UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1335 East-West Highway
Silver Spring, MD 20910
THE DIRECTOR

AUG 28 1992

Mr. Phillip Anderson
Chairman, Pacific Fishery
Management Council
Metro Center
2000 S.W. First Avenue
Portland, Oregon 97210

Dear Mr. Anderson:

Enclosed is our biological opinion regarding the impacts of fishing conducted under the Pacific Coast Groundfish Fishery Management Plan (groundfish FMP) on species listed under the Endangered Species Act (ESA).

There have been two previous biological opinions that considered the effect of the groundfish fishery on species listed under the ESA. The first biological opinion (August 10, 1990) considered the impacts of the groundfish fishery on marine mammals, sea turtles, and Sacramento River winter-run chinook salmon. A second opinion (November 26, 1991) considered the impact of the whiting fishery on Sacramento winter-run chinook. The purpose of this biological opinion is to provide a more comprehensive review of the effects of fishing conducted under the groundfish FMP on salmon species listed under the ESA. In particular, the opinion considers (1) new information regarding the incidence of salmon bycatch in the bottom trawl fishery, (2) an evaluation of the effect of the whiting fishery on all four of the listed salmon species, and (3) a review of the impacts of other components of the groundfish fishery.

The biological opinion concludes that impacts of fishing conducted under the groundfish FMP on Sacramento River winter-run chinook and Snake River sockeye and spring/summer chinook salmon are negligible. The estimated bycatch of Snake River fall chinook salmon is most likely on the order of a few tens of fish per year. Based on the available information, NMFS concluded that operation of the fishery under the groundfish FMP is not likely to jeopardize the continued existence of these species.

THE ASSISTANT ADMINISTRATOR
FOR FISHERIES

We appreciate the efforts of members of the Council in providing the necessary information, and look forward to your continued cooperation in future consultations.

Sincerely,

William W. Fox, Jr.

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BIOLOGICAL OPINION

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Date Issued: 8-28-92

I. Background

There have been two previous biological opinions that considered the effect of fishing conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery (groundfish FMP) on species listed under the Endangered Species Act (ESA). The first biological opinion (NMFS 1990; August 10, 1990) reported the impacts of the groundfish fishery on marine mammals, sea turtles, and Sacramento River winter-run chinook salmon (SRWRC). A second opinion (NMFS 1991a; November 26, 1991) considered the impact of the whiting fishery on SRWRC in more detail and briefly addressed the effects on Snake River sockeye salmon which were newly listed (November 20, 1991) just as the opinion was being finalized. Since the completion of this latter opinion, Snake River spring/summer and fall chinook salmon were listed as a threatened species (April 22, 1992) and there has been a proposed change in the status of the SRWRC from threatened to endangered (57 FR 27416; June 19, 1992). This opinion supersedes those portions of the November 26, 1991, and August 10, 1990, opinions that addressed impacts on SRWRC.

The purpose of this biological opinion is to provide a more comprehensive review of the effects of fishing conducted under the Pacific Fishery Management Council (PFMC) groundfish FMP on salmon species listed under the ESA. In particular, the opinion considers (1) new information regarding the incidence of salmon bycatch in the bottom trawl fishery, (2) an evaluation of the effect of the whiting fishery on all four of the listed salmon species, and (3) a review of the impacts of other components of the groundfish fishery. Also provided in this opinion is available information regarding Canadian groundfish fisheries. Although these fisheries are not subject to management under the

groundfish FMP, the information is presented to provide a more comprehensive review of west coast groundfish fisheries.

This biological opinion is one in a series of formal and informal consultations and conferences related to the effect of fisheries and harvest actions on listed salmon species. The effects of fishing under the Bering Sea and Gulf of Alaska groundfish FMPs on the four listed species were considered in a conference and informal consultation (February 20, 1992). The effects of various components of the salmon fisheries on the listed species have also been reviewed. On March 1, 1992, NMFS issued a biological opinion that considered the effects of fisheries conducted under the PFMC FMP for the Commercial and Recreational Salmon Fisheries off the coasts of Washington, Oregon, and California on SRWRC salmon. A subsequent opinion (NMFS 1992a; May 1, 1992) considered the effects of 1992 fisheries conducted under the salmon FMP on the three listed species from the Snake River. There have also been a series of formal and informal consultations and conferences regarding the effects on Snake River species from 1992 fisheries in the Columbia River conducted according to provisions of the Columbia River FMP. Winter and spring season fisheries were addressed in conference letters dated February 21, 1992, and April 3, 1992, respectively. A biological opinion regarding summer and fall season fisheries was issued on June 12, 1992, with a subsequent addendum dated June 30, 1992. An opinion regarding a fishery in Idaho proposed by the Shoshone-Bannock Tribes was issued June 29, 1992.

The biological assessment for the groundfish fishery was prepared by Dr. Richard Methot, Chairman, PFMC Groundfish Management Team and was provided in two parts. The first part summarized available information on salmon bycatch in the Pacific whiting fishery (Methot 1992a); the second report summarized the bycatch data for Pacific coast bottom trawl fisheries (Methot 1992b). Additional input was provided by Dr. Ken Henry, Chairman, PFMC Salmon Technical Team. While preparing this biological opinion, NMFS considered the information provided in the biological assessment and other information available from the scientific literature and experts in the field of salmon biology.

II. Proposed Activity

The PFMC proposes to continue management of the groundfish fishery under the groundfish FMP, including proposed

Amendment 6 to that FMP (57 FR 32499, July 22, 1992), as well as appropriate implementation of regulations and other management actions consistent with the FMP. The FMP establishes a framework for the management of the groundfish fisheries off the coasts of California, Oregon, and Washington by both Federal and state governments. The purpose of Amendment 6 is to implement a limited entry program. The primary objective of the limited entry program is to reduce harvesting capacity of the Pacific coast groundfish fishery. Each vessel involved in the limited entry fishery will be required to obtain a Federal permit. Only those vessels with a specified level of previous participation will be issued a permit. Amendment 6 will not directly effect the amount of groundfish taken or regulatory mechanisms used to specify when or where fisheries may occur. One of the secondary objectives is to reduce bycatch and waste, but there are no provisions of the plan that address bycatch issues directly.

The groundfish fisheries target many different species using a variety of gear types and fishing strategies. Current regulations include quotas, seasonal restrictions, gear requirements, area closures, and trip limits. Specific regulations are recommended annually under the authority of the FMP. The PFMC monitors the progress of the various fisheries as the season progresses and has the authority under the framework plan to make inseason adjustments as necessary to ensure compliance with harvest guidelines and other management objectives of the FMP.

This biological opinion provides a general review of the anticipated impacts of the groundfish fishery under the FMP and proposed Amendment 6 on listed salmon species rather than being specific to a particular year's planned fishery. The plan allows for some flexibility in the future management of the fishery. However, this biological opinion is based on estimated impacts and the expectation that future impacts will be similar to or less than those anticipated here. To the extent that impacts on listed species resulting from future management actions or impacts resulting from operation of the fishing during a particular year are the same or less than those analyzed in this opinion, further consultation may be unnecessary.

III. Listed Species and Critical Habitat

Sacramento River winter-run chinook salmon (Oncorhynchus tshawytscha), Snake River sockeye salmon (Oncorhynchus nerka), Snake River spring/summer chinook and Snake River fall chinook salmon (Oncorhynchus tshawytscha) are the listed species that may be affected adversely by the proposed activity. Critical habitat has not yet been designated for these species.

IV. Biological Information

A. Sacramento River Winter-Run Chinook Salmon

For detailed information regarding the status of Sacramento River winter-run chinook (SRWRC), see 55 FR 46515 (November 5, 1990) and 57 FR 27416 (June 19, 1992). There are four runs or races of chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River, California: the fall-run, late fall-run, winter-run, and spring-run. The winter-run (so called because of the timing of its upstream spawning migration) is considered a "species" within the definition of the ESA (52 FR 6041; February 27, 1987).

The best data on long-term trends in abundance for SRWRC are the annual estimates of spawning run size made by the California Department of Fish and Game (CDFG) based on dam counts at Red Bluff Dam. These annual estimates show a decline in the average run size from 84,000 fish in the years 1967-1969 to about 2,000 for the years 1982-1984. The run size ranged from 2,000 to 4,000 from 1984-1988, but then dropped precipitously to 549, 441, and 191 in the years 1989 to 1991, respectively.

Winter-run chinook exit the ocean from early November to mid-May with the majority of fish leaving from February to early March. There are few data available on the ocean distribution of winter-run fish. The only direct information comes from a fin clip study conducted from 1969 to 1971 (Hallock and Fisher 1985). These data were used in developing the Winter Chinook Ocean Harvest Model (CDFG 1989) that is used to analyze the relative impacts of fishery regulation options in the waters of California. The model uses the assumption that all ocean fishery impacts on winter-run chinook occur off California and southern Oregon. The abundance of SRWRC relative to other stocks in northern Oregon and Washington fisheries has not been estimated, but would be low compared to the Eureka area and decrease from south to north.

B. Snake River Sockeye Salmon

For detailed information on the Snake River sockeye salmon's life history, see Waples et al. (1991a) and 56 FR 58619 (November 20, 1991). There are three stocks of sockeye remaining in the Columbia River system including the Wenatchee, Okanogan, and Snake River stocks. There is no specific information regarding the ocean distribution of Snake River sockeye, although they are assumed to migrate to the north. Sockeye adults migrate through the lower Columbia River during June and July, with average peak passage at Bonneville Dam near July 1. It can therefore be assumed that any maturing fish will have left the ocean by early July.

Based on counts at Ice Harbor Dam, the Snake River sockeye run has averaged less than 150 fish per year since 1975, when the lower Snake River hydroelectric system was completed. Since 1985, the Ice Harbor Dam count has been less than 25 fish annually. Only one fish was counted in 1990 and nine fish were recorded in 1991 (CRTS 1992, Table 1).

C. Snake River Spring/Summer Chinook Salmon

Although Snake River spring and summer chinook stocks have been listed as a single "distinct population segment," based on NMFS' finding that they constitute a single "Evolutionarily Significant Unit (ESU)" (Matthews and Waples 1991), upper Columbia River spring and summer chinook stocks are treated separately in management-related data bases. Spring and summer chinook are also managed during different seasonal fishing periods using different regulatory criteria. The timing distinctions are, therefore, relevant to the understanding of the current management regime.

For detailed information on the life history of Snake River spring/summer chinook salmon, see Matthews and Waples (1991), NMFS (1991b) and 56 FR 29542 (June 27, 1991). Snake River spring chinook salmon are part of an aggregate of stocks from hatchery and natural production areas upstream of the Bonneville Dam, including middle Columbia tributaries between the Bonneville and McNary dams and the upper Columbia system above McNary Dam. Upriver spring chinook salmon begin entering the Columbia River in late February and early March, reaching peak abundance in April and early May in the lower river (below Bonneville Dam). All chinook passing Bonneville Dam from March through May are counted as upriver spring chinook.

The summer chinook salmon run is comprised of an earlier-migrating race destined primarily for the Salmon River drainage in Idaho and a later-migrating race destined for the upper Columbia and its tributaries above Priest Rapids Dam (ODFW/WDF 1991). Summer chinook salmon enter the Columbia River in late May, June, and July. Summer chinook are by definition those counted at the Bonneville Dam from June 1 through July 31, and at the McNary Dam from June 9 through August 8.

Redd counts in index areas provide the best indicator of trends and status of the population of naturally spawning spring and summer chinook salmon in the Snake River Basin. Redd counts have declined sharply over the last 33 years. In 1957, over 13,000 redds were counted in index areas excluding the Grande Ronde River. By 1964 and including the Grande Ronde River, the annual count in index areas was 8,542 redds. Over the next 16 years, annual counts in all areas declined steadily, reaching a minimum of 620 redds in 1980. Annual counts increased gradually over the next 8 years, reaching a peak of 3,395 redds in 1988. In 1989 and 1990, counts dropped again to 1,008 and 1,224 redds, respectively.

Information regarding the ocean distribution of Snake River spring and summer chinook is limited. They are assumed to be north migrating stocks similar to other spring and summer stocks from the upper Columbia River system. The available information indicates that impacts from ocean fisheries are minimal. Very few coded wire tags (CWTs) have been recovered from any ocean fishery despite the fact that associated indicator stocks have been tagged continuously since the 1976 brood year. Genetic stock identification techniques also indicated that contribution rates to ocean fisheries off the Washington coast are very low (NMFS 1992a).

D. Snake River Fall Chinook Salmon

For detailed information on the life history of Snake River fall chinook salmon, see Waples, et al. (1991b); NMFS (1991c) and 56 FR 29542 (June 27, 1991). The Columbia River fall chinook run has five major components: Lower River Hatchery, Lower River Wild, Bonneville Pool Hatchery, Upriver Bright, and Mid-Columbia Bright. Fall chinook from the Snake River are part of the Upriver Bright stock complex. The Upriver Bright, Bonneville Pool, and a portion of Mid-Columbia Bright stocks are produced above the Bonneville Dam and, in aggregate, comprise the Upriver Bright run of fall chinook, which is subject to allocation requirements specified in the CRFMP.

Fall chinook enter the Columbia River from late July through October, with peak abundance in the lower river from mid-August to mid-September. The Upriver run peaks over Bonneville Dam in early September, with Bonneville Pool Hatchery passage occurring over a shorter time frame than the bright chinook. The Bonneville Pool Hatchery stock is produced at Spring Creek Hatchery in the Bonneville Pool. The majority of the Upriver Bright fall chinook stock is destined for the Hanford Reach section of the Columbia River. Smaller components are destined for the Deschutes, Snake, and Yakima rivers. The Mid-Columbia Bright component is comprised of brights reared and released at the Bonneville Hatchery (below Bonneville dam) and brights from the Bonneville, Little White Salmon, and Klickitat hatcheries released in areas between the Bonneville and McNary dams.

Returns of adult fall chinook salmon to the Snake River have declined to very small numbers in recent years. Yearly adult counts at the uppermost Snake River main-stem project affording fish passage averaged 12,720 from 1964 to 1968, 3,416 from 1969 to 1974, and 610 from 1975 to 1980. The estimated return of naturally spawning Snake River fall chinook to Lower Granite Dam averaged 293 from 1986-1991, reaching a low of 78 in 1990. The return to Lower Granite Dam increased to 318 in 1991.

Using the available CWT data, it is possible to estimate the ocean distribution and relative fishery impacts on Snake River fall chinook. Although naturally spawning fall chinook have not been marked directly, CWT data from fingerling, non-transported releases from the Lyons Ferry hatchery most closely represent the stock. Results of the analysis indicate that the Lyons Ferry stock is widely distributed and subject to harvest in marine fisheries from southern California to Alaska. An analysis of the distribution of ocean fishery impacts in 1992 indicated that the majority of the catch occurs in Canadian waters, primarily off the west coast of Vancouver Island (NMFS 1992a).

Relative Distribution (%) of Ocean Fishery Impacts on Lyons Ferry Chinook Salmon Under the PFMC's 1992 Regulations

Region	Relative Impacts Age 3	Age 4
Southeast Alaska	1.8	6.8
Canada	74.7	85.6
PFMC	23.5	7.7

V. Assessment of Impacts

A. Description of Fishery

The groundfish fishery off the west coast of Washington, Oregon, and California is prosecuted by three major gear types including trawl, pots, and hook-and-line gear with small amounts of additional catch taken by other miscellaneous gear types.

Nearly 96 percent of all groundfish in the U.S. fishery is taken by trawl gear (Table 1). The principal trawl gear configurations include midwater, bottom, and shrimp trawls. Midwater trawls are used primarily to harvest Pacific whiting. This is the largest volume fishery on the U.S. west coast with landings in 1991 of 210,354 metric tons (mt) representing nearly 72 percent of the total landed catch of groundfish (by weight). Midwater trawls were used more extensively during the 1980s to harvest widow rockfish, but as trip limits for this fishery became more restrictive, an increasing fraction of the widow rockfish catch was landed by bottom trawls. Midwater trawls have also been used in exploratory fisheries for shortbelly rockfish and jack mackerel.

Bottom trawls are used to harvest flatfish, rockfish, sablefish, and other species. There are three primary fishery types or strategies for the use of bottom trawls including nearshore mixed, bottom rockfish and deepwater strategies. Nearshore mixed describes the use of bottom trawls in waters shallower than 100 fathoms primarily to harvest flatfish. Bottom rockfish trawls are equipped with rollers on the footrope to enable usage in rocky habitat. Most rockfish trawling occurs over the continental shelf, shallower than 200 fathoms. Deepwater trawling may occur as deep as 600 fathoms. Principal species taken with deepwater trawls include Dover sole, sablefish, and thornyheads.

Shrimp trawls are a specialized, small mesh trawl used to harvest shrimp in shallow waters. Approximately 19,000 mt of shrimp were taken in the Pacific coast fishery in 1992 (Table 1). The shrimp fishery itself is regulated by the states, although the groundfish FMP does establish trip limits for the bycatch of groundfish in the shrimp fishery. Nevertheless, available information on salmon bycatch is presented to provide a more comprehensive review of west coast fisheries.

Fish pots are used primarily to harvest sablefish. Hook-and-line gear includes a variety of gear configurations, principally longline and vertical hook-and-line gear. Longline gear has traditionally been used to harvest sablefish and Pacific halibut, and the recent decade has been marked by an increase in the harvest of rockfish by hook-and-line. Off some areas of California, setnets (gillnets and trammel nets) are used to harvest rockfish and other species. Fishing strategies in the Canadian groundfish fisheries are similar. As is the case with U.S. fisheries, whiting dominate the catch. The Canadian whiting fishery occurs primarily off the southwest coast of Vancouver Island. Trawl gear accounted for 96 percent of the total catch in 1991. The catch of whiting was 104,522 mt (Dorn and Methot 1992) representing 64 percent of Canadian groundfish landings (Table 2).

B. Salmon Bycatch by Gear Type

There are two steps required in order to analyze the effect of groundfish fisheries on listed salmon species. The first is to describe how many salmon are caught, and the second is to examine stock composition in order to infer the likely impact on each of the listed species. The purpose of this section is to summarize the available information on the bycatch of salmon for each of the major gear types. Following sections will describe the likely impact on the four salmon stocks of concern using available information on stock composition.

The groundfish fisheries managed under the PFMC groundfish FMP can be outlined by gear type as follows. (As indicated above, only the bycatch of groundfish in the shrimp fishery is regulated by the FMP.)

1. Trawl
   a. Midwater
   b. Bottom
   c. Shrimp
2. Pot
3. Hook-and-line
4. Other

The available information on salmon bycatch in the groundfish fisheries is limited primarily to the trawl fisheries. The whiting fishery, which is the principal midwater trawl fishery, has been the subject of a comprehensive observer program since at least 1977. The bycatch of salmon in the whiting fishery was

considered in previous biological opinions (NMFS 1990, NMFS 1991a). The whiting fishery off the California coast received particular attention during the last few years because of concerns regarding the declining status of SRWRC and Klamath River fall chinook. As a result, there is a great deal of information available regarding bycatch in the whiting fishery.

There are three sources of information regarding bycatch in the bottom trawl fisheries. During 1985-1987, observers on Oregon trawlers documented patterns of groundfish discard, particularly with regard to trip limits (Pikitch, et al. 1988).

During 1988-1990, a mesh size experiment was conducted with California, Oregon, and Washington trawlers during actual fishing operations (Pikitch, et al. 1991). An analysis of salmon bycatch in these studies is in preparation (Erickson and Pikitch, in prep.) and is the primary source of information for the biological assessment of the bottom trawl fishery (Methot 1992b) and this biological opinion. Some information regarding the shrimp fishery is also available from the 1985-1987 groundfish discard study.

Information on salmon bycatch from NMFS bottom trawl surveys was used to supplement the fishery information on spatial patterns of bycatch and level of incidence. Bottom trawl surveys were conducted on the continental shelf (30-200 fathoms) during 1980, 1983, 1986, and 1989. A similar survey in 1977 covered the depth range 50-250 fathoms. Each survey was conducted in approximately mid-July to mid-September and extended as least as far south as Monterey Bay and at least as far north as the U.S.-Canada border. The survey gear is a high-rise bottom trawl with rollers and is roughly comparable to that used in the bottom trawl rockfish fishery. The survey design is stratified random. Nearly 3,000 tows have been taken in the five surveys.

There is little direct information on bycatch in pot, hook-and-line or other gear type fisheries in the PFMC area. These are addressed indirectly by inference and using limited information derived from available sources.

Information regarding bycatch in the Canadian whiting fishery is available for 1988-1990 (Sandy McFarlane, CDFO, January 17, 1992, personal communication). There are observations regarding bycatch in the bottom trawl or other Canadian groundfish fisheries.

Table 1. Landed catch of groundfish (mt) in PFMC catch areas in 1991 by gear type (according to best available data in PacFIN on 15-FEB-92). TR indicates trace amounts.

SPECIES	TRAWLS	SH-TRAWLS	POTS	HOOK&LINE	NETS	TROLLS	OTH GEARS	ALL GEARS
ARROWTOOTH FLOUNDER	4921.2	24.3	1.0	12.5	TR	TR	0.6	4959.5
DOVER SOLE	17881.6	23.6	1.8	2.9	31.3	TR	262.0	18203.2
ENGLISH SOLE	2123.1	0.7	0.5	3.1	4.0	-	47.8	2179.1
PETRALE SOLE	1833.7	0.3	1.2	3.6	27.5	TR	34.6	1900.9
REX SOLE	1134.1	0.7	0.6	0.5	0.6	-	32.1	1168.6
ROCK SOLE	14.5	TR	-	0.4	0.2	TR	0.1	15.2
STARRY FLOUNDER	676.7	TR	0.1	2.1	1.1	-	0.6	680.5
OTHER FLATFISH	1279.0	0.5	0.1	15.1	5.0	TR	11.8	1311.5
UNSP. FLATFISH	30.6	-	TR	3.4	5.0	-	2.8	41.8
___ALL FLATFISH	29894.5	50.1	5.2	43.5	74.6	0.1	392.3	30460.1
BLACK ROCKFISH	2.9	TR	-	102.5	-	-	-	105.5
BOCACCIO	1190.3	10.8	0.3	133.0	202.5	1.4	93.9	1632.2
CANARY ROCKFISH	2450.3	25.4	-	63.4	-	-	-	2539.1
CHILIPEPPER	1680.5	3.8	-	235.0	-	-	-	1919.4
DARKBLOTCHED ROCKFISH	942.0	7.3	-	0.1	-	-	-	949.4
REDSTRIPE ROCKFISH	212.0	TR	-	-	-	-	-	212.0
SHARPCHIN ROCKFISH	216.7	0.6	-	-	-	-	-	217.3
SILVERGREY ROCKFISH	320.8	0.1	-	0.2	-	-	-	321.1
SPLITNOSE ROCKFISH	221.2	0.1	-	1.2	-	-	-	222.4
YELLOWEYE ROCKFISH	132.6	0.1	-	48.1	-	-	-	180.8
YELLOWMOUTH ROCKFISH	540.6	TR	-	-	-	-	-	540.6
YELLOWTAIL ROCKFISH	3521.9	415.4	-	210.1	-	8.6	-	4156.0
OTHER ROCKFISH	1488.8	5.4	TR	177.2	TR	-	0.1	1671.5
___SEBASTES COMPLEX	12920.6	469.0	0.3	970.8	202.5	10.0	93.9	14667.0
PACIFIC OCEAN PERCH	1387.4	3.1	-	0.1	-	-	-	1390.6
THORNYHEADS	6387.4	2.2	0.6	70.8	4.8	0.2	69.9	6536.0
WIDOW ROCKFISH	6724.6	25.3	0.6	56.3	116.6	0.1	8.2	6931.8
UNSP. ROCKFISH	1101.6	279.2	11.8	2957.5	1131.7	56.5	452.9	5991.2
___ALL ROCKFISH	28525.8	778.9	13.3	4055.5	1455.7	66.8	624.9	35520.9
JACK MACKEREL	139.3	-	-	-	-	-	-	139.3
LINGCOD	2611.8	23.2	1.2	330.1	148.1	34.6	27.4	3176.4
PACIFIC COD	1803.5	2.6	-	4.5	-	0.1	TR	1810.7
PACIFIC WHITING	210354.1	-	-	2.9	0.4	-	48.4	210405.8
SABLEFISH	4863.4	17.5	1059.6	3384.9	33.9	16.2	76.9	9452.4
OTHER ROUNDFISH	-	-	-	TR	22.8	-	-	22.8
___ALL ROUNDFISH	219779.1	43.3	1060.7	3722.5	205.2	50.9	152.8	225014.5
SPINY DOGFISH	692.8	0.1	-	207.7	-	0.1	-	900.7
OTHER GROUNDFISH	281.0	0.6	2.3	47.4	57.0	0.6	5.8	394.8
UNSP. GROUNDFISH	107.2	-	TR	3.5	7.1	TR	8.4	126.2
___MISC. GROUNDFISH	1080.9	0.7	2.4	258.6	64.1	0.8	14.2	1421.8
ALL GROUNDFISH	279280.2	873.0	1081.6	8080.1	1799.5	118.6	1184.2	292417.3
CALIFORNIA HALIBUT	158.1	-	1.4	38.1	235.4	0.8	34.0	467.8
PACIFIC HALIBUT	0.5	0.1	-	166.4	TR	1.7	0.1	168.8
PINK SHRIMP	4643.2	14362.1	-	-	-	-	-	19005.4

Table 2. Landed catch of groundfish (mt) in Canadian waters (International North Pacific Fisheries Commission or INPFC areas) in 1991 by gear type. The catch of whiting is shown separately from that of other groundfish species.

INPFC Area		Trawl	Shrimp	Hk/Line	Net	Troll	Total
Charlotte	Other	33,797	0	3,122	1	93	37,013
Vancouver	Other	19,377	11	3,323	5	113	22,829
	Whiting	104,522	0	0	0	0	104,522
Total		157,696	11	6,445	6	206	164,364

1.a. Midwater Trawl

The Pacific whiting fishery is the only midwater trawl groundfish fishery of significance in the PFMC representing 72 percent of Pacific coast groundfish landings. Midwater gear has been used to target widow rockfish, but this fishery has declined in recent years as trip limits became more restrictive. There have been some efforts to harvest shortbelly rockfish and jack mackerel with midwater gear, although these fisheries are still exploratory in nature. There is currently an experimental fishery proposed for up to 13,000 mt of shortbelly rockfish that would be taken off the California coast. The decision on whether to issue the permit has not been made. If the permit is issued, the fishery will likely be subject to area restrictions and NMFS-certified observers would examine every tow by whole-haul sampling for bycatch.

i. Description of the Pacific Whiting Resource

Pacific whiting is a migratory species that spawns off central California to northern Baja California, Mexico, during January-February. During March-April there is a northward migration of adults. Juveniles tend to remain off central California and larger, older whiting tend to migrate farthest north. The traditional fishery (see below) tended to begin in late April off northern California and Oregon. By June, whiting are available to the whiting fishery off Vancouver Island, Canada. While on the feeding grounds, whiting are semi-pelagic and found primarily over the continental shelf. The date of the return migration is not certain and some fishing has occurred through November. The total available harvest (U.S. plus Canada) fluctuates because of

extreme variation in recruitment, and is expected to average 221,000 mt in the long term (Figure 1).

ii. Description of the Pacific Whiting Fishery

The fishery for Pacific whiting in U.S. waters has evolved through three eras since its inception in the mid-1960s. Throughout this period, whiting has been harvested almost entirely by midwater trawls. The first era was dominated by foreign fisheries that were restricted to operate offshore of 12 miles and north of 39 degrees. During the second era, 1978-1989, a joint venture fishery involving domestic catcher boats and foreign at-sea processors was initiated. The joint venture fishery grew to 203,578 mt in 1989 when it completely displaced the foreign fishery. During this same decade, the shorebased whiting fishery grew from less than 1,000 mt to 7,418 mt in 1989. The third era began in 1991 with the complete displacement of the joint venture fishery by domestic at-sea processors, domestic catcher-processors, and substantial growth in the shorebased whiting fishery (Figure 2). The distribution of catch among these groups in 1991 was influenced by allocation by the PFMC and resulted in 119,123 mt (including discards) to catcher-processors, 81,835 mt to motherships and 20,601 mt to shoreside.

In 1992, the harvest guideline for whiting in the U.S. fishery is 208,800 mt. The PFMC allocated 98,800 mt for processing at sea. Of the remainder, 80,000 mt is available for processing onshore and 30,000 mt is reserved for either shoreside or at-sea processing, although shoreside processors have priority. If the shoreside plants are unable to use any portion of their allocation, it may be reallocated for use by the at-sea fleet. The first decision regarding reallocation would be made on or about September 1, 1992. Additional management actions were taken in 1992 to limit bycatch, particularly in southern INPFC areas. Fishing for whiting inside of 100-fathoms was limited in the Eureka area, night fishing was prohibited and the area south of 42°N was closed to at-sea processing. The 1992 season opened on April 15. By May 5, the at-sea processors had taken all of the initial allocation and were closed pending possible reallocation of available surplus latter in the year.

The catch in the Canadian fishery averaged about 42,000 mt since 1966 accounting for an average of about one quarter of the total harvest coastwide (Figure 1). In recent years, the Canadian catch of whiting has increased. The catch since 1987 has averaged nearly 89,000 mt and totaled 104,522 mt in 1991 (Dorn and Methot 1992).

iii. Salmon Bycatch in the Whiting Fishery

The bycatch of salmon in the foreign, joint venture, and at-sea domestic whiting fishery in PFMC waters has been well monitored by the NMFS Fishery Observer Program. With the exception of 1986, the annual salmon catch in the whiting fishery has ranged from 2,300 to 16,200 and averaged approximately 9,500 (Figure 3).

The reason for the higher bycatch in 1986 is unknown, but was due at least in part to the higher abundance of salmon, particularly in the Columbia area. Because of the changing nature of the fishery, catch patterns from more recent years are described in more detail and used to project the likely range of bycatch for 1992 and beyond.

The vast majority of salmon taken in the whiting fishery are chinook. Chinook comprised 82 to 98 percent of the salmon bycatch in the 1986-1990 U.S. joint venture whiting fishery. Most of the remainder are chum and coho. In the 1982-1987 foreign and joint venture fishery, sockeye bycatch averaged 22 fish per year. In the 1988-1990 joint venture fishery, no sockeye were observed. The salmon bycatch in the Canadian fishery over 3 years (1988-1990) comprised an average of 93 percent chinook and an average of 54 sockeye per year.

Patterns of salmon bycatch rate are summarized in Table 3 by International North Pacific Fisheries Commission (INPFC) area and user type (Figure 4). Areas with less than 1,000 mt of whiting catch are not presented because of the high variability in salmon bycatch (typically, salmon occur in about 27 percent of all whiting tows, but about 2 percent of the tows contribute 50 percent of the salmon bycatch).

Salmon bycatch rate in the Vancouver area typically has been two or three times the rate in the Columbia area. There has been little fishing in the U.S. Vancouver area, partly due to restrictions on foreign vessels, but increased activity by the domestic fleet is possible. The Canadian fishery in the Vancouver area has increased in recent years (Figure 2).

A large fraction of the whiting fishery occurs in the Columbia area. In four of the five years examined, the salmon bycatch rate by the joint venture fishery in this area was lower than the coastwide average (Table 3). The foreign fishery tended to have a higher salmon bycatch rate in the Columbia area than in the Eureka area, perhaps because the 12 mile from shore restriction on the foreign fishery moved them offshore of the high salmon

bycatch depth zone (<100 fathoms) in the Eureka area, but not in the Columbia area which has a wider shelf.

The bycatch rate of the 1991 domestic fishery in the Eureka area was similar to the rate achieved by the joint venture fishery in this area during 1988-90. In 1990 and 1991, the Eureka area rate was greater than the Columbia area rate, but this has not always been the case and is inconsistent with observations from the bottom trawl fishery (see below).

In 1989-1991, the Monterey area had a salmon bycatch rate that was slightly lower than the rate observed in the Columbia area, but the sample size was small in 1989 and 1990 (1,800 mt whiting in each year).

Table 3. Observed bycatch rates (# salmon/mt whiting) for salmon in the Canadian and PFMC area foreign, joint venture and domestic whiting fishery by INPFC catch area.

Year	Vancouver	Columbia	Eureka	Monterey	Total
Canadian Waters					
1988	0.148				
1989	0.150				
1990	0.103				
U.S. Waters/Foreign					
1986		0.201	0.065		0.146
1987		0.094			0.094
1988		0.126	0.053		0.121
U.S. Waters/Joint Venture					
1986	0.434	0.284	0.959		0.331
1987	0.201	0.073			0.081
1988	0.238	0.085	0.107		0.103
1989		0.058	0.036	0.041	0.047
1990	0.050	0.029	0.098	0.023	0.054
U.S. Waters/Domestic					
1991	0.037	0.011	0.071	0.007	0.032

A depth effect has been observed in the Eureka area in the past with higher salmon bycatch rates observed inside of the 100 fathom contour (Table 4). Higher bycatch rates were also observed in near-shore areas in the bottom trawl fishery. The continental shelf off the Eureka area is narrow and the 100 fathom contour generally occurs 6 to 10 nautical miles offshore. In the Columbia and Vancouver areas, the shelf is broader, the 100 fathom isobath is further offshore, and much of the whiting fishery occurs inside of the 100 fathom contour. The PFMC restricted fishing inside of 100 fathoms in the Eureka area by emergency rule in 1992 based primarily on the analysis of data specific to the Eureka area.

Table 4. Salmon bycatch rate (# salmon/mt whiting) in the Eureka area whiting fishery.

Year	1988	1989	1990	1991
Nearshore	0.476	0.093	0.335	no tows
Offshore	0.083	0.015	0.029	0.071
All	0.107	0.036	0.098	0.071

iv. Annual Variability in Bycatch

Bycatch rates in the Eureka and Vancouver area have not shown significant trends in recent years. However, the bycatch rate in the Columbia area has been on a downward trend, even without considering the high rate in 1986. It is not clear whether the low rate achieved by the domestic fishery in this area in 1991 is a continuation of this trend or a manifestation of an unknown difference in the fishing operations. The fishery was compressed into the April-June period, but the lack of apparent seasonality in bycatch suggests that this shift in timing had little effect on total bycatch.

v. Salmon Bycatch by Shorebased Vessels

Until recently shorebased vessels did not account for a significant amount of the whiting catch (Figure 2). However, the catch of the shorebased fleet grew to 20,500 mt in 1991 and further growth is expected in 1992. Shorebased vessels were not sampled by the observer program in 1991 or in previous years. Information related to salmon bycatch is therefore limited. The

Oregon Department of Fish and Wildlife (ODFW) did place observers on 25 vessel trips fishing out of Newport, Oregon, during 1991. These trips accounted for 1,026 mt of whiting and two chinook salmon (0.002 chinook/mt) (Claire Wood, ODFW, January 24, 1992, personal communication). ODFW instituted a more comprehensive sampling program in 1992. Preliminary information for the shorebased fleet operating out of Newport, Oregon, for the period April 15 to June 30, 1992, indicate that the bycatch rate is relatively low and comparable to that of the domestic at-sea processors that operated in the Columbia area in 1991. ODFW sampled 159 deliveries accounting for 6,149 mt of whiting and observed 86 salmon. The resulting bycatch rate is 0.014 salmon/mt whiting. In lieu of more comprehensive information on bycatch rates in the shore-based fishery for whiting, the rates observed in the at-sea fisheries were applied to the shorebased fishery.

vi. Expected Distribution of Whiting Fishery in 1992

The PFMC adopted a series of management actions for the 1992 season designed to reduce bycatch, particularly in the Eureka area. First, the opening date was delayed until April 15. Second, catcher-processors and at-sea processors were prevented from operating south of 42°N latitude. Third, directed harvest was prohibited inside of the 100-fathom contour within the Eureka area. Finally, fishing at night was prohibited coastwide. These management actions have affected the distribution of catch. For example, the April 15 opening date reduced the amount of fishing time in April and shifted the at-sea processors northward because of the northward migration of the fish. Additionally, warm water conditions associated with a moderate El Niño are occurring. This also moves the whiting, and their fishery, northwards. These factors indicate that only the shorebased fishery will operate to a substantial degree in the Eureka area. The at-sea fishery opened April 15, 1992, and closed on May 5 having taken their initial allocation. Preliminary data on the catch of the at-sea processors and the projected distribution of the shoreside fishery is shown by area in Table 5.

Table 5. Catch of whiting (mt) and salmon (#) in the 1992 PFMC whiting fishery. Observed catch includes catch of at-sea processors taken during the April 15 to May 5, 1992, opening. Projected catch represents the anticipated distribution for the remainder of the whiting harvest guideline.

	Observed			Projected
INPFC Area	Whiting	Salmon	#/mt	Whiting
Vancouver	11,739	186	0.0158	15,000
Columbia	69,515	1,039	0.0150	85,000
Eureka	17,650	110	0.0062	10,000
Monterey	0	0	0	0
Total	98,904	1,335	0.0135	110,000

vii. Expected Bycatch Rates in 1992

There are two approaches that can be used for projecting bycatch rate in the U.S. fishery for the remainder of the season. Projections can be based on patterns observed in recent years or the rates observed to date for the 1992 fishery. In the Vancouver area, the expected rate based on recent years is 0.13 salmon per mt whiting (mean of the 1987-1991 rates; also equal to the 1988-90 rate reported for the Canadian hake fishery). In the Columbia area, the mean rate since 1987 has been 0.05 salmon per mt, but there has been a downward trend to 0.01 salmon per mt in 1991. In the Eureka area, the bycatch rate in 1992 is expected to be about 0.05 salmon per mt whiting which is the simple mean of the 1988-1991 rates observed while fishing offshore of the 100 fathom contour. Preliminary data from the 1992 at-sea fishery indicate that the rates have been lower than expected based on recent year averages (Table 5).

viii. Expected Salmon Bycatch in 1992

The expected salmon bycatch in 1992 ranges from 2,909 to 8,035 fish depending upon whether the recent year average rates or the lower rates observed during 1992 are used (Table 6). The mean of these two estimates, 5,472 salmon, is taken as a reasonable projection for the 1992 fishery. This would be substantially less than the overall bycatch observed in recent years (Table 7),

although it also shows a displacement of the fishery and bycatch from south to north.

Bycatch rates in the Canadian fishery averaged 0.134 salmon/mt from 1988-1990. The expected catch of whiting in the 1992 Canadian fishery is approximately 90,000 mt. The expected bycatch of salmon in 1992 is, therefore, approximately 12,000 salmon based on average bycatch rates from recent years or 1,400 based on the observed rate in the U.S. Vancouver area in 1992.

It is difficult to project the magnitude or distribution of salmon bycatch in the whiting fishery for future years. Bycatch will depend on the abundance of salmon and the success in finding management measures designed to reduce bycatch without unduly constraining the whiting fishery. It is likely that the PFMC will continue to experiment with management actions that can be used to reduce salmon bycatch. Given the current status and concerns regarding SRWRC and Klamath River fall chinook, PFMC will likely continue to focus their attention regarding bycatch on the Eureka and Monterey areas as was done in 1992. This will likely result in more whiting being caught in areas to the north.

Table 6. Projected bycatch of salmon (numbers of salmon) in the 1992 PFMC whiting fishery. Observed catch represents catch to date by at-sea processors. Projected catch is based on bycatch rates observed in 1992 (low) and those observed in recent years (average).

INPFC Area	Observed	Projected		Total	
		Low	Average	Low	Average
Vancouver	186	237	1,950	423	2,136
Columbia	1,039	1,275	4,250	2,314	5,289
Eureka	110	62	500	172	610
Monterey	0	0	0	0	0
Total	1,335	1,574	6,700	2,909	8,035

Table 7. Salmon bycatch (numbers of salmon) in the U.S. whiting fishery by INPFC area.

Year	Vancouver	Columbia	Eureka	Monterey	Total
1986	4,920	27,372	4,867	18	37,177
1987	1,399	11,886	0	0	13,285
1988	2,969	10,453	2,744	2	16,168
1989	35	5,464	3,626	74	9,199
1990	326	2,945	5,995	42	9,308
1991	268	753	4,811	499	6,331
1992[1]	1,280	3,801	391	0	5,472

[1] **Projected catch**

Although the harvest of whiting is expected to average approximately 221,000 mt in the long-term, it is expected that the allowable catch of whiting in the near future will be reduced below 1992 levels (208,800 mt). The preliminary recommendation for whiting harvest in 1993 is 177,000 mt coastwide including Canada (PFMC 1992b).

Bycatch rates have varied considerably between years and areas in recent years, but it is expected that the bycatch rate can be kept below 0.05 salmon/mt calculated on an annual and coastwide basis. The 0.05 rate was adopted as a voluntary industry standard in 1991 and is used here to define the upper limit of expected catch of salmon for future years. The upper range of anticipated catch of salmon in the U.S. whiting fishery is, therefore, approximately 11,000 (221,000 mt * 0.05 = 11,050) the majority of which will be chinook. This estimate and the projected catch for 1992 will be used to define the range of anticipated catch in the subsequent discussion regarding stock specific impacts.

How to approximate the likely bycatch for future Canadian fisheries is less clear. The bycatch rates have tended to be higher in the Vancouver area fisheries. The Canadian whiting fisheries are not subject to the same level of scrutiny as the U.S. fisheries and were not subject to the 0.05 salmon/mt whiting voluntary industry standard used by the United States. The bycatch rate in the Canadian fishery has been consistently higher

in recent years. For the purposes of this review, it is assumed that the bycatch of salmon may again be as high as it has been in recent years. The bycatch of salmon in 1989 was nearly 14,000 salmon taken in conjunction with nearly 100,000 mt of whiting. This is perhaps a reasonable estimate of the maximum catch in the near future since the allowable harvest of whiting is expected to decline.

I.b. Bottom Trawl

The primary source of information used for estimating salmon bycatch in the bottom trawl fishery was the report of Erickson and Pikitch (in prep.). The report summarized the results of a discard study conducted from 1985-1987 and a mesh size study conducted from 1988-1990. The discard study covered the Washington and northern Oregon coasts and all four quarters. Sampling in the mesh size study included the entire Pacific coast, but only the third and fourth quarters (Table 8).

Erickson and Pikitch used the Pacific States Marine Fisheries Commission (PSFMC) rather than INPFC catch areas to stratify their study design. To discuss the results of their study and summarize the results regarding anticipated bycatch, it is necessary to refer to the PSMFC and INPFC catch areas interchangeably. Reference to Figure 4 and Table 8 will help minimize the associated confusion.

Chinook were the dominate salmon species observed in both the discard (94 percent) and mesh size (98 percent) studies. This is consistent with the results from other bycatch studies involving trawl gear. In the midwater trawl fishery for Pacific whiting, chinook comprise 82-98 percent of the salmon taken in the 1986-1990 U.S. joint venture fishery. In the NMFS bottom trawl surveys, 617 of the 640 salmon taken (96 percent) were chinook.

Virtually all of the salmon caught in the trawl fishery were taken in relatively shallow water. Only one chinook was observed from tows in water that was greater than 300 fathoms and there were few taken in water greater than 100 fathoms. This depth effect was similar to that observed in the midwater trawl fishery.

Three different bottom trawl fishing strategies were investigated including the near-shore mixed, bottom rockfish and deepwater strategies. Bycatch rates did not differ between strategies (Erickson and Pikitch in prep.) thus permitting development of estimates of bycatch rate that were generally applicable to all bottom trawl gear types.

Table 8. Sampling effort (number of tows) by quarter and area in depths less than 549 m during discard and mesh size field studies for the bottom groundfish trawling strategy (Erickson and Pikitch, in prep.). The PSMFC area and approximate corresponding INPFC area are shown for reference.

PSMFC	INPFC	Discard (1985-87)				Mesh Size (1988-90)			
Area	Area	1	2	3	4	1	2	3	4
3B	Van	13	15	22	13	-	-	232	65
3A	Col	49	12	95	74	-	-	101	52
2C	Col	45	89	240	100	-	-	115	113
2B	Col	46	34	85	95	-	-	115	22
2A	Eur	5	2	-	-	-	-	25	25
1C	Eur	-	-	-	-	-	-	40	11
1B	Mon	-	-	-	-	-	-	23	69
1A	Con	-	-	-	-	-	-	-	8

Spatial patterns of chinook bycatch were also considered. In the 1985-87 study, Erickson and Pikitch (in prep.) reported that the bycatch rate in area 2B (central Oregon) was higher than areas to the north during each of the four quarters sampled. Area 2B also had the highest rate in the 1988-90 study, although the differences were not statistically significant. These results differed somewhat from those of the NMFS survey studies where the occurrence of salmon was highest in the Eureka area. Higher chinook bycatch in the Eureka area was also observed in the Pacific whiting midwater trawl fishery.

There were significant differences in the bycatch rate between seasons. Bycatch rates in the 1985-87 study were higher in the first and fourth quarters than during the second and third quarters. During the 1988-90 study, sampling was limited to the third and fourth quarters, but the results were consistent with those of the discard study (Table 9).

Table 9. Bycatch rate (number/tow hour) of salmon derived from the discard and mesh size studies (Methot 1992b). Sampling in the mesh size study was limited to the third and fourth quarters.

Study	Quarter	
	1 and 4	2 and 3
Discard (1985-87)	0.211	0.031
Mesh Size (1988-90)	0.280	0.015

Estimates of total chinook bycatch were developed by expanding bycatch rates using logbook estimates of total trawl hours.

Erickson and Pikitch compiled estimates of bottom trawl effort in depths less than 300 fathoms by quarter and PSMFC area for 1986 and 1987 (their Table 7) and 1990 (their Table 8). The effort estimates were multiplied by estimates of chinook bycatch rates for each quarter and PSMFC area (Methot 1992b). When the 1986 level of effort is applied to the 1985-87 rates, the estimated total chinook bycatch for the Washington and central Oregon coast (areas 2B through 3B-C) is 5,300 chinook. When the same calculation is made with the 1987 level of bottom trawl effort, the estimated bycatch of chinook is 7,757 chinook. When the 1990 effort is applied to the 1988-1990 rates, the estimated bycatch of chinook for the entire California, Oregon, and Washington coast is 9,178. This is a conservative estimate because of their recommended exclusion of an outlier. Approximately 990 of these chinook were estimated to have been taken south of the areas included in the 1986 and 1987 estimates. The resulting range of estimates for annual, coastwide chinook bycatch in the bottom trawl fishery is 6,290 to 9,178 fish.

The analysis therefore provides three estimates (from 1986, 1987, and 1990) of chinook bycatch in the bottom trawl fishery for the Washington and central Oregon coast (areas 2B through 3B-C) and one (from 1990) for the California and southern Oregon coast (areas 1A through 2A). There is obviously less certainty regarding the general magnitude of bycatch in the southern areas. Areas 1A through 2A (the Monterey and Eureka INPFC areas) were not as well represented in the sampling design as areas to the north. Observations from the midwater trawl whiting fishery suggest that bycatch rates in the Eureka area in particular, are

generally higher than areas to the north. This is inconsistent with the bottom trawl data. However, despite the relative uncertainty regarding bycatch in the south, it is useful to maintain the north/south stratification because it corresponds to assumptions related to the distribution of SRWRC and Snake River fall chinook discussed later.

An alternative calculation of total bycatch can be made by pooling some strata before calculating the expansions. This is possible because there tended to not be significant differences between areas and because the first and fourth quarters were similar, but different from the second and third quarters. The resulting estimate of coastwide, annual chinook bycatch during 1985-1990 is approximately 11,000 chinook. However, this approach did not provide the north/south stratification that was desirable for the subsequent analysis of stock specific impacts. The level of chinook bycatch in current and future bottom trawl fisheries is difficult to project. The available information suggests that the bycatch of chinook for northern areas is on the order of 5,000 to 8,000 with another 1,000 chinook taken off southern Oregon and California. Erickson and Pikitch (in prep.) strongly caution against extrapolating from the rates observed in their studies because of changing trawl mesh size and technique, changing abundance of salmon, and other factors. However, their studies do help define the approximate magnitude of chinook bycatch in the bottom trawl fishery and provide perspective when comparing to other fisheries. A coast-wide catch of 6,000 to 9,000 chinook compares roughly to the take in the midwater trawl whiting fishery, but is only a few percent of the annual catch of chinook salmon in commercial and recreational salmon fisheries (Table 10).

Table 10. Coastwide chinook salmon landings (numbers of salmon) for ocean troll and recreational fisheries (PFMC, 1992c).

Year	Washington	Oregon	California	Total
1986	71,000	425,000	968,000	1,464,000
1987	125,000	589,000	1,069,000	1,783,000
1988	133,000	508,000	1,488,000	2,129,000
1989	106,000	386,000	718,000	1,210,000
1990	93,000	259,000	563,000	915,000
1991	63,000	89,000	376,000	528,000

1.c. Shrimp Trawl

A total of 247 shrimp trawl tows were examined for bycatch during the 1985-87 discard study. No salmon were observed in any of the tows. It is, therefore, reasonable to conclude that the shrimp fishery has negligible impact of salmon.

Erickson and Pikitch (in prep.) speculated that the absence of salmon in the shrimp trawl fishery may be due to timing of the fishery. The shrimp season takes place during the late spring and summer, when salmon bycatch for all trawl fisheries was generally lowest. They also suggested that the absence of salmon bycatch might be related to hydrodynamics of the small mesh net or slower towing speed.

2. Pot Gear

Pots are baited traps that are deployed on the bottom and used to target sablefish. The pot fishery in PFMC areas accounted for less than 1,100 mt or about 0.4 percent of groundfish landings in 1991. There is no direct information regarding bycatch in the pot fishery. However, because of the pelagic, visually oriented feeding strategy of salmon, it is unlikely salmon would enter a baited trap placed on the bottom. The bycatch of salmon in the pot fishery is assumed to be essentially zero.

3. Hook-and-Line

Hook-and-line gear is used to target primarily sablefish, Pacific halibut, and rockfish. (Pacific halibut are managed by the International Pacific Halibut Commission established by treaty between the United States and Canada, and are not one of the designated species managed under the groundfish FMP.) There are several different hook-and-line gear configurations. Longlines are strings of baited hooks that are anchored to the bottom and used to target sablefish and halibut. Vertical longlines are again strings of baited hooks that are fished vertically and used to target various rockfish species, particularly in southern Oregon and California. Jigs are fished differently, but are again strings of baited hooks or other attractants that are fished more actively from a vessel. Jigs are used to target primarily rockfish and some lingcod.

The hook-and-line fishery in 1991 took about 8,100 mt or about 2.8 percent of all of groundfish landings coastwide. Retention of salmon in groundfish fisheries is prohibited and, because of the scale of the fishery, there has been no monitoring program designed to collect bycatch information. As a result, there is

no specific data regarding the bycatch of salmon. It is unlikely that salmon would be taken by baited hooks on longlines anchored to the bottom, because of the general feeding habit of salmon. It is conceivable that salmon might be taken on the vertical longline or jig operations. However, based on personal communication with biologists involved in managing these fisheries in each of the states and fishermen that have been involved with these fisheries, it seems unlikely that the bycatch of salmon is more than an occasional event which would have negligible impact on the species of concern.

4. Other Gear

There are a variety of localized setnet (gillnet and trammel net) fisheries located off the California coast. The use of gillnets is prohibited by the groundfish FMP north of 38° N latitude (just north of San Francisco Bay). In PFMC groundfish fisheries, sunken gillnets are used to target rockfish. Information from the central California area indicates that the rockfish fishery takes place in relatively deep water and that salmon interactions are negligible (Marine Resources Division 1987).

California halibut and white croaker are the primary target species of inshore fisheries, although these fisheries are managed under California State regulation and are not part of the groundfish FMP. The state fisheries have been monitored in recent years because of concerns for bird and marine mammal interactions. Estimates of the total salmon taken incidental to the gillnet and trammel net fisheries for the area from the Mendacino-Sonoma county line to Yankee Point south of Monterey Bay for 1983-1985 are 1,898, 1,663, and 2,170, respectively (Marine Resources Division 1987). Chinook salmon comprised 94 percent of the salmon catch. Many of the nearshore fishing areas where most of the bycatch was observed have been closed in recent years to minimize impacts on birds and mammals. These regulatory changes have also resulted in substantial reductions in the bycatch of salmon (Wild 1990).

VI. Species Specific Impacts

A. Sacramento River Winter-Run Chinook Salmon

Estimating the bycatch of SRWRC in the whiting fishery in any particular area depends on estimates of the catch of salmon and the relative abundance of salmon stocks present in that area. Projections of bycatch of salmon by INPFC area for 1992 were developed in a previous section (Table 6 and 7). The information necessary to estimate the relative abundance of SRWRC is

generally not available. However, an analysis was developed in the previous biological opinion regarding the impacts of the whiting fishery (NMFS 1991a) that provided a method for approximating the magnitude of bycatch of SRWRC. The analysis was based on a series of assumptions from existing data sources and management models. The numbers generated by this process are not intended for use as point estimates, but are rather best viewed as professional judgement of the approximate magnitude of the catch.

SRWRC are distributed primarily off the California coast. The abundance of SRWRC relative to other stocks in the Monterey and Eureka areas was previously estimated to be approximately 1/1500 and 1/5500, respectively (NMFS 1991a). The contribution of SRWRC to catch in the Columbia and Vancouver areas was not explicitly estimated, but would be substantially lower than in the Eureka area.

Management measures in 1992 have effectively eliminated the whiting fishery from the Monterey area. The delayed opening and ocean conditions have tended to displace the fishery to the north. At-sea processors are prohibited from fishing south of 42° north latitude (the Eureka extends from 43°00" to 40°30" N latitude). The capacity of the onshore processing fleet within the Eureka area is limited and the catch of whiting in the Eureka area is not expected to exceed 10,000 mt in 1992. There are no onshore processing plants for whiting south of Eureka, California or in the Monterey area. These same measures have also greatly reduced the projected bycatch of salmon in the Eureka area from a few thousand observed in recent years to a few hundred in 1992 (Table 7). Because of the more northerly distribution of the bycatch and assumptions regarding relative abundance of stocks, the probability of catching a SRWRC in the 1992 whiting fishery is considered negligible.

The prospects of impacting SRWRC in future years depends on the distribution and magnitude of the whiting fishery and bycatch rate. Substantial increases in the catch of whiting in the Eureka or particularly the Monterey areas would be cause for concern. However, for the foreseeable future, continuing concerns for SRWRC and Klamath River fall chinook are likely to lead to the continuing use of management actions to minimize bycatch in areas south of the Columbia area as was done in 1992.

It was estimated that the bycatch of salmon in the bottom trawl fishery in areas south of the Columbia area would be on the order of 1,000 fish per year. Determining the impact of this bycatch on SRWRC depends on how this catch is distributed across the

Eureka, Monterey and Conception areas. If we assume that all of the bycatch was taken in the Monterey area, the area of highest relative abundance, we would still estimate that less than one SRWRC would be taken per year.

B. Snake River Sockeye Salmon

There is no information to suggest that Snake River sockeye are harvested in Pacific coast groundfish fisheries. Nearly all of the salmon caught in the midwater whiting and bottom trawl fisheries are chinook. Chinook comprise 82 to 98 percent of the salmon bycatch in the 1986-90 U.S. joint venture whiting fishery. Most of the remainder are coho and chum. In the 1982-1987 foreign and joint venture fishery, sockeye bycatch averaged 22 fish per year. In the 1988-1990 joint venture fishery, no sockeye were observed. In the bottom trawl surveys, 96 percent of the salmon observed were chinook and none were sockeye.

The likelihood that any of the very few sockeye taken in groundfish fisheries are from the Snake River is extremely remote. The number of Snake River sockeye returning to the Columbia River is likely quite small (probably on the order of a few tens of fish) compared to the millions of sockeye from other stocks that enter the PFMC management area and pass primarily through the Strait of Juan de Fuca to the Fraser River. Methot (1992a, 1992b) concluded that the likelihood of taking any sockeye from the Snake River in whiting or bottom trawl fisheries is negligible.

C. Snake River Spring/Summer Chinook Salmon

Although chinook are the primary salmon species taken as bycatch in the groundfish fisheries, there is little affirmative evidence to suggest that Snake River spring/summer chinook are included in the bycatch. Snake River spring and summer chinook are assumed to be north migrating. As a result, any taking that may occur is likely limited to the northern Oregon and Washington coast.

Review of CWT recovery data also suggests that these stocks are absent from PFMC areas during most of their life history. The CWT data is problematic because survival rates of tagged fish have been quite low. However, over 2.8 million tagged spring chinook and nearly 1.6 million tagged summer chinook have been released over a twelve year time period beginning in 1976. None of these tags have ever been recovered from PFMC area groundfish fisheries; there have been very few tags recovered in PFMC area salmon. There have been four observed recoveries of spring chinook in ocean fisheries (all in Canadian waters) compared to

622 from inriver fisheries and escapement. There have been 20 estimated recoveries of summer chinook in U.S. ocean fisheries and seven more in Canadian ocean fisheries, compared to 195 estimated recoveries in the inriver fisheries and escapement. The STT (1992) concluded that there was insufficient information to determine the ocean distribution of Snake River spring or summer chinook, but based on the review of CWT and other information, that these stocks are unlikely to be significantly impacted by ocean salmon fisheries in the PFMC area.

Suggestive, albeit negative evidence (absence of tag recoveries where recoveries would be expected if spring/summer chinook were impacted), indicates that these stocks are not significantly affected by salmon or groundfish fisheries in the PFMC area. Therefore, NMFS concludes that fishing conducted under the groundfish FMP is not likely to jeopardize the continued existence of Snake River spring/summer chinook.

D. Snake River Fall Chinook Salmon

As was the case with SRWRC, estimating the impact of the groundfish FMP on Snake River fall chinook depends on estimates of bycatch and assumptions regarding the relative abundance of salmon stocks in the areas of concern. It was previously estimated that the bycatch of salmon in the whiting fishery in 1992 would be approximately 5,100 in the Vancouver and Columbia areas and 400 in the Eureka area (Table 6 and 7). It was also estimated that the bycatch of salmon in the whiting fishery is unlikely to exceed 11,000 per year coast-wide for the foreseeable future. There is some uncertainty regarding the geographic distribution of the whiting fishery in future years, but it is most likely to be located primarily to the north in the Columbia and Vancouver areas. Bycatch in the bottom trawl fishery is expected to be on the order of 1,000 salmon in the areas south of the Columbia area and 5,000 to 8,000 in Columbia and Vancouver areas.

There is some direct information indicating the presence of Snake River fall chinook in the whiting fishery bycatch. The CWT groups used to represent naturally spawning Snake River fall chinook are limited to non-experimental, fingerling type releases. Only releases from the Lyons Ferry Hatchery are incorporated in the Pacific Salmon Commission and PFMC salmon fishery models (Berkson 1991). There have been four observed recoveries of Lyons Ferry fingerling type CWTs in the whiting fishery. There were three additional recoveries of fingerling type CWT groups from the Hagerman Hatchery, although these are considered experimental type releases. All the CWTs were

recovered off the northern Oregon or Washington coasts during the summer months.

Estimates of the distribution and relative abundance of Snake River fall chinook were derived from recoveries of CWTs from the 1984 and 1985 brood year releases of the Lyons Ferry Hatchery stock that is used as a surrogate for naturally spawning Snake River fall chinook. The recovery information was recently incorporated into a chinook harvest model used by the PFMC for the first time in 1992 (CMWG 1990, 1991; PFMC 1992a) to assess impacts of ocean salmon fisheries on chinook stocks, particularly in the area north of Cape Falcon, Oregon (Figure 4). This same model was used to evaluate the impact of ocean salmon fisheries in the PFMC areas on Snake River fall chinook compared to the 1986-90 base period. The analysis provided the basis for the biological opinion regarding 1992 PFMC ocean salmon fisheries (NMFS 1992a).

One of the shortcomings of the analysis was the inability to estimate the absolute abundance of Snake River fall chinook. Without the appropriate stock scalars, it was not possible to estimate the number of fish actually caught, relative contribution to the various fisheries, or ocean escapement of Snake River fall chinook (i.e., the number of mature fish expected to return to the Columbia River mouth in 1992). Following completion of the ocean opinion, a subsequent biological assessment was developed regarding summer and fall season fisheries in the Columbia River (CRTS 1992). This assessment included an age-specific estimate of the ocean escapement of Snake River fall chinook. This was the information that was needed for scaling ocean abundance that was not available prior to completion of the earlier analysis. Using the new information, the initial abundance of Snake River fall chinook was scaled and the model rerun using the 1992 pre-season fishery structure. The model then provided estimates of the catch of Snake River fall chinook by fishery.

The estimates of catch by fishery were aggregated into three broad geographic areas to conform with estimates of salmon bycatch in the groundfish fisheries. The three areas included the west coast of Vancouver Island (representing the Canadian fishery), a northern U.S. area including the U.S. portion of the Vancouver INPFC area and the Columbia area, and a southern area including the Eureka, Monterey, and Conception areas. The catch of naturally spawning Snake River fall chinook estimated by the salmon harvest model was 1,776 in the Canadian area, 285 in the U.S. north and 7 in the U.S. south.

The expected catches of chinook in ocean commercial, recreational, and tribal salmon fisheries in Canada off the southwest coast of Vancouver Island and the northern and southern areas of the U.S. coast in 1992 are 300,000, 169,200 and 156,600, respectively (PFMC 1992a). The resulting ratios indicate that the contribution of Snake River fall chinook in the 1992 salmon fisheries were approximately 1/170 (300,000/1,776 = 169), 1/600 (169,200/285 = 594) and 1/22,000 (156,600/7 = 22,371).

These ratios are used here to approximate the impact of bycatch in the groundfish fisheries on Snake River fall chinook. The expected bycatch of salmon in the northern area whiting fishery in 1992 is 5,081 (Table 7), which would include approximately 9 (5,081/594 = 8.6) Snake River fall chinook. It was estimated that the bycatch of salmon in future U.S. whiting fisheries might be as high as 11,000. If all of that bycatch were taken in the Columbia and Vancouver areas, the catch of Snake River fall chinook could be as high as 19 (11,000/594 = 18.5). The anticipated bycatch in the bottom trawl fishery in the northern areas ranged from 5,000 to 8,000 indicating that as many as 13 (8,000/594 = 13.5) Snake River fall chinook might be taken in the bottom trawl fishery. The relative abundance of Snake river fall chinook in southern areas suggests that impacts from groundfish fisheries in areas south of the Columbia area will be negligible.

The contribution of Snake River fall chinook to the Canadian fishery off the southwest coast of Vancouver Island is substantially higher than that of the U.S. fisheries. It was projected that the bycatch of salmon in the whiting fishery could be as high as 14,000 in future years. This would result in an estimated take of approximately 83 (14,000/169 = 82.3) Snake River fall chinook.

Determining the impact of other Canadian groundfish fisheries on Snake River fall chinook is more difficult. It is possible to tabulate groundfish landings, but the effect of these fisheries on Snake River fall chinook will depend to a large degree on where the fish are caught. The fishery takes place in both the Vancouver and Charlotte areas. A substantial portion of the catch occurs in inside waters where the relative contribution of Snake River fall chinook is likely quite low. There is no direct information of bycatch rates in Canadian fisheries or contribution rates in particular areas. The estimates for the U.S. fisheries were based on expansions of effort data, which are also unavailable. Given the absence of applicable information, no effort was made to estimate the impact on Snake River fall

chinook of Canadian groundfish fisheries directed at species other than whiting.

It is important to qualify these estimates and point out some of the underlying assumptions of the analysis. The basic assumption is that the distribution of stocks taken in the salmon fisheries is the same as that of the groundfish fisheries. There are several reasons to believe that this may not be the case. First, although very broad geographic areas have been defined, salmon fisheries are not coincident in time or place with groundfish fishery. For example, bottom trawl fisheries take place year around while salmon fisheries are restricted primarily to the summer months. Second, the catch in the groundfish fisheries is composed primarily of immature age-two and age-three fish, whereas the catch in salmon fisheries is composed primarily of older age classes. Third, the analysis of relative contribution is specific to the 1992 estimates of ocean abundance of all stocks in the model and is therefore year-specific. Also, the model itself is scaled based on recovery data from only 2 brood years. The estimates of stock distribution in the salmon fishery model will improve as the number of brood years in the model increases. Finally, a new and untested procedure was used for estimating the ocean escapement of Snake River fall chinook (CRTS 1992). The estimates of contribution rates derived from the model are directly related to the forecast of ocean escapement.

Although the assumption that the distribution of stocks in the salmon fisheries is the same as that of the groundfish fisheries is problematic, there is no inherent reason to believe that the relative impacts in the groundfish fisheries will be more or less than those of the salmon fisheries. The analysis, therefore, provides a reasonable approximation of the likely magnitude of the bycatch that is based on the best available data.

Given the shortcomings of the analysis, the estimates of the impact of the bycatch on Snake River fall chinook are not intended as point estimates, but are rather best viewed as a qualitative judgement regarding the approximate magnitude of the impact on the stock of concern. The estimated bycatch of salmon in all PFMC groundfish fisheries is probably on the order of 10,000, and may be as high as 20,000 in some years. The impact on Snake River fall chinook is probably on the order of a few tens of fish. It may be less, but is unlikely to be as many as 100. The impact from the Canadian whiting fishery of Snake River fall chinook is roughly comparable, perhaps somewhat higher than that of the U.S. groundfish fisheries; probably some tens of fish, but likely less than 100.

VII. Cumulative Effects

Cumulative effects are those impacts of future non-Federal, state, and local government and private actions that are reasonably certain to occur within the area of Federal action under review. No such effects are anticipated. Future Federal actions, including future ocean and inriver fisheries, and renegotiation of the Pacific Salmon Treaty, will be subject to the consultation requirements of 50 CFR Part 402 and, therefore, are not considered cumulative to the proposed action. Consultations are anticipated regarding future in-river fisheries and the renegotiation of the Pacific Salmon Treaty.

VIII. Conclusion

In this biological opinion, NMFS reviewed the available information regarding the bycatch of salmon for each of the major gear types. The review indicated that there were significant interactions in the midwater whiting and bottom trawl fisheries. For these gears, the magnitude and distribution of the bycatch of salmon was estimated. The likely impact on each of the listed salmon species was then reviewed in more detail. For the other gear types, including shrimp trawls, pots, hook-and-line and other miscellaneous net gear, there was little direct information, but reason to believe that the gears would not take significant numbers of salmon. Conclusions with respect to other gear types are reviewed briefly after consideration of species specific impacts due to midwater whiting and bottom trawl gear.

A. Impacts of Trawl Fisheries

1. Sacramento River Winter-Run Chinook Salmon

SRWRC are distributed primarily off the California coast. The relative abundance of SRWRC in the Monterey and Eureka areas was previously estimated to be approximately 1/1500 and 1/5500, respectively. The contribution of SRWRC to catch in the Columbia and Vancouver areas was not explicitly estimated, but would be substantially lower than in the Eureka area. Management actions taken in 1992 have effectively eliminated the whiting fishery from the Monterey area and greatly reduced to expected catch in the Eureka area. The bycatch of salmon in the Eureka area will be reduced from the few thousand observed in recent years to a few hundred in 1992. The prospects of impacting the SRWRC in future years depends on the distribution and magnitude of the whiting fishery and bycatch rate. However, for the foreseeable

future, continuing concerns for salmon stocks off the California coast are likely to lead to the continuing use of management actions to minimize bycatch in areas south of the Columbia area as was done in 1992.

Information on the bycatch of salmon in the bottom trawl fishery off the coast of southern Oregon and California is rather limited. However, based on the available information, it was estimated that the bycatch of salmon in these areas would be on the order of 1,000 salmon per year. If all of the bycatch was taken in the Monterey area, the area of highest relative abundance, the estimated catch of SRWRC would still be less than one per year. Given the above information, NMFS concludes that continuing implementation of the PFMC groundfish FMP is not likely to jeopardize the continue existence of SRWRC.

2. Snake River Sockeye Salmon

There is no information to suggest that Snake River sockeye are harvested in Pacific coast groundfish fisheries. The likelihood that any of the very few sockeye taken in groundfish fisheries are from the Snake River is extremely remote. The number of Snake River sockeye returning to the Columbia River is likely quite small (probably on the order of a few tens of fish) compared to the millions of sockeye from other stocks that enter the PFMC management area and pass primarily through the Strait of Juan de Fuca to the Fraser River. Given the above information, NMFS concludes that continuing implementation of the PFMC groundfish FMP is not likely to jeopardize the continue existence of Snake River sockeye salmon.

3. Snake River Spring/Summer Chinook Salmon

Although chinook are the primary salmon species taken as bycatch in the groundfish fisheries, there is little evidence to suggest that Snake River spring/summer chinook are included in the bycatch. The distribution of Snake River spring and summer chinook is likely limited to the northern Oregon and Washington coast since spring and summer chinook from the Snake River are assumed to be north migrating stocks. There are no CWT recoveries from these stocks in Pacific coast groundfish fisheries. The available evidence from ocean salmon fisheries also suggests that the spring and summer Snake River stocks are not affected to any significant degree by fisheries in the PFMC area (NMFS 1992a). Bycatch from other gear types has been determined to be negligible. Given the lack of affirmative

evidence that these stocks are significantly affected by salmon fisheries in the PFMC area and the absence of evidence regarding incidental takes in groundfish fisheries, NMFS concludes that fishing conducted under the groundfish FMP is not likely to jeopardize the continued existence of Snake River spring/summer chinook salmon.

4. Snake River Fall Chinook Salmon

The greatest effect of PFMC groundfish fisheries on Snake River fall chinook will occur off the Washington and Oregon coast. It was estimated that the relative contribution of Snake River fall chinook in northern (Vancouver and Columbia) and southern (Eureka, Monterey and Conception) INPFC areas is approximately 1/600 and 1/22,000, respectively. These ratios were used to estimate the impact of bycatch in the groundfish fisheries on Snake River fall chinook. The expected bycatch of salmon in the northern area whiting fishery in 1992 is 5,081 (Table 7), which should include approximately 9 Snake River fall chinook. It was estimated that the bycatch of salmon in future U.S. fisheries might be as high as 11,000. If all of that bycatch was taken in the Columbia and Vancouver areas, the catch of Snake River fall chinook could be as high as 19. The anticipated bycatch in the bottom trawl fishery in the northern areas ranged from 5,000 to 8,000 indicating that as many as 13 Snake River fall chinook might be taken in the bottom trawl fishery. The relative abundance of Snake river fall chinook in southern areas suggests that impacts from groundfish fisheries in areas south of the Columbia area will be negligible.

The key assumption used in this analysis is that the distribution of stocks in the salmon fisheries is the same as that of the groundfish fisheries. There are a number of reasons which suggest that this may not be the case, but there is no inherent reason to believe that the relative impacts in the groundfish fisheries will be either more or less than those of the salmon fisheries. The analysis, therefore, provides a reasonable approximation of the likely magnitude of the bycatch that is based on the best available data.

Given the shortcomings of the available data, the estimated impacts of bycatch on Snake River fall chinook are not intended as point estimates, but are rather best viewed as a qualitative judgement regarding the approximate magnitude of the impact on the stock of concern. The estimated bycatch of salmon in all PFMC groundfish fisheries is probably on the order of 10,000,

perhaps as high as 20,000 per year. The impact on naturally spawning Snake River fall chinook is probably on the order of a few tens of fish. It may be less, but is unlikely to be as many as 100.

Bycatch in the whiting fishery will account for roughly half of the total salmon taken in groundfish fisheries. It is apparent that the PFMC and fishing industry are mindful of the bycatch problem and have taken management actions designed specifically to reduce the bycatch of salmon. Management actions taken in 1992 to reduce bycatch were implemented by emergency regulation. The PFMC is currently developing Amendment 7 to the plan that would provide them the authority to implement management measure designed to reduce bycatch on a routine basis. Additionally, for the past 2 years, the industry has voluntarily limited the incidental take of salmon to 0.05 salmon/mt whiting, a rate that is substantially below rates observed in most previous years

(Figure 5). Given the small magnitude of the catch of Snake River fall chinook relative to other actions and the actions taken to date to reduce bycatch, NMFS concludes that continuing implementation of the PFMC groundfish FMP is not likely to jeopardize the continued existence of Snake River fall chinook salmon.

B. Impacts of Other Gear Types

There is some observational data regarding the shrimp trawl fishery from the 1985-87 discard study. A total of 247 shrimp trawls were examined for bycatch, but no salmon were observed.

The bycatch of salmon in the pot fishery is assumed to be essentially zero. Because of the pelagic, visually oriented feeding strategy of salmon, it is unlikely that salmon would enter a baited trap placed on the bottom.

There are several different hook-and-line gear configurations including longlines fished on the bottom, various vertical longlines, and jigs. It is unlikely that salmon would be taken by baited hooks on longlines anchored to the bottom, because of their general feeding habit. It is conceivable that salmon might be taken on the vertical longline or jig operations. However, based on personal communication with biologists involved in managing these fisheries in each of the states and fishermen that have been involved with these fisheries, it seems unlikely that

the bycatch of salmon is more than an occasional event which would have negligible impact on the species of concern.

There have been a variety of localized setnet fisheries located off the California coast. The use of gillnets is prohibited by the groundfish FMP north of 38°N latitude (just north of San Francisco Bay). In PFMC groundfish fisheries, sunken gillnets have been used to target rockfish, but available information indicates that impacts on salmon are negligible.

Given the above considerations and absence of information to the contrary, NMFS concludes that the bycatch of salmon by the above described gear types is unlikely to be more than an occasional event that is unlikely to jeopardize the continued existence of any of the listed salmon species.

IX. Reinitiation of Consultation

Consultation should be reinitiated if (1) the amount or extent of taking specified in any incidental take statement is exceeded;

(2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action is subsequently modified in a manner that was not considered in the biological opinion; or (4) a new species listed, or critical habitat designated that may be affected by the action. In addition, if and when NMFS refines its methodology for determining whether proposed fisheries jeopardize listed Pacific salmonids in a way that may significantly affect the analysis and conclusions of this opinion, NMFS will reinitiate consultation.

X. Conservation Recommendations

Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species or critical habitat; to develop additional information, or to assist Federal agencies in complying with their obligations under section 7 of the ESA.

A. The PFMC should continue to pursue development of the groundfish data collection program.

The PFMC has developed a draft plan for an observer program that could be used to monitor vessels participating in groundfish fisheries other than the at-sea whiting fishery that is currently

covered by the NMFS observer program. One objective of the program will be collection of information pertaining to the bycatch of salmon. The PFMC should pursue development and funding of the observer program, and implement it as soon as possible.

B. **Improve available estimates regarding salmon bycatch in bottom trawl fisheries in the southern INPFC areas.**

Observations regarding bycatch in bottom trawl fisheries were concentrated in the Vancouver and Columbia areas with relatively few observations to the south. The available information suggests that bycatch in these areas is limited, but an effort should be made to reevaluate this conclusion once the observer program is in place or earlier based on other information if possible.

C. **Continue to evaluate and implement management measures currently used to minimize bycatch in the whiting fishery in the Eureka and Monterey areas.**

Previous analysis of bycatch rate in the whiting fishery have focused on the Eureka and Monterey areas. As a result, several management action were implemented including restrictions related to starting date, time of day, depth, and latitude. Efforts should continue to evaluate the effectiveness of these measures. Those that are considered effective in reducing bycatch rate should be implemented in the future.

D. **Monitor the bottom trawl fisheries for changing patterns of fishing activity.**

The available information indicates that bycatch rates in the bottom trawl fishery tend to be high during the winter months and in nearshore areas. Broad scale fishing patterns should be monitored in an effort to detect changes in the timing or location of the fisheries. The effect of proposed management actions should also be evaluated to avoid greatly increasing fishing activity in nearshore areas during the winter months.

E. **Seek additional information regarding salmon bycatch in the pot, hook-and-line and other gear type fisheries.**

There is little information available regarding salmon bycatch in the pot, hook-and-line, and other gear type fisheries. Although these are relatively small scale fisheries and available

information suggests that salmon encounters are minimal, efforts should be made to confirm the conclusions drawn based on available information. The gear types within this group most likely to encounter salmon are setnets and the various types of vertical longline gear.

F. Any new groundfish fisheries should be monitored for bycatch.

New fisheries proposed for development under the groundfish FMP should be monitored to determine the relative magnitude of salmon bycatch.

G. Focus more attention on the analysis of bycatch in the Columbia and Vancouver areas with respect to actions that might be taken to reduce bycatch of salmon.

Management actions in the south have tended to displace the whiting fishery into the northern INPFC areas. Previous analyses that have focused on the Eureka area may not be applicable to the Columbia or Vancouver areas. The available information should be reviewed to evaluate what actions could be used effectively to reduce the bycatch in the northern areas. These actions may differ from those used in the south.

H. Continue to evaluate available information regarding the distribution and relative abundance of Snake River fall chinook in INPFC areas.

Information from salmon management models was used to evaluate the relative abundance of Snake River fall chinook in various fishing areas. Salmon management models will be updated in the near future and annually, thereafter. If there are substantial changes in the assumed distribution of Snake River fall chinook, the estimated impacts from the groundfish fisheries should be reevaluated.

I. Evaluate the assumption that the distribution of salmon stocks in the salmon and groundfish fisheries are similar.

A key assumption of the analysis regarding impacts on Snake River fall chinook was that the relative abundance of stocks taken in the salmon fisheries is similar to that of the groundfish fisheries. There are reasons to believe that this may not be the case. The assumption should be evaluated by comparing CWT recovery information from groundfish and salmon fisheries in those time-area strata where the numbers of recoveries are sufficient to permit the analysis.

J. Confirm estimates of ocean escapement of Snake River fall chinook.

The impact analysis for Snake River fall chinook was directly related to the newly developed estimate of ocean escapement. If the actual ocean escapement is substantially different, it may be necessary to reevaluate the estimated impacts of the groundfish fisheries on Snake River fall chinook.

XI. Incidental Take Statement

A. Anticipated Incidental Take

Section 7(b)(4) of the Endangered Species Act (ESA) provides for the issuance of an incidental take statement on the agency action if the biological opinion concludes that the action is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. In such a situation, the National Marine Fisheries Service (NMFS) will issue an incidental take statement specifying the impact of any incidental taking of endangered or threatened species, providing for reasonable and prudent measures that are necessary to minimize impacts, and setting forth the terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures. Incidental takings resulting from the agency action, including incidental takings caused by activities authorized by the agency, are authorized under the incidental take statement only if those takings are in compliance with the specified terms and conditions.

SRWRC are distributed primarily off the California and southern Oregon coast. The relative abundance of SRWRC was estimated to be approximately 1/1500 and 1/5500 in the Monterey and Eureka areas, respectively. Management actions applied to the whiting fishery in 1992 in the Eureka and Monterey areas have effectively reduced the anticipated bycatch to a few hundred salmon. It is expected that efforts to minimize bycatch of salmon in these areas will continue in the future. It is also expected that approximately 1,000 salmon will be taken in the bottom trawl fishery in areas off the California and southern Oregon coast in present and future fisheries. The expected impact on SRWRC depends on the assumed distribution of the bottom trawl bycatch, but in any case would be less than one fish. The bycatch of salmon in groundfish fisheries using other gear types managed under the groundfish FMP are assumed to occur infrequently and, thus, would not affect the estimated impact on SRWRC.

Sockeye salmon are rarely taken as bycatch in the groundfish fisheries. Given the abundance of Snake River sockeye relative to other stocks, the estimated impact on Snake River sockeye salmon is considered negligible.

Although chinook are the primary salmon species taken as bycatch in the groundfish fisheries, there is little evidence to suggest that Snake River spring/summer chinook are included in the bycatch. Given the lack of affirmative evidence that these

stocks are significantly affected by either salmon or groundfish fisheries in the PFMC area, the estimated impact from the groundfish FMP on Snake River spring/summer chinook is considered negligible.

Of the listed stocks, Snake River fall chinook salmon are the species most likely to be impacted by the groundfish fisheries. The greatest impacts will occur in the whiting and bottom trawl fisheries.

The data record regarding bycatch of salmon in the whiting fishery is sufficient to provide some understanding about the likely range of bycatch and the kinds of management measures that can be used to minimize the bycatch of salmon. In 1991 and 1992, the industry adopted a voluntary guideline for bycatch of 0.05 salmon/mt whiting. In 1992, the PFMC adopted particular management actions designed to minimize bycatch by emergency regulation and are now developing Amendment 7 to the FMP that would allow the Council to implement similar regulations on a permanent basis. The bycatch rate in 1991 and the observed bycatch rate to date in 1992 are substantially below the 0.05 target. For the purposes of this consultation, 0.05 salmon/mt of whiting was used to define the upper limit of anticipated bycatch in the whiting fishery.

The expected bycatch of salmon in the Vancouver and Columbia area whiting fishery in 1992 is approximately 5,100. This would include approximately nine Snake River fall chinook. It was estimated that the bycatch of salmon in future U.S. whiting fisheries might be as high as 11,000, and that if all of that bycatch were taken in the Columbia and Vancouver areas, the bycatch of Snake River fall chinook could be as high as 19. Because of the uncertainties related to these estimates, it is more appropriate to characterize the expected impact on Snake River fall chinook as a few tens of fish.

The estimated bycatch of salmon in the whiting fishery and estimates of impacts on listed species are based on the assumption that the bycatch rate in future fisheries will not exceed 0.05 salmon/mt whiting (calculated on a annual and coastwide basis). Therefore, pursuant to section 7(b)(4) of the ESA, NMFS authorizes the incidental take of salmon in the whiting fishery of 0.05 salmon/mt whiting.

There is less information available regarding bycatch of salmon in groundfish fisheries using gear types other than the midwater trawls used in targeting whiting. It was estimated that 6,000 to 9,000 salmon have been taken in the bottom trawl fishery in

recent years and that 5,000 to 8,000 of these are likely to be taken in the Vancouver and Columbia catch areas where Snake River fall chinook are most likely to be impacted. The estimated impact on Snake River fall chinook would be as high as 13, although this was again intended as an approximate measure of impact rather than a point estimate. Available information indicates that salmon bycatch in groundfish fisheries using other gear types is unlikely to be more than a rare event that would not affect the estimated impact on Snake River fall chinook.

Setting incidental take limits in the bottom trawl fishery is more problematic. In absence of a monitoring program, it is not possible to assess directly an incidental take limit that would normally be expressed as some measure of salmon bycatch or bycatch rate. It was estimated that as many as 9,000 salmon would be taken annually in the bottom trawl fishery and that such a take is not likely to jeopardize the continued existence of any of the listed species. Therefore, pursuant to section 7(b)(4) of the ESA, NMFS authorizes a bycatch of 9,000 salmon per year.

This estimate of bycatch in the bottom trawl fishery is based on an analysis of available information from 1985-1990. Because bycatch is not being monitored directly, expectations of bycatch in future years are based on the assumption that the general character of the fishery will not change substantially, particularly in times and places where bycatch rates are assumed to be higher. If the fishery in future years changes substantially in magnitude or character compared to 1985-1990, and in particular, if there is increased catch in nearshore areas or during the winter months or in the Eureka or Monterey areas, consultation should be reinitiated.

Review of available information regarding salmon bycatch for other groundfish gear types, including shrimp trawls, pots, hook-and-line gear and setnets used in PFMC area fisheries indicated that salmon interactions are unlikely to be more than a rare event and that the impacts on listed species will be negligible. As a result, NMFS concludes that the taking of any of the listed salmon species by these gear types is neither anticipated or authorized.

B. Reasonable and Prudent Measures and Terms and Conditions for Implementation

The estimated impacts included in the incidental take statement for the whiting fishery are based, in part, on the assumed bycatch rate of 0.05 salmon/mt. In order to evaluate whether that assumption is valid for future fisheries, continued

monitoring of salmon bycatch in the whiting fishery is necessary. Until recently, the shorebased fishery has accounted for a relatively small proportion of the total catch of whiting and was not included in the monitoring program. The shorebased fishery is expanding. It is possible that fishing patterns and, thus, bycatch rates for the shorebased fishery differ from those of the at-sea processors. The monitoring efforts initiated in 1992 must continue at a level sufficient to define the bycatch rate of the shorebased fleet and any distinguishing patterns of bycatch that may become evident.

In addition to collecting bycatch information in the whiting fishery, it is necessary to evaluate, at least monthly, the projected annual total bycatch rate of the fishery. If at anytime during the fishery, it is anticipated that the seasonal, coastwide bycatch rate will exceed 0.05 salmon/mt whiting, then consultation must be reinitiated and the PFMC must take action to implement additional management measures to reduce the bycatch rate such that the annual authorized take limit can be met. If and when it becomes apparent, based on analyses by either NMFS or PFMC that management measures cannot adequately reduce the bycatch rate to the prescribed level, consultation must be reinitiated.

In 1992, a number of management measures were implemented that were specifically designed to reduce the bycatch of salmon in the Eureka and Monterey areas. These included a delayed opening until April 15, no nighttime fishing, no at-sea processing south of 42°N and no targeted harvest of whiting inside of 100 fathoms in the Eureka area. Of these, the only management action that will be specified as a condition of the incidental take statement in this opinion is the restriction regarding targeted harvest inside of 100 fathoms in the Eureka area. This provision is specified because the available information indicates that bycatch rates are generally higher in nearshore areas. It is not applied to the rest of the coast because previous analyses of depth related effects in the whiting fishery were specific to the Eureka area. A subsequent conservation recommendation requires further analysis of depth effects and other measures that may be used to reduce bycatch rates in the future.

Two of the other measures used in 1992, including the delayed opening and restriction to at-sea processing south of 42°N, are not established here as a condition of the incidental take statement because the principal effect is to displace the fishery to the north rather than reduce bycatch rate. Although these measures clearly reduce bycatch in the Eureka and Monterey areas and impacts on SRWRC, they have the undesired effect of

increasing bycatch in the Columbia and Vancouver areas. As a result, impacts on Snake River fall chinook are higher. The nighttime closure is not set as a condition because the analyses provided to date do not clearly demonstrate the desired benefit of reducing the bycatch rate. Further analysis of controls related to time of day is suggested as a conservation recommendation.

The bottom trawl fishery is not being monitored directly for bycatch at this time. The incidental take statement permits an annual bycatch of 9,000 salmon, but assumes that the magnitude and character of the fishery will not increase substantially, particularly in those times and areas where bycatch rates are assumed to be higher. In order to meet this assumed condition, the PFMC must develop an annual summary that characterizes the bottom trawl fishery and can thus be used to evaluate potential changing trends in fishing patterns.

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Groundfish SAFE document?

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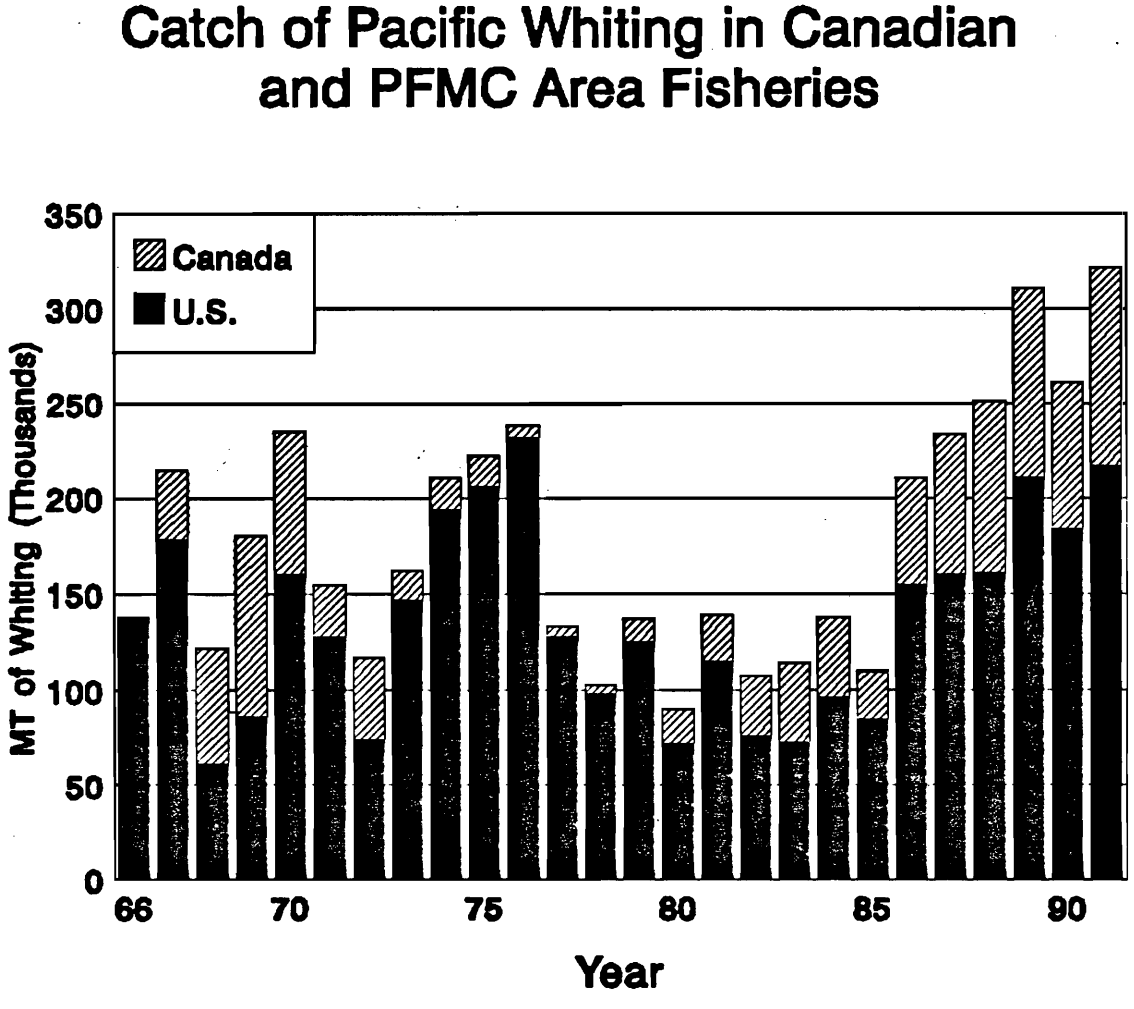

Figure 1. The catch of Pacific whiting in Canadian and U.S. fisheries.

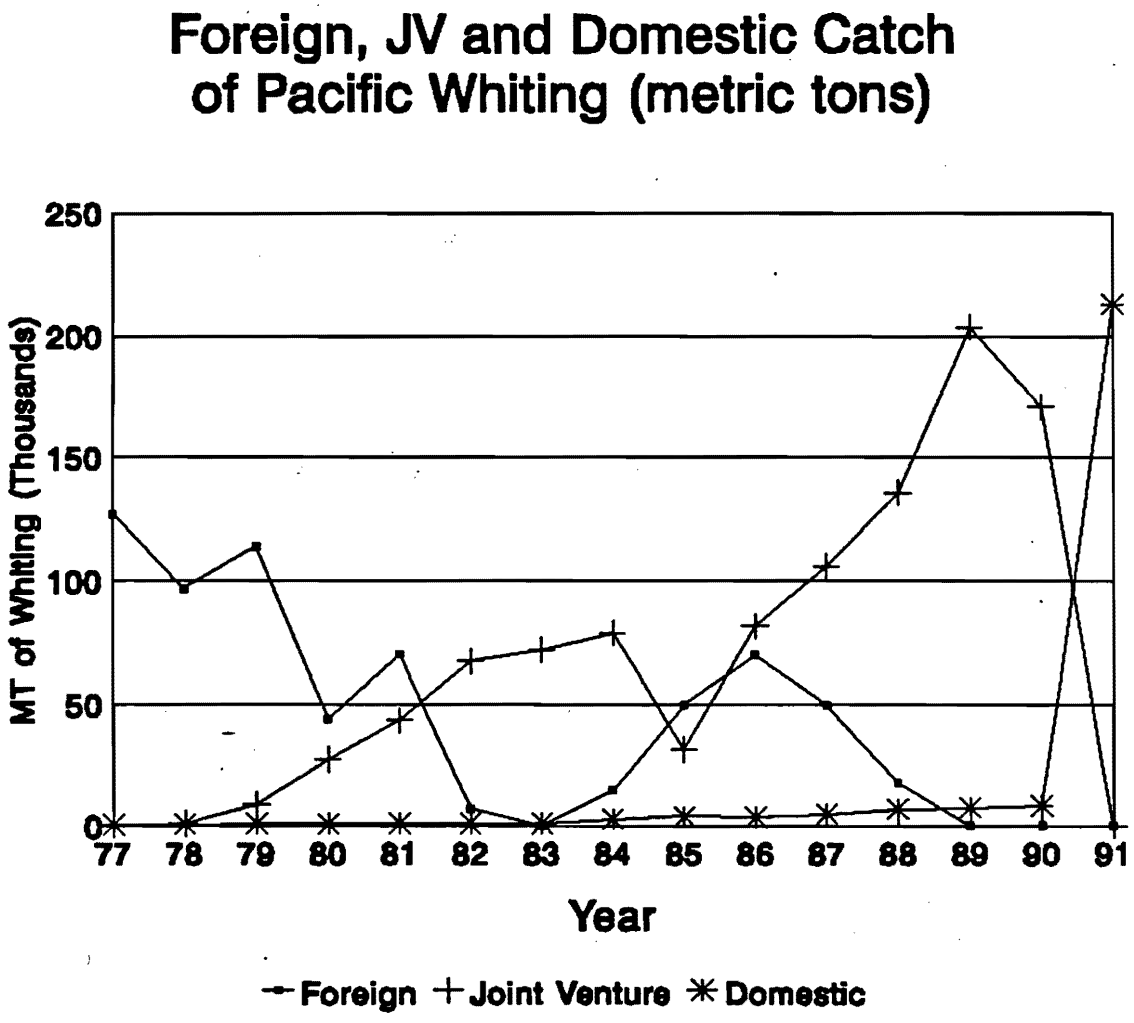

Figure 2. The catch of Pacific whiting in the PFMC area by the foreign, joint venture and domestic fisheries.

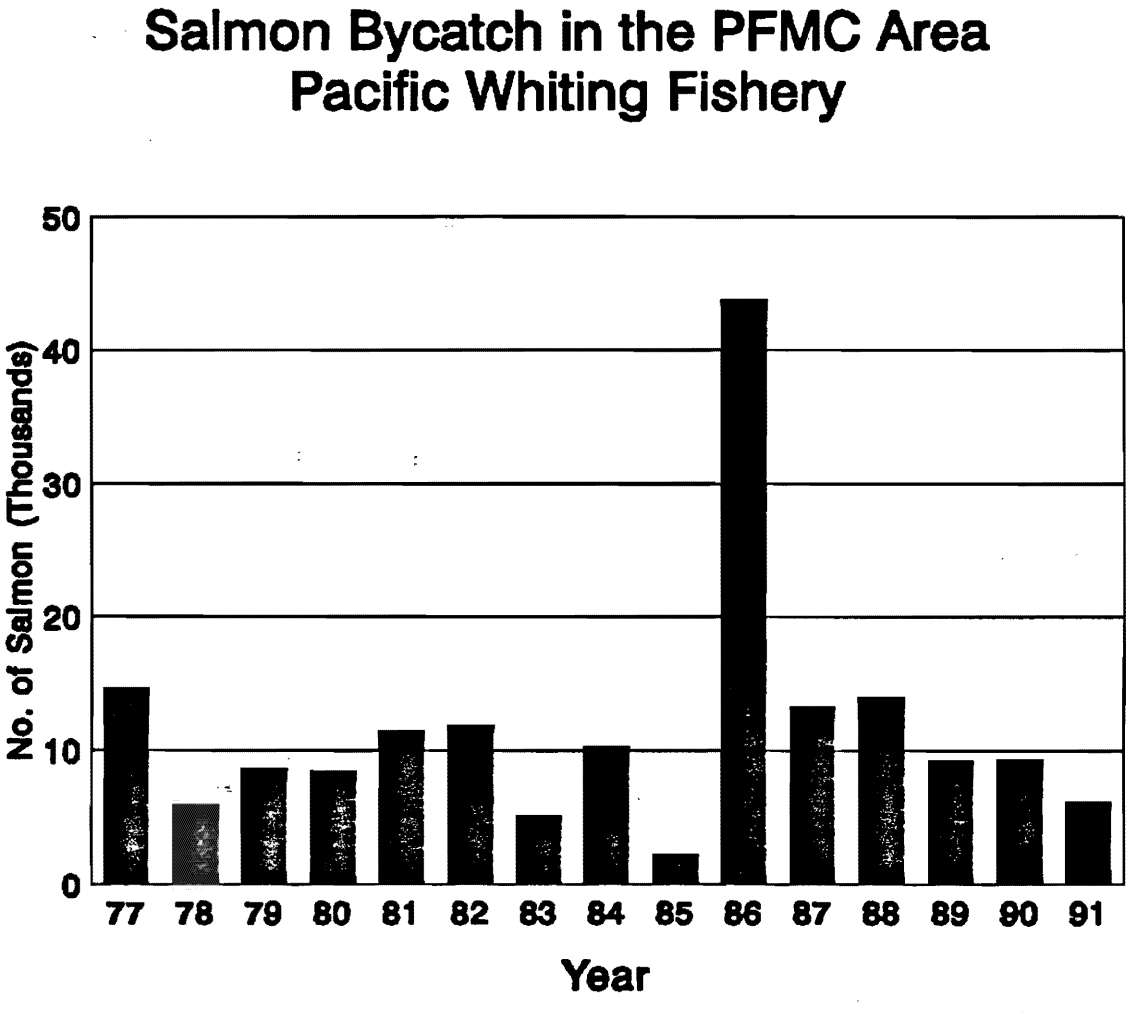

Figure 3. Salmon bycatch in the U.S. Pacific whiting fishery.

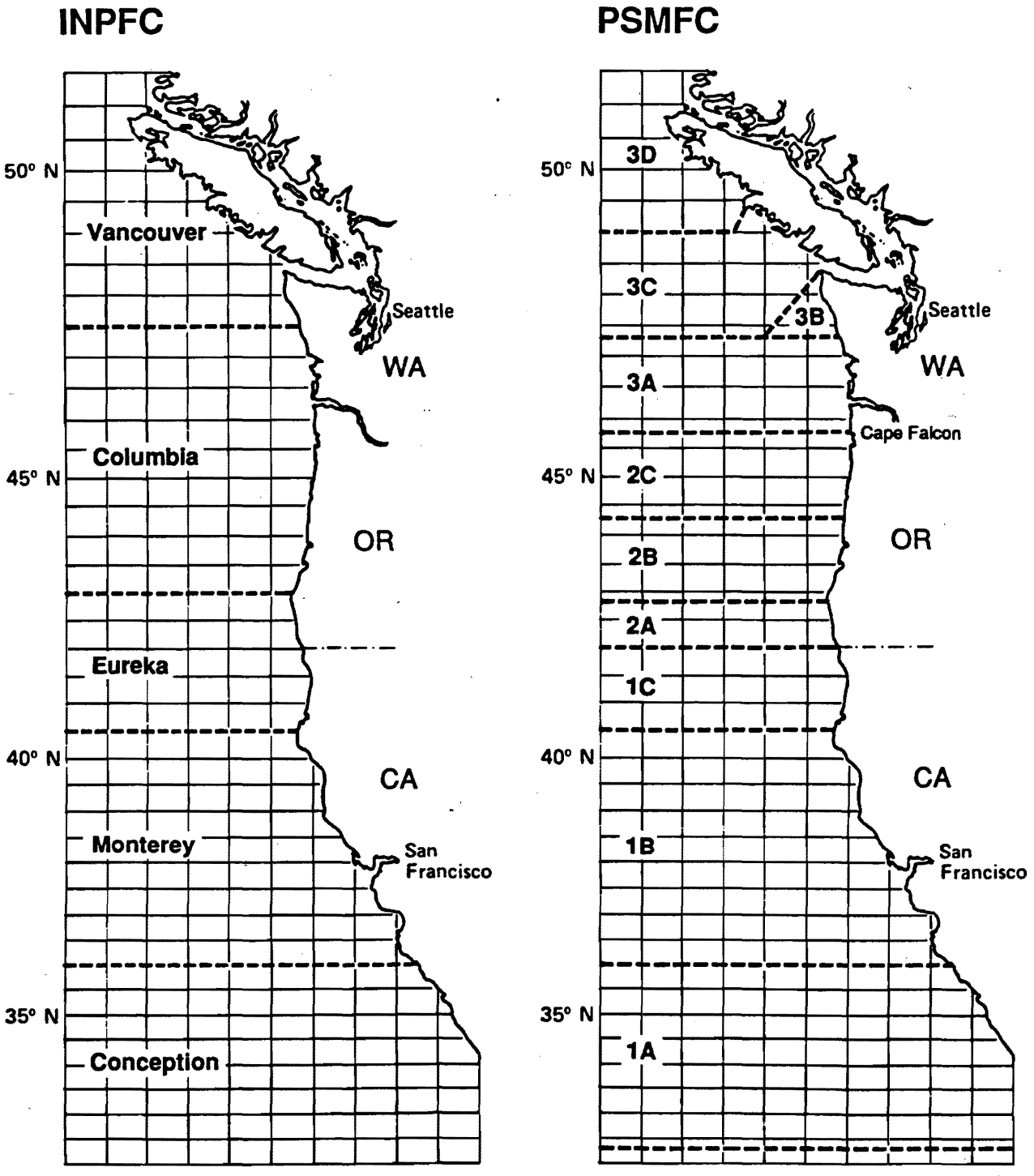

Figure 4. Pacific States Marine Fisheries Commission and International North Pacific Fisheries Commission catch areas.

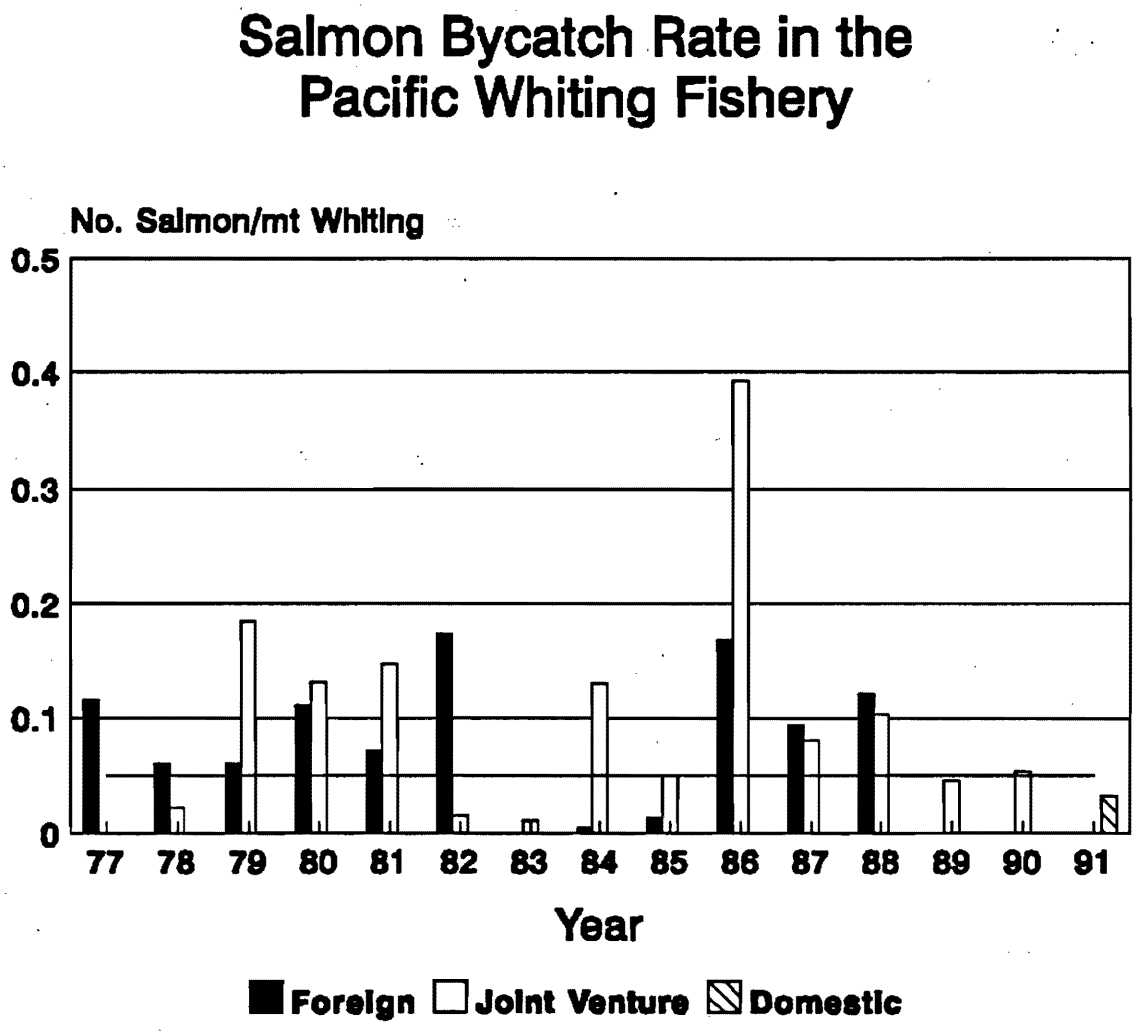

Figure 5. Bycatch rate of salmon in the Foreign, joint venture and domestic whiting fisheries. The horizontal line indicates relation to 0.05 salmon/mt whiting bycatch rate standard.