amendments 16, 16a, 19, 21a and 21c), including closures of a directed fishery upon attainment of a prohibited species catch (PSC) limit and time and area closures triggered by attainment of a PSC limit. Chinook salmon bycatch currently is not managed by a PSC limit, or time and area closures.

Currently the trawl industry, through establishment of the Salmon Research Foundation, is attempting to control chinook salmon bycatch by increasing awareness of the bycatch problem, assessing fines for chinook salmon bycatch and implementing research to investigate both when and how chinook are caught and the origins of the chinook salmon bycatch in the Bering Sea. The Salmon Research Foundation also established an information network to, in as timely a manner as possible, inform the fishing fleet about potential "hot spots" and encourage the avoidance of chinook salmon interception. NMFS also implemented a regulation that mandates the retention of all salmon until counted and sampled by an observer. The mandatory retention of salmon should lead to more accurate counts of bycatch and allow biological samples of the fish to be taken.

The objective of the alternatives considered in this analysis is to provide the Council with the means to control chinook salmon bycatch in the BSAI groundfish trawl fisheries. Chinook salmon bycatch control measures are needed for two reasons. First, many chinook salmon stocks are fully utilized, and uncontrolled bycatch constitutes an additional, unaccounted for allocation of the resource. Second, uncontrolled bycatch levels exceeding recent highs may lead to conservation problems for Alaskan and Canadian chinook salmon populations. During the past 10 years, several major river systems have experienced low levels of returns, particularly the Nushagak, Yukon, and Kuskokwim rivers.

1.2 Alternatives Considered

Three primary alternatives are considered:

Alternative 1: status quo - no chinook salmon bycatch limitations for the BSAI trawl fisheries.

Alternative 2: A chinook salmon PSC limit that would trigger a time and area closure for the BSAI trawl fisheries.

PSC limit options are based on a range of annual chinook salmon bycatch rates of 0.004 to 0.024 chinook per metric ton of groundfish, or about 8,000 to 48,000 chinook.

Area options

1. Close the entire BSAI to a specific fishery upon attainment of the chinook PSC limit by that fishery, or group of fisheries.

2. Close specific federal statistical areas to a specific fishery upon attainment of the chinook PSC limit by that fishery, or group of fisheries.

3. Close areas that do not conform to federal statistical areas but which have been shown historically to have high chinook bycatch, including:

   (a) a 30 mile-wide buffer strip along the 200 meter contour that defines the Continental Shelf break (the "Contour");

   The following areas defined by 1/2° latitude by 1° longitude blocks:

   (b) 3-blocks in the "horseshoe" area of the 200 meter contour (Figure 1-57);

   (c) 1-block in the corner of the horseshoe (Figure 1-57);

   (d) 2-blocks in the horseshoe and north of Unimak Island (the "Unimak" blocks shown in Figure 1-57);

   (e) 3 non-contiguous areas made up of 8 blocks primarily in statistical areas 509, 517, and 541 (Figure 1-165);

   (f) 3 non-contiguous areas made up of 9 blocks primarily in statistical areas 509, 517, and 541 (Figure 1-166).

Time closure sub-options: Divide all closures listed above into two time periods: January-April, and May-December.

Alternative 3: Time and area closures for BSAI trawl fisheries without a chinook salmon PSC limit.

Closures would be based on historical chinook bycatch patterns, which indicate high bycatch along the 200 meter contour line (shelf break), the Horseshoe area, and the area north of Unimak Island. Chinook salmon bycatch would be monitored and invoke a triggering mechanism that would close these areas to a fishery during certain times of the year, which have historically exhibited high bycatch (January - April and/or September - December). The closures could be selectively applied to those fisheries that account for the vast majority of the salmon bycatch (i.e., mid-water and bottom pollock, Pacific cod).

1.2.1 The Preferred Alternative

Amendment 21 initially addressed three priority bycatch issues identified by the Council during its January 1992 meeting. These were (1) halibut bycatch limits for the trawl and non-trawl fisheries, (2) chinook salmon bycatch limits for the trawl fisheries, and (3) trawl closures around the Pribilof Islands. At its April 1992 meeting, the Council reviewed a draft analysis of the second proposal (now called Amendment 21b), expanded the scope of the proposal to include additional alternatives, and requested additional analysis. During its January 1993 meeting, the Council recommended that this analysis go out for public review. The Council, at its April 1993, meeting decided to postpone action on Amendment 21b to allow public review of a Vessel Incentive Program (VIP), and provide industry an opportunity to develop the concept of a salmon foundation. During the June 1993 meeting, the Council voted to adopt the industry initiative Salmon Foundation, which would include the following: (1) prohibit the discard of salmon; (2) implement data gathering and analysis of bycatch patterns; and (3) require the posting of salmon bycatch numbers on a vessel by vessel basis. This analysis was updated in the fall of 1993 to include analysis of additional time/area closure alternatives.

At its April 1995 meeting, the Council adopted Alternative 2, Option 3f to control the amount of chinook salmon taken as bycatch in BSAI trawl fisheries while having the least impact on groundfish trawl fisheries. Specifically, the preferred alternative would close a 9-block area (Figure 1-166) in the BSAI, the Chinook Salmon Savings Areas (CHSSA) to all trawling when 48,000 chinook salmon were taken as bycatch. The closure will remain in effect from the time the PSC limit is reached until April 15, when the areas would reopen to trawling for the remainder of the year. Accounting for chinook salmon bycatch would start on January 1. In selecting this alternative, the Council recognized that a PSC limit of 48,000 chinook salmon is higher than total annual chinook salmon bycatch in recent years, except 1991. Therefore, the PSC limit is not expected to constrain groundfish fisheries, except in years of unusually high chinook salmon bycatch. If the PSC limit is reached, trawl fisheries will be closed in areas and times of historic high salmon bycatch. However, the preferred alternative does not constrain chinook salmon bycatch at 48,000 fish, because bycatch could continue to occur in other times and areas throughout the year.

1.3 Context for the Proposed Action

1.3.1 Commercial Catch History and Status of Chinook Salmon Stocks

Statewide/Regional:

The total statewide commercial harvest of chinook salmon has been relatively stable since the late 1980's (Geiger and Savikko, 1992). The total statewide harvest in 1990 was 665,000 chinook, the 1991 harvest was 615,000 chinook, and the 1992 was 611,000 chinooks, and the estimated 1993 harvest was 650,000 chinook (Figure 1-1). The statewide harvest of chinook salmon was greater than 800,000 fish in all years between 1978 and 1983 with the exception of 1980. The statewide harvest averaged approximately 642,000 fish from 1984 to 1990, following the decline from previous high numbers. The majority of the commercial catch has been from Southeast Alaska in all years. The combined Yukon and Kuskokwim management areas have been the next largest contributors to the statewide harvest. Sport harvests of chinook salmon in Alaska have increased significantly in most areas of the state since 1981 (Figure 1-2)

Western Alaska is comprised primarily of three major salmon management areas: the Yukon; the Kuskokwim; and Bristol Bay. The highest number of chinook salmon harvested in the commercial and subsistence fisheries of western Alaska are taken in the Yukon and the Kuskokwim management areas. The Yukon and Kuskokwim area commercial and subsistence harvests have been slightly increasing since 1980, due in part to the Kuskokwim area subsistence catch which has tended to increase in recent years (Figure 1-3, taken from Figure 1-1). The 1992 preliminary estimated commercial harvest (for the Yukon and Kuskokwim management areas combined) of 188,000 chinook salmon was above both the 1991 estimated harvest of 150,000 chinook and the 1990 harvest of 180,000 chinook salmon. The 11 year (1980-1990) average was 198,000 fish. The 1992 catch was 94.9% of the 11 year average. The 1993 preliminary estimated catch from the Yukon and Kuskokwim management areas combined was only 120,000 chinook salmon. This directed catch was low because of the extensive commercial closures instituted due to poor returns of chum salmon to these areas in 1993. Commercial and subsistence harvests in the Bristol Bay management area have declined since the early 1980's because of weak runs in the Nushagak River, the primary chinook salmon production system in the management area. Returns to the Nushagak increased in 1991, 1992, and 1993 bolstering commercial catch in the management area.

Yukon River:

Chinook salmon harvested in the Yukon River commercial and subsistence fisheries consist of a mixture of stocks destined for spawning areas throughout the Yukon River drainage. Although more than 100 spawning streams have been documented (Barton, 1964), aerial surveys of chinook salmon escapements indicate that the largest concentrations of spawners occur in three distinct geographic regions. Chinook salmon stocks within these geographic regions were collectively termed runs by McBride and Marshall (1983) and are now referred to as lower, middle, and upper Yukon River runs. Several streams are monitored each year to index overall run escapements. The lower river stock originates from Alaskan tributary streams that drain the Andreafsky Hills and the Kaltag mountains between river miles 100 and 500. Tributaries that represent the lower river stock include the Andreafsky, Anvik, Nulato, and Gisasa Rivers. The Middle river stock originates from Alaskan tributary streams of the Upper Koyukuk and Tanana Rivers between river miles 800 and 1,000. The middle river stock is represented by the Chena and Salcha Rivers. The Upper river stock originates from Canadian tributary streams that drain the Pelly and Big Salmon Mountains between river miles 1,300 and 1,800. Representative tributaries of the upper river stock include Tincup Creek, Tatchun, Little Salmon, Big Salmon, and Nisutlin Rivers, and fish passage at the Whitehorse Fishway on the mainstream Yukon River in Canada.

Management of the Yukon River commercial salmon fisheries is complex because of the interaction of several factors, which include: the difficulty in determining run sizes; the difficulties of harvesting mixed stocks; the increasing efficiency of the commercial fleet; and fishery allocation issues (ADF&G, 1993). Based on current knowledge of stock-specific entry timing, it is impossible to manage individual stocks independently. For this reason, some tributary populations may be under- or over-harvested in relation to their actual abundance, and consequently, success in achieving escapement goals for selected tributary streams representing each run has been mixed. In recent years, success has been generally achieved in meeting escapement goals of tributary streams which represent the lower river stock (Figures 1-4 and 1-5). However, chinook salmon escapement objectives of tributary streams which represent the middle river stock have not been achieved in many of the recent years (Figure 1-6). Although chinook salmon escapements to tributary streams representing the upper river, or Canadian chinook salmon stock, have been monitored (Figures 1-7 to 1-9), escapement objectives for specific tributary streams have not been set. In March 1987, the Joint U.S. and Canada Technical Committee (JTC 1987) recommended a spawning escapement objective of 33,000-43,000 chinook salmon for the Canadian portion of the mainstream Yukon River. This escapement objective has been met only once in the six years since recommendation (Figure 1-9). Additionally, to prevent any further decrease in chinook salmon escapements during international negotiations, a 6-year stabilization program ending after the 1995 season has been agreed upon by the U.S and Canadian governments. This program seeks to stabilize the upper river stock by achieving a spawning escapement of 18,000 or more chinook salmon for each year through

1995. The U.S. and Canadian management agencies are to develop a chinook salmon rebuilding program to begin in 1996 for the purpose of achieving a more optimal escapement level in the future.

Kuskokwim River:

The Kuskokwim River (a portion of the Kuskokwim salmon management area) has had relatively high commercial and subsistence catches. However, due to low returns beginning in 1983, gear and time restrictions were put in place for the 1987 and subsequent commercial fisheries. These restrictions were necessary to meet the drainage-wide escapement index objective of approximately 16,000 chinook (Figure 1-10) in 1988-1990, although the index escapement objective was not met in 1991 nor 1992. The escapement index was met in 1993, and this escapement was due in part to commercial and subsistence fishing closures for chum salmon because of poor chum salmon returns. The index escapement objective is derived as a weighted sum of aerial survey index areas and the Kogrukluk River weir. This escapement index is not meant to represent total escapement in numbers but is an approximate index for management purposes.

Gear restrictions have helped more and larger females to return to spawning grounds. Despite restrictions on the commercial fisheries, both subsistence and commercial fisheries have tended to increase in the Kuskokwim drainage. The subsistence catch has increased over time with an average subsistence catch of 47,000 fish in the 1970's, an average catch of 57,000 in the 1980's and an average subsistence catch of 76,000 fish in the 1990's. Commercial catches have also increased somewhat over time in the Kuskokwim drainage, with an average commercial catch in the 1970's of 34,000 chinook, in the 1980's of 39,000 chinook, and an average catch in the 1990's of 46,000 chinook (excluding the 1993 catch, Francisco et al., 1992).

Nushagak and Togiak Rivers:

Historically, the total harvest from the Bristol Bay area has been approximately one half to one third that of the Yukon/Kuskokwim area, with the exception of the years 1987-1990 during which the Bristol Bay directed gillnet fishery targeting on chinook salmon was terminated. The only chinook catch in those years was as catch incidental to the directed sockeye salmon fishery. The Bristol Bay chinook salmon stocks suffered the greatest decline of all areas in Western Alaska during the late 1980's. Following an exceptionally high number of returns during the period of 1978 to 1983, chinook salmon numbers began to decline in the early to middle 1980's and remained low through 1990 (Minard et al.. 1992), raising concern over the health of the Nushagak and Togiak River runs. The 1991 and 1992 returns, however, showed a marked improvement over previous years, and in 1991 a commercial fishery was again allowed on Nushagak River chinook salmon. This was the first directed chinook harvest since 1986, but a boycott by salmon fishermen precluded the fishery in that year (Figure 1-11). A commercial catch was also permitted in 1992 and 1993.

The escapement goal for the Nushagak system has been 75,000 chinook since 1984, and this goal was not met in 3 of the last 9 years.[1] In 1993, the escapement goal for the Togiak River of 10,000 chinook salmon was reached for the first time since 1985 (Figure 1-12). Managers attribute this to a prolonged fisheries closure allowing the escapement. Escapements to Egegik have been below goals in 1992 and 1993.

1 A new biological escapement goal of 65,000 chinook spawners has been adopted for the Nushagak by area management biologists. The in-river escapement goal is 75,000 chinook.

1.3.2 Origins of Chinook Salmon Caught Incidentally in Groundfish Fisheries

Information on the origins of chinook salmon caught incidentally in trawl and other net fisheries of the Bering Sea comes primarily from salmon scale pattern analysis. The study most relevant to the trawl groundfish fisheries is Myers and Rogers (1988). Salmon scales collected by groundfish observers were analyzed to identify the origin of chinook salmon bycatch in the foreign and joint-venture trawl groundfish fisheries in the Bering Sea EEZ during 1979, 1981, and 1982. The percent origin of chinook salmon from various regions and within the Western Alaska region over all 3 years was (also Figure 1-13):

Western Alaska		60 %
Yukon	17 %	
Kuskokwim	24 %	
Bristol Bay	29 %	
Central Alaska	17 %	
Asia	14 %	
S.E. Alaska/British Columbia	9 %	

The percentages for the Yukon, Kuskokwim, and Bristol Bay drainages are not intended to sum to the western Alaska total percentage. These percentages were derived through the same analysis used to determine the percent of chinook salmon of western Alaska origin, but with standards for each of these systems used separately. When the separate western Alaska systems were included in the analysis, the percentages of chinook salmon estimated to be of Central Alaska, Asia, and S.E. Alaska/British Columbia origin varied somewhat because the separate western Alaska systems did not sum to the western Alaska total percentage. The Central Alaska percentage includes fish from the Karluk, Chignik, Susitna, Kenai and Copper Rivers, and the percentage represented by any one of these systems alone would be difficult to determine.

Several studies have estimated the origin of chinook salmon captured in the Japanese mothership fisheries for salmon, both in the Bering Sea and in the North Pacific Ocean (Major, et al. 1975, 1977 a,b; Myers et al. 1984; Ito et al. 1985; Davis, 1990). Davis (1990) used scale pattern analysis to determine origins of chinook salmon near Japanese mothership and landbased driftnet salmon fisheries in 1985 (Figure 1-14) and 1986. Based on scales collected in the vicinity of the mothership fisheries (north of the Aleutians and between 175°E and 175°W) the percent origin of immature (age-1.2) chinook salmon was:

	1985	
Western Alaska		58 %
Central Alaska	3 %	
Asia (Kamchatka)	39 %	

Scale pattern information from 1986 was also analyzed, but the Kamchatka and Yukon standards were similar and did not allow an Asian/Western Alaskan origin stock separation (Davis, 1990).

A previous study of chinooks from the area of the Japanese mothership salmon fishery, 1975 to 1981 (Myers et al., 1987), indicated the following percentage origin of chinooks from the Bering Sea (also Figure 1-15):

Western Alaska		70 %
Yukon	48 %*	
Kuskokwim	21 %*	
Bristol Bay	14 %*	
Central Alaska	10 %	
Asia	18 %	
S.E. Alaska/British Columbia	2 %	

* Not intended to sum to Western Alaska total percentage as explained above.

Davis (1990) cites additional scale pattern studies (Major et al. 1975, 1977a,b) which also indicated "that western Alaskan fish predominated in the Bering Sea and that the proportion of western Alaskan fish increased to the east."

Tagging data to determine region of chinook origin have been very limited but tend to corroborate results of scale pattern analyses (Myers and Rogers, 1988). Davis states, "In summary, the meager information available from tagging experiments suggests that chinook in the Bering Sea may be predominantly of western Alaska origin and that chinook in the North Pacific Ocean may be a mixture of North American and Asian stocks." (Davis, 1990) North Pacific Ocean here refers to the area south of the Aleutian Island chain. Although scales from chinooks are currently being collected by observers, no scale pattern analysis is currently being conducted to determine the origin of chinook salmon bycatch in the groundfish fisheries. Observers are also collecting the heads of salmon with clipped adipose fins for potential recovery of coded wire tags.

Davis also cites ongoing studies on infection rates by myxosporean brain parasites of chinook salmon (Nagasawa and Urawa 1987; Urawa and Nagasawa 1988, 1989; Urawa et al. 1990). Of the two varieties of parasite under investigation, the parasite suggested to indicate an Asian origin has not been found in chinook salmon captured in the Bering Sea, indicating a prevalence of North American origin fish in the Bering Sea (Davis, 1990).

Myers and Rogers (1988) indicated that the predominant ages of chinook salmon intercepted in the Bering Sea groundfish fisheries based on 1979, 1981, and 1982 samples were ages 1.2 and 1.3 (years in fresh water.years in salt water (i.e. age 1.2 = 4 year old fish)). Age 1.2 chinook accounted for 56% of the samples, and age 1.3 chinook accounted for 26% of the samples. Myers and Rogers speculated that the greatest effect of large incidental catches of ages 1.2 and 1.3 chinooks offshore on inshore harvests would likely occur 1 or 2 years later (or ages 1.3 and 1.4). Davis (1990) also found age 1.2 chinook salmon to comprise the major age group in research vessel catches (70% and 61% in 1985 and 1986, respectively).

In general, the majority of chinook salmon encountered in the Bering Sea, whether in directed Japanese mothership salmon fisheries or groundfish trawl fisheries, are of western Alaskan origin. There is a general tendency for the percentage of western Alaskan chinook to increase moving west to east toward the North American continent. However, western Alaskan chinook are the major component of chinooks caught throughout the Bering Sea. These results are indicated by scale pattern analyses, tagging, and parasite information. In addition, although the chinook salmon encountered in the North Pacific Ocean (e.g., south of the Aleutian Islands) are primarily of Asian or central Alaska origin (depending on the study), "All studies agreed that western Alaska is an important secondary stock." (Davis, 1990) Chinook salmon of western Alaska origin utilize the entire Bering Sea, and to some extent the North Pacific Ocean as their range during the saltwater phase of their life.

The mean percentages of chinook salmon in the Bering Sea estimated to be of western Alaska origin in the various studies (expressed as a range with lowest and highest values if from multiple areas) are summarized as follows:

Study	Percent western Alaska
Major et al. 1975.	58% - 93%
Myers et al. 1987.	65% - 76%
Myers and Rogers. 1988.	53% - 72%
Davis. 1990.	51% - 62%

1.3.3 Historic Chinook Salmon Bycatch

Foreign and Joint Venture Fisheries:

The total groundfish catch in the Bering Sea from foreign, joint venture (JV) and domestic trawlers has been between 1.7 million and 2.0 million metric tons (mt) since 1985. However, chinook salmon bycatch has varied between 9,000 and 115,000 fish since 1980 (Figure 1-16). The reported bycatch between 1982 and 1986 was below 20,000 fish and occurred predominantly in the foreign and JV fisheries.

Following the high chinook salmon bycatch in 1980 of approximately 115,000 chinook, the foreign fleet bycatch of chinook salmon was constrained by a bycatch reduction schedule (Figure 1-17). Beginning in 1981, the foreign fleet was not to exceed a bycatch limit of 65,000 chinook salmon, and the bycatch limit was reduced by 75% over a 5-year period to a level of 16,500 chinook by 1986. According to reported bycatch, the foreign fleet did not exceed the reduction schedule bycatch level in any year. Assuming accurate reporting, the foreign fleet either encountered fewer salmon, or were able to find means to avoid chinook salmon.

The annual bycatch rate of the foreign and JV fisheries, defined as the total number of chinook salmon divided by the total mt of groundfish, followed roughly the same pattern as the annual chinook salmon bycatch (Figure 1-18). The JV fleet maintained a lower annual bycatch rate than did the foreign fleet, and the foreign fleet was able to reduce bycatch levels below an annual rate of .004 chinook salmon per mt in 1986.

Domestic Fisheries:

The domestic groundfish trawl fleet has caught the majority of the chinook salmon since 1987. With the exception of 1990, chinook salmon bycatch has exceeded 20,000 fish in each year since 1987 and exceeded 40,000 fish since 1991.

Table 1-1 and Figure 1-19 summarize cumulative weekly chinook salmon bycatch estimates for the domestic groundfish trawl fisheries in the BSAI. Bycatch estimates totaled 13,990 fish in 1990; 48,821 fish in 1991; 41,903 fish in 1992; 45,964 fish in 1993; and 44,437 fish in 1994. Estimated chinook salmon bycatch was 17,679 fish through July 29, 1995.

In years prior to 1993, the pollock nonroe season began on June 1 and much of the groundfish catch was taken prior to September. Little chinook bycatch occurred in the last third of the year in 1990 or 1991. In 1993, the nonroe season began on August 15, and the increased effort in September probably contributed to the rise in bycatch beginning in September of that year. The increased bycatch during the final weeks of 1992 and 1993 were from the newly developed Community Development Quotas (CDQ), which allowed fisheries to be prosecuted at the end of the year. December is a month of high bycatch for chinook salmon, and these fisheries are expected to be prosecuted earlier in the year in future years.

The total groundfish catch in 1990, 1991, and 1992 came primarily from area 521. There was also significant catch in areas 517, 515, 518, and 519 (515 is currently split into 518 and 519) (Figures 1-20, 1-22 and 1-24). Chinook salmon bycatch, on the other hand, was highest in areas 517, 515, 518, and 519 (Figures 1-21, 1-23, and 1-25) in 1990-1992, and in areas 509 (formerly the western portion of 511), 517 and 521 in 1993 and 1994 (Figure 1-26). These areas lie in the vicinity of the 200 m contour of shelf break which extends roughly northwest from Unimak Island, the "horseshoe" and the Alaska Peninsula and Aleutian Islands. The monthly estimated catch of chinook salmon from observed vessels by statistical area is provided in Appendix A. Ranking of each of the areas by bycatch also shows these areas to have higher bycatch across years.

1.3.4 Impacts of Chinook Bycatch on Western Alaskan Stocks

Chinook salmon bycatch in the Bering Sea trawl fisheries are predominantly of western Alaskan origin (see 2.3 above). The impact of such bycatch on western Alaskan stocks is unknown. There are several variables which interact to influence the effect bycatch might have on stocks including chinook salmon run size, stock composition and catchability. Variations in run strength and/or year class strength could lead to disproportional bycatch of given runs; any tendency for individual stocks to aggregate separately from other stocks would also lead to disproportional bycatch of stocks; and the catchability of chinook salmon may vary by season or age of fish which also could lead to differential effects of bycatch.

The state of Alaska manages directed commercial, recreational, and subsistence fisheries on chinook salmon in western Alaska using time/area closures and gear restrictions to meet a variety of conservation and allocation objectives. Estimates of escapement are not available in-season for the Yukon and Kuskokwim Rivers. Fisheries in these rivers are managed based on guideline harvest level ranges. Catches are constrained to be within the guideline harvest level range; however, managers target catches to the lower or upper end of the ranges if run strength, based on fishery performance, is weak or strong, respectively. In-season estimates of escapement are available for the Nushagak District fishery.

The chinook fisheries in Bristol Bay are managed for constant escapement goals. For the Togiak, Nushagak, and Egegik Districts in Bristol Bay, the early gillnet fishery, which uses large meshed gear and targets on chinook salmon, has been closed in recent years. These closures were predicated on low escapement levels. Harvests of chinook salmon for these years occurred in subsistence and recreational fisheries, and as bycatch in the commercial gillnet fishery, which is targeted on sockeye salmon.

The effect of increased interceptions of chinook salmon in offshore fisheries reallocate fish away from inshore fishermen and reduce the runs to the terminal harvest areas. These reductions increase the risk that the terminal fisheries will harvest the runs at a rate greater than that required to meet minimum escapement objectives. The resolution of these fishery allocation issues often requires additional stock identification studies, and greatly increases the cost of fishery management. Because of the increased management cost and increased conservation risk due to expanding mixed stocks fisheries, the Board of Fisheries and the State of Alaska has acted to limit the expansion of interception and mixed stocks salmon fisheries. This policy is stated in the Board's mixed stocks fishery policy which has been recently adopted in regulation.

In order to arrive at a rough estimate of the effects that trawl bycatch might have on individual runs or systems, two western Alaskan river systems with the most available information were analyzed. The Nushagak chinook salmon run has been closely monitored by the Alaska Department of Fish and Game, and annual estimates of catch and escapement as well as age composition information were available for this river. Brannian (1990) has also provided abundance estimates and exploitation information for portions of the Yukon river for the years 1982-1986, and this information was used to roughly estimate Yukon River abundance for years of interest. No age composition information is available for the Yukon river.

Nushagak River:

The Nushagak River drainage covers an extensive portion of the Bristol Bay watershed, and is the largest producer of chinook salmon in Bristol Bay (Minard et al. 1992). Escapement into the Nushagak was approximated from aerial surveys from 1966-1985, and has been estimated using side scanning sonar since 1986. Age composition of escapements was from spawning ground samples in 1981-1985 and 1987-1991, and from the commercial catch samples in all other years (Minard et al. 1992).

The following procedure and assumptions were followed in order to roughly estimate the impacts of trawl chinook salmon bycatch on the Nushagak river run.

The total annual number of chinook salmon intercepted in the Bering Sea from foreign, joint venture and domestic trawl fisheries during the period 1977-1992 was estimated from NMFS observer program reports. Based on the results of Myers and Rogers (1988), 57%, 63%, and 60% of the chinook bycatch in trawls during 1979, 1981, and 1982, respectively, were estimated to be of western Alaskan origin. The mean percentage of western Alaska origin chinook (60%) was assumed for all other years. These percentages were multiplied (as proportions) against the total bycatch in a year to estimate the number of chinook of western Alaskan origin in a given year. Following the example of Myers and Rogers, the percentages of chinook salmon from the Yukon, Kuskokwim and Bristol Bay systems (< 100%) were adjusted to equal 100%, assuming that all of the western Alaskan fish are from the Yukon, Kuskokwim and Bristol Bay systems only. The average percentage of Bristol Bay chinook (29%) was thus adjusted to 41.4% of all western Alaska fish, and this percentage (as a proportion) was multiplied against the total estimated number of western Alaskan chinook to estimate the total number of chinook of Bristol Bay origin.

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. Assuming that all chinook bycatch in trawl fisheries are either age 1.2 or 1.3 fish, the percentages were then adjusted to 68.3% and 31.7% age 1.2 and age 1.3 fish, respectively. The estimated number of Bristol Bay chinook was then multiplied by these proportions to estimate the number of age 1.2 and age 1.3 Bristol Bay bound fish.

Appendix A2 from Minard et al. (1992) was used to determine that the majority of chinook salmon return to the Nushagak River as age 1.3 (average 35.2% 1980-1991) and age 1.4 (average 42.0% 1980-1991) fish. Assuming that all chinook return at age 1.3 or 1.4, the proportion of Nushagak River fish from the same brood year which returned as age 1.3 in a given year and the proportion which returned as age 1.4 in the following year was determined.

Based on the age composition of the bycatch chinook salmon (predominantly age 1.2 and age 1.3), and the Nushagak returns (predominantly age 1.3 and age 1.4), it was assumed that a portion of the chinooks bycatch in the trawl fisheries as age 1.3 fish would have returned in the same year if they had not been intercepted. The remainder of the age 1.3 chinook were assumed to return to the Nushagak River in the following year as age 1.4 fish. None of the age 1.2 bycatch chinook salmon were assumed to have returned to the Nushagak during that year had they not been intercepted, and a portion were assumed to return in the following year as age 1.3 fish, and the remainder were assumed to return 2 years later as age 1.4 fish. Numbers were adjusted for natural mortality as described below.

The estimated number of Bristol Bay origin age 1.3 chinook salmon, derived as outlined above from annual trawl bycatch, was multiplied by the proportion of age 1.3 chinook salmon which had actually returned to the Nushagak in that same year. It was assumed that this proportion of the age 1.3 chinook salmon would have returned in the same year in which they were bycatch, and no natural mortality was assumed for this portion of the returns. This assumption was made because a large portion of the chinook salmon are bycatch in the spring of the year.

Annual at-sea natural mortality rates were assumed to be similar to those used by the Joint Chinook Technical Committee in the Alaska-Canada treaty (PSC, 1988). The treaty assumes that the natural mortality rate over the year between ages 1.2 and 1.3 is 20%, and that the natural mortality rate over the year between ages 1.3 and 1.4 is 10%.

The age 1.3 portion of the intercepted chinook salmon were assumed to return in the same year or in the following year as age 1.4 fish. The estimated number of Bristol Bay origin age 1.3 chinook salmon which were assumed to return in the following year as age 1.4 salmon was multiplied by the proportion of age 1.4 chinook salmon, which had actually returned to the Nushagak River in the year following the 1.3 returns of the same brood year. Prior to multiplication, the age 1.3 salmon which were estimated to return the following year as age 1.4 salmon were discounted by the 10% natural mortality rate.

A similar procedure was followed to estimate the returns which would have been expected of salmon intercepted as age 1.2 fish. Fish returning the following year as age 1.3 fish were discounted by a natural mortality rate of 20%, and those that returned 2 years later as age 1.4 were further discounted by a natural mortality rate of 10%. Fish were allocated as ages 1.3 or 1.4 Nushagak returns as above, by brood year contribution to returns as age 1.3 and 1.4 fish.

The total number of chinook salmon which might have returned to Bristol Bay had they not been intercepted in the trawl fisheries of the Bering Sea were then determined by year. The proportion of chinook salmon returning to the Nushagak River (Minard et al..) and to the Togiak River (Cross, ADF&G, Personal Communication) in each year was determined. The proportion of Nushagak River returns in a given year was then multiplied by the sum of fish over all age groups which were estimated to have returned in that year to arrive at the total Nushagak River component.

The reported returns to the Nushagak River in each year were then compared to the estimated number of chinook, which would have returned to the Nushagak given no trawl interception. The estimated percentage by which the returning number of chinook would have increased, given no interception, was between roughly 2% and 7%, and averaged 4.6% over the period 1979-1991 (Figure 1-27, upper graph). Bycatch trawl salmon were estimated to have contributed between 3,000 and 16,000 fish to Nushagak returns (Figure 1-27, lower graph). Apportioning the additional chinook into the commercial fishery based on annual exploitation rates, the commercial catch would have been increased by between approximately 1,000 and 9,000 fish. It should be noted that the low commercial catch recorded between 1987 and 1990 was actually chinook taken during the commercial sockeye fishery since the directed chinook gillnet fishery was closed during those years.

Since bycatch numbers in the trawl fisheries are highly variable across years, the impact of a constant number of chinook bycatch in any year was examined as well. Given a set bycatch (e.g. the approximate number encountered in recent years) of, for example, 40,000 chinook in every year, the number of chinook returning to the Nushagak River, given no interception, would have increased by approximately 2% to 8% and averaged 4.4% over the period 1979-1991. The 40,000 bycatch trawl chinook were estimated to have contributed between approximately 4,500 and 12,000 fish to Nushagak returns, and between 1,000 and 5,000 fish to the commercial fishery with an average of approximately 2,700 fish.

The year with the highest trawl bycatch, 1980, would have contributed to the catch and escapement in 1980, 1981, and 1982. As Figure 1-11 indicates, 1981 and 1982 were the 2 years with the highest commercial catch and the highest total run since 1966. In order to examine similarities in the magnitude of bycatch and run size, the total trawl bycatch and the total returns to the Nushagak River for the years

1979-1991 are provided in Figure 1-28 with numbers of bycatch chinook corresponding to the left axis, and numbers of returns corresponding to the right axis. A greater number of returning chinook are apparent in general from 1980-1985 and the numbers are reduced for the remaining years.

Since bycatch influences escapement 1 to 2 years later, the bycatch was lagged by one year in Figure 1-29. Bycatch and the total Nushagak returns were each represented on separate axes to approximate the same scale (Figure 1-29). There is a fairly good correlation, both in trend and magnitude between bycatch and returns (with the exception of 1982 and 1983) when the bycatch is lagged by one year.

Yukon River:

Less data are available for the Yukon River system, and further information is necessary to estimate stock production and exploitation levels (Brannian, 1990). However, as Brannian (1990) notes:

> The Yukon River chinook salmon resource appears to be fully utilized under current management plans. Any decline in stock abundance or proposals for increased harvests by one user group requires a reallocation by the regulatory agencies. It is not known if the stock is being sustained at MSY. Given the gauntlet nature of the fishery and the wide distribution of spawning populations, it is likely that optimum exploitation has been exceeded for upriver stocks, while downriver stocks may be less utilized.

Commercial, subsistence, and some recreational catch data for the Yukon River are available and there is information from monitored index streams that help gauge escapement levels, but stock size information for the entire river is lacking. Based on a Canadian tagging study and on some run composition information from ADF&G, Brannian (1990) was able to estimate the total Yukon River run for the years 1982-1986. The following analysis utilizes the estimated proportions of fish taken from lower, middle and upper river runs, and the estimated exploitation rates for 1982-1986 derived by Brannian to roughly determine the total run size for other years. These estimates are based on many assumptions which may not accurately portray the actual run size in any given year, and Brannian (1990) suggests caution in their use. The analysis conducted below based on the North Pacific Fisheries Management Council desire to proceed with the "best available" information at the time.

The estimation of the number of chinook that might have returned to the Yukon River from Bering Sea trawl fisheries was similar to the estimation for the Nushagak above, with the exception that the Yukon River was viewed as consisting of three individual runs (lower, middle and upper river runs), each with individual exploitation rates and age composition. As with the Nushagak analysis above, the Bering Sea trawl bycatch was totalled for each year, and 60% of the bycatch was estimated to be of western Alaskan origin (57% in 1979 and 63% in 1981). Myers and Rogers (1988) estimated that Yukon River fish comprised 17% of bycatch chinook, and this was expanded, as in Myers and Rogers, to 24.3% of western Alaskan chinook. Assuming that all chinook bycatch in trawl fisheries are either age 1.2 or 1.3 fish, 68.3% and 31.7% of the Yukon River origin chinook were estimated to be age 1.2 and age 1.3 fish, respectively.

As discussed above for the Nushagak, the majority of chinook salmon return to the Yukon River as age 1.3 (average 23.1% 1980-1991) or age 1.4 (average 54.0% 1980-1991) fish. Assuming that all chinook return at age 1.3 or 1.4, the proportion of Yukon River fish from the same brood year which returned as age 1.3 in a given year and the proportion that returned as age 1.4 in the following year were determined by expanding the percentages to 100% for each of the three runs over the years 1980-1991. Given natural mortality rates, and the assumed age structure of the bycatch and returning fish, the Yukon River origin chinook salmon were apportioned to returns in each year as above for the Nushagak River. The at-sea natural mortality rates were the same as employed above.

The number of chinook salmon returning to the Yukon River in a given year is unknown, but an estimate of the abundance is necessary in order to gauge the degree to which trawl chinook salmon bycatch might impact the Yukon River stocks. Since the Yukon River chinook return is actually made up of the lower, middle and upper river runs, and stocks of each river section encounter a different level of fishing pressure, the exploitation rates for the three runs must be considered separately. Brannian (1990) estimated the proportion of the total river catch which the lower, middle and upper river runs comprised over the years 1982-1986 (Figure 1-30, upper graph), and the average proportions were used for years prior to 1982 and subsequent to 1986. Similarly, estimated and average exploitation rates developed by Brannian (1990) were used as well. Brannian cautioned the use of these exploitation rates, especially given some implausible rates (Figure 1-30, lower graph - 1986 middle run value not indicated). Given the rough nature of the estimates provided in this discussion, the estimated exploitation rates were used for the years 1982-1986, and the mean exploitation rates were used for years lacking exploitation rate estimates. In addition to these exploitation rates, Brannian (1990) suggested using a range of exploitation rates (30%-50% for the lower run and 58%-70% for the middle run). These ranges for the lower and middle runs, and the range of estimated values for the upper river runs were used to bracket the mean exploitation rates. The total estimated abundance for the Yukon River was determined in each year by dividing run catch by run exploitation rate, and summing over the three runs.

The mean exploitation rates (and the estimated exploitation rates for 1982-1986) resulted in an estimated Yukon River abundance of between 200,000 to 450,000 fish over the years 1979-1991 (Figure 1-31, upper graph). Note that because of the difficulty in accurate abundance estimation, the disparity, for instance, between the high run size in 1984 the lower levels in 1982 may be the result of an actual range of variability, or may overestimate or underestimate the between year variability in abundance. During this period, bycatch chinook salmon, had they not been intercepted in Bering Sea trawl fisheries, would have increased the total run size by between approximately 0.8%-3.9% (mean = 2.1%). The additional chinook salmon would have added between approximately 2,400 and 10,300 chinook to the Yukon River returns (mean = 5,740 chinook), and between approximately 1,100-5,500 chinook salmon to the commercial salmon fishery (mean = 2,830 chinook; Figure 1-31, lower graph).

Using the lower range of exploitation rates for the three runs, the estimated annual abundance of chinook salmon was between approximately 300,000-400,000 fish over the years 1979-1991 (Figure 1-32, upper graph). Bycatch chinook salmon would have increased the total run by between .6% and 3.0% (mean = 1.7%). Between approximately 900-4,300 chinook salmon would have been added to the commercial salmon fishery (mean = 2,200 chinook; Figure 1-32, lower graph). Using the upper range of exploitation rates, the estimated abundance of chinook salmon ranged between approximately 250,000 - 300,000 fish, and bycatch chinook salmon would have increased these numbers by between 0.8% - 4.1% (mean = 2.3%; Figure 1-33, upper graph). The commercial fishery would have increased by between approximately 1,200 - 5,900 chinook (mean = 3,100 chinook; Figure 1-33, lower graph).

Following the example above for the Nushagak with a set bycatch of 40,000 chinook in every year, the number of chinook returning to the Yukon River, given no interception and mean exploitation rates, would have increased by approximately 1.2% to 2.3% and averaged 1.7% over the period 1979-1991. The 40,000 bycatch trawl chinook were estimated to have contributed an annual mean of 4,700 fish to Yukon returns, and between 1,600 and 2,600 fish to the commercial fishery with an average of approximately 2,300 fish.

The similarity of the approximate impact of chinook salmon bycatch on the returns to the Nushagak and Yukon Rivers allows for a very rough approximation of the impact of chinook salmon bycatch on western Alaskan systems in general. Chinook salmon bycatch in the trawl fisheries of the Bering Sea appear to be taken at a relatively constant exploitation rate, and the number of bycatch chinook is likely to be related to the general abundance of chinook salmon in the Bering Sea. The Nushagak River is the only system in western Alaska for which fairly reliable abundance estimates can be made. Assuming, however, that the patterns in abundance of other western Alaska systems are similar, some generalizations may be made based on the analysis of the Nushagak River presented above. The translation of bycatch chinook salmon into individual system returns indicates that the bycatch chinook salmon might have accounted for an increase in returns to any western Alaska system of a small percentage. There may be considerable interannual variability, however, as guideline percentages, the average percentage by which the Yukon River abundance might have increased was approximately 2%, and the average percentage addition to the Nushagak River was approximately 4%. As stated above, this is assuming that bycatch impacts all stocks and ages similarly, which has yet to be verified.

1.3.5 Socioeconomic Values

In addition to the ex-vessel value of a chinook salmon to directed salmon fisheries, the chinook salmon also has value to the recreational and subsistence fisheries. Although the values to these fisheries are difficult to quantify, and in some cases are non-monetary, they add to the overall value of chinook salmon to western Alaska. There are valuation techniques that could be applied to the problem, but are beyond the scope of this analysis.

Commercial Fisheries:

The average annual total amount paid to Bristol Bay fishermen for chinook salmon was $1,938,000 over the years 1982-1991 (ADF&G, 1992). The average catch over the same period was 64,461 fish from the Nushagak District, and 21,497 fish from the Togiak District for an average total of 85,958 chinook from the Bristol Bay area. A very rough per fish value of chinook salmon in Bristol Bay over the period 1982-1991, was $22.55 per chinook. Over the same period, using exploitation rates on the Nushagak fishery (which includes years with no commercial fishery), the average number of bycatch chinook which would have entered the entire Bristol Bay commercial fishery in any given year was approximately 2,900 fish (as derived above). Applying the approximate price per fish estimated above, the average annual value of the bycatch chinook to the Bristol Bay commercial fishery was roughly $65,400.

Similarly for the Yukon River, the average annual total price paid to Yukon River fishermen for chinook salmon was $4,787,000 over the years 1982-1991 (Bergstrom et al., 1992). The average catch over the same period was 128,327 chinook. Again, a rough per fish value of chinook salmon in the Yukon River fishery over the period 1982-1991, was $37.30 per chinook. Over the same period, using mean exploitation rates on the Yukon River fishery as derived above, the average number of bycatch chinook which would have entered the Yukon River fishery in any given year was approximately 2,850 fish. Applying the approximate price per fish estimated above, the average annual value of the bycatch chinook to the Yukon River commercial fishery was roughly $106,300. The average price per fish for the Yukon River has increased over recent years, and applying the average per fish value from 1991 of $64.33 to the average 2,850 bycatch chinook, the annual value of the bycatch chinook was $183,340.

Recreational Fishery:

Recreational fishing is a major industry in Bristol Bay, and it has been estimated that anglers expended $44 million ($20.4 million in the Naknek-Kvichak Drainage) in 1986 with a total gross willingness to pay of $50 million (Ackley, 1988). A study by the Bristol Bay Coastal Resource Service Area Board (1986) estimated that total income to lodges and related businesses from sport fishing in the Nushagak-Mulchatna River drainages alone was $13.5 million in 1985.

It is difficult to determine a per-fish value for a recreational fishery. Many fishermen engage in catch and release fishing, and thus the value of a caught salmon is not comparable to those caught and kept in, for instance, a commercial fishery. Several studies have shown that the fishing experience, which includes the value of scenery, water quality and solitude, was of primary importance to anglers, and that the number or type of fish caught was of less importance (Ackley, 1988). For this reason, and because many studies use the cost of the trip to help determine the value of the fishery, it is more applicable to value the recreational fishery on a per trip rather than a per fish basis.

Since there is no direct market by which to value recreation, the value of recreational activities such as sport fishing are determined by the net willingness to pay for use of the resource. This includes both site quality as well as species abundance and diversity. Willingness to pay, or consumer surplus, is the amount beyond actual expenditures, which the user would be willing to pay to use or continue to use the resource. The average net willingness to pay by anglers in Bristol Bay was $373 per trip (for a total net willingness to pay of $6 million in 1986; Ackley, 1988), and, for comparison, the average net willingness to pay by anglers in Southcentral Alaska was $305 per trip (for a total net willingness to pay of $30 million in 1986; Jones and Stokes, 1987). The total net willingness to pay, above and beyond actual expenditures, for the chinook salmon fishery on the Kenai River alone was $11.9 million in 1986 (Jones and Stokes, 1987).

Chinook salmon are a fundamental component of the Nushagak recreational fishery. The two fish of primary importance to anglers in Bristol Bay were rainbow trout and chinook salmon (Ackley, 1988). Among surveyed anglers in the Naknek-Kvichak drainage, the average angler caught four rainbow trout and one chinook salmon per day spent fishing, and kept one rainbow trout for every three days spent fishing and one chinook salmon for every day spent fishing. In 1991, anglers on the Kvichak River Drainage Area (Mills, 1992) caught 1,500 chinook salmon (> 28 inches), and kept 400 chinook, or 27% of all caught chinook. In the same year, Kvichak Drainage anglers caught 89,529 rainbow trout and kept 1,590 rainbow trout, or 2% of all caught rainbow trout. Similarly, in 1991 anglers in the Nushagak Area caught 8,813 chinook salmon (> 28 inches), and kept 4,082 chinook, or 46% of all caught chinook. In the same year, Nushagak Area anglers caught 24,690 rainbow trout and kept 1,059 rainbow trout, or 4% of all caught rainbow trout. The chinook salmon population is thus exploited to a much greater extent than rainbow trout in that a much higher percentage are kept by recreational fishermen. In addition to recreational fishing pressure, chinook salmon are also taken by a commercial fishery (which does not impact rainbow trout), and in a subsistence fishery.

Given that the recreational fishery is valued on a per trip basis, and that chinook salmon are one of several species sought by anglers, it is difficult to determine the social and economic impact which a reduction in the number of chinook salmon would have on the recreational fishery. It should be noted that in addition to the scenic and outdoor values of the fishing trip, anglers also valued the number of fish and quantity of species available. It could be expected that a decline in the number of fish and number of available species would decrease the demand of anglers for fishing in Bristol Bay, and that alternate sites would become more attractive (Ackley, 1986). Such a change in demand would negatively impact the local economies.

Because of the difficulty in estimating a value for chinook salmon in the recreational fishery, and because recreational and commercial values are not comparable, the value of a sport caught chinook salmon was not included in this analysis.

Subsistence Fishery:

<u>The Importance of Chinook Salmon in the Traditional Cultures and Socioeconomic Systems of the Yup'ik Eskimos and Athabaskan Indians of Western and Interior Alaska</u>

Chinook salmon is one of the major food items of the Yup'ik Eskimo and Athabaskan Indians of Western and Interior Alaska. Chinook salmon plays an important role in supporting the indigenous cultures and mixed, subsistence-cash socioeconomic systems of the Yup'ik and Athabaskan peoples in Alaska. As is described below, subsistence activities, especially harvesting, processing, sharing, and using chinook salmon, provide a number of social, cultural, and economic values to indigenous peoples of Western and Interior Alaska.

The drainages of the Yukon River, Kuskokwim River, and Bristol Bay area are the ancestral homes of several indigenous groups who use chinook salmon, as listed in Tables 1-2 to 1-3 with their historic cultural affiliations. These groups include Central Yup'ik Eskimo, Dena'ina Athabaskan, Gwich'in Athabaskan, Han Athabaskan, Holikachuk Athabaskan, Ingalik Athabaskan, Koyukon Athabaskan, Tanana Athabaskan, and a few Inupiat Eskimo (Table 1-3). These cultural groups resided in about 95 rural communities in 1990, according to the U.S. Census, with about 21,807 Alaska Natives. In addition, there resided about 6,324 non-Natives in rural communities of this area, who are persons primarily from Euro-American cultural traditions.(Table 1-4).

Currently, most Alaska Native villages in the drainages of the Yukon River, Kuskokwim River, and Bristol Bay area have traditional tribal governments, which are organized under the Indian Reorganization Act and recognized by the United States government. The tribal governments are further organized under regional non-profit organizations, listed in Tables 1-2 to 1-3.

The peoples of the Yukon, Kuskokwim, and Bristol Bay area continue to maintain traditional cultures and mixed, subsistence-market economies, modified in particular aspects by the incorporation of certain features of the outside Euro-American culture and market economy. The local economy of this area has been called a "mixed, subsistence-market economy" (Wolfe 1984, Wolfe and Walker 1987). The mixed, subsistence-market economy is a system of production and distribution of goods and services that supports the rural communities of the area. There are three components to the economy: (1) traditional subsistence fishing and hunting; (2) monetary income earned through sales of fish and furs produced and marketed through local, small-scale commercial fishing and fur trapping industries; and (3) monetary income earned through limited, local wage employment, usually through public sector grants. The subsistence sector of the local economy is organized under a "domestic mode of production," meaning that traditional kinship groups provide the primary social organization of subsistence food production (in contrast to the non-kinship economic firms of industrial-capitalism) (Wolfe et al. 1984).

Wild Food Harvests

Wild food production is one major component of the mixed, subsistence-market economies of the Yukon-Kuskokwim-Bristol Bay area. The indigenous societies of the drainages of the Yukon River, Kuskokwim River, and Bristol Bay area are still heavily reliant on subsistence fishing and hunting for survival. In Alaska Native villages, daily life is commonly organized around traditional fishing, hunting, gathering, and trapping activities for local uses, including direct family consumption and customary distribution and sharing. Subsistence harvests of wild foods in the area are large, as shown in Table 1-5, with many communities harvesting between 400 to 900 lbs of wild resources per person each year. This level of wild food production contains more than the communities' yearly protein requirements. By comparison, Americans in the continental United States purchase an estimated 1,370 lbs of food annually, of which 220 lbs are meat, fish, and poultry. In addition to the subsistence foods, communities in the Yukon-Kuskokwim-Bristol Bay area import certain food products, especially carbohydrates such as flours and sugars which are high in kilocalories.

Chinook salmon is one of the major subsistence food products produced within the Alaska Native communities of the Yukon, Kuskokwim, and Bristol Bay areas, as shown in Tables 1-6 to 1-8. Chinook salmon is highly valued as a food fish for human consumption. A large, bright fish with firm, rich flesh, chinook are excellent for drying and smoking. Families commonly establish fish camps during summer to fish for chinook salmon. Some camps have been continuously occupied for generations. Fish are caught using set gill nets, drift gill nets, or fish wheels, depending upon the community. The fish are processed with a traditional division of labor, typically with the men harvesting and the women processing. Chinook commonly are cut, air dried on outdoor racks, and smoked in family smokehouses, using labor-intensive methods.

Commercial Fisheries

A second component of the local mixed, subsistence-market economy are small-scale fisheries and fur trapping for commercial sale on export markets. The development of local commercial salmon fisheries has created the potential for a more stable source of cash income for communities. These fisheries have produced a small, potentially sustainable source of income to the region (Wolfe 1984). Historically, fur trapping of beaver, mink, land otter, white fox, and red fox for sale has contributed income to the local economy. During recent decades, unstable world market prices for furs have meant this activity contributes at most only about 10 percent of the total earned monetary income by families in the Yukon, Kuskokwim, and Bristol Bay area.

Wage Employment

Wage employment, a third component of the local, mixed economy, is limited in the rural communities of the Yukon, Kuskokwim, and Bristol Bay area. The primary source of wage employment is in state, federal, and local government-funded services, providing a few local wage jobs in schools and municipal services. In general, there is no private business sector in the communities providing wage employment. State and federal capital improvement projects have provided temporary local wage employment in construction of housing and schools during Alaska's oil-boom period from 1978 to 1986, but this source of employment is disappearing with falling state oil revenues.

The market-wage component of the mixed economy historically has not been strong in many of the area's communities. According to the 1990 U.S. Census, median household incomes commonly are below $20,000. As a comparison, Anchorage had a median household income of $43,946 in 1990, and Fairbanks had a median household income of $32,033 (Table 1-5). In addition to low incomes, the purchasing power of monetary incomes in these rural areas is eroded by a high cost of imported items.

Because of the low incomes, most of the area's communities could not sustain themselves without subsistence fishing and hunting. Historically, the communities' most secure economic adaptation is to participate in a traditional mixed economy, combining subsistence fishing and hunting with cash earnings from limited wage employment and commercial fishing. The money generated in the commercial-wage sector of the economy enables families to capitalize in the subsistence sector, producing a substantial portion of the local food supply. To correctly understand the importance of subsistence resources like chinook salmon, one must understand the importance of wild resources in the sustained functioning of the local, mixed, subsistence-market economy.

Values of Subsistence

Monetary measures are not designed to adequately account for many values derived from traditional, indigenous cultural systems of the Central Yup'ik Eskimo and Athabaskan Indians. The values derived from the indigenous culture and economy are traditional ones, embedded within traditional systems of kinship, beliefs, customs, and ritual which are substantially different from those of Euro-American systems.

Ascribing a value to subsistence chinook fishing within Alaska Native communities is difficult because of the markedly different cultural and economic contexts of the subsistence use. From the point of view of the indigenous culture, chinook has great value because of its central position in the traditional economy, culture, and social system. Some of these values are listed below.

Food Supply:

As indicated above, subsistence salmon fishing provides a substantial part of the food supply in the Yukon-Kuskokwim-Bristol Bay area. For most rural communities, subsistence harvests contain over 100 percent of the protein requirements of the population (about 44 g protein per person per day). Chinook salmon is one of the main food species in most communities. Chinook salmon plays a central nutritional role in the local economies because of its large volume, annual reliability, and inexpensive procurement costs.

Economic Security to Families:

Subsistence salmon fishing provides a type of long-term economic security to families which wage employment does not provide. For many communities, subsistence food production is more reliable from year to year than income from wage employment. Subsistence serves as an economic safety net for families during regular, periodic downturns in the local wage sector or personal family finances. It provides security and stability to the local subsistence economy in ways that other resources cannot.

Social Security to Dependents:

Subsistence serves as a form of social security for the aged and the dependent in villages. Subsistence foods are shared to the elderly and people unable to fish and hunt themselves as a form of traditional social security (Wolfe 1987). The high value of chinook salmon is related to its importance in the networks of non-market distribution and exchange of subsistence products between households in the community. Households that cannot fish and hunt for themselves due to age or other personal circumstances receive subsistence foods from productive households, usually along lines of kinship or traditional exchange relations. Negative impacts on subsistence production would compromise these traditional social support networks, especially for the elderly and unmarried mothers with dependent children. Because of the large volume produced, chinook salmon is one of the major food products flowing through these traditional distribution and exchange networks.

Transmission of Knowledge:

Subsistence salmon fishing benefits the continued transmission of traditional cultural knowledge, skills, and beliefs between older and younger generations. Subsistence activities teach group responsibility and leadership which have value in other social areas. The intergenerational transmission of knowledge promotes continuity and social order in the community.

Functioning Family Groups:

Subsistence salmon fishing benefits the functioning of extended family groups which are responsible for subsistence activities. Subsistence activities provide meaningful, productive work roles to men, women, and children in the community. Subsistence fishing and hunting are more than mere occupations in indigenous Yup'ik and Athabaskan cultures, they are activities central to the functioning of family and community, and central to the personal psychological integrity of the individual. Alaska Natives as a people traditionally define themselves in terms of mutual social relationships with kinship groups and spiritual relationships with the natural world. The traditional work tasks of catching and processing subsistence foods for the kin group are primary social roles of men and women. For instance, the Yup'ik word for "man" (*angun*, "human male"), literally means "something that chases something for food" (from the root *angu-*, "to catch after chasing," and the lexical stem *-n*, "instrument") (Jacobson 1984:500). A *nukalpiaq*, "a young man in his prime," also means "a good hunter and provider" (Jacobson 1984:268). Thus hunting and fishing are more than just character-defining occupations for men, they help to define gender itself. Similarly, processing subsistence foods is a primary social role for women in Yup'ik and Athabaskan culture, defining her important position in the social order. Once the subsistence kill is turned over to the woman for processing, she typically owns and controls the subsistence product. The woman determines its disposition, and can keep or give it away as she chooses.

The high value of salmon in the Yukon, Kuskokwim, and Bristol Bay area is due in part to its central position in the functioning of families in the traditional annual cycle of subsistence activities. Production of salmon is one of the major social functions of extended family groups in the area. Because of the traditional domestic mode of production for salmon, negative impacts on subsistence salmon production have direct negative impacts on the functioning of family groups. The disruption of salmon production activities would directly disrupt primary social functions of families.

Self-Determination:

Subsistence salmon fishing provides a means for local self-determination in rural communities. Subsistence fishing and processing activities are organized locally and draw on local knowledge and skills. Subsistence is an area of life where local communities can support themselves in meaningful, productive, and valuable work. It reinforces confidence in the local group's ability to achieve a satisfying way of life.

Reduced Social Problems:

Because subsistence salmon fishing creates meaningful livelihoods for Alaska Natives, it probably helps to decrease rates of social pathologies in rural communities which have resulted from rapid rates of culture change. Social pathologies which are problems in rural areas include chronic substance abuse, domestic violence, suicides, homicides, accidents, and destructive anomie. Rural communities have sought to halt these processes through a continuance of traditional ways of living, including subsistence fishing and hunting.

Customary Foods:

Food customs differ in Alaska's rural areas, and rural diets are commonly built around staple traditional food products such as dried chinook salmon. Alaska Natives and other long-term rural residents state they have a need to eat traditional foods to which they have become accustomed. These types of foods commonly cannot be imported from the continental United States.

Cultural Survival:

Alaska Native groups insist that without traditional fishing and hunting activities, they would disappear as culturally-distinctive peoples (cf., Berger 1985). Harvesting wild resources expresses and reinforces special relationships among Alaska Native peoples and the land, relationships with roots stretching back many centuries. Subsistence instills group identity and purpose, which are essential to well-being of individuals, families, and communities.

Ceremonial Exchange:

Subsistence foods are primary items for ritualized exchange relations between families. Reciprocal and ceremonial exchange relations are primary social mechanisms for unifying communities in Central Yup'ik and Athabaskan Indian cultures, and for expressing spiritual relationships between humans and animals. There are a variety of ceremonial contexts through which the exchange of food expresses spiritual values, including funeral potlatches and winter ceremonials. For instance, the first subsistence activities of young Yup'ik children are ritually celebrated with feasts (*kalukaq*, or *nerevkarin*). Subsistence foods (raw and cooked) typically are distributed in the name of the young child among the guests, which include unrelated kin groups from the larger community. These ceremonies involve spiritual and reproductive symbolisms, for the sharing of the first fruit is to help the child's future hunting and fishing success and marriage prospects, which in turn supports the community's future reproductive success (Fienup-Riordan 1984). They also express on-going mutual obligations between humans and the spirit owners of the animals, by properly using the subsistence product, so that the animals will continue to offer themselves to humans in the future. Without subsistence foods, the rites linking humans and animals in the traditional cosmology would not be possible, and the future of the human race jeopardized.

Clearly, subsistence chinook salmon and other subsistence resources provide a variety of values to the indigenous Central Yup'ik and Athabaskan cultures which go beyond their nutritional and economic values. Without these subsistence activities and uses, the indigenous cultures could not survive in their traditional forms. It is impossible to put an economic value to the survival of traditional cultures like those of the Central Yup'ik and Athabaskan Indians in Alaska. There is growing international concern that the survival of indigenous, culturally diverse groups should be a central social goal in relations between national and ethnic groups. That is, the existence of culturally diverse, indigenous groups is a desirable social end (and in fact, a social right of the indigenous group). The loss of a traditional culture is usually irreversible. And the lost values of that culture is a loss to the world.

Given this framework of values, management of Bering Sea chinook salmon stocks should be done with great awareness of the cultural survival of the indigenous Yup'ik Eskimo and Athabaskan Indian cultural groups. Management of chinook stocks should be carefully done in ways that are compatible with the continued cultural survival of the Yup'ik and Athabaskan people and their culture.

Because of the difficulty in estimating a value for chinook salmon in the subsistence fishery, however, and because subsistence and commercial values are not directly comparable, the value of a subsistence caught chinook salmon was not included in this analysis.

1.3.6 Observer Data

The data used in the analysis of time and area patterns in chinook salmon bycatch were obtained from the National Marine Fisheries Service (NMFS) Alaska Fisheries Science Center (AFSC) and consisted of haul by haul observer data from trawl fisheries in the Bering Sea. Data were collected from foreign vessels during the years 1981-1989, from Joint Venture (JV) operations during the same years, and from domestic fisheries from 1989 to 1993. The number of hauls observed in foreign fisheries began to decline in 1987; there were few observed hauls in the joint venture fisheries prior to 1984; and domestic fisheries prior to 1990 had low observer coverage. Analysis of data representing years with a greater number of hauls in each fishery were emphasized for this report (foreign 1981-1986, JV 1985-1989, and domestic 1990-1993). It should also be noted that the domestic observer program was not fully operational until March of 1990, and that the data set for geographical analysis in the prior version of this Amendment did not extend beyond September of 1991. Data from 1992 and 1993 have been updated where possible. Observer coverage of the foreign and JV fleets (expressed as days observed/days fished) was 10% to 30% during the early 1980's, but increased to above 80% by 1984, and exceeded 90% by 1986 (Figure 1-34). Given the low observer coverage during the early 1980's, the bycatch rates and totals may not be as accurate as in later years.

The observer data included ship positional and operational data as well as size of catch and prohibited species catch. The number of salmon captured in each haul was recorded, but the method of sampling was not available in the data provided (whole haul or basket samples). The species composition of salmon was recorded for a subsample of the data in each year for each fishery. The number of chinook salmon in each haul was used if observed in the subsamples, but was estimated for the hauls for which no species composition was recorded.

In order to estimate the number of chinook salmon in hauls for which species composition was not recorded, the following stepwise algorithm was followed using hauls with available species composition: if at least five observations with species composition within a specific block (1/2° latitude by 1° longitude) and month were available, the percentage of chinook salmon for that month and block was multiplied by the total number of salmon in a haul in that month and block to arrive at the number of chinook; otherwise, if at least five observations for a month and defined area (Figure 1-35) were available, the percentage of chinook salmon for that month and area was multiplied by the total number of salmon from a haul; otherwise, if at least five observations from that month were available, the total number of salmon in a haul was multiplied by the percentage of chinook salmon in that month; otherwise if at least five observations from either the period of January-April, or May-December were available, the number of salmon was multiplied by the percentage of chinook salmon in that season; otherwise the if at least five observations from a fishery for the year were available, the percentage of chinook salmon for the entire fishery was used to calculate the number of chinook salmon in a haul; otherwise the percentage of chinook salmon for the entire year was used to calculate the number of salmon in a haul.

The rationale for this approach was that the percentage of chinook salmon encountered in hauls was both time and area related. The percentage of chinook salmon in a haul was likely to be most similar to hauls from the same block and month, or from a similar larger area and month, or from a similar month, or from a similar season. The use of the season and larger area variables to define similar chinook salmon percentages was confirmed by a general linear model in which area and season were explanatory variables for chinook salmon percentages (Table 1-9). Both variables were significant in years with a large sample size since 1983.

Table 1-9. General linear model parameters with percentage of chinook salmon as the dependent variable and larger area (Figure 1-35) and season as explanatory variables.

Year	R^2	Model p	Variable	p
1981	.06	.38	Season	.310
			Area	.344
1982	.25	.0001	Season	.0001
			Area	.0012
1983	.44	.0001	Season	.0001
			Area	.0009
1984	.65	.0001	Season	.0001
			Area	.026
1985	.46	.0001	Season	.0001
			Area	.0004
1986	.46	.0001	Season	.0001
			Area	.0118
1987	.59	0.0	Season	0.0
			Area	.0001
1988	.45	.0001	Season	.0001
			Area	.0001
1989	.29	.0001	Season	.0001
			Area	.0001

1.3.7 Seasonality of Chinook Salmon Bycatch

Chinook salmon bycatch occurs primarily in the first and last 4 months of the year (as noted in the annual observer summaries prepared by National Marine Fisheries Service, Alaska Fisheries Science Center (e.g., Berger et al. 1984)), although groundfish catch is fairly constant throughout the year, if not higher during the summer months. Figures (1-36 and 1-37) provide chinook salmon bycatch and groundfish catch by month in the 1990-1993 domestic fisheries. The high bycatch during the months of January through April is apparent. Bycatch of chinook salmon declined significantly during the summer months. Groundfish catch, on the other hand, remained high through the summer months.

This pattern can also be seen in similar graphs for the foreign and JV fisheries with high bycatch during January-April and during September-December or October-December with groundfish catch being constant or increasing during the summer months (Figures 1-38 - 1-41). The chinook salmon bycatch rates by month for the domestic, JV, and foreign fisheries are also provided in Figures 1-42 through 1-44 and show the same seasonal pattern of high rates from January through April, and from September or October through December, hereafter referred to as the "bycatch season." Although the month of September did not have a consistently high bycatch of chinook salmon, the occasional high bycatch during this month (as in the JV fisheries) lead to its inclusion in the bycatch season.

A comparison of groundfish catch within the bycatch season with the catch during the summer months (May-August) is provided in Figures 1-45 through 1-48 for the foreign and JV fisheries. In the foreign fisheries (Figure 1-45), approximately 50% of the total groundfish catch was taken during the bycatch season in any given year or fishery. However, nearly all of the chinook salmon taken in the foreign fisheries were captured during the bycatch season. The JV fisheries (Figure 1-47) showed a gradual shift in groundfish catch from a high proportion of summer groundfish catch in earlier years to a high proportion of groundfish catch taken during the bycatch season in later years. A high proportion of chinook salmon were taken during the bycatch season in the JV fisheries during any given year.

1.3.8 Areal Patterns in Groundfish Catch

The Bering Sea consists of an expansive, fairly level shelf which extends west from the coast of Alaska out to an area near Unimak Island to the south, and along a shelf break, or 200 m contour, which extends to the north and west from Unimak Island. To the west of the shelf break, depths increase to over 3,000 m.

The maps discussed below portray the distribution of fishing effort, with each dot representing a single haul. Multiple hauls at exactly the same location would be visible as only a single dot because of overlapping. The 200 m contour is provided on the maps for reference, as is a 15 mile buffer which extends on each side of the contour to cover an area 30 miles wide.

The patterns of effort in the groundfish fisheries of the Bering Sea varied somewhat with the fishery. Foreign vessels, being excluded from the area near the Aleutians during some years, fished the length of the 200 m contour both on the shelf to the east of the shelf break, and in the deep waters to the west of the break. The distribution of foreign catch for small to medium sized tows (20-30 mt) and for larger tows (> 70 mt) are provided in Figures 1-49 and 1-50. The JV fisheries concentrated their effort in the area near the horseshoe and to the north of Unimak Island as illustrated in Figures 1-51 and 1-52. The domestic fisheries fished in all of the areas covered by both the foreign and JV fisheries, with the exception of the deep waters to the east of the shelf break (Figures 1-53 and 1-54). It should be noted that, because the dots representing each tow can overlap, the densities or levels of effort in the most popular areas are not fully revealed in the maps. The maps represent the extent of the effort over space.

1.3.9 Areal Patterns in Chinook Bycatch

There is a high degree of variability in bycatch in many 1/2° latitude by 1° longitude blocks over time, both within years and between years. Because of this variability in bycatch, and the problems in using data which has been averaged over time or space, individual blocks were sometimes found to have an exceedingly high bycatch in some years, and very little in other years while neighboring blocks often varied in yet different yearly patterns (Ackley and Carlile, 1991). Data from several years were examined over a larger scale to expose more general patterns in chinook salmon bycatch.

As indicated in the series of annual observer summaries prepared by the National Marine Fisheries Service, Alaska Fisheries Science Center (e.g., Guttormsen et al. 1990), chinook salmon bycatch is largely associated with groundfish catches in the "Horseshoe," in the area north of Unimak Island, and along the 200 m contour that demarks the shelf break (discussed below, Figures 1-55 - 1-57). It is notable that chinook salmon bycatch does not extend, for the most part, far from the contour, from the horseshoe, or from the north of Unimak Island. This is especially true for chinook salmon encounters during the months of January-April and September-December, and there is little apparent bycatch during the summer season. Although very apparent across years, the spatial bycatch pattern within a given year appears to be more patchy within these defined areas. Therefore, it would be very difficult to predict "hot spots" of high salmon bycatch in terms of specific 1/2° latitude by 1° longitude blocks.

In order to examine the patterns of chinook salmon bycatch given the importance of the 200 m contour, the horseshoe and the area above Unimak Island, four areas have been defined for the purpose of this analysis. The map of the Bering Sea with federal statistical areas and the 200 m contour is provided in Figure 1-55. The first area was defined as a buffer strip which extended 15 miles on each side of the 200 m contour (Figure 1-56), and catch and bycatch within this 30 mile wide buffer strip was compared to catch outside of the buffer. Largely included within a portion of this buffer were three contiguous 1/2° latitude by 1° longitude blocks in the area of the horseshoe (Figure 1-57) which comprised the second defined area, hereafter referred to as the "horseshoe blocks." The third defined area was the corner or core block of these three horseshoe blocks, hereafter called the "corner block," an area of higher salmon bycatch within the three blocks. The final defined area consisted of two blocks which were shown to have high salmon bycatch, particularly in the JV fisheries. These blocks, designated the "Unimak blocks" were located above the horseshoe and slightly to the north of Unimak Island (Figure 1-57). It is important to note that a large portion of the horseshoe blocks (but not all) are contained within the 200 m buffer, that the corner block of these horseshoe blocks is contained within the three blocks, and that the two blocks above Unimak Island are separate from any of the other defined areas.

A geographical information system (GIS) was used to analyze the observer data from the foreign, domestic and JV fisheries. The GIS is capable of spatially defining the areas described above and selecting only those observations which occur within the defined areas. In addition, attributes of the data can be used for selection, such as all hauls within a certain area which caught more than a predefined number of salmon within a given time period. Analyses of the selected data are provided below.

Patterns of chinook salmon bycatch during the first four months of the year in the domestic fishery have been concentrated within the 15-mile buffer sketched on either side of the 200 m contour (30 miles across buffer). Figures 1-58 and 1-59 indicate hauls which caught more than 5 salmon, or which had a bycatch rate greater than 0.5 chinook per mt of groundfish catch. Much of this bycatch is found within the horseshoe and especially at the eastern most corner of the horseshoe (note that a portion of the 1990 data is not portrayed in this figure). During the summer months (Figures 1-60 and 1-61), little chinook salmon bycatch is apparent. During the latter 4 months of the year, hauls with the greatest number of chinook salmon and highest bycatch rates are again for the most part within the buffer surrounding the contour at the horseshoe (Figures 1-62 and 1-63).

The pattern of chinook salmon bycatch in the foreign fishery is very similar to that seen in the domestic fishery during the first third of the year with the exception that the area near the horseshoe was not as extensively fished by the foreign fleet (Figure 1-49). Chinook salmon (e.g. hauls with > 5 chinook per haul or bycatch rates > .5) were caught all along the 200 m contour, but were, for the most part, not intercepted outside of the 15 mi buffer strip (Figures 1-64 and 1-65). During the summer months, very few chinook salmon were intercepted (Figures 1-66 and 1-67). Bycatch during the final third of the year is very apparent again along the 200 m contour and in the horseshoe (Figures 1-68 and 1-69).

The JV fisheries concentrated fishing effort in the area near the horseshoe and above Unimak Island, and also fished along the shelf (Figures 1-51 and 1-52). The hauls with the highest chinook salmon bycatch were located in the horseshoe and in the area directly above Unimak Island (Figures 1-70 and 1-71). The hauls with larger numbers of chinook salmon (or > 5 fish) also extended north from this area onto the shelf, however, the hauls with the highest bycatch rates were located in the vicinity of the horseshoe. During the summer, the JV fisheries encountered more chinook salmon, on a haul by haul basis, than did the foreign or domestic fisheries, but the bycatch rates during the summer months for the JV fisheries remained low (Figures 1-72 and 1-73). As was the case with the domestic and foreign fisheries, chinook salmon bycatch became apparent in the final 4 months of the year, and was located in the area of the horseshoe and along the 200 m contour (Figures 1-74 and 1-75).

Figures 1-76 through 1-84 provide the patterns in chinook salmon bycatch for the bottom trawl for pollock, bottom trawl for Pacific cod, and pelagic trawl for pollock targets in the foreign, domestic and JV fisheries. There was little difference in the distribution of bycatch between target types in the foreign or JV fisheries. The domestic pelagic trawl for pollock encountered chinook salmon in the area of the horseshoe (also an area of intense fishing pressure by this target type), whereas the domestic bottom trawl fisheries encountered chinook salmon in the horseshoe and along the 200 m contour.

1.3.10 Chinook Salmon Bycatch Within Predefined Areas

In order to quantify the spatial patterns observed above, total groundfish catch, total chinook salmon bycatch, total number of hauls, mean chinook bycatch rates, mean groundfish catch, and mean chinook salmon bycatch were calculated from observer data for the following spatial divisions: all observed tows in the Bering Sea; all tows within a 15-mile buffer on either side of the 200 m contour (30 miles across); all tows within three blocks at the horseshoe (described above, Figure 1-57); all tows within the block at the corner of the horseshoe (the corner block); and all tows within two blocks above the horseshoe and Unimak Island (the Unimak blocks). The observer data was also categorized by the time of year the tow was made, either within the bycatch season (January-April and September-December), or during the summer months (May-August). Figures 1-85 through 1-141 provide graphical representation of the data for each of the major fisheries (foreign, domestic, and JV) in each year. The graphs have also been divided to indicate the values attributable to each of the three target fisheries (bottom trawl for pollock = "B", bottom trawl for Pacific cod = "C", and pelagic trawl for pollock = "P"). The main trends in the graphs are discussed below.

Domestic Fishery:

In the 1991 and 1990 domestic fisheries[2], approximately 70% to 80% of the observed groundfish catch was taken in the pelagic trawl fishery for pollock, and approximately half of the catch in this fishery was caught during the summer months (upper graphs in Figures 1-85 and 1-88). In each year, 25% to 35% of the total groundfish catch was taken by the pelagic pollock fishery within the 15 mile buffer around the 200 m contour, and approximately 10% to 15% was taken from the horseshoe blocks. Figures 1-91, 1-92 and 1-93 provide an annual proportion of groundfish catch within each fishery (rather than from the 3 fisheries combined), which was taken in the defined areas. Within the pelagic pollock fishery itself, approximately 32% and 50% of the fishery's groundfish catch came from the contour buffer, and 13% and 20% from the horseshoe in 1990 and 1991, respectively, (Figure 1-93).

In contrast to groundfish catch, nearly all of the chinook salmon were taken during the bycatch season (with the exception of a summer catch of chinooks in the Unimak blocks during the summer of 1990) (lower graphs in Figures 1-85 and 1-88). During 1991, a high proportion of the total chinook salmon were taken in the contour, and a very high proportion of those taken in the contour were taken in the horseshoe blocks in the pelagic and bottom trawl fisheries for pollock. It should be noted that portions of the three horseshoe blocks fall outside of the contour buffer, and that some of the horseshoe catch therefore does not fall within the contour buffer. This pattern was similar in the 1990 domestic fisheries with a somewhat smaller percentage of the chinook captured in the contour coming from the horseshoe blocks. The proportions of chinook bycatch within each fishery in the defined areas are provided in Figures 1-91 - 1-93. Approximately 56% and 75% of all chinook encountered within the pelagic fishery itself were taken within the buffer contour in 1990 and 1991, respectively. Approximately 35% and 60% were taken from the horseshoe blocks in 1990 and 1991, respectively.

The chinook bycatch rates in the domestic fisheries varied between 1990 and 1991 with the highest mean rates being from the bottom trawl for Pacific cod in 1990 and in the bottom trawl for pollock in 1991 (upper graphs in Figures 1-86 and 1-89). The high bycatch rates during the bycatch season rather than in the summer months is apparent in the figures with the exception of a high summer bycatch rate in the 1990 pelagic pollock fishery in the Unimak blocks. In most cases there is a trend for bycatch rates to increase as the focus narrows from all tows in the Bering Sea to the contour buffer, from the contour buffer to the horseshoe blocks, and from the horseshoe blocks, to the corner block.

There is surprisingly little variation in the mean groundfish catch per tow within the defined areas, indicating a relatively homogenous catch per tow regardless of location (upper graphs in Figures 1-87 and 1-90). The mean catch per tow tends to be higher in the summer months in the bottom trawl for pollock fishery, and lower during the summer months in the pelagic trawl for pollock fishery.

In contrast to mean groundfish catch, the mean chinook bycatch is markedly decreased during the summer months (with the exception of a high mean catch of chinook from the pelagic pollock fishery in the Unimak blocks - the lower graphs of Figures 1-87 and 1-90). Mean chinook bycatch does not appear to be homogenous, but increases (as do bycatch totals and rates) as the focus moves from all hauls in the Bering Sea to the contour buffer, from the contour buffer to the horseshoe blocks and from the horseshoe blocks to the corner block.

Foreign Fishery:

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2 Note that the domestic data is incomplete for the first quarter of 1990 and the last quarter of 1991, and that currently this section of the analysis has not been updated with data from 1992 and 1993. For an analysis of bycatch in these years see below.

The patterns within defined areas were fairly similar from year to year in the foreign fisheries, and in this discussion the year with the highest catch (1984 - Figures 1-103 to 1-105) may be referred to as an example. The majority of the groundfish catch in any given year was taken in the pelagic trawl for pollock fishery, and the proportion of the total catch in this fishery increased from approximately 50% in 1981 to approximately 85% in 1984-1986 (upper graphs in Figures 1-94, 1-97, 1-100, 1-103, 1-106 and 1-109). Typically, one half or more of the groundfish catch in this fishery was captured during the summer months. Generally from 10% to 50% of the total groundfish catch was caught by the pelagic trawl for pollock fishery within the contour buffer, and a small proportion of the groundfish catch was taken in the horseshoe blocks or the corner block. Figures 1-112, 1-113 and 1-114 provide an annual proportion of groundfish catch within each fishery (rather than from the 3 fisheries combined) which was taken in the defined areas. Within the pelagic trawl fishery for pollock itself, approximately 13% - 42% of the catch from that fishery itself came from within the 15 mile contour buffer (Figure 1-114). Very little catch was taken in the Unimak blocks, and this catch was not represented in the graphs.

In every year, the foreign vessels captured a high proportion of chinook salmon within the 15 mile buffer on either side of the 200 m contour (lower graphs in Figures 1-94, 1-97, 1-100, 1-103, 1-106 and 1-109). In some years virtually all of the chinook salmon were captured within the contour buffer, and in every year very few chinook salmon were taken during the summer months. Of the total observed chinook salmon taken in all fisheries, roughly 40% to 60% were taken by the pelagic trawl for pollock within the 15 mile buffer distance from the 200 m contour. Of the total chinook salmon taken by the pelagic trawl for pollock itself, 53% to 92% were taken within the 200 m contour buffer (Figure 1-114). The horseshoe was not as significant for chinook bycatch in the foreign fisheries as has been described in the domestic fisheries above. This is in part because the fishing effort by the foreign fleet in the horseshoe was relatively low.

The mean chinook salmon bycatch rates in the foreign fisheries was always highest in the bottom trawl for Pacific cod (upper graphs in Figures 1-95, 1-98, 1-101, 1-104, 1-107, and 1-110), however this fishery accounted for a small proportion of the total chinook salmon bycatch. The mean bycatch rate was always higher in fisheries prosecuted within the contour buffer than in all of the tows combined. Beginning in 1984 and in subsequent years, the bycatch rates in the horseshoe blocks, and in the corner block increased to be similar to or surpass the bycatch rates seen in the contour.

As was the case in the domestic fisheries, the mean groundfish catch per tow tended to be relatively homogenous across defined areas during the bycatch season (January-April and September-December). The mean catch per tow was higher in the "all tows combined" category than in the contour buffer or the horseshoe during the summer months (upper graphs in Figures 1-96, 1-99, 1-102, 1-105, 1-108, and 1-111).

Again, as was the case in the domestic fisheries, the mean number of chinook salmon per tow is markedly decreased during the summer months (virtually nonexistent in most years) (lower graphs in Figures 1-96, 1-99, 1-102 1-105, 1-108, and 1-111). The mean chinook bycatch per tow is also higher in the contour buffer than in all tows combined in every fishery in every year, as was seen in the domestic fisheries. However, it is interesting that the mean chinook bycatch per tow within the contour buffer, although higher, does not vary considerably from the mean chinook per tow among all tows. This is probably because the mean chinook bycatch for all tows includes the observations within the contour. As will be shown below, the difference in mean chinook bycatch per tow between all tows and those within the contour buffer increases dramatically when the two are examined separately (e.g. within the contour buffer and outside the contour buffer). In 1981-1983 and 1986 the highest mean bycatch per tow in the foreign fisheries was in the bottom trawl for Pacific cod (although this fishery caught few salmon overall), and the mean bycatch was highest in the bottom trawl for pollock in 1984 and 1985.

Joint Venture Fishery:

Whereas the patterns within defined areas were similar between the domestic and foreign fisheries, the JV fisheries differed somewhat from these trends, especially in the earlier years. The year with the highest observed groundfish catch (1987) in the JV fisheries may be used for reference (Figures 1-130 to 1-132). Approximately 70% to 80% of the total groundfish catch was captured by the pelagic trawl fishery for pollock in any given year (upper graphs in Figures 1-115, 1-118, 1-121, 1-124, 1-127, 1-130, 1-133, and 1-136). A high proportion of the catch was taken during the summer months in the early years of the JV fisheries, and the catch shifted increasingly to the bycatch months in later years. The proportion of the total groundfish captured in the contour buffer decreased from approximately 33% by the pelagic pollock fishery in 1982 to 25% or less in later years with the exception of 1989 when almost 1/2 of the groundfish catch came from the contour buffer. The proportion of total groundfish catch from the Unimak blocks, which exceeded the proportion from the contour buffer in 1984, also declined from the early years of the fishery. Figures 1-139, 1-140 and 1-141 provide an annual proportion of groundfish catch within each fishery (rather than from the 3 fisheries combined) which was taken in the defined areas. Approximately 20%-42% of the pelagic pollock groundfish catch alone was taken within the contour buffer. The catch from the pelagic pollock fishery taken from the horseshoe ranged from almost none to 37%, and the catch from the Unimak Island blocks ranged from 4%-28%.

The proportion of chinook salmon captured during the summer months was fairly high in 1982 and 1983 (lower graphs in Figures 1-115, 1-118, 1-121, 1-124, 1-127, 1-130, 1-133, and 1-136). These were years during which a high proportion of the groundfish catch was taken during the summer, however, in total, relatively few chinook salmon taken (note 328 observed chinook in 1983). During the years 1983-1986 and 1988, a higher proportion of chinook salmon were taken from the two Unimak blocks than were taken in the entire contour buffer. As indicated above, the proportion of groundfish catch taken in the Unimak blocks was relatively high in 1983 and 1984, and decreased significantly in 1985 and 1986. Chinook bycatch within the Unimak blocks remained high in spite of the decrease in groundfish catch. A higher proportion of chinook salmon were taken from the contour buffer in 1987 and 1989.

The mean bycatch rates for chinook salmon in the JV fisheries were high during the summer months in 1982, 1983, and 1986 (upper graphs in Figures 1-116, 1-119, 1-122, 1-125, 1-128, 1-131, 1-134, and 1-137). As indicated above, there was also a high proportion of groundfish catch during the summer in the earlier two years. The bycatch rates during the summer months in the foreign fisheries were insignificant, and were low in the domestic fishery during the summer with the exception of the high mean bycatch rate during the 1990 pelagic pollock fishery within the Unimak blocks. No particular JV target fishery had bycatch rates consistently higher than the other target fisheries, and the highest rates varied from year to year. Bycatch rates were often higher in the Unimak blocks, however there were also years when the bycatch rates across spatial divisions were fairly similar, and years when the bycatch rates increased in a pattern similar to that seen in the domestic fishery with an increase in bycatch rates within the horseshoe and the horseshoe corner block.

In most instances, the mean groundfish catch per tow tended to be slightly lower during the summer months than during the bycatch season for all tows combined (upper graphs in Figures 1-117, 1-120, 1-123, 1-126, 1-129, 1-132, 1-135, and 1-138). The mean catch per tow in the Unimak blocks tended to be as high or higher than the mean groundfish catch per tow for all tows combined, with the exception of 1987. In general, the mean groundfish catch in the contour, the horseshoe blocks, and the horseshoe corner block tended to be slightly lower than in either all tows combined or the Unimak blocks. Mean groundfish catch was generally highest in the pelagic trawl fishery for pollock, and lowest in the bottom trawl fishery for Pacific cod.

Although there was considerable variability from year to year, there was a tendency for high mean bycatch during the summer months to occur in the Unimak blocks, or alternatively in the corner block (lower graphs in Figures 1-117, 1-120, 1-123, 1-126, 1-129, 1-132, 1-135, and 1-138). In most cases, the mean chinook salmon bycatch was highest during the bycatch season. There was also a tendency for the mean bycatch of chinook salmon to be lowest in all tows combined, and to increase as the focus narrowed to the contour, the horseshoe and the corner block. The mean chinook bycatch in the Unimak blocks also tended to be high but was generally somewhat lower than that seen in the corner block.

Summary:

In summary, the foreign fishery generally fished north along the 200 m contour, and a significant proportion (0.10-0.50) of the catch in the pelagic trawl fishery for pollock was taken within a buffer strip which extended for 15 miles on either side of the contour. The majority of the chinook salmon bycatch was taken within this strip, and virtually all of the chinook salmon were encountered during the bycatch season. The domestic fishery also fished in the area frequented by the foreign vessels, but had additional access, particularly in the pelagic trawl for pollock, to the region of the horseshoe. Again, a significant proportion (0.50) of the groundfish catch in the pelagic fishery for pollock was taken within the contour buffer, and a smaller proportion was taken within the horseshoe blocks. The majority of the chinook salmon intercepted by the domestic fishery were taken in the horseshoe blocks, and the highest bycatch rate and mean number of chinook occurred in the corner block. The JV fisheries fished generally to the south of the areas fished by the foreign fisheries, and a significant proportion of the groundfish catch came from the Unimak blocks, especially in the early 1980's. The highest proportion of chinook salmon bycatch was taken in the Unimak blocks and the corner block in the early years of the JV fishery, and in the Unimak blocks and the contour buffer in later years. In the early 1980's the JV fisheries encountered a larger proportion of chinook salmon during the summer months than was seen in the foreign or domestic fisheries.

The proportion of chinook salmon intercepted in the contour buffer, the horseshoe, or the Unimak blocks was much higher than the proportion of groundfish catch which came from the same areas in almost all cases. Chinook salmon were also predominantly taken during the bycatch season. Chinook salmon intercepted during the summer months tended to be found in the horseshoe or the Unimak blocks.

1.3.11 Contour Buffers of Different Widths

The proportions of groundfish taken by the foreign, domestic and JV fisheries within the buffer which extends 15 miles on either side of the 200 m contour were presented in the discussion above. A summary of these proportions in each year is provided in Figures 1-142 through 1-144, for the bottom trawl for pollock, the bottom trawl for Pacific cod, and the pelagic trawl for pollock fisheries. The proportions presented in these figures are based on the proportion of the total groundfish catch or total chinook bycatch for a fishery (foreign, domestic or JV) in a year. In addition to the 15 mile buffer (spanning 30 miles across the contour), a buffer of 10 miles (spanning 20 miles across the contour), and a buffer of 5 miles (spanning 10 miles across the contour) were constructed, and the proportion of total groundfish catch and chinook salmon bycatch within these buffers were examined as well.

In general, the proportion of groundfish catch taken within the 15-mile contour buffer varied in each fishery from year to year, with the proportion taken in the 15-mile contour buffer by the bottom trawl for pollock ranging from 0.01 to 0.08 across years, the proportion taken by the bottom trawl for Pacific cod ranging from near zero to 0.07 across years, and the proportion taken by the pelagic trawl for pollock ranging from 0.10 to 0.35 across years. The proportion decreased, as would be expected, by narrowing the width of the contour buffer, and for instance, the proportion taken within the 5 mile contour buffer (10 miles across) by the pelagic trawl for pollock ranged from 0.02 to 0.17.

As a general observation, the amount the proportion of total groundfish catch decreased when the distance from the 200 m contour was reduced by 5 miles was the same as the amount the proportion decreased when the distance from the 200 m contour was reduced by an additional 5 miles. For instance, given a decrease in the proportion of total groundfish catch of 0.10 between the 15 mile and the 10 mile buffers, a similar decrease in the proportion of total groundfish catch of 0.10 between the 10 mile and the 5-mile buffers was also seen. The foreign fleet tended to catch a higher proportion of the groundfish catch within the contours in the bottom trawl for pollock, the JV fleet tended to catch a higher proportion of the total groundfish catch within the contours in the bottom trawl for Pacific cod, and all fisheries caught similar proportions of the total groundfish catch in the pelagic trawl for pollock.

The proportion of total chinook salmon bycaught also varied across years and the proportion taken in the 15-mile contour buffer by the bottom trawl for pollock ranged from 0.01 to 0.43 across years, the proportion taken by the bottom trawl for Pacific cod ranged from near zero to 0.27 across years, and the proportion taken by the pelagic trawl for pollock ranged from 0.10 to 0.62 across years (Figures 1-145 to 1-147). As might be expected from the discussion above, the domestic and foreign fisheries caught a higher proportion of the total chinook salmon within the 15-mile contour buffer than did the JV fisheries.

There was little difference in the proportion of chinook salmon taken within the 15 mile, 10 mile, or 5 mile buffers in the two bottom trawl fisheries across several years. This is an indication that most of the chinook salmon taken near the 200-m contour were taken within 5 miles of the 200 m contour (e.g. the foreign bottom trawl for pollock, Figure 1-145). However, there were also several years and fisheries in which the proportion captured within the 5-mile contour buffer was significantly less than the proportion of salmon captured within the 15- or 10-mile buffers (e.g., the 1991 domestic bottom trawl for pollock). The proportion captured within the 5-mile buffer was also significantly lower than the proportion from the other buffers in all of the pelagic trawl for pollock fisheries (Figure 1-147). The 10 mile contour buffer often had a proportion of total chinook bycatch which was similar to the bycatch proportion in the 15-mile contour, but the proportion of bycatch within the 5-mile buffer was often significantly lower than within either the 10- or 15-mile buffers.

In order to compare groundfish catch and chinook bycatch within the contour buffers with catch and bycatch outside of the buffers, the mean catch of groundfish and the mean chinook bycatch per tow were calculated for all of the tows in the Bering Sea, all of the tows within a 5, 10 or 15 mile contour buffer, and all of the tows outside of a given buffer. There was little difference in the mean groundfish catch within or outside of any of the buffers in the domestic fisheries (1991 or 1990, upper graphs in Figures 1-148 and 1-149). In fact, mean groundfish catch was slightly higher outside of the contours in 1990. The mean chinook bycatch was markedly lower in the tows made outside of the contours in both years, particularly in the pelagic trawl for pollock and the bottom trawl for Pacific cod fisheries (lower graphs in Figures 1-148 and 1-149). The bottom trawl for pollock experienced low chinook bycatch and a low mean chinook bycatch within the 5-mile contour buffer in 1991, but was otherwise similar to the other fisheries. The mean chinook bycatch also increased as the buffer distance from the contour narrowed from 15 miles to 10 miles and from 10 miles to 5 miles.

The mean groundfish catch was much higher outside of the contour buffers than within the buffers across all years in the foreign pollock fisheries (both bottom and pelagic trawls) (upper graphs in Figures 1-150 -1-155). Mean groundfish catch was similar within and outside the buffers in the bottom trawl fishery for Pacific Cod. Mean groundfish catch in the foreign fisheries also tended to decrease slightly as the buffer distance from the contour decreased (e.g., from 15 to 10 miles and from 10 to 5 miles). Chinook bycatch, on the other hand, was dramatically lower outside of the contour buffers in every fishery in every year (lower graphs in Figures 1-150 - 1-155). Mean chinook bycatch tended to increase slightly as the buffer distance from the contour decreased.

Mean groundfish catch in the JV fisheries was generally similar within and outside of the contour buffers, or slightly greater outside of the contour buffers (with the exception of 1982 and 1983 when groundfish catch was occasionally lower outside of the contours)(upper graphs in Figures 1-156 - 1-163). Between 1983 and 1986, and in 1988, the mean bycatch of chinook salmon in the JV fisheries tended to be somewhat higher outside of the contour buffers, or was very similar to the mean bycatch within the contours (in 1983 the mean bycatch was much higher outside of the contours). The Unimak blocks are not located within the contour and chinook salmon bycatch was high in the Unimak blocks during those years (see above). The chinook bycatch was much higher within the contour buffers than outside of the buffers in 1987 and 1989, and chinook salmon bycatch and bycatch rates were high within the horseshoe blocks and horseshoe corner block during those years (these blocks are largely contained within the 15 mile contour buffer)(lower graphs in Figures 1-156 - 1-163).

In summary, the effect of the buffer distance from the 200-m contour on groundfish catch and chinook salmon bycatch was examined. The proportion of groundfish catch within a given buffer distance decreased as the buffer distance from the 200-m contour decreased, as would be expected, and the amount of the decrease was fairly constant with distance. The mean groundfish catch was rarely higher within the contour buffers (with the exception of some JV fisheries in some years), and was generally comparable or higher outside of the contour buffers. The proportion of chinook salmon intercepted within the contours was often contained within the 5-mile contour buffer, however this proportion was also occasionally much lower than the proportions from either the 15- or the 10-mile contour buffers, as was the case with the pelagic pollock fishery. The proportion of chinook salmon intercepted within the 10-mile contour buffer were similar to the proportion intercepted within the 15-mile buffer. The mean chinook bycatch was dramatically higher within the contour buffers (again with the exception of several JV fisheries in several years) than outside of the buffers, and the mean chinook bycatch generally increased as the buffer distance from the 200-m contour decreased.

1.3.12 The 8-block and 9-block Area Closure Alternatives

Hauls with a chinook salmon bycatch of more than 20 fish between 1990 and 1993 have been plotted in Figure 1-164. As was discussed above, the primary location of chinook salmon bycatch lies within the contour buffer and in the vicinity of Unimak Island during most years. In 1992, increased chinook bycatch occurred in the vicinity of the Pribilof Islands outside of the contour buffer and in the block north of the western Unimak Island block. The CVOA has been outlined in Figure 1-164, and blocks which appear to have higher concentrations of chinook salmon appear with cross-hatching.

In order to update the present document and investigate potential areas for closure smaller than the entire contour, the groundfish catch and chinook salmon bycatch from the following four alternatives were examined: (1) a 15-mile buffer strip along the 200 m contour; (2) the contour buffer and the two blocks above Unimak Island (Figure 1-56); (3) 8 blocks as indicated in Figure 1-165; and (4) 9 blocks as indicated in Figure 1-166.

Figures 1-167 to 1-170 provide the percentage of chinook salmon bycatch (the top of each graph) and total groundfish catch (bottom of each graph) by month for January-April and September-December in 1990 - 1993. The percentages are cumulative with the cumulative percentage of the entire Bering Sea catch or bycatch ending at 100% in December of each year.

In 1990 and 1991, more of the groundfish catch was taken in the contour alternative and the contour and Unimak blocks alternative than in the 8 block or 9 block alternatives. The combination of the Unimak blocks and the contour buffer accounted for the highest percentage of the total groundfish catch in all four years (38%, 60%, 39% and 53% in 1990, 1991, 1992, and 1993, respectively). The highest percentage of groundfish catch taken in the contour was in 1991 when 51% of the total groundfish catch for the months of January - April and September-December was taken. The Unimak blocks accounted for an additional 9% of the groundfish catch in 1991, and an additional 3% in 1990. In 1992, on the other hand, only 27% of the total groundfish catch was taken in the contour and an additional 11% (for a total of 39%) of the total groundfish catch was taken in the Unimak blocks. This was approximately the same percentage (39%) taken in both the 8 block and 9 block alternatives in 1992. In 1993 there was a smaller percentage of groundfish catch taken in the contour buffer (34%) than in the other alternatives as well. An additional 19% of the total groundfish catch was taken in the two Unimak blocks in 1993. The percentage of groundfish taken from the 9 blocks has increased each year from 1990 - 1993 (20%, 36%, 38%, and 49%, respectively).

The contour buffer and two Unimak Island blocks accounted for the highest percentage of chinook salmon in 1990 (80%), 1991 (83%) and 1993 (70%). In 1992, however, the contour buffer and Unimak blocks accounted for 54% of the total chinook bycatch which was less than that found in the 8 block (61%) or the 9 block (64%) alternatives. This reduction of bycatch in the contour buffer during 1992 is coincidental with the reduction of groundfish catch from the contour in 1992. As mentioned above, the Unimak blocks accounted for 11% of the groundfish catch in 1992 and this area accounted for 19% of the total chinook bycatch. The 9 block alternative accounted for 52%, 66%, 64% and 60% of the total chinook bycatch over the years 1990-1993, respectively, which does not necessarily mirror the increased amount of groundfish from that area in each year.

There is a high degree of overlap between several of the areas as outlined above. In order to examine the patterns in chinook salmon bycatch with regard to the selected areas, the catch and bycatch from non-overlapping segments were determined for the months of January through April and September through December. The following mutually exclusive areas were examined: (1) The portion of any of the 9 blocks which fell within the 15 mi contour buffer; (2) the remainder of the contour buffer which did not overlap any of the 9 blocks; (3) the two Unimak Island blocks; (4) the remainder of the 9 blocks which did not overlap the contour and were not either of the Unimak blocks; and (5) the remainder of the Bering Sea.

The highest proportion of total groundfish catch taken in these discrete areas was the remainder of the Bering Sea in 1990 (58%), 1992 (49%) and 1993 (40%), and in the section of the contour buffer which did not overlap the 9 blocks in 1991 (40%)(Figure 1-171). There was an increase in the percentage of catch taken from the portion of the 9 blocks that overlap the contour and from the Unimak blocks in 1993 (23% and 19%, respectively). Generally, as mentioned above, there has been an increase in the percentage of groundfish taken in the Unimak Island blocks and in the 9 blocks over time.

The area defined by the overlap of the contour buffer with the 9 blocks accounted for the highest percentage of chinook salmon bycatch in 1990 (42%), 1991 (52%), and 1993 (32%) (Figure 1-172). In 1992 this area accounted for 24% of the chinook salmon bycatch and the remainder of the Bering Sea also accounted for 24% of the total chinook bycatch in 1992. In 1990, 1991, and 1993 the portion of the 9 blocks, which does not overlap the 200 m contour buffer accounted for only a small percentage of the chinook bycatch. This portion of the 9 blocks outside of the contour accounted for a high percentage of chinook only in 1992 when the percentage of chinook encountered within the contour was reduced (although groundfish catch was fairly constant in this area). The section of the contour outside of the 9 blocks has accounted for the second largest percentage of chinook bycatch in all years except 1992.

Summary:

In summary, the area defined by a 15-mi buffer on either side of the 200-m contour and the two Unimak Island blocks have consistently accounted for the highest percentage and numbers of chinook salmon bycaught in the Bering Sea. Bycatch can, however, also occur outside of this area as was the case in 1992. The contour buffer and Unimak blocks are also important to the fishing fleet, and closure of this area could lead to high costs to industry if groundfish were not as available outside the closed area. A smaller area closure such as the alternative with 9 blocks could potentially reduce chinook salmon bycatch while allowing groundfish catch along large portions of the contour. However, chinook salmon bycatch occurs all along the contour and increased effort in any portion of the contour would be expected to be accompanied by chinook salmon bycatch. Although representing key areas of high salmon bycatch, it is difficult to estimate the bycatch levels which would occur if these blocks were closed and fishing continued along the 200-m contour.

1.3.13 Analysis of Additional Factors

The possibility that fishing related factors, such as depth of tow or tow duration, would be a contributing factor to chinook salmon bycatch was investigated. The analysis was conducted using the domestic observer data from 1990 and 1991. The domestic observer data was thought to be more current and reliable than available foreign or joint venture observer data. Although observer sampling from 1989 was incomplete, the results of analysis from data collected during this year are presented as well. A similar analysis using observer data from the foreign fleet offered similar results, however because some of the earlier foreign data was often collected on a daily rather than a haul basis, the foreign data is not presented in this analysis.

Several factors including depth of tow in meters, duration of tow in minutes, total weight of catch in tons and time of net retrieval were plotted and regressed against the number of chinook salmon captured in each haul. The regressions were applied to data within a single year (1989, 1990 or 1991), and to the data from a single target fishery (B=bottom trawl for pollock; C=bottom trawl for Pacific cod; and P=pelagic trawl for pollock).

The data were plotted to investigate possible relationships between each of the factors and chinook bycatch (Figures 1-173 - 1-176). The plots revealed no definite linear relationship, and no non-linear relationships were apparent.

Each of the factors of interest - depth of tow; total tow weight; tow duration; and time of net retrieval - were regressed against the number of chinook salmon from a haul using a stepwise regression which retains only significant factors (in this case at the 0.15 level). All records with at least one chinook salmon were retained for analysis. Regressions were performed for all non-zero observations within each year, and for all non-zero observations within each target fishery.

Although several factors were found to be statistically significant through regression analysis, the factors were of no practical significance. None of the regression models accounted for more than 9% of the total variation in the data ($R^2 = 0.090$), and most were near 1 percent, so that none of the factors could be used to effectively predict chinook salmon bycatch.

Table 1-10 provides the results of the regression analyses with resultant R^2 values. The regression analyses provide a linear coefficient for each factor. The results of employing the model against a factor of interest to predict the change in the number of chinook salmon in each case have been provided by example. The time of day that the net was retrieved was never a significant factor. The depth of tow and the size of the catch entered most frequently as significant factors.

When depth of tow was a significant factor, the coefficient was negative, except in the Pacific cod model in which the coefficient was positive. A negative coefficient means that the number of salmon would decrease with an increase in depth. The slopes, or size, of most of the coefficients are small and have little effect on the number of chinooks. For instance, based on the 1990 data, a 10 meter change in depth would predict a reduced chinook catch of 0.04 fish, and 10 meter depth change using the 1991 data would predict a reduced catch of 0.22 fish. The same coefficient in the Pacific cod fishery was, however negative and predicted an increase in the catch of chinook salmon of 0.3 fish with each 10 m change in depth.

The catch of chinook salmon was positively correlated with size of tow, and the coefficients varied so that a 10 mt increase in catch would predict an increase in the catch of chinook salmon of between 0.15 and 2.5 chinook salmon. Duration of tow was also positively correlated with chinook salmon bycatch, as might be expected.

An identical analysis using the same data was also performed on the rate of chinook salmon bycatch expressed as the number of chinook salmon per mt of groundfish catch. As was the case with the number of chinook salmon above, although some factors were significant within the regression model, the amount of variability explained by the model was low and therefore the various factors would be a poor predictor of the rate of chinook bycatch (the highest R^2 value was 0.083). It should be noted that although the total weight of the tow was retained as an explanatory variable in the model, this variable is correlated with the rate of chinook salmon bycatch since it is the denominator used in calculating rate. Table 1-10 summarizes the results of the regression of various factors on the rate of chinook bycatch.

Table 1-10. Results of a stepwise regression of several factors on the number of chinook salmon captured in each haul.

Domestic Fisheries by Year

$R^2 = .090$

<u>1989</u>

For every additional hour towed, an additional 1.6 chinook caught.

$R^2 = .007$

<u>1990</u>

For every additional 10 meters in depth, 0.04 fewer chinook caught.
For every additional 10 mt of catch, 0.16 more chinook caught.
For every additional hour towed, 0.17 more chinook caught.

1991 R^2=.010

For every additional 10 meters in depth, 0.22 fewer chinook caught.
For every additional 10 mt of catch, 0.62 more chinook caught.

Domestic Fisheries by Target

Bottom Pollock R^2=.012

For every additional 10 mt of catch, 2.48 more chinook caught.

Bottom Cod R^2=.065

For every additional 10 meters in depth, 0.30 more chinook caught.
For every additional 10 mt of catch, 1.4 more chinook caught.
For every additional hour towed, 0.66 more chinook caught.

Pelagic Pollock R^2=.005

For every additional 10 meters in depth, 0.045 fewer chinook caught.
For every additional 10 mt of catch, 0.22 more chinook caught.
For every additional hour towed, 0.15 more chinook caught.

The results from regressions using bycatch rates and numbers of chinook were very similar in the cases where the same variable was retained by the model. Often a variable which was significant in predicting numbers of chinook was insignificant in predicting bycatch rates, and *visa versa*. As was the case with numbers of chinook, the depth of tow and the size of the catch entered most frequently as significant factors. However, since size of catch is used to determine the rate of bycatch, and since there is correlation between groundfish catch and bycatch rate, both the coefficients and significance of this variable are influenced by the correlation and the actual effects of the size of tow are unclear. Although provided in Table 1-11, the size of tow is not included as a variable in this discussion.

As was the case with numbers of chinook, the slopes, or size, of most of the coefficients are small and have little effect on the bycatch rate. Depth of tow was often significant, however, in some cases the rate was found to increase with depth, and some cases an increase in depth lead to a decrease in rate. In contrast to the regressions involving numbers of chinook, the time of day the net was retrieved was a significant factor in the regressions involving bycatch rate, as was the case with bottom trawl for pollock in 1990. The rate tended to decrease with the time the net was retrieved.

Table 1-11. Results of a stepwise regression of several factors on the rate of chinook salmon bycatch in each haul.

Domestic Fisheries by Year

1989 R^2=.083

For every additional hour towed, the rate increased by 0.06.

For every additional 10 mt of catch, the rate decreased by 0.09.

$R^2 = .019$

1990

For every additional 10 mt of catch, the rate decreased by 0.04.
For every additional hour in the day, the rate decreased by 0.01.

$R^2 = .023$

1991

For every additional 10 meters in depth, the rate decreased by 0.002.
For every additional 10 mt of catch, the rate decreased by 0.02.

Domestic Fisheries by Target

$R^2 = .023$

Bottom Pollock

For every additional 10 mt of catch, the rate decreased by 0.07.
For every additional 10 meters in depth, the rate increased by 0.02.
For every additional hour in the day, the rate decreased by 0.03.

$R^2 = .057$

Bottom Cod

For every additional 10 meters in depth, the rate increased by 0.02.
For every additional 10 mt of catch, the rate decreased by 0.12.

$R^2 = .036$

Pelagic Pollock

For every additional 10 meters in depth, the rate decreased by 0.001.
For every additional 10 mt of catch, the rate decreased by 0.016.
For every additional hour towed, the rate increased by 0.004.

2.0 NEPA Requirements: Environmental Impacts of the Alternatives

An environmental assessment (EA) is required by the National Environmental Policy Act of 1969 (NEPA) to determine whether the action considered will result in a significant impact on the human environment. The environmental analysis in the EA provides the basis for this determination and must analyze the intensity or severity of the impact of an action and the significance of an action with respect to society as a whole, the affected region and interests, and the locality. If the action is determined not to be significant based on an analysis of relevant considerations, the EA and resulting finding of no significant impact (FONSI) would be the final environmental documents required by NEPA. An environmental impact study (EIS) must be prepared for major Federal actions significantly affecting the human environment.

An EA must include a brief discussion of the need for the proposal, the alternatives considered, the environmental impacts of the proposed action and the alternatives, and a list of document preparers. The purpose and alternatives were discussed in Sections 1.1 and 1.2, and a list of preparers is in Section 6.0. This section contains the discussion of the environmental impacts of the alternatives including impacts on threatened and endangered species and marine mammals.

2.1 Environmental Impacts of the Alternatives

The environmental impacts generally associated with fishery management actions are effects resulting from; (1) harvest of fish stocks which may result in changes in food availability to predators, changes in the population structure of target fish stocks, and changes in community structure; (2) changes in the physical and biological structure of the benthic environment as a result of fishing practices, e.g. effects of gear use and fish processing discards; and (3) entanglement/entrapment of non-target organisms in active or inactive fishing gear. A summary of the effects of the 1994 groundfish total allowable catch amounts on the biological environment and associated impacts on marine mammals, seabirds, and other threatened or endangered species are discussed in the final environmental assessment for the 1994 groundfish total allowable catch specifications (NMFS 1994a).

The proposed alternatives for Amendment 21b to the BSAI FMP would provide for chinook salmon bycatch management in the BSAI trawl fisheries by time and area closures either with (Alternative 2) or without (Alternative 3) a PSC limit to trigger the closure. The PSC limit considered ranges from 8,000 to 48,000 chinook salmon.

Alternative 1, status quo, would result in no chinook salmon bycatch management program for the BSAI trawl fisheries other than voluntary programs. Although historical chinook salmon bycatch has varied considerably since 1979, both temporally and spatially, an increasing trend in annual bycatch amounts occurred between 1990 and 1994. Bycatch rates in 1995 appear to have declined considerably (see Table 1-1). Whether this is due to changes in chinook salmon abundance or successful avoidance practices by trawl fishermen is unknown. However, in the absence of a chinook salmon bycatch management program, future annual bycatch amounts are not constrained, and significant increases in bycatch could impact chinook salmon escapement in Western Alaska River systems, several of which of experienced low escapement in the last decade (Section 1.3.1).

The impact of Alternative 2 or 3 on chinook salmon bycatch amounts or returns to Western Alaska depend on whether the time and area closures or the PSC limit constrain chinook salmon bycatch amounts below current or historic levels, limit bycatch to current amounts, or allow an increase in bycatch. If chinook salmon bycatch is effectively limited or reduced, increased returns to Western Alaska river systems and other areas of origin may occur. However, highly restrictive bycatch measures such as options to close the entire or large portions of the Bering Sea or to have an 8,000 chinook salmon PSC limit may result in significant reductions in groundfish harvests. Although one may view reduced groundfish harvests are a positive environmental impact, Total Allowable Catch levels rather than chinook salmon bycatch measures are the appropriate avenue to address this issue.

All options under Alternatives 2 and 3 represent times and areas of historic high chinook salmon bycatch. In general, high chinook salmon bycatch amounts have occurred in the target fisheries and areas of high groundfish catch. However, areas along the 200 m contour and fisheries that occur during the winter months have been identified with high chinook salmon bycatch. In selecting a preferred alternative, the Council considered many time, area, and PSC limit combinations. Alternative 2, Option 3f was selected as the preferred alternative for several reasons. First, the PSC limit of 48,000 chinook salmon is not expected to constrain current groundfish trawl fisheries because it is higher than the bycatch amounts in most recent years. In this selection, the Council expressed that current chinook salmon bycatch amounts likely did not represent biological harm to Western Alaska chinook salmon stocks. The focus of the preferred alternative is to limit increases in chinook salmon bycatch. In selecting the 9-block area (discussed in Section 1.3.12), the Council focused the closure in the areas of high chinook salmon bycatch. Finally, in specifying that the area would be closed only through April 15, the Council recognized that chinook salmon bycatch generally occurs during winter months and that closure of the area during the summer and fall could constrain groundfish fisheries without measurably affecting chinook salmon bycatch. April 15 corresponds with closure of the pollock roe ("A") season.

2.2 Impacts on Endangered, Threatened or Candidate Species

Listed and candidate species that may be present in the BSAI are discussed in detail in the EA conducted on the annual total allowable catch specifications. Listed and candidate species under the Endangered Species Act (ESA) that may be present in the BSAI include:

	Endangered
Northern right whale	<u>Balaena glacialis</u>
Sei whale	<u>Balaenoptera borealis</u>
Blue whale	<u>Balaenoptera musculus</u>
Fin whale	<u>Baleanoptera physalus</u>
Humpback whale	<u>Megaptera novaeangliae</u>
Sperm whale	<u>Physeter macrocephalus</u>
Snake River sockeye salmon	<u>Oncorhynchus nerka</u>
Snake R. fall chinook salmon	<u>Oncorhynchus tshawytscha</u>
Short-tailed albatross	<u>Diomedea albatrus</u>
	Threatened
Steller sea lion	<u>Eumetopias jubatus</u>
Snake R. spring and summer chinook salmon	<u>Oncorhynchus tshawytscha</u>
Spectacled eider	<u>Somateria fischeri</u>

An informal consultation conducted on effects of the GOA and BSAI groundfish fisheries concluded that the continued operation of these fisheries would not adversely affect listed species of salmon as long as current observer coverage levels continued and salmon bycatch was monitored on a weekly basis. Consultation must be reinitiated when chinook salmon bycatch exceeds 40,000 fish in either the BSAI or GOA or sockeye salmon bycatch exceeds 200 fish in the BSAI or 100 fish in the GOA. Annual chinook salmon bycatch in the BSAI exceeded 40,000 fish in 1993 and 1994.

Since the 1990 listing of Steller sea lions under the ESA, NMFS has consulted, pursuant to Section 7 of the ESA, on the overall effects to Steller sea lions of the BSAI groundfish fisheries and of each amendment to the BSAI FMP. In formal consultations, NMFS has determined that the BSAI fishery is not likely to jeopardize the continued existence or recovery of Steller sea lions. NMFS has also implemented specific management measures to mitigate the possible adverse effects of the BSAI groundfish fisheries on Steller sea lions and their prey resources. The proposed action to limit chinook salmon bycatch would not significantly change the way the groundfish fisheries in the BSAI operate, and thus, is not likely to have any affect on Steller sea lions. Therefore, further Section 7 consultation on this action is not required.

The action is not expected to affect threatened or endangered seabird species in any manner or extent not already addressed under previous consultations

2.3 Impacts on Marine Mammals

Marine mammals not listed under the Endangered Species Act that may be present in the GOA and BSAI include cetaceans, [minke whale (Balaenoptera acutorostrata), killer whale (Orcinus orca), Dall's porpoise (Phocoenoides dalli), harbor porpoise (Phocoena phocoena), Pacific white-sided dolphin (Lagenorhynchus obliquidens), and the beaked whales (e.g. Berardius bairdii and Mesoplodon spp.)] as well as pinnipeds [northern fur seals (Callorhinus ursinus), and Pacific harbor seals (Phoca vitulina)] and the sea otter (Enhydra lutris).

None of the alternatives is expected to have a significant impact on marine mammals.

2.4 Coastal Zone Management Act

Implementation of either alternative to the status quo would be conducted in a manner consistent, to the maximum extent practicable, with the Alaska Coastal Management Program within the meaning of Section 30(c)(1) of the Coastal Zone Management Act of 1972 and its implementing regulations.

2.5 Conclusions or Finding of No Significant Impact

Adoption of Alternatives 1, 2, or 3 likely would not significantly affect the quality of the human environment, and the preparation of an environmental impact statement for the proposed action is not required by Section 102(2)(C) of the National Environmental Policy Act or its implementing regulations.

Date:

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3.0 Regulatory Impact Review: Economic and Socioeconomic Impacts of the Alternatives

This section provides information about the economic and socioeconomic impacts of the alternatives including identification of the individuals or groups that may be affected by the action, the nature of these impacts and quantification of the economic impacts if possible.

The requirements for all regulatory actions specified in E.O. 12866 are summarized in the following statement from the order:

> In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environment, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.

This section also addresses the requirements of both E.O. 12866 and the Regulatory Flexibility Act to provide adequate information to determine whether an action is "significant" under E.O. 12866 or will result in "significant" impacts on small entities under the RFA.

E. O. 12866 requires that the Office of Management and Budget review proposed regulatory programs that are considered to be "significant". A "significant regulatory action" is one that is likely to:

> (1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;
>
> (2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
>
> (3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or
>
> (4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order.

A regulatory program is "economically significant" if it is likely to result in the effects described above. The RIR is designed to provide information to determine whether the proposed regulation is likely to be "economically significant."

3.1 Impact of the Alternatives

The alternatives considered for chinook bycatch management in the BSAI trawl fisheries include:

Alternative 1: status quo, no chinook salmon bycatch management program.

Alternative 2: time and area closures that would be triggered by a chinook salmon PSC limit (ranging from 8,000 to 48,000 fish).

Alternative 3: time and area closures without a chinook salmon PSC limit.

Area options under Alternatives 2 and 3 include:

Area options

1. Close the entire BSAI to a specific fishery upon attainment of the chinook PSC limit by that fishery, or group of fisheries.

2. Close specific federal statistical areas (zones) to a specific fishery upon attainment of the chinook PSC limit by that fishery, or group of fisheries.

3. Close areas which do not conform to federal statistical areas but which have been shown historically to have high chinook bycatch, including:

   (a) a 30 mile-wide buffer strip along the 200 meter contour that defines the Continental Shelf break (the "Contour");

   The following areas defined by 1/2° latitude by 1° longitude blocks:

   (b) 3-blocks in the "horseshoe" area of the 200 meter contour (Figure 1-57);

   (c) 1-block in the corner of the horseshoe (Figure 1-57);

   (d) 2-blocks in the horseshoe and north of Unimak Island (the "Unimak" blocks shown in Figure 1-57);

   (e) 3 non-contiguous areas made up of 8 blocks primarily in statistical areas 509, 517, and 541 (Figure 1-165);

   (f) 3 non-contiguous areas made up of 9 blocks primarily in statistical areas 509, 517, and 541 (Figure 1-166).

The primary socioeconomic impacts of the alternatives include the effects of the chinook salmon bycatch management program on the BSAI trawl fisheries and on those people dependent on chinook salmon. The socioeconomic values of the chinook salmon to subsistence, commercial and recreational fisheries were described in Section 1.3.5. In summary, a large proportion of chinook salmon bycatch in the BSAI is believed to originate from Western Alaska. If these salmon were not caught as bycatch in the BSAI trawl fisheries, some proportion of them would return to Western Alaska and would contribute to escapement and to subsistence, recreational and commercial fisheries. All three fisheries contribute significantly to the economies and cultural life of Western Alaska communities.

Alternative 1 would mean that NMFS implemented no limits on chinook salmon bycatch. The only reductions or limitations that may occur would be those voluntarily taken by fishermen. Alternative 1 would result in negative socioeconomic impacts on Western Alaska if increases in chinook salmon bycatch in the future resulted in reduced returns to Western Alaska. On the other hand, potential benefits to

Western Alaska occur if Alternatives 2 or 3 resulted in reductions or limits on chinook salmon bycatch.

Both Alternatives 2 and 3 could impose costs on the trawl fisheries in terms of reduced groundfish harvests if closures occur or increased costs to harvest the same amount of groundfish in alternative areas where CPUE may be lower. Under Alternative 2, no impacts will occur unless the proposed PSC limit is reached and a closure is triggered. Based on weekly chinook salmon bycatch data between 1990 and 1994 (Table 1-1):

- a 8,000 PSC limit would have been reached between the last week of February and the end of March;
- a 16,000 PSC limit would have been reached between the third week of February and not at all;
- a 24,000 PSC limit would have been reached between the last week of February and not at all; and
- a 48,000 PSC limit would have been reached by late August based on 1991 bycatch data and not all at based on the other years' data.

In other words, based on recent domestic trawl fishery data, all PSC limit options except a 48,000 limit, would have resulted in a closure that could have occurred as early as the third week of February. Based on 1991 chinook salmon bycatch, the 48,000 fish limit would have been reached by late August. Depending on the area option selected, the closure could displace trawl fishermen from areas where they have historically harvested substantial proportions of their annual groundfish harvest.

Under Alternative 2, the cost of chinook salmon bycatch management to the BSAI trawl fisheries depends on how successfully fishermen can avoid chinook salmon and thereby reduce salmon bycatch to a level that will not trigger a closure. The sooner a closure is triggered and the more area that is closed, the higher the costs to the trawl fishery in terms of foregone groundfish catch.

Under Alternative 3, time and area closures would occur regardless of total amount, location, or timing of actual chinook salmon bycatch in a particular year. While times and areas of historic chinook salmon bycatch have been identified, this Alternative may result in costly constraints to the groundfish trawl fisheries without a commensurate impact on chinook salmon bycatch.

The information summarized in Tables 3.1 and 3.2 provide information about the potential trade-offs of various area options under Alternatives 2 and 3. The tables show the proportion of groundfish catch and chinook salmon bycatch the various proposed closure areas. Table 3.1 illustrates catch and bycatch in federal statistical areas (zones) in 1994. For example, zone 509 represented 54 percent of the 1994 chinook salmon bycatch in the BSAI trawl fisheries and 27 percent of the total groundfish catch. Zone 517 represented 28 percent of the chinook salmon bycatch and 31 percent of the groundfish catch, and zone 513 represented 1 percent of the chinook salmon bycatch and 16 percent of the groundfish catch.

Table 3.2 illustrates chinook salmon bycatch and groundfish catch proportions in observed catch in the pollock and Pacific cod trawl fisheries during the winter months from 1990 to 1993 (the observer data discussed in Section 1.3.6 through 1.3.13). The majority of chinook salmon bycatch occurs along the 200 m contour (between 36 percent and 77 percent). This area also represents significant groundfish harvests (between 27 percent and 51 percent). The Council's preferred option, the 9-block area, represented between 50 percent and 66 percent of the chinook salmon bycatch and between 20 percent and 49 percent of the groundfish harvests.

Table 3.1 Proportion of groundfish catch and chinook salmon bycatch in the 1994 BSAI trawl fisheries, by zone.

Zone	Groundfish	Chinook Salmon
509	27%	54%
513	16%	1%
517	31%	28%
521	10%	8%
541-543	9%	8%
Other	7%	1%
Total	100%	100%

Table 3.2 Proportion of groundfish catch and chinook salmon bycatch by observed trawl vessels in the BSAI pollock and Pacific cod target fisheries between January and April and September and December, 1990-1993, by area.

Year	Area and Percent of Catch and Bycatch					
	Contour Buffer		8-block Area		9-block Area	
	Groundfish	Salmon	Groundfish	Salmon	Groundfish	Salmon
1990	35%	73%	4%	3%	20%	52%
1991	51%	77%	16%	8%	36%	66%
1992	27%	36%	13%	21%	38%	64%
1993	34%	53%	7%	10%	49%	60%

3.2 The Preferred Alternative

The Council recommended implementation of Alternative 2, Option 3f which would set a 48,000 chinook salmon PSC limit for all BSAI groundfish trawl fisheries. If this PSC limit is reached, 3 non-contiguous areas of the BSAI comprised of 9 1/2° latitude by 1° longitude blocks would close to trawling through April 15. The 9-block area would reopen on April 15 and remain open until December 31 regardless of chinook salmon bycatch amounts. The impact of the Council's preferred alternative on the groundfish trawl fisheries depends on whether the PSC limit is reached, when the 9-block area is closed, and the cost of making up catch in other areas.

Chinook salmon bycatch in the BSAI groundfish trawl fisheries exceeded 48,000 during the foreign fisheries of 1979 and 1980 and during the domestic fishery of 1991. In addition, Table 1-1 and Figure 1-19 show that cumulative bycatch amounts before April 15 have not exceeded 45,000 salmon from 1990 to the present. The bycatch through April 15, 1995 was about 17,100 fish. Therefore, based on historic bycatch estimates for the domestic groundfish trawl fisheries, closure of the 9-block area is not expected except in a year of unusually high bycatch. Selection of this PSC limit represents the desire of the Council to limit future increases in chinook salmon bycatch rather than to constrain existing fisheries. It is unlikely that the preferred alternative for chinook salmon bycatch management will impact the groundfish fisheries at all.

In the event that the 9-block area closes in the future, the timing of this closure will impact costs to the groundfish trawl fleet. For example, closure during the pollock roe season or the Pacific cod fishery could be costly to operators of vessels that must move out of their preferred fishing areas. Although they can fish in other areas, and the closure would occur only through April, the limited seasons and highly competitive nature of these fisheries, make changes in CPUE or the necessity of moving a fishing operation potentially costly.

3.3 Enforcement and Administrative Costs

Chinook salmon bycatch will be monitored based on in-season observer reports currently collected for general fisheries monitoring purposes. Once the PSC limit is reached, the area specified will be closed.

Areas defined by latitude and longitude coordinates or federal statistical areas would be monitored through routine NMFS and U.S. Coast Guard surveillance and observer position reports. To allow minimal enforcement of these closures, the 200-meter depth contour and associated specified buffer zones should be more 'simply' defined by a set of geographic coordinates that provide one or more rectangular-shaped enclosures that include most of the area along the 200-meter contour. This approach would provide vessel operators and enforcement personnel with a clear designation of open and closed areas that do not rely on depth contours that are subject to vary with time, tides, charts or other factors.

The option to close the 200 m contour would be unenforceable within the existing monitoring and enforcement means because the area does not correspond to clear, easy to identify boundaries. Enforcement capabilities are fully utilized to monitor existing time/area closures in the BSAI management areas, high seas driftnet activities, and fishing operations in international waters. Additional enforcement personnel, aircraft, and dedicated floating platforms do not exist to implement an intensive monitoring program that would be required to enforce closures along the contour.

Effective monitoring and enforcement of a closure along the 200 m contour would require that each trawl vessel be equipped with a satellite transmitter, which provides real-time position information that would be accessible to enforcement agencies. Costs of these transmitters vary depending on the type of system that is acquired. An interactive IMARSAT Standard C transponder would cost about $6,000 per trawl vessel for a base unit. An ARGO system that serves as a simple transmitter would cost only about $1,000 per unit, however annual data processing costs of about $4,500 would also be incurred by vessel owners. Unlike IMARSAT, these systems would not be capable of expansion into an interactive system.

Enforcement agencies would incur cost associated with monitoring vessel position. Existing IMARSAT systems cost about $1.20 per day to receive 12 position readings on a single vessel. Given these costs, NMFS enforcement estimates that annual monitoring costs could approach $25,000 to monitor 200 vessels.

4.0 FINAL REGULATORY FLEXABILITY ANALYSIS

The objective of the Regulatory Flexibility Act is to require consideration of the capacity of those affected by regulations to bear the direct and indirect costs of regulation. If an action will have a significant impact on a substantial number of small entities a Regulatory Flexibility Analysis (RFA) must be prepared to identify the need for the action, alternatives, potential costs and benefits of the action, the distribution of these impacts, and a determination of net benefits.

NMFS has defined all fish-harvesting or hatchery businesses that are independently owned and operated, not dominant in their field of operation, with annual receipts not in excess of $2,000,000 as small businesses. In addition, seafood processors with 500 employees or fewer, wholesale industry members with 100 employees or fewer, not-for-profit enterprises, and government jurisdictions with a population of 50,000 or less are considered small entities. A "substantial number" of small entities would generally be 20% of the total universe of small entities affected by the regulation. A regulation would have a "significant impact" on these small entities if it reduced annual gross revenues by more than 5 percent, increased total costs of production by more than 5 percent, or resulted in compliance costs for small entities that are at least 10 percent higher than compliance costs as a percent of sales for large entities.

If an action is determined to affect a substantial number of small entities, the analysis must include:

(1) a description and estimate of the number of small entities and total number of entities in a particular affected sector, and total number of small entities affected; and

(2) analysis of economic impact on small entities, including direct and indirect compliance costs, burden of completing paperwork or recordkeeping requirements, effect on the competitive position of small entities, effect on the small entity's cashflow and liquidity, and ability of small entities to remain in the market.

Most of the approximately 107 trawl catcher vessels landing groundfish from the BSAI meet the definition of a small entity under the RFA. Any of the alternatives that would result in a closure of a portion of the BSAI to trawling for any amount of time will affect these catcher vessels. The impact increases with larger closure areas or longer closure times. However, in all cases except a closure of the entire BSAI, these vessels would be able to continue fishing in another areas of the BSAI.

The preferred alternative is not expected to result in a closure of the nine-block area because the PSC limit recommended by the Council is higher than any annual bycatch amount, except for that experienced by the foreign fleet in 1979 and 1980, and by the domestic fleet in 1991. In the absence of a closure, this alternative is not likely to affect small entities. However, because a large proportion of the groundfish catch occurs within the CHSSA, closure of these areas could result in a significant impact on a substantial number of small entities in years of high chinook salmon bycatch. The costs associated with lower catch per unit effort or other costs associated with fishing in a less preferred area are unknown.

The absence of a mechanism to limit chinook salmon bycatch (Alternative 1) may adversely impact other small entities that rely on chinook salmon returns to Western Alaska and other areas.

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LIST OF TABLES

LIST OF FIGURES

Figure 1-65. The distribution of tows in the foreign fisheries (1981-1989) with a chinook salmon bycatch rate of more than 0.5 fish per metric ton during the months January-April.

Figure 1-66. The distribution of tows in the foreign fisheries (1981-1989) with a chinook salmon bycatch of more than 5 fish during the months May-August.

Figure 1-67. The distribution of tows in the foreign fisheries (1981-1989) with a chinook salmon bycatch rate of more than 0.5 fish per metric ton during the months May-August.

Figure 1-68. The distribution of tows in the foreign fisheries (1981-1989) with a chinook salmon bycatch of more than 5 fish during the months September-December.

Figure 1-69. The distribution of tows in the foreign fisheries (1981-1989) with a chinook salmon bycatch rate of more than 0.5 fish per metric ton during the months September-December.

Figure 1-70. The distribution of tows in the JV fisheries (1981-1989) with a chinook salmon bycatch of more than 5 fish during the months January-April.

Figure 1-71. The distribution of tows in the JV fisheries (1981-1989) with a chinook salmon bycatch rate of more than 0.5 fish per metric ton during the months January-April.

Figure 1-72. The distribution of tows in the JV fisheries (1981-1989) with a chinook salmon bycatch of more than 5 fish during the months May-August.

Figure 1-73. The distribution of tows in the JV fisheries (1981-1989) with a chinook salmon bycatch rate of more than 0.5 fish per metric ton during the months May-August.

Figure 1-74. The distribution of tows in the JV fisheries (1981-1989) with a chinook salmon bycatch of more than 5 fish during the months September-December.

Figure 1-75. The distribution of tows in the JV fisheries (1981-1989) with a chinook salmon bycatch rate of more than 0.5 fish per metric ton during the months September-December.

Figure 1-76. The distribution of tows in the foreign bottom trawl for pollock fishery with a chinook salmon bycatch of more than 5 fish (1981-1989).

Figure 1-77. The distribution of tows in the foreign bottom trawl for Pacific cod fishery with a chinook salmon bycatch of more than 5 fish (1981-1989).

Figure 1-78. The distribution of tows in the foreign pelagic trawl for pollock fishery with a chinook salmon bycatch of more than 5 fish (1981-1989).

Figure 1-79. The distribution of tows in the domestic bottom trawl for pollock fishery with a chinook salmon bycatch of more than 5 fish (1990-1993).

Figure 1-80. The distribution of tows in the domestic bottom trawl for Pacific cod fishery with a chinook salmon bycatch of more than 5 fish (1990-1993).

Figure 1-81. The distribution of tows in the domestic pelagic trawl for pollock fishery with a chinook salmon bycatch of more than 5 fish (1990-1993).

Figure 1-82. The distribution of tows in the JV bottom trawl for pollock fishery with a chinook salmon bycatch of more than 5 fish (1981-1989).

Figure 1-83. The distribution of tows in the JV bottom trawl for Pacific cod fishery with a chinook salmon bycatch of more than 5 fish (1981-1989).

Figure 1-84. The distribution of tows in the JV pelagic trawl for pollock fishery with a chinook salmon bycatch of more than 5 fish (1981-1989).

Figure 1-85. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1991 domestic trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-86. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1991 domestic trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-87. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1991 domestic trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-88. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1990 domestic trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-89. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1990 domestic trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-90. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1990 domestic trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-91. Proportion of groundfish catch taken within the domestic bottom trawl for pollock fishery in defined areas over all years.

Figure 1-92. Proportion of groundfish catch taken within the domestic bottom trawl for Pacific cod fishery in defined areas over all years.

Figure 1-93. Proportion of groundfish catch taken within the domestic pelagic trawl for pollock fishery in defined areas over all years.

Figure 1-94. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1981 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-95. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1981 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-96. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1981 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-97. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1982 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-98. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1982 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-99. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1982 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-100. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1983 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-101. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1983 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-102. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1983 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-103. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1984 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-104. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1984 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-105. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1984 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-106. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1985 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-107. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1985 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-108. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1985 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-109. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1986 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-110. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1986 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-111. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1986 foreign trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-112. Proportion of groundfish catch taken within the foreign bottom trawl for pollock fishery in defined areas over all years.

Figure 1-113. Proportion of groundfish catch taken within the foreign bottom trawl for Pacific cod fishery in defined areas over all years.

Figure 1-114. Proportion of groundfish catch taken within the foreign pelagic trawl for pollock fishery in defined areas over all years.

Figure 1-115. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1982 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-116. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1982 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-117. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1982 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-118. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1983 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-119. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1983 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-120. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1983 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-121. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1984 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-122. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1984 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-123. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1984 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-124. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1985 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-125. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1985 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-126. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1985 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-127. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1986 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-128. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1986 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-129. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1986 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-130. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1987 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-131. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1987 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-132. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1987 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock):

Figure 1-133. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1988 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-134. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1988 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-135. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1988 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-136. Proportion of total groundfish catch (upper graph) and total chinook bycatch (lower graph) in the 1989 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-137. Mean chinook bycatch rates (upper graph) and proportion of total hauls (lower graph) in the 1989 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-138. Mean groundfish catch per tow (upper graph) and mean chinook bycatch per tow (lower graph) in the 1989 JV trawl fisheries within defined areas and by season. (B=bottom pollock, C=bottom cod, P=pelagic pollock).

Figure 1-139. Proportion of groundfish catch taken within the JV bottom trawl for pollock fishery in defined areas over all years.

Figure 1-140. Proportion of groundfish catch taken within the JV bottom trawl for Pacific cod fishery in defined areas over all years.

Figure 1-141. Proportion of groundfish catch taken within the JV pelagic trawl for pollock fishery in defined areas over all years.

Figure 1-142. Comparison of the proportions of total groundfish catch within a 15, 10 or 5 mile buffer distance from the 200 m contour in the domestic, foreign and JV fisheries. Bottom trawl for pollock.

Figure 1-143. Comparison of the proportions of total groundfish catch within a 15, 10 or 5 mile buffer distance from the 200 m contour in the domestic, foreign and JV fisheries. Bottom trawl for Pacific cod.

Figure 1-144. Comparison of the proportions of total groundfish catch within a 15, 10 or 5 mile buffer distance from the 200 m contour in the domestic, foreign and JV fisheries. Pelagic trawl for pollock.

Figure 1-145. Comparison of the proportions of total chinook salmon bycatch within a 15, 10 or 5 mile buffer distance from the 200 m contour in the domestic, foreign and JV fisheries. Bottom trawl for pollock.

Figure 1-146. Comparison of the proportions of total chinook salmon bycatch within a 15, 10 or 5 mile buffer distance from the 200 m contour in the domestic, foreign and JV fisheries. Bottom trawl for Pacific cod.

Figure 1-147. Comparison of the proportions of total chinook salmon bycatch within a 15, 10 or 5 mile buffer distance from the 200 m contour in the domestic, foreign and JV fisheries. Pelagic trawl for pollock.

Figure 1-148. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. Domestic 1991 trawl fisheries for pollock and Pacific cod.

Figure 1-149. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. Domestic 1990 trawl fisheries for pollock and Pacific cod.

Figure 1-150. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. Foreign 1981 trawl fisheries for pollock and Pacific cod.

Figure 1-151. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. Foreign 1982 trawl fisheries for pollock and Pacific cod.

Figure 1-152. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. Foreign 1983 trawl fisheries for pollock and Pacific cod.

Figure 1-153. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. Foreign 1984 trawl fisheries for pollock and Pacific cod.

Figure 1-154. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. Foreign 1985 trawl fisheries for pollock and Pacific cod.

Figure 1-155. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. Foreign 1986 trawl fisheries for pollock and Pacific cod.

Figure 1-156. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. JV 1982 trawl fisheries for pollock and Pacific cod.

Figure 1-157. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. JV 1983 trawl fisheries for pollock and Pacific cod.

Figure 1-158. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. JV 1984 trawl fisheries for pollock and Pacific cod.

Figure 1-159. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. JV 1985 trawl fisheries for pollock and Pacific cod.

Figure 1-160. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. JV 1986 trawl fisheries for pollock and Pacific cod.

Figure 1-161. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. JV 1987 trawl fisheries for pollock and Pacific cod.

Figure 1-162. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. JV 1988 trawl fisheries for pollock and Pacific cod.

Figure 1-163. Mean groundfish catch (upper graph) and mean chinook bycatch (lower graph) within and outside of the 15, 10 and 5 mile buffer distances from the 200 m contour. JV 1989 trawl fisheries for pollock and Pacific cod.

Figure 1-164. Hauls with a chinook salmon bycatch of more than 20 fish during the years 1990 - 1993 are plotted as dots. 200 m contour, contour buffer, and CVOA borders are indicated. 1/2° latitude by 1° longitude blocks with higher salmon bycatch are identified wiht cross-hatch.

Figure 1-165. 8 blocks identified with high chinook salmon bycatch as in Figure 164.

Figure 1-166. 9 blocks identified with high chinook salmon bycatch as in Figure 164.

Figure 1-167. Top: Chinook salmon bycatch from 1990 for the months of January - April and September - December expressed as a percentage of the total for that period. Bottom: Cumulative percent of groundfish catch over the same period. The five identified areas can include portions of other areas (e.g. portions of the contour are contained in the 9 blocks).

Figure 1-168. Top: Chinook salmon bycatch from 1991 for the months of January - April and September - December expressed as a percentage of the total for that period. Bottom: Cumulative percent of groundfish catch over the same period. The five identified areas can include portions of other areas (e.g. portions of the contour are contained in the 9 blocks).

Figure 1-169. Top: Chinook salmon bycatch from 1992 for the months of January - April and September - December expressed as a percentage of the total for that period. Bottom: Cumulative percent of groundfish catch over the same period. The five identified areas can include portions of other areas (e.g. portions of the contour are contained in the 9 blocks).

Figure 1-170. Top: Chinook salmon bycatch from 1993 for the months of January - April and September - December expressed as a percentage of the total for that period. Bottom: Cumulative percent of groundfish catch over the same period. The five identified areas can include portions of other areas (e.g. portions of the contour are contained in the 9 blocks).

Figure 1-171. .Bering Sea divided into 5 mutually exclusive areas. The percentage of total groundfish catch taken in each of 5 non-overlapping areas during the months January-April and September-December.

Figure 1-172 .Bering Sea divided into 5 mutually exclusive areas. The percentage of chinook salmon bycatch taken in each of 5 non-overlapping areas during the months January-April and September-December.

Figure 1-173. Scatterplot of chinook bycatch vs depth of tow (upper graph), and chinook bycatch rate vs depth of tow (lower graph) from domestic 1989-1991 fisheries.

Figure 1-174. Scatterplot of chinook bycatch vs total groundfish catch in tow (upper graph), and chinook bycatch rate vs total groundfish catch in tow (lower graph) from domestic 1989-1991 fisheries.

Figure 1-175. Scatterplot of chinook bycatch vs duration of tow (upper graph), and chinook bycatch rate vs duration of tow (lower graph) tow from domestic 1989-1991 fisheries.

Figure 1-176. Scatterplot of chinook bycatch vs time of tow retrieval (upper graph), and chinook bycatch rate vs time of tow retrieval (lower graph) tow from domestic 1989-1991 fisheries.

Figure 3-1. Location of blocks selected as approximating the spatial pattern of the 200 m contour. The 2 Unimak blocks were selected as well.