

ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILES 8672

827 SCOMM.29: HOUSE INTERIM COMM. FOREIGN INVESTMENTS 1979

Chain in waters deeper than 1000 meters. Abundance was relatively low adjacent to the shelf areas; the lowest densities appear to be in the northwestern part of the survey region from the shelf edge to about 75-100 miles south. In the eastern part of the region, moderate densities were observed to within about 50 miles of the shelf.

There was little evidence of significant quantities of fish at depths greater than 200 meters and the occurrence of echo sign normally dropped off rapidly at depths greater than about 125-150 m. During the day fish were generally concentrated between 50 and 150 m. At night this "band" of fish became more dispersed and rose in the water column. There was a difference between day and night trawl catch rates, with the average day catch rate being significantly higher. This can be attributed mainly to the less dense night time aggregations.

A very rough, and probably conservative, estimate of the biomass of the off-shelf component of the pollock population was made using the mean catch per 1 hour haul to calculate an average density, assuming the trawl caught all fish in its path. Other assumptions were:

Trawl mouth opening	900 m ² (30 x 30 m)
Ave. thickness of pollock layer	100 m
Mean weight per fish	0.5 kg

The mean fish density estimate was 1.06×10^{-5} kg/m³ and the resulting biomass estimate was 840,000 metric tons.

Pollock size Composition

A total of approximately 16,000 trawl caught pollock were measured from off-shelf trawl stations. The mean length was 46.9 cm. There was an unusually symmetric and narrow distribution of lengths, and a pronounced lack of young fish. Over 99% of the fish were from 39 to 55 cm; 82% were between 44 and 50 cm. As shown in Figure 2, the size distribution of this deep-water component of the pollock population differs significantly from that typically found in commercial catches taken over the shelf.

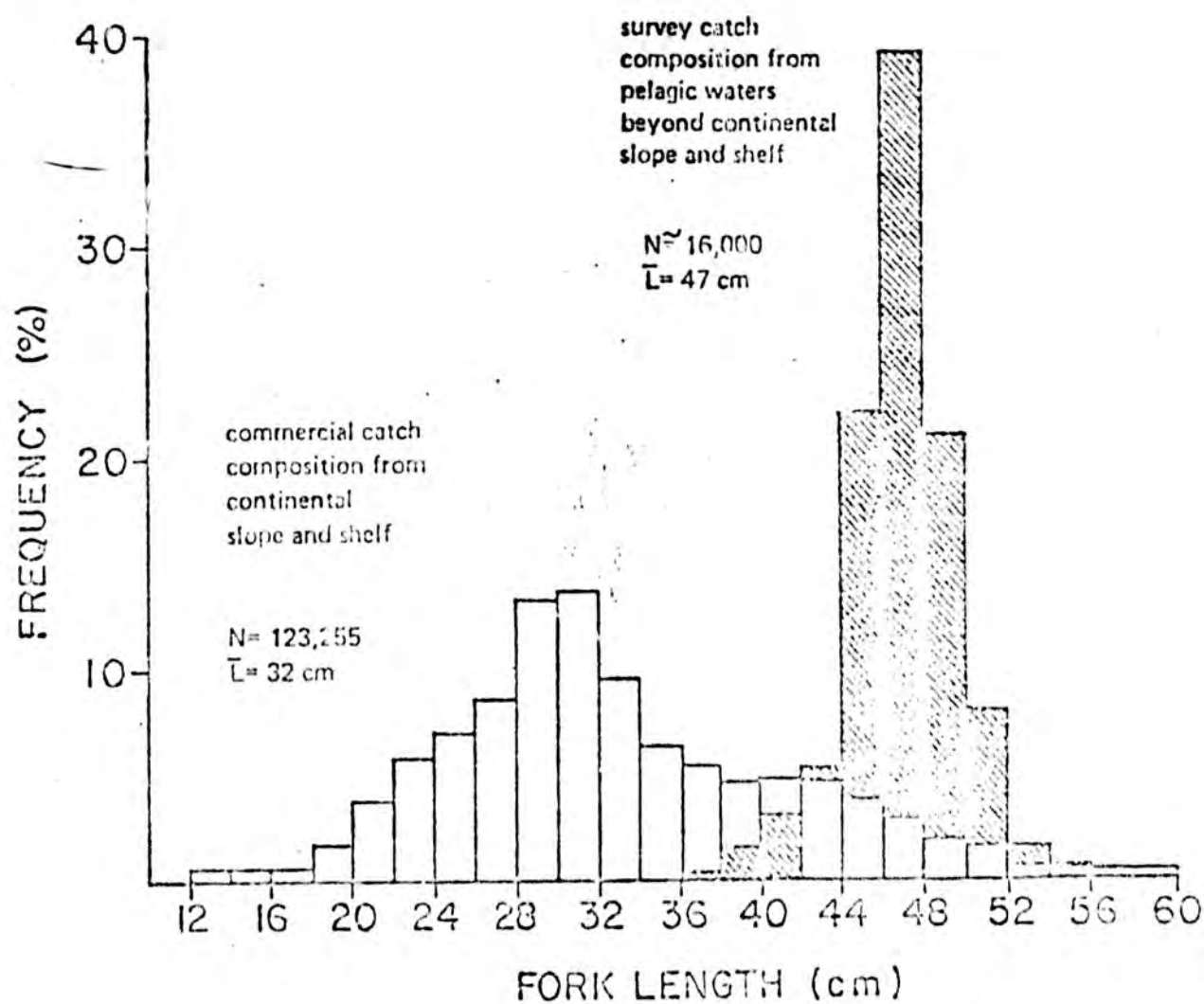


Figure 2.

Composition of length frequency distribution of pollock caught by midwater trawl by the Torii Maru 52 during the 1978 deep water survey of the Bering Sea and those caught by commercial fishing operations during 1977. Commercial catch data were collected by U.S. observers aboard Japanese, Soviet and South Korean vessels and weighted by nation.

Catches of Non-Target Species

Species other than pollock were usually a small fraction of the catch from each trawl haul. "Lumpfish" (smooth lumpsucker, Apocycylus ventricosus) were by far the most frequently occurring non-target species. It occurred in 45 (58%) of the hauls and the average catch/haul for these hauls was 11 fish.

Squid were the second most frequently occurring incidental "species" but they were taken in only 10 hauls. The squid catches included several large specimens which were probably Moroteuthis robusta.

Relatively dense scattering layers were sometimes observed and occasionally sampled with the trawl when it appeared pollock were present in them. However, hauls made in the layers were not productive and they accounted for most of the catches with no pollock.

The degree to which the composition of the nontarget species (and possibly the size composition of the pollock) was influenced by the codend mesh size of the trawl is unknown. The codend consisted of inner and outer bags, each of which had approximately 2 inch mesh (stretched measure), and chafing gear (further information on the mesh size of the codend is being requested).

Hook and Line Catches

At most hook and line stations, fishing took place for approximately 1/2 hour and about 100-200 pollock were usually captured for tagging. Since the tagging is being done only to obtain information on movements and migrations, the fish would be released even if their physical condition was marginal.

Research by the Japan Fishery Agency during the summer of 1978 identified a widely dispersed but substantial body of pollock in midwater beyond the continental shelf of the central Bering Sea (Nunnallee, 1978). Midwater trawl samples from that deep-water area produced a conservative biomass estimate of 840,000 mt (swept-area technique, $q = 1.0$) and a size composition which is much different from that of the commercial fishery which operates over the continental shelf and slope (figure I.2.a).

This difference in size composition leads to the speculation that pollock distribution changes with size, with the larger individuals tending to a pelagic existence beyond the continental slope and beyond the commercial fisheries as they currently operate.

The discovery of this deep-water component of the Bering Sea pollock population raises questions about the size of the exploitable biomass and estimates of MSY, EY and ABC/OY of the population as a whole.

Assuming that the deep-water and shallow-water i.e., those available to the commercial fishery) pollock are both components of the same spawning population and that recruitment to the deep-water component is via the exploited, shallow-water component, three interrelated considerations are germane:

(1) Once recruited to the deep-water component, pollock will no longer be subjected to exploitation by the slope/shelf fishery. Therefore, in any one year abundance of the deep-water component has no direct bearing on the ABC/OY of the exploitable portion of the population. If, however, the commercial fishery develops techniques for harvesting the deep-water component, a separate ABC/OY for that component might be appropriate (subject to consideration 3, below).

(2) If, prior to their recruitment to the deep-water component, individual pollock passed through the exploitable portion of the population, a higher fishing rate on the exploitable component might be considered in order to reduce the number of fish which would otherwise survive, move offshore, and be lost to further exploitation (subject to consideration 3, below).

(3) Although no longer available to the fishery, the deep-water component presumably represents a substantial spawning potential for the population as a whole (especially in light of the exponential increase in fecundity which accompanies increases in length). Maintenance of a deep-water component (by not permitting all of the exploitable component to be taken and by limiting the development of fishing directly on the deep-water component) would seem desirable to assure adequate spawning potential regardless of fluctuations in the abundance of the exploitable component of the population. Such a reproductive "buffer" should allow

utilization of the exploitable component without undue concern about the possibility of an adverse spawner-recruit relationship being caused or aggravated by the shelf/slope fishery.

Until: (1) it has been determined that the deep-water pollock are, in fact, a component of the same population which is exploited (at younger ages) over the continental shelf and slope; (2) it is clear that the deep-water component is made up only of older fish that are no longer available to the slope/shelf fishery; and (3) an empirically-derived model has been developed 1/ in which the relation between slope/shelf exploitation and abundance of the deep-water component can be demonstrated, the only change that will be considered in the Bering Sea pollock ABC/OY because of the discovery of the deep-water component is that of a separate ABC/OY for fishing in deep water.

During 1979, in addition to the 1,000,000 mt ABC/OY for pollock in the traditional fishing areas (i.e., statistical areas I, II, and III), a separate ABC/OY of 100,000 mt is designated for statistical Area IV (see Figure I.2a). This special ABC/OY should be more than sufficient to support exploratory or experimental fishing operations in this new fishing area, will provide a substantial but controlled opportunity to expand the pollock fishery to an apparently unused segment of the population, and, if utilized, will produce further information about the deep-water component that can be used for future population evaluations and management decisions. 2/

1/ The construction of such a model was begun by the NMFS Northwest and Alaska Fisheries Center, Seattle.

2/ Records of the Japanese research survey which identified the deep-water component of the pollock population showed highest concentrations within 50-150 miles of the Aleutian chain in water depths greater than 1,000 m. Most of that described region lies within statistical Area IV.

I.2 Yellowfin sole

I.2.1 Maximum Sustainable Yield

The history of exploitation of yellowfin sole in the eastern Bering Sea (Table I.5) can be summarized as follows:

<u>Period</u>	<u>Number of Years</u>	<u>Total Catch</u>	<u>Average Annual Catch</u>
1954-58	5	120,247	24,049
1959-62	4	1,615,869	403,967
1963-68	6	599,567	99,928
1969-71	3	460,612	153,537
1972-75	5	300,453	60,091

Prior to 1963 virgin (or near virgin) biomass was estimated to be about 1.3 to 3 million mt (Wakabayashi 1976). The results of cohort analyses (Table I.6) indicate that exploitable biomass reached a historic low in 1969 but then rose to 910,000 mt by 1975.

Applying the Alverson-Pereyra yield equation ($MSY = 0.5 MBo$, where Bo = virgin biomass and M = natural mortality) to the pre-1963 biomass estimate results in the following approximation: $MSY = 0.5 \times 0.26 \times 1,300,000$ to $2,000,000 = 169,000$ - $260,000$ mt.

I.2.2 Equilibrium Yield

The above determination of MSY was based on the assumption that a single stock of yellowfin sole occupies the eastern Bering Sea. There may, however, be separate northern and southern stocks. If so, the larger of the two is the southern stock that winters south and east of the Pribilof Islands. U.S. research vessel surveys in May 1976, a season when intermixing of fish from the area areas is minimal, indicate that about 93% of the fish were located in the southern stock area.

Catch, effort and CPUE values since the beginning of the Japanese winter flounder fishery are given in Table I.7. If two stocks exist, these data are indicative of only the southern (larger) one. There are two CPUE trends shown: that of pair trawlers and of stern trawlers.

Table I.5.—Annual catch (metric tons) of yellowfin sole in the eastern Bering Sea (east of 180° and north of 54°N). (INPFC proceedings, 1977).

Year	Japan	U.S.S.R.	Total
1954	12,562	0	12,562
1955	14,690	0	14,690
1956	24,697	0	24,697
1957	24,145	0	24,145
1958	39,133	5,000	44,133
1959	123,121	62,200	185,321
1960	350,103	36,000	386,103
1961	399,542	154,200	553,742
1962	281,103	139,600	420,703
1963	27,504	65,306	92,810
1964	48,380	62,297	110,677
1965	26,039	27,771	53,810
1966	45,423	56,930	102,353
1967	60,429	101,799	162,228
1968	40,834	41,355	82,189
1969	61,444	65,665	127,109
1970	59,351	73,226	132,577
1971	62,179	73,320	135,499
1972	34,046	12,010	46,056
1973	75,724	2,512	78,236
1974	37,947	4,210	42,157
1975	59,715 ^b	6,060 ^a	65,775 ^a
1976	61,082 ^b	5,133 ^c	66,215 ^a

^a Preliminary data.

^b Fishing year data from mothership, North Pacific longline-gillnet, and North Pacific trawl fisheries. Calendar year data for landbased dragnet fishery.

^c Includes catches of all small flounders.

Table I.6. --Biomass of age 6 and older yellowfin sole and numbers of age 6 fish (as an index of recruitment) in the eastern Bering Sea as estimated by cohort analysis. (INPFC proceeding, 1977).

Year	Biomass ($\times 10^3$ mt)			Estimate for data combined over stock areas	Number age 6 fish ($\times 10^6$)	Year class of age 6 fish
	Southern stock area	Northern stock area	Total of estimates by stock area			
1963					2,941	1957
1964	840.3	132.0	972.3	912.5	2,276	1958
1965	868.0	144.2	1,012.2	960.7	1,765	1959
1966	867.8	145.0	1,012.8	969.0	1,507	1960
1967	774.9	140.2	915.1	879.0	921	1961
1968	567.5	102.9	670.4	635.4	1,266	1962
1969	508.3	103.9	612.1	604.0	1,026	1963
1970	593.2	105.0	728.2	720.8	928	1964
1971	551.6	102.8	654.4	648.2	980	1965
1972	522.9	83.9	606.8	600.2	1,420	1966
1973	730.0	112.7	851.7	849.1	2,407	1967
1974	654.6	108.4	763.0	751.4	2,345	1968
1975	779.2	131.8	911.7	910.2	2,169	1969

Table I.7.—Catch, effort, and CPUE for yellowfin sole by the Japanese trawl fisheries in the southern stock area for 1/2° by 1° statistical blocks and months in which yellowfin sole made up 50% or more of total catch of groundfish.

Gear type	Fishing year	Catch (mt)	Hours	Average HP	Thousands of HP hours	CPUE (mt per thousand HP-hours)
Pair trawl	1969-70	14,250	1,925	1,200	2,310	6.17
	1970-71	26,766	1,762	1,200	2,114	12.66
	1971-72	25,873	2,937	1,400	4,112	6.29
	1972-73	32,354	2,788	1,400	3,903	8.29
	1973-74	27,234	1,853	1,400	2,594	10.50
	1974-75	32,456	833	1,400	1,166	27.84
	1975-76	41,206	1,002	1,400	1,403	29.37
Stern trawl	1969-70	6,559	1,997	1,650	3,295	1.99
	1970-71	2,266	558	1,400	781	2.90
	1971-72	8,479	2,176	1,325	2,883	2.94
	1972-73	11,319	5,030	1,400	7,042	1.61
	1973-74	3,765	2,814	1,400	3,940	0.96
	1974-75	3,078	3,515	1,250	4,394	0.70
	1975-76	12,331	2,109	1,250	2,636	4.68

Table I.8.—Catch rates from comparative area sampled by the United States National Marine Fisheries Service since 1973 in the eastern Bering Sea. Catch rates (metric tons per km trawled) have been standardized to that of the research vessel Oregon.

Species	1973	1974	1975	1976
Pollock	46.54	34.22	21.54	56.36
Yellowfin sole	54.05	86.65	80.49	80.35
Pacific cod	4.60	4.20	8.68	4.47
Rock sole	9.99	12.94	14.74	22.72
Flathead sole	4.94	9.94	7.02	9.75
Alaska plaice	3.88	3.38	9.67	12.81
Greenland turbot	1.17	2.17	1.47	1.94
Arrowtooth flounder	1.09	1.12	1.42	2.96
Pacific halibut	0.27	0.51	1.11	0.88

There are differences in trends in the two gear types, but since stern trawlers are usually employed as scout vessels to locate concentrations of yellowfin sole, their CPUE may not reflect relative abundance as well as do CPUE trends of pair trawlers. Pair trawl CPUE cannot be directly compared for the period before and after the 1974-75 season because of changes in fishing strategy (from 24 hours operation prior to the 1974-75 winter season to daylight hour fishing after that) and gear improvements (anchored reflectors have recently been used by the vessels to stay on fish concentrations). Therefore the large increase between 1973-74 and 1974-75 is partially an artifact of increased fishing power. Standardized CPUE data from NMFS trawl surveys in a comparative area fished each year since 1973 also indicate a substantial increase in yellowfin sole abundance between 1973 and 1974 (Table I.8). Two of the NMFS surveys (one in late summer 1975 and the other in spring 1976) covered an expanded survey area which is believed to encompass the major part of the distribution of yellowfin sole. Using the area-swept technique of Alverson and Pereyra (1969), standing stock estimates for age groups available to the commercial fishery (age 6 and older) were as follows:

<u>Year</u>	<u>Month(s)</u>	<u>Biomass estimate (mt)</u>	<u>95% Confidence Interval</u>
1975	August-October	991,917	831,226 - 1,152,608
1976	June	1,099,731	610,131 - 1,589,331

Based on the 1975 research survey, equilibrium yield was calculated by Bakkala and Hirschhorn (1976) to be 126,000 mt with a confidence interval of 106,000 to 147,000 mt. Wakabayashi (1976) estimated that equilibrium yield in the same period was 117,000 mt. On the basis of data through 1975 Wakabayashi, Bakkala, and Low (1977) inferred that a conservative approximation of equilibrium yield would be the low end of the above range--106,000 mt.

A cohort analysis was conducted to determine population age structure and abundance. The procedure used was developed by Pope (1972) and specific details of the calculations are given by Wakabayashi et al. (1977).

Results of the cohort analysis (Table I.6) indicate that the biomass of age 6 and older fish increased from 1971 to 1975. Although details of the analysis demonstrated variations in year class strength (Figure I.3 and I.4), it is evident that the many year classes included in the population buffered much of the variation in recruitment. Projected estimates of biomass from cohort analysis also suggest that the improvement of yellowfin sole resource, which started in 1973 or earlier, continued at least through 1976 and into 1977. Preliminary information from both the 1977 NMFS trawl survey and from observers sampling the 1977-78 Japanese fishery indicates that abundance is remaining high. Moreover, because of operational factors (not reduced availability), the total allowable catch was not taken in 1977 and may not be achieved in 1978.

Considering the conservative nature of the estimate of EY based on data through 1975 and the positive trends indicates since then, EY is believed to have increased by perhaps 10 percent, to 117,000 mt.

1.2.3 Acceptable Biological Catch

This resource has rebounded surprisingly well from a state of depletion in mid-1960's. Current abundance is high (55-85% of the estimated virgin biomass) and all fishery and biological indicators are positive. Furthermore, the average catch in 1977-78 was well below the conservative estimate of EY which, considering the low natural mortality of the species, should provide additional enhancement to the population in 1979. Accordingly, ABC is considered equivalent to current EY--117,000 mt.

1.3 Turbots (arrowtooth flounder and Greenland turbot)

Under the Preliminary Fishery Management Plans for 1977 and 1978, the management of all flatfishes, other than Pacific halibut and yellowfin sole, was grouped under an "other flounders" category consisting of arrowtooth flounder, Greenland turbot, flathead sole, rock sole, Alaska plaice, and a few other minor species. However, the species within this category may be separated into two main complexes by virtue of their biology and bathymetric distribution.

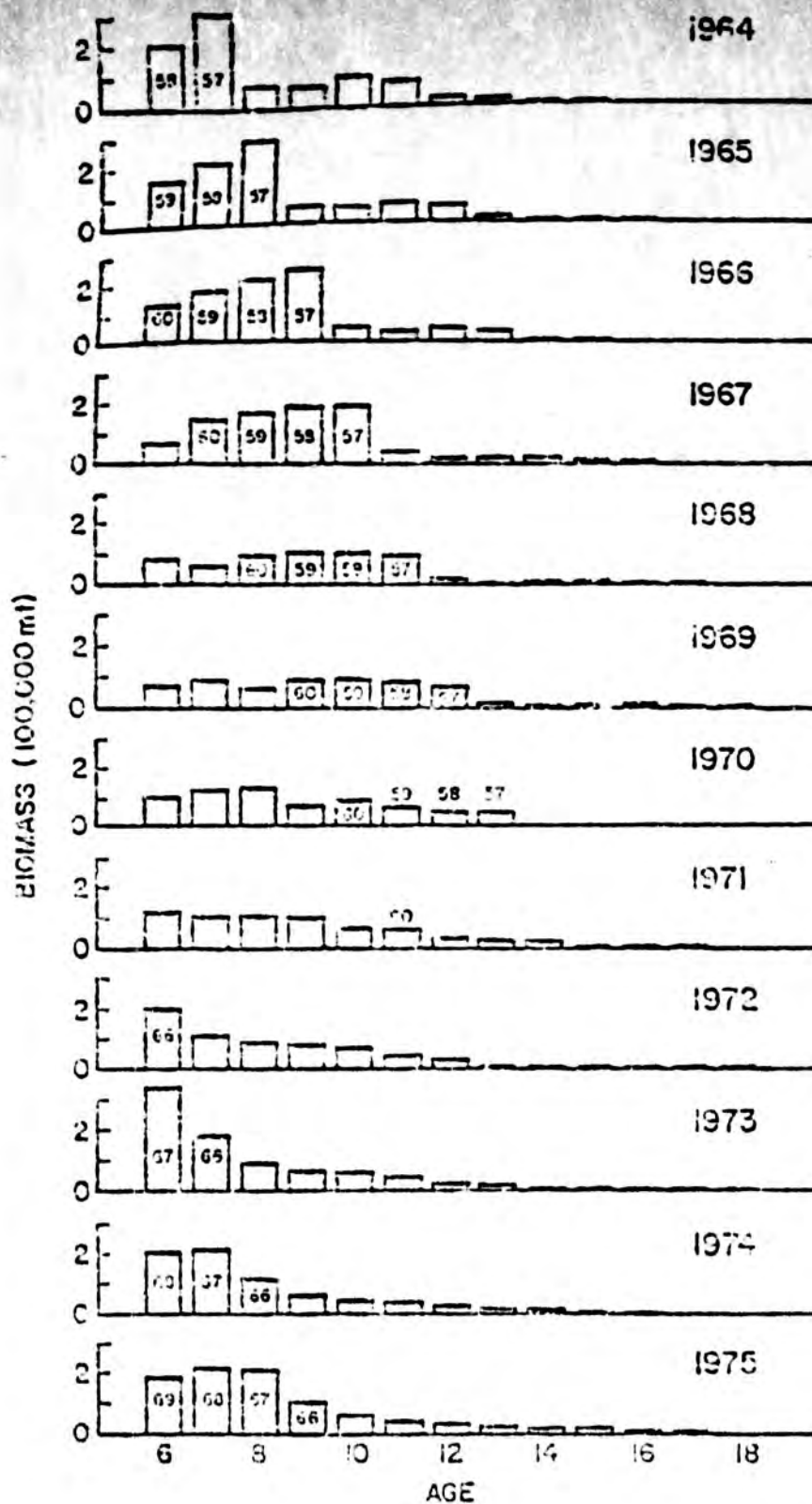


Figure I.3.---Estimated biomass of yellowfin sole from cohort analysis for age groups available to the fishery.

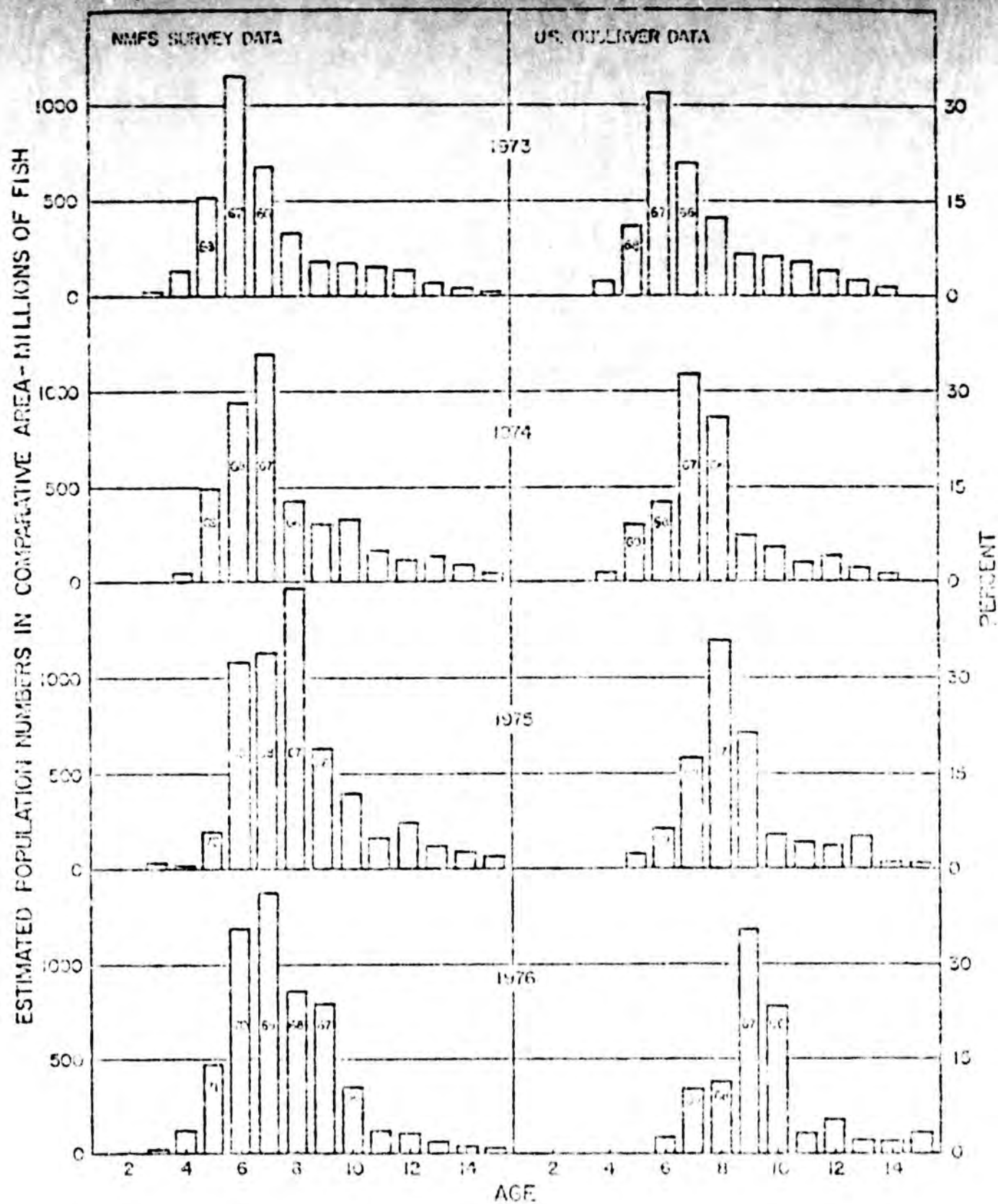


Figure 1.4.--Age composition of yellowfin sole as shown by data from U.S. research vessel surveys in June-August and by U.S. observer samples from the Japanese flounder fishery in October-November. Year classes for certain age groups are shown in appropriate bars.

The turbot (arrowtooth flounder and Greenland turbot) are large flatfishes which are distributed along the continental slope in deep water; the "other flatfishes" are small in size and are generally found well up on the continental shelf in shallow water. Furthermore, the fisheries for these two flounder complexes are quite distinct.

I.3.1 Maximum Sustainable Yield

After a long period of relatively small catches, turbot production increased substantially in the early 1970's and continues at a high level (Table I.9). Of the two species in this complex Greenland turbot has accounted for 80 percent of the catch.

Since turbot are secondary or only occasional target species taken in the fisheries for pollock, sablefish, and yellowfin sole, it is difficult to estimate the MSY of this complex with standard production models which rely on commercial catch-effort statistics.

Although catches averaging 105,000 mt have been sustained during the period 1972-76, catch rates of Greenland turbot in one foreign fleet have decreased substantially during the same period (see section I.3.2, following). Accordingly, MSY for the turbot complex is believed to be in the order of 100,000 mt.

I.3.2 Equilibrium Yield

Commercial catch-effort statistics are of little use for stock assessment of turbot because they are not primary target species. In the case of such secondary species, it is extremely difficult to determine data points that are indicative of stock abundance. Catch rates for these species tend to vary more in response to fishing strategy for primary target species than to turbot abundance. The problem is compounded because data from individual vessels that do target on turbot are often merged and summarized with data of all other vessels.

Given the difficulty in using commercial CPUE data for non-target species and the lack of research survey coverage of the depth strata where adult turbot reside, the only quantitative information bearing on current stock condition is that for juveniles which occur in shallow water and were sampled by research vessels. In one area sampled since

Table I.9.--Annual catch of Greenland turbot and arrowtooth flounders in the eastern Bering Sea in metric tons (INPFC proceedings, 1977).

Year	Japan		U.S.S.R.	PRK	Total all nations	
	MS-IG-NPT ^a	LBD ^c Total				
<u>Turbots (Greenland turbot and arrowtooth flounder)</u>						
1960	36,343	0	36,343	-	0	36,343
1961	57,348	2	57,350	-	0	57,350
1962	58,226	84	58,310	-	0	58,310
1963	31,565	59	31,624	-	0	31,624
1964	34,493	40	34,533	-	0	34,533
1965	7,970	307	8,277	1,800	0	10,007
1966	10,938	97	11,035	2,800	0	13,835
1967	20,741	1,733	22,474	2,639	0	25,113
1968	17,608	4,749	22,357	13,292	-	35,649
1969	13,532	3,674	17,206	14,708	-	31,914
1970	14,609	15,003	29,612	3,220	-	32,832
1971	30,890	20,331	51,221	17,460	-	68,681
1972	27,013	59,823	86,836	24,285	-	111,121
1973	33,465	39,568	73,033	16,576	-	89,609
1974	42,096	43,170	85,266	29,509	-	114,775
1975	38,386	37,364	75,750	31,928	-	107,678
1976	43,162 ^d	35,620 ^e	78,782 ^e	25,111	-	103,893 ^e

Greenland turbot

1970	3,188	15,606	18,794	4,976	-	23,770
1971	24,409	12,561	36,970	10,271	-	47,241
1972	25,583	54,803	80,386	14,853	-	95,239
1973	10,719	31,024	41,743	12,265	-	54,008
1974	12,134	37,519	49,653	10,362	-	60,015
1975	17,941	34,890	52,831	12,124	-	64,955
1976	42,335 ^d	27,904 ^e	70,239 ^e	8,979	-	79,218 ^e

Arrowtooth flounder

1970	9,321	307	9,628	3,244	-	12,872
1971	6,281	8,140	14,421	7,139	-	21,560
1972	1,427	4,925	6,352	9,467	-	15,819
1973	2,707	7,643	10,350	4,311	-	14,661
1974	2,762	5,321	8,083	15,650	-	23,733
1975	415	2,471	2,886	12,734	-	15,620
1976	1774	1,868 ^e	3,642 ^e	16,127	-	19,769 ^e

^aCatches are from data in file with the Japanese and U.S. National Fisheries.

^bOwnership, North Pacific Longline-Filinet and North Pacific trawl fisheries.

^cPlant-based trawl fishery.

^dCatch for fishing in the Bering Sea from 1970 to 1976.

^eEstimates.

^fFrom data in fishing log for the year 1976.

1973, catch rates for young arrowtooth flounder increased from 1.1 kg per km trawled to 3 kg per km trawling in 1976 (Table I.8); the preliminary value for 1977 was almost identical to that for 1976. Therefore, the current catch level of about 21,000 metric tons (Table I.9) does not appear to be detrimental to recruitment.

Catch rates of juvenile Greenland turbot have been relatively stable since 1974 also indicating that fishery removals have not impacted Greenland turbot recruitment in recent years.

As mentioned above, it is difficult to evaluate the condition of individual species using catch rates of mixed species fisheries. Nonetheless, it may be significant that during the period 1972-76 when the total annual Greenland turbot catch decreased about 16 percent (from 95,300 to 79,800 mt), the catch rate of that species in the Japanese landbased dragnet fishery decreased from 32 percent (from 40 to 27 mt/100 hours). This fleet accounted for 44 percent of the total Greenland turbot catch.

In summary, recognizing the lack of adequate stock assessment information, but considering the downward trend in catch and CPUE for Greenland turbot, the equilibrium yield for this complex is believed to be about 5-10 percent below MSY, or 90,000-95,000 mt.

I.3.3 Acceptable Biological Catch

The inadequate data base available for evaluating stock condition and the downward trend in CPUE for one of the species in one fleet are cause for slight concern. Accordingly, ABC for the turbot complex is considered equivalent to the low end of the EY range--90,000 mt.

I.4 Other Flatfishes

This species complex is made up of the following smaller shallow water species; flathead sole, rock sole, Alaska plaice, and trace amounts of rex sole, Dover sole, starry flounder, longhead dab, butter sole, and lefteye flounders.

I.4.1 The catch history for this species complex shows a general increase of catches up to a peak of 95,000 mt in 1971 followed by a drastic decline through 1975 (Table I.10). It is difficult to discern whether that decline was due to declining abundance or to changing

Table I.10.--All nation catches of other flatfishes in the Bering Sea in metric tons.

Year	East of 180° (INPFC area 1 + 2)				West of 180° (INPFC area 3 + 4)				Aleutians (INPFC area 5)				Total - all areas			
	Rock sole	Flathead sole	Alaska Plaice	Total	Rock sole	Flathead sole	Alaska Plaice	Total	Rock sole	Flathead sole	Alaska Plaice	Total	Rock sole	Flathead sole	Alaska Plaice	Total
1963	5,002	29,625	975	35,602	1,640	74	4	1,718	27	14	-	41	6,669	29,713	979	37,361
1964	3,238	25,288	1,838	30,364	1,306	1,287	10	2,603	152	43	45	240	4,696	26,618	1,893	33,207
1965	3,673	6,713	979	11,370	36	26	-	62	147	128	41	316	3,861	6,867	1,020	11,748
1966	9,104	11,020	4,633	24,757	-	63	-	63	82	25	-	107	9,186	11,108	4,633	24,927
1967	4,762	23,437	3,853	32,052	154	594	-	748	25	32	-	57	4,941	24,063	3,853	32,857
1968	5,250	21,375	2,619	29,444	261	586	-	847	17	186	-	203	5,528	22,347	2,619	30,494
1969	9,240	18,563	6,942	34,745	774	435	-	1,209	2	2	-	4	10,016	19,000	6,942	35,958
1970	20,112	41,152	3,402	64,677	900	932	79	1,911	2	11	-	13	21,025	42,095	3,481	66,601
1971	40,419	51,024	992	92,435	1,962	540	31	2,533	1	16	-	17	42,382	51,580	1,023	94,985
1972	60,824	15,690	290	76,804	1,714	511	40	2,265	5	4	-	9	62,543	16,205	330	79,078
1973	23,835	18,141	1,917	43,893	1,862	472	59	2,393	2	24	-	26	25,699	18,637	1,976	46,312
1974	19,975	14,917	2,346	37,238	655	214	-	869	36	41	-	77	20,666	15,192	2,388	38,246
1975	11,145	5,345	2,614	19,104	507	112	1	620	3	1	-	4	11,655	5,658	2,615	19,928

Source: Wakabayashi, K. and R. Bakkala. 1977. Estimated Catches of Flounders by species in the Bering Sea. U.S. Natl. Mar. Fish. Serv., Northwest Fish. Center. Document submitted to Intl. North Pac. Fish. Comm. 27 p. (Document 1964).

patterns of fishing activities. Commercial catch rates are not necessarily indicative of stock abundance and together with a lack of biological information on these species, MSY is difficult to determine. Because declines in catches in 1973 and 1975 are believed to be due, at least in part, to operational changes in the Soviet fishery and to winter area closures in the southeastern Bering Sea, the recent average catch level may have little bearing on MSY.

By assuming that the complex had been fully utilized prior to 1975, the average catch (1963-74) of 44,300 mt should approximate MSY. Furthermore, if the complex had been fully utilized prior to 1975, the Schaefer model indicates that by 1975 biomass would be about half of its virgin level. A NMFS trawl survey in 1975 (swept area technique) indicated a standing stock of 232,000-334,100 mt of flathead and rock sole (Table I.11) implying a virgin biomass of 462,000-668,200 mt. Inasmuch as plaice and dab are virtually unutilized by the fisheries, they are excluded from the following computations. If $m = 0.23$ for this complex (Section 9.1; flathead sole 0.2, roc, sole 0.26), the Alverson-Pereyra yield equation produces an estimate of MSY of 53,200-76,800 mt ($0.5 \times 0.23 \times 462,400 - 668,200$).

Therefore, estimates of MSY range from a low of 44,300 mt (as described on page I-27) to 76,800 mt (the high end of the above range).

I.4.2 Equilibrium Yield

There is no evidence to suggest that the MSY for this species complex is unattainable.

I.4.3 Acceptable Biological Catch

This species complex appears healthy and a significant portion of it (plaice and longhead dab) are yet to come under exploitation. Therefore, ABC is considered equivalent to the mid-point of the MSY range--61,000 mt.

I.5 Pacific Cod

I.5.1 Maximum Sustainable Yield

Pacific cod are distributed widely over the Bering Sea continental shelf and slope and have a distributional pattern similar to that of

Table I.11.--Estimated biomass of the "other flatfish" complex in the eastern Bering Sea by the U.S. National Marine Fisheries Service in 1975.

Species	Mean CPUE ^{1/}	Estimated biomass ^{2/}	Percent frequency of occurrence
Rock sole	5.73	138,300 - 202,000	66
Alaska plaice	4.11	101,800 - 152,800	41
Flathead sole	3.89	93,900 - 132,100	69
Longhead dab	0.37	8,000 - 14,200	19

^{1/} Mean catch per unit effort, kg/kg trawled

^{2/} 95% confidence limits in metric tons

Source: Pereyra et. al. (1976). Table IX-26.

pollock. During the early 1960's, when a fairly large Japanese longline fishery operated on the continental slope, cod were harvested by longliners for the frozen fish market. Beginning in 1964, the Japanese North Pacific trawl fishery for pollock expanded and cod became an important incidental catch in the pollock fishery. At present, cod are believed to be an occasional target species when high concentrations are detected during pollock fishing operations.

The annual catch of Pacific cod by Japan increased from 19,100 mt in 1974 to about 74,600 mt in 1970; since then, catches have varied between 40,000 and 50,400 mt (Table I.12). Catches by the USSR have only been reported since 1971 and have increased from 4,000 mt in 1971 to 18,500 mt in 1975. Since 1973, the total cod catch has varied between 55,000-67,000 mt.

Few biological data concerning cod are available, and their incidental occurrence in the trawl catch makes questionable the use of CPUE trends for evaluating stock condition. Considering that the cod catch grew very quickly in the mid-1960's and then became rather stable thereafter, the average catch since 1968 should reflect at least a minimal estimate of MSY. That average is 58,700 mt.

I.5.2 Equilibrium Yield

The MSY of 58,700 mt is believed to be achievable.

I.5.3 Acceptable Biological Catch

The above estimate of MSY is considered to be minimal. Therefore, ABC is considered equivalent to MSY--58,700 mt.

I.6 Pacific Ocean Perch and Other Rockfishes

I.6.1 Maximum Sustainable Yield

Pacific ocean perch is the most abundant rockfish species in the North Pacific. Chikuni (1975) identified two main stocks in the Bering Sea: an Eastern Slope stock along the southern part of the eastern Bering Sea continental slope and an Aleutian stock along both sides of the Aleutian Islands.

Of these two, commercial catch records (Table I.13) indicate that the Aleutian stock is much larger than that of the Eastern Slope.

Table I.12.--Pacific cod catches by nation in the Bering Sea^{a/} 1964-76 (Source: INPFC proceedings 1977).

Year	Japan		Total	U.S.S.R.	ROK	Total all nations
	MS-LG-NPT ^b	LBDC ^c				
1964	19,078	- ^f	19,078	- ^f	0	19,078
1965	15,710	1,638	17,348	-	0	17,348
1966	17,347	1,693	19,040	-	0	19,040
1967	30,728	2,780	33,508	-	0	33,508
1968	52,309	11,426	63,735	-	- ^f	63,735
1969	45,078	8,221	53,299	-	-	53,299
1970	61,335	13,278	74,613	-	-	74,613
1971	33,076	13,281	46,357	4,139	-	50,496
1972	34,776	5,158	39,934	7,028	-	46,962
1973	39,489	6,099	45,588	12,980	-	58,568
1974	44,364	6,058	50,422	16,592	-	67,014
1975	33,089 ^d	3,448	36,537	18,486	49	55,072 ^e
1976	34,976 ^d	4,754	39,730	18,912	306	58,948 ^e

^a Catches are from data on file with the Japanese and U.S. National Sections.

^b Mothership, North Pacific longline-gillnet, & North Pacific trawl fisheries.

^c Landbased dragnet fishery.

^d Catch for fishing year, November of previous year to October.

^e Preliminary.

^f Dash denotes fishing but no reported catch.

Table 1.13.--Annual catch of Pacific ocean perch in the Bering Sea in metric tons.

Year	Japan ^{a/}			U.S.S.R. ^{b/}			Total		
	Eastern Slope	Alutian	Total	Eastern Slope	Alutian	Total	Eastern Slope	Alutian	Total
1960	1.1	----	1.1	5.0	----	5.0	6.1	----	6.1
1961	13.0	----	13.0	34.0	----	34.0	47.0	----	47.0
1962	12.9	0.2	13.1	7.0	----	7.0	19.9	0.2	20.1
1963	17.5	0.8	18.3	7.0	20.0	27.0	24.5	20.8	45.3
1964	14.4	29.3	43.7	11.5	61.0	72.5	25.9	90.3	116.2
1965	7.8	38.1	45.9	9.0	71.0	80.0	16.8	109.1	125.9
1966	17.5	28.2	45.7	2.7	57.7	60.4	20.2	85.9	106.1
1967	16.6	9.3	25.9	----	46.6	46.6	19.6	55.9	75.5
1968	20.4	10.3	30.7	3.1	25.6	29.7	31.5	44.9	76.4
1969	14.5	15.6	30.1	0.0	23.2	23.2	14.5	38.8	53.3
1970	9.9	13.6	23.5	0.0	53.3	53.3	9.9	66.9	76.8
1971	7.8	14.6	22.4	0.0	7.2	7.2	9.8	21.8	31.6
1972	5.5	8.6	14.1	0.2	24.6	24.8	5.7	33.2	38.9
1973	2.7	9.3	12.0	1.0	2.5	3.5	3.7	11.8	15.5
1974	6.6	21.7	28.3	7.4	0.8	8.2	14.0	22.4	36.5
1975	3.2	8.5	11.7	5.4	8.1	13.5	8.6	16.6	25.2
1976	2.8	10.3	13.1						

a/ Figures are compiled from both statistics for the mothership-longline Bering Pacific trawl fishery and the landbased dragnet fishery.

b/ Including some amounts of rockfishes, Sebastes, spp. other than Pacific ocean perch, except for 1975.

Catches peaked at about 47,000 mt in the Eastern Slope Region in 1961, whereas they peaked at 109,000 mt in the Aleutian Region in 1965. Since then, catches have declined drastically in both regions. This decline is attributed mainly to lower stock abundance caused by the removal of larger, older fish.

Under ideal resource conditions, MSY for the Eastern Slope stock was estimated to be as high as 32,000 mt while that for the Aleutian stock may be as high as 75,000 mt (Chikuni 1975). Whether or not the ecosystem could again support a population large enough to sustain catches of that magnitude is unknown.

No information is available bearing on the MSY of the other rockfish species.

I.6.2 Equilibrium Yield

Since 1960, the Eastern Slope region has produced perch catches in excess of 30,000 mt only twice (1961 and 1968). Following each such instance, catches fell substantially (Table I.13); after the large 1968 catch, catch and catch rate both dropped to very low levels. An inspection of catch (Table I.13) and catch rate (I.14) indicates that perch stocks of the Eastern Slope Region must not have been able to support a fishery of 10,000-15,000 mt annually without detrimental effects to the already low level of stock abundance.

In the Aleutian Region, there were more obvious signs of overexploitation in the early stages of the fishery when amounts in excess of 90,000 mt were taken consecutively from 1964 through 1966. Since then, except for a high catch in 1970, production has dropped and during the period 1971-75 averaged only 21,200 mt. It is evident that the sustained annual catch of 75,000 mt estimated by Chikuni cannot now be realized.

It was the consensus of Japanese, U.S., and Canadian scientists at the 1975 INPFC meeting, that Pacific ocean perch stocks are at a relatively low level of abundance and generally not in good condition. The opinion is derived from various state of stock indicators including (i) a continuous decline in CPUE after 1968; (ii) drastic reductions in the availability of all sizes of ocean perch through the period 1969-72; (iii) a heavy

Table I.14.—Pacific ocean perch catch and effort data of stern trawlers in the Japanese mothership-longline North Pacific trawl fishery by vessel class in the eastern Bering Sea Slope Region, 1968-1976.

Year	Vessel class ^{a/}						
	3	4	5	6	7	8	9
(A) Catch in metric tons.							
1968	895	3,347	695	1,938	378	10,012	1,776
1969	361	3,709	102	258	94	4,037	2,103
1970	77	215	73	55	301	3,168	1,495
1971	96	1,558	35	303	992	1,855	459
1972	0	1,005	317	7	410	313	1,276
1973	-	351	0	199	187	146	242
1974	-	416	90	520	700	609	442
1975	-	552	204	343	784	171	246
1976	-	257	188	148	704	70	434
(B) Fishing effort in hundred hours trawled.							
1968	104	298	26	18	1	47	46
1969	95	264	17	15	12	95	125
1970	103	293	18	12	34	122	139
1971	125	411	21	19	15	146	266
1972	120	348	29	13	49	140	192
1973	-	163	13	16	35	118	197
1974	-	147	27	39	37	171	310
1975	-	303	55	41	38	158	263
1976	-	286	34	4	11	135	227
(C) Percentage composition in total ocean perch catch by vessel class category.							
1968	4	19	3	10	2	49	3
1969	3	31	1	8	1	34	13
1970	1	4	1	1	6	58	27
1971	2	30	1	1	19	35	9
1972	0	29	9	+	12	9	37
1973	-	21	0	12	33	9	14
1974	-	12	3	15	21	18	13
1975	-	22	8	14	32	7	10
1976	-	13	10	8	36	4	22
(D) CPUE in mt per hour trawled.							
1968	.08	.13	.26	1.10	2.55	1.50	.39
1969	.03	.14	.06	.18	.08	.42	.17
1970	.01	.01	.04	.23	.09	.26	.11
1971	.01	.04	.02	.11	.28	.13	.02
1972	-	.03	.10	.01	.07	.02	.05
1973	-	.02	-	.12	.14	.01	.01
1974	-	.03	.03	.13	.10	.04	.01
1975	-	.02	.04	.08	.21	.01	.01
1976	-	.01	.05	.14	.62	.01	.02

a/ No data for classes 1 and 2. 1973 and 1974 data converted to pre-1973 area tonnage classification of

1 = 71-100.	4 = 301-500	7 = 1801-2500
2 = 101-200	5 = 501-100	8 = 2501-3500
3 = 201-300	6 = 1001-1500	9 = 3501 and above

dependence in the fishery after 1968 on young-small fish; and (iv) the lack of any evidence of strong year, incoming classes.

In the Eastern Slope Region, catch, fishing effort, and CPUE data indicate that stock abundance has declined severely from the 1960's and has fluctuated at a low level in the 1970's (Table I.14). Although most effort in the Eastern Slope Region is not directed specifically at Pacific ocean perch, and CPUE may not be the best index of abundance, continuing low ocean perch harvests despite high effort levels do suggest relatively low abundance. Also, catch rates have declined to very low levels since the early 1970's at depths beyond 125 m where most of the Pacific ocean perch grounds are found (Figure I.5). The spawning stocks of Pacific ocean perch in the Eastern Slope Region is also considered to be substantially reduced from earlier levels. It is believed that the early extensive ocean perch harvests by Japan and the USSR had removed most of the larger and older fish from the stock, dramatically affecting its reproductive potential. Chikuni (1975) reported that the fecundity of ocean perch in this region (number of eggs) was as follows: 10,000 at age 7, 29,000 at age 10, 75,000 at age 15, 122,000 at age 20, and 162,000 at age 25. Extensive harvests of older, more fecund fish must have severely reduced larval production in later years, but reduced recruitment as yet has not been directly related to a decline in larval production.

In the Aleutian Region, the stock has also declined in abundance. CPUE data from both the Japanese independent stern trawl fishery (Table I.15) and the land-based dragnet fishery (Table I.16) show that abundance has been fluctuating at a very low level relative to earlier years since 1971. For example, class 4 and 7 stern trawlers (301-500 gross tons and 1500-2500 gross tons, respectively), which accounted for the majority of annual ocean perch catches by stern trawlers, suffered severe declines in CPUE from 1968 to 1974 (Table I.15). In both cases, catch rates in 1976 were less than 30% of levels attained in 1968, and, on the basis of catch trends, it is believed that stock abundance in 1968 was already reduced considerably from earlier years.

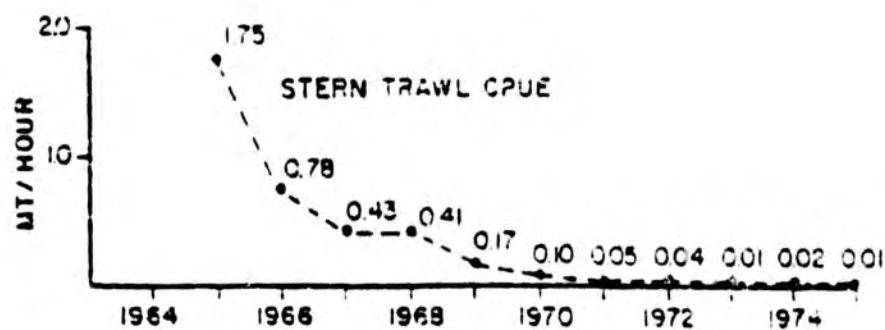
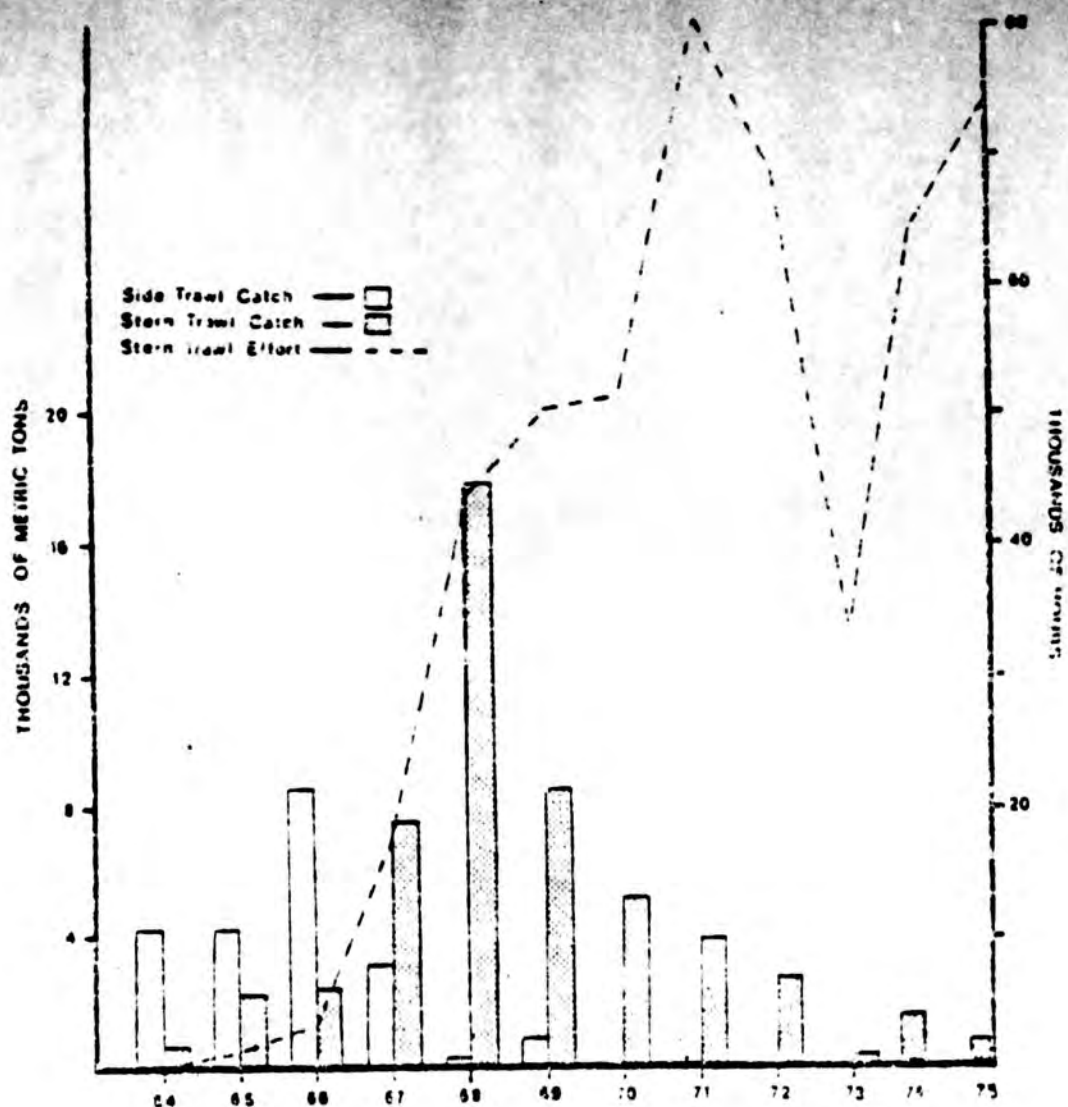


Figure I.5.—Annual catches of Pacific ocean perch by side and stern trawlers, and stern trawl effort by the Japanese mother-ship, longline, and North Pacific trawl fisheries, in areas of the Eastern Slope Region where depths exceed 125 meters.

Table I.15.—Pacific ocean perch catch and effort data for stern trawlers of the Japanese mothership-longline North Pacific trawl fishery by vessel in the Aleutian Region, 1968-1976.

Year	Vessel class ^{a/}					
	4	5	6	7	8	9
(A) Catch in metric tons.						
1968	12,157	280	32	2,711	6,787	532
1969	7,290	440	0	4,339	1,125	144
1970	2,384	1,227	0	7,741	249	82
1971	3,322	889	1,038	4,984	2,249	449
1972	3,527	1,318	645	2,035	188	135
1973	4,591	0	995	1,881	0	0
1974	10,196	1,564	1,326	2,507	25	16
1975	3,720	972	764	1,815	666	0
1976	3,976	784	392	1,462	45	0
(B) Fishing effort in number of hours trawling.						
1968	8,575	115	8	116	759	772
1969	1,952	333	0	910	179	38
1970	1,755	600	0	976	161	25
1971	4,543	634	383	720	785	174
1972	6,533	546	492	388	114	56
1973	3,592	0	650	530	36	0
1974	12,249	1,816	964	529	70	22
1975	11,170	1,233	543	521	509	0
1976	8,926	866	629	499	244	0
(C) Percentage composition of total ocean perch catch by vessel class ^{b/}						
1968	54	1	+	12	30	2
1969	51	2	0	34	8	1
1970	20	10	0	56	2	1
1971	26	7	8	38	17	3
1972	45	17	8	26	3	2
1973	61	0	13	25	0	0
1974	63	10	8	16	0	+
1975	46	12	9	22	8	0
1976	59	12	6	22	1	0
(D) Catch (in metric tons) per hour trawled.						
1968	1.4	2.4	4.0	12.6	8.9	0.7
1969	3.7	1.3	-	5.3	6.3	3.2
1970	1.4	2.0	-	7.9	1.5	3.3
1971	0.7	1.4	2.7	6.9	2.9	2.6
1972	0.5	2.4	1.3	5.2	1.6	2.4
1973	1.3	-	1.5	2.8	-	-
1974	0.8	0.9	1.4	3.7	0.4	0.7
1975	0.3	0.8	1.4	3.5	1.3	-
1976	0.4	0.9	0.6	3.3	0.2	-

a/ No data for classes 1, 2, and 3 which are mainly side and pair trawls. 1973 and 1974 data converted to pre-1973 gross tonnage classification of

- | | |
|--------------|--------------------|
| 1 = 71-100 | 6 = 1001-1500 |
| 2 = 101-200 | 7 = 1501-2500 |
| 3 = 201-300 | 8 = 2501-3500 |
| 4 = 301-500 | 9 = 3501 and above |
| 5 = 501-1000 | |

b/ Totals may fall short of 100% because of rounding method.

Table I.16.—Catch and effort data of stern trawlers of the Japanese land-based dragnet fishery in the Aleutian Region, 1969-76.

Year	Catch of all species in mt	Catch of Pacific ocean perch in mt	Percentage of POP in total catch	Total effort in hours	CPUE of POP in mt per hour
1969	5,478	1,246	23	3,850	.32
1970	4,550	1,956	43	5,040	.39
1971	5,977	1,664	28	6,567	.25
1972	17,801	651	4	17,169	.04
1973	16,220	1,873	12	12,792	.15
1974	24,851	5,571	22	22,593	.25
1975	8,067	1,263	16	8,593	.15
1976	8,514	2,663	31	9,597	.27

Notation: POP is Pacific ocean perch; mt is metric tons.

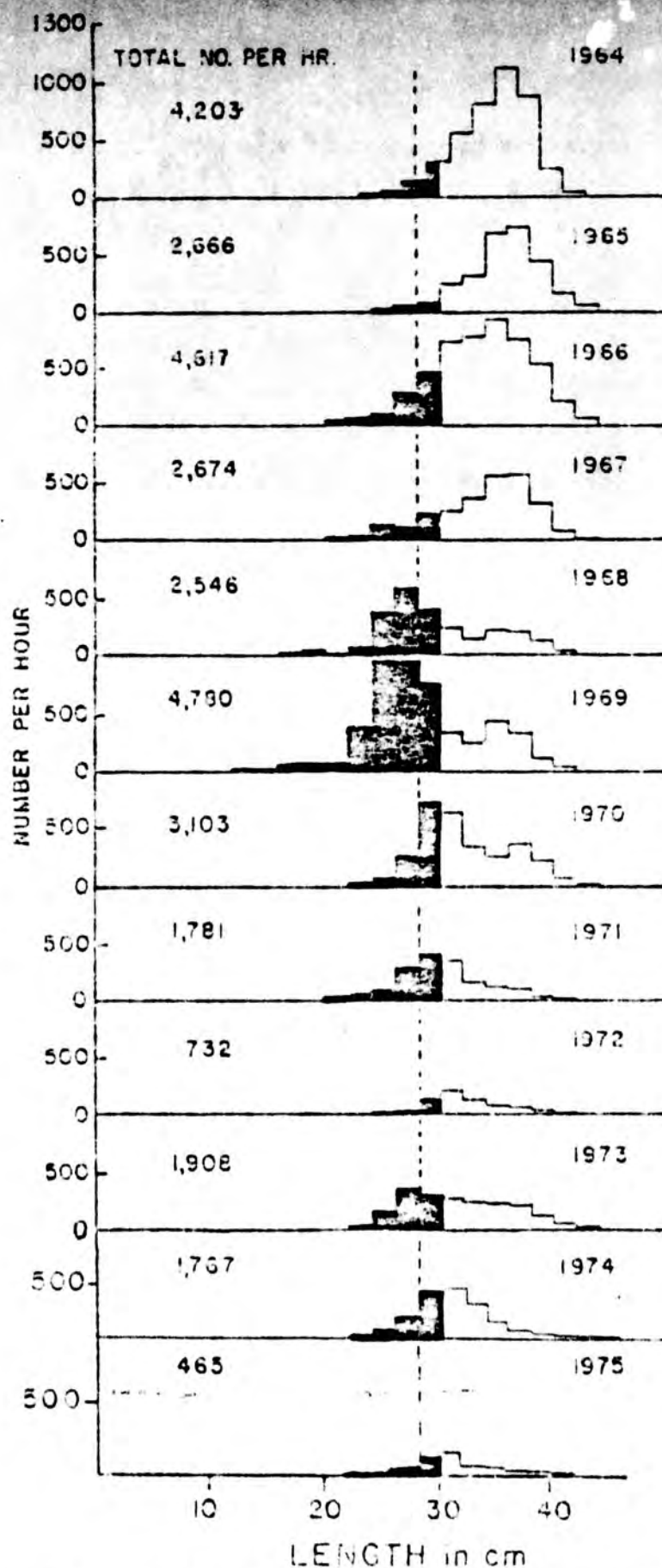


Figure I.6.--Catch per unit effort by size increment for Pacific ocean perch harvested by stern trawlers of the Japanese mothership-longline North Pacific trawl fishery in the Aleutian Region, 1964-75.

Current length-frequency information also indicates a poor condition of ocean perch stocks in the Aleutian Region. In the early years of the fishery (1964-67), the size composition in the Japanese catches was relatively stable and dominated by fish greater than 28 cm (Figure I.6). After that time, there was a large increase in the proportion of fish smaller than 28 cm, due in part to recruitment into the fishery of the strong year-classes of 1961 and 1962 and in part because of a considerable reduction in abundance of the larger perch after 1967. The abundance of these older fish remained low through 1975. Inasmuch as most annual yields since 1967 have consisted of large numbers of fish less than 28 cm and dwindling numbers of older, more fecund fish, the reproductive potential of Aleutian Region ocean perch stocks must also have been reduced. Additionally, recruitment of ocean perch to the fishery occurs at about 6-8 years of age. Thus, year-classes spawning during the peak years of fishing (1964-1966) would have appeared in catches beginning in 1970. As shown by CPUE values for small fish (less than 28 cm) in 1970-75, recruitment was relatively low. Indeed, the 1975 catch rates, measured in terms of number of fish caught per hour trawled, was the lowest on record (Figure I.6).

In summary, it appears clearly evident that Pacific ocean perch stocks from the eastern Bering Sea and the Aleutian regions are at an extremely low level of abundance with no evidence of strong recruitment in recent years. On the basis of fishery information through 1974, it was estimated in the 1977 PMP for the Trawl Fishery of the Bering Sea that equilibrium yield for Pacific ocean perch was 6,500 mt in the eastern Bering Sea and 15,000 mt in the Aleutians. Based on fishery information available since then, no increase in exploitable biomass has occurred.

No information is available which bears on the EY of the other rockfish species.

I. 6.3 Acceptable Biological Catch

The Pacific ocean perch stocks of the Bering Sea/Aleutian Region are badly depleted-current equilibrium yield is believed to be no more

than 20 percent of MSY. Therefore, as was the case in the Gulf of Alaska, the ABC of Pacific ocean perch will be set at half of the current EY in order to balance the need for rebuilding against severe economic dislocation in the foreign trawl fisheries--3,250 mt in the eastern Bering Sea sub-area (Statistical Areas I, II, and III combined) and 7,500 mt in the Aleutian sub-area (Statistical Area IV).

The lack of biological data concerning Other Rockfish requires a more pragmatic consideration of ABC. For this species category, there is virtually no information available bearing on stock abundance or condition. Furthermore, the catch record for this category is incomplete and believed to suffer from past misidentifications or misreportings among the POP and Other Rockfish categories.

The Japanese trawl industry reports that in 1977 the Japanese catch of Other Rockfish in the Bering Sea/Aleutian Region was 11,747 mt and that if the other foreign fisheries in the Region had a similar species composition the total catch of Other Rockfish would have been about 19,000 mt. Species composition data collected by U.S. observers, however, lead to the following estimates of Other Rockfish catches during 1977 (mt):

	<u>Japan</u>	<u>USSR</u>	<u>ROK</u>	<u>Total</u>
Eastern Bering Sea (Stat. areas I, II, III)	47	0	0	47
Aleutian (stat. area IV)	6,084	1,596	0	7,680
Total	6,131	1,596	0	7,727

Until additional, accurate fishery information becomes available, the ABC of Other Rockfishes in the Bering Sea/Aleutian Region will be held at the estimated level of the 1977 catch -- 7,727 mt.

I.7 Sablefish (Blackcod)

I.7.1 Maximum Sustainable Yield

The sablefish resource is found in waters off California, northward to the Gulf of Alaska, westward to the Aleutian Region, and into the Bering Sea. The sablefish found in these wide geographical regions are apparently genetically related in the sense that some migrations have been noted to occur between the regions. However, the degree of interchange between regions is noted to be small in relation to the stock size within each region which led Low et al. (1976) and Wespestad et al. (1977) to suggest that management of the resource be conducted by discrete geographical regions. These geographical regions are the eastern Bering Sea, the Aleutian Region, the Gulf of Alaska, waters off Canada, and waters off Washington to California.

Although the sablefish resource should be managed by regions, the long-term productivity in each region is probably related to the overall condition of the resource. Therefore, it is difficult to get an accurate estimation of the MSY within each region by using fishery information of that region alone. To reduce this problem, both Japanese and U.S. scientists have estimated MSY of the resource as a whole. The latest Japanese estimate of MSY for the entire resource from California to the Bering Sea was 69,000 mt (Anon. 1978). The U.S. estimate of MSY was 42,600 to 46,500 mt (Low et al. 1976), using essentially the same general production model, but with a different weighting of data among regions. The MSY estimate of 69,600 mt appears high in view of the fact that the highest catch in history was 65,500 mt (1972) and that average catches from 1968 to 1975 of 48,200 mt have resulted in continuing and rapid declines in CPUE (Table I.17); accordingly, the high end of the U.S. estimate of overall MSY is considered to be most appropriate -- 46,500 mt.

In order to apportion the overall MSY to individual management regions, the all-nation catch (Table I.17) was averaged over the obvious periods of full fishery development in each: 1961-75 for the Bering Sea/Aleutian Region; 1970-75 for the Northeastern Pacific Ocean (which

Table I.17.--Sablefish landings in metric tons by nation in the Bering Sea and Aleutians and the northeastern Pacific Ocean, 1958-76.

Year	Northeastern Pacific Ocean						Bering Sea & Aleutians			Grand total
	United States	Canada	Japan	USSR	Republic of Korea	Subtotal	Japan	USSR	Subtotal	
1958	2,586	383				2,969	32		32	3,001
1959	3,989	362				4,351	393		393	4,744
1960	5,136	705				5,841	1,861		1,861	7,702
1961	3,040	306				3,346	26,182		26,182	29,528
1962	4,017	428				4,445	28,521		28,521	32,966
1963	2,932	396	1,681			5,009	18,404		18,404	23,413
1964	3,659	637	1,041			5,337	9,237		9,237	14,574
1965	3,304	649	2,107			6,060	8,600		8,600	14,660
1966	3,142	970	3,514			7,626	13,088		13,088	20,714
1967	3,208	591	5,660			9,459	14,840	274	15,114	24,523
1968	2,027	577	17,592			20,196	16,258	4,256	20,514	40,710
1969	2,762	391	22,808			25,961	18,813	1,579	20,392	46,353
1970	2,935	327	28,632	980		32,874	10,904	2,874	13,778	46,652
1971	2,887	328	29,293	762		33,270	14,981	3,000	17,981	51,251
1972	5,636	1,104	38,714	834	308	46,596	16,538	2,406	18,944	65,540
1973	5,710	966	32,519	230	58	39,483	9,270	1,354	10,624	50,107
1974	6,998	504	26,595	202	2,431	33,715	7,587	91	7,678	41,393
1975	8,629	927	26,370	113	6,000 ^{1/}	38,621	4,922	117	5,039	43,660
1976			26,802				4,840			

1/ Includes some catch from the Bering Sea and Aleutian Regions.

Source: INPFC Docs. 1776, 1831, 1883, and pers. comm. T. Sasaki, Far Seas Fishery Research Lab., Shimizu, Japan.

KOK and USSR data for 1974 and 1975 from data submitted to the U.S. through bilateral agreements. U.S. and Canadian data from PFMC Data Series, Groundfish Section, and from Fishery Statistics of the U.S., Technical Digests 49-67.

actually encompasses the Gulf of Alaska, British Columbia, and Washington-California management regions). The resulting percentages of the total MSY and tonnages (percent x 46,500 mt) are: Northeastern Pacific Ocean - 71% and 33,000 mt; Bering Sea/Aleutian Region - 29% and 13,500 mt.

To further separate this regional MSY to the Bering Sea and Aleutian subareas, a similar calculation was made (using the period 1964-76, Table I.18). Resulting percentages and tonnages are: Bering Sea - 86% and 11,600 mt; Aleutian - 14% and 1,900 mt.

I.7.2 Equilibrium Yield

Catch and CPUE trends clearly indicate that sablefish stocks in the eastern Bering Sea/Aleutian Region are considerably reduced in abundance when compared to earlier years of the fishery. CPUE data analyzed by different procedures by U.S. and Japanese scientists both show declining trends in catch rates (Table I.19) but the trends in the U.S. analysis are much more severe.

The main difference in CPUE computation was the selection of appropriate fishing effort. Without detailed fishing operation data available to them, U.S. scientists attributed all longline fishing effort towards catching sablefish since that is the target species of the fishery. Japanese scientists selected only that portion of the time spent fishing by excluding time spent for travelling, loading, weathering storms, repairs, and other activities not considered to be associated with production fishing. Differences in resultant CPUE's can not yet be rectified but it is important to note that even though the sablefish catch in the Region during 1973-75 was only 43 percent of the average for the preceeding five years (7,300 vs 18,300 mt), averages for eight of the nine CPUE indicators shown in Table I.19 were lower (some substantially so) during the latter period than during the former. Furthermore, all CPUE indicators continued downward during 1976-77. In other words, even though average annual catch has been reduced more than 50 percent since 1972, abundance (as reflected by CPUE) has continued to decline.

Table I.18.—Historical catches of sablefish in metric tons by area and nation, 1958-76.

Year	Bering Sea			Aleutian Region		
	Total	Japan ^{1/}	USSR	Total	Japan ^{1/}	USSR
1958	32	32	--	<u>2/</u>	<u>2/</u>	--
1959	393	393	--	<u>2/</u>	<u>2/</u>	--
1960	1,861	1,861	--	<u>2/</u>	<u>2/</u>	--
1961	26,182	26,182	--	<u>2/</u>	<u>2/</u>	--
1962	28,521	28,521	--	<u>2/</u>	<u>2/</u>	--
1963	18,404	18,404	--	<u>2/</u>	<u>2/</u>	--
1964	8,262	8,262	--	975	975	--
1965	8,240	8,240	--	360	360	--
1966	11,981	11,981	--	1,107	1,107	--
1967	13,731	13,457	274	1,383	1,383	--
1968	18,853	14,597	4,256	1,661	1,661	--
1969	18,588	17,009	1,579	1,804	1,804	--
1970	12,501	9,627	2,874	1,277	1,277	--
1971	15,240	12,410	2,830	2,741	2,571	170
1972	15,368	13,231	2,137	3,576	3,207	269
1973	7,615	6,395	1,220	3,009	2,875	134
1974	5,158	5,081	77	2,520	2,506	14
1975	3,422	3,384	38	1,617	1,538	79
1976	3,411 ^{3/}	3,267	29	1,705 ^{3/}	1,573	61

^{1/} Japanese catch is reported by fishing year (November-October); all other catches are reported by calendar year.

^{2/} Included in the Bering Sea catch totals.

^{3/} Includes catches by ROK, 115 mt in Bering Sea and 71 mt in Aleutian.

Source: IMFPC Document 1883 and pers. comm., T. Sasaki, Far Seas Fishery Research Lab., Shimizu, Japan. USSR 1975 data from U.S.-USSR fishery statistic exchange.

Table I.19.—Sablefish catch per unit effort trends in the eastern Bering Sea and Aleutian Region.

	EASTERN BERING SEA				ALEUTIAN REGION				
	CPUE 1	CPUE 2	CPUE 3	CPUE 5	CPUE 1	CPUE 2	CPUE 3	CPUE 4	CPUE 5
1964	61	93	2.4		139	141	3.1		
1965	54	105	3.0		110	163	4.1		
1966	139	166	4.5		229	233	6.3		
1967	210	216	6.2	151	277	275	7.1		154
1968	143	140	5.1	134	165	161	5.9		259
1969	189	187	6.9	142	184	183	7.1		318
1970	231	241	8.7	50	189	241	9.4		112
1971	120	185	5.6	76	165	202	9.4	4.5	222
1972	50	117	3.3	62	203	208	11.6	11.8	123
1973	47	148	6.0	41	192	204	7.7	4.6	115
1974	141	164	7.4	24	187	208	7.8	4.4	44
1975	68	131	4.9	13	98	168	6.0	1.8	30
1976	71	147	5.6	6	78	114	4.5		7
1977			5.4			108	4.0	1.1	

CPUE 1: U.S. estimate, kg per 10 hachi longline units

CPUE 2: Japanese estimate, kg per 10 hachi longline units

CPUE 3: Japanese estimate, mt per vessel-day fishing by longliners

CPUE 4: U.S. estimate, mt per vessel-day fishing by longliners

CPUE 5: U.S. estimate, kg per hour trawling by land-based stern trawlers

Data Sources: CPUE 1, CPUE 4, and CPUE 5 from Low (1977) -- U.S. document on sablefish submitted to INPFC

CPUE 2 and CPUE 3 from Anonymous (1978) -- Report of U.S.-Japan meeting on status of stocks

Clearly, an average catch of 7,800 mt cannot currently be sustained by the standing stock of sablefish in the Bering Sea/Aleutian Region.

Considering that the declines in CPUE trends appear to have been less severe in 1976 and 1977, catch levels during that period may be close to the current equilibrium yield. The average catch was about 5,000 mt, 3,500 mt in the Bering Sea Area and 1,500 mt in the Aleutian Area.

I.7.3 Acceptable Biological Catch

Sable fishstocks in this Region have been overfished and are not now capable of producing MSY. Although the source of recruitment to these stocks is not known, neither eggs nor larvae of sablefish have been detected in the Region. It is possible, therefore, that recruitment comes from spawning in the Gulf of Alaska. If so, rebuilding of abundance will be a function of healthy spawning stocks in the Gulf rather than in the Bering Sea/Aleutian Region. Therefore, ABC is considered equivalent to EY-3,500 mt in the Bering Sea Area, 1,500 mt in the Aleutian Area.

I.8 Atka Mackerel

I.8.1 Maximum Sustainable Yield

The fishery for Atka mackerel is relatively new and is conducted primarily by the USSR. The main fishing area is the western Aleutian Islands, with small amounts taken in the eastern Bering Sea. The entire catch history of Soviet catches is as follows:

Year	1970	1971	1972	1973	1974	1975	1976	1977
Catch:	949	--	5,907	1,712	1,377	13,326	13,126	20,975

From the fishery data, it is difficult to approximate MSY. The only source of information that would suggest an MSY level greater than the maximum catch to date of 21,000 mt in 1977 is that provided verbally by Soviet scientists: several large concentrations of Atka mackerel were noted in the Aleutian Region, and from hydroacoustic and trawl samples were estimated to total at least 100,000 mt. From this biomass figure, it was inferred that MSY would equal one-third of the standing stock, or

33,000 mt. Because neither the Soviet data nor the analytical procedures used to estimate biomass and sustainable yield have been made available to scientists of other countries, those estimates must be considered provisional.

I.8.2 Equilibrium Yield

Annual catches of this species have increased from less than 1,000 mt to over 21,000 mt since 1970. Catch rate information is available only for 1977 and 1978 (from U.S. observers aboard Soviet trawlers); catch per hour, for vessels on which Atka mackerel was the target species, averaged 3.9 and 4.1 mt, respectively. By itself, this information could be interpreted to indicate no substantial change in abundance from 1977 to 1978 when annual catches were in excess of 20,000 mt. Two factors, however, must be evaluated before this indication can be considered conclusive.

First, size and age data taken by U.S. observers aboard Soviet vessels in both 1977 and 1978 show the bulk of the catch to have been 2-3 year-olds, whereas Soviet research off Kamchatka indicates that this species lives to at least 11 years of age. The lack of older fish in this developing fishery is of concern.

Second, observations of Soviet commercial fisheries and U.S. trawl surveys indicate that Atka mackerel occur in rather large concentrations. The sparse catch per hour information available provides some insight into the density of such concentrations but does not necessarily reflect the size or number of concentrations and, therefore, might not necessarily be indicative of overall abundance.

In light of the above, it is neither possible to estimate EY nor to determine whether current EY is equal to or less than MSY.

I.8.3 Acceptable Biological Catch

In the PMP for 1977 and 1978, the allowable catch of this species was set at 24,800 mt, 75 percent of the unverified Soviet estimate of MSY of 33,000 mt. The information currently available provides no biological basis for changing the allowable catch in 1979; accordingly ABC is considered equivalent to the 1977-78 total allowable catch of 24,800 mt.

I.9 Squid

I.9.1 Maximum Sustainable Yield

Virtually nothing is known about the status of the squid resource except that the current catch of about 10,000 mt does not seem large for a resource that occupies a low trophic level in the food chain and is known to be very abundant throughout the world's oceans. Therefore, it is assumed that this resource is in very good condition and that MSY is at least 10,000 mt.

I.9.2 Equilibrium Yield

Catches of 10,000 mt are believed to be sustainable.

I.9.3 Acceptable Biological Catch

ABC is equivalent to the minimal estimate of MSY -- 10,000 mt.

I.10 Pacific Halibut

I.10.1 Maximum Sustainable Yield

Dunlop et al. (1964) estimated that MSY was about 3,000 mt (round weight) in the southeastern Bering Sea (IPHC Areas -A and 4B).

Historically, this area has been the most productive for the North American setline fishery, and the MSY for the entire eastern Bering Sea (east of 175°W) probably is no more than 5,000 mt. Estimates of MSY are not available for the western Bering Sea as the North American setline catch in this area has been minor (less than 300 mt). Relatively large catches of halibut (over 3,000 mt) in the western Bering Sea were reported by the Japanese setline fishery in the early 1960's. MSY has not been estimated for the Aleutian area; stocks are small relative to those in the Bering Sea and are considered to be a component of stocks in the Gulf of Alaska.

I.10.2 Equilibrium Yield

Halibut stocks have declined sharply in the eastern Bering Sea since the early 1960's. This is indicated by a decline in CPUE in the North American setline fishery (IPHC 1977) and by IPHC surveys of juvenile halibut (Best 1977). Since 1970, stocks of adult halibut appear to have stabilized at a low level and the North American setline catch has averaged about 300 mt. The incidental catch of juvenile halibut in the

eastern Bering Sea peaked in 1971 at about 7,000 mt but has declined since then. Recent surveys indicate an increase in the abundance of juveniles, but abundance is still below that in the early 1960's and the increase will not benefit the setline fishery for several years. Therefore, the equilibrium yield available to the North American setline fishery probably is about the same as the present level of catch, and is well below MSY.

The EY in the western Bering Sea and Aleutians is unknown but probably substantially below MSY.

I.10.3 Acceptable Biological Catch

ABC and OY for Pacific halibut are not applicable to this Plan.

I.11 Other Included Species ("Others")

This category includes all species of finfishes taken by trawls and setlines except: pollock, rockfishes, soles and flounders, sablefish, cod, Atka mackerel, herring, and salmon.

Virtually nothing is known of the population structure, biological attributes, or potential yield of the individual components of this category; therefore, only a pragmatic appraisal of "MSY" is possible.

During the last 5 years of record, the catch of this category has averaged about 4 percent of the combined catch of the other, specified groundfish species. During that period, no indication of declining abundance has been noted; accordingly, it is assumed that the aggregation of stocks in the "Others" category can sustain removals equal to 4 percent of the total catch of the specified species as long as that catch remains less than the 1972 peak of 2,234,500 mt (see Annex IV-4).

Accordingly, "MSY" of this category is considered to be $0.04 \times 2,234,500 = 89,400$ mt.

I.11.2 Equilibrium Yield

"MSY" is believed attainable.

I.11.3 Acceptable Biological Catch

ABC is considered equal to 4 percent of the combined ABC of specified species which, in 1979, will be: $0.04 \times 1,388,000 = 55,500$ mt.

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ANNEX II

Derivation of Expected Domestic Annual Processing Capacity and Intent (DAP)
and Harvest

ANNEX II -- Derivation of Expected Domestic Annual Processing
Capacity and Intent (DAP) and Harvest

The western Alaska Peninsula and the Aleutian Islands are two of the more expensive locations for business to be conducted in Alaska. It was not surprising to learn during the survey that most of the plant owners in the area either had no firm plans to commence groundfish operations, or were developing in-house experience and expertise at other locations on the coast where costs are considerably less.

Perhaps even more surprising was the magnitude of the amount of product anticipated by the three processors who indicated that they planned to process groundfish. Their combined 1/ estimate of expected domestic annual harvest of Bering Sea/Aleutian groundfish is as follows:

Pollock	10,000 mt
Pacific cod	7,000 mt
Rockfishes	1,100 mt (eastern Bering Sea)
	1,100 mt (Aleutian)
Yellowfin sole	1,000 mt
Turbots	1,000 mt
Other flounders	1,000 mt
Sablefish	500 mt (eastern Bering Sea)
	500 mt (Aleutian)
Others	1,400 mt
Total	24,600 mt

There are no plans, at present for "Joint Venture" agreements.

1/ Individual company projections are not given here because of the proprietary nature of that data.

ANNEX III -- Derivation of Total Allowable Level of Foreign Fishing

(TALFF) (metric tons)

Reference:		Annex I	Section 13.1	Annex II	
Species group	sub-area <u>1/</u>	ABC	Reserve	Initial	Initial
		=OY		DAH <u>3/</u>	TALFF
Pollock	BSea	1,000,000	50,000	10,000	940,000
Pollock	Aleutian	100,000	-	-	100,000
Yellowfin sole		117,000	5,850	1,000	110,150
Turbots		90,000	4,500	1,000	84,500
Other flatfishes <u>2/</u>		61,000	3,050	1,000	56,950
Pacific cod		58,700	2,935	7,000	48,765
Pacific ocean perch	BSea	3,250	162	550	2,538
Pacific ocean perch	Aleutian	7,500	375	550	6,575
Other rockfish		7,727	500	1,100	6,127
Sablefish	BSea	3,500	350	500	2,650
Sablefish	Aleutian	1,500	150	500	850
Atka mackerel		24,800	1,240	0	23,560
Squid		10,000	500	0	9,500
Others		<u>55,500</u>	<u>2,775</u>	<u>1,400</u>	<u>51,325</u>
<u>Total</u>		1,540,477	72,327	24,600	1,443,490

* 1/ BS = Bering Sea (Statistical Areas I, II, III combined)

AI = Aleutian Island Area (Statistical Area IV)

2/ Excluding Pacific halibut

3/ Equals DAP, see Annex II

* Includes territorial waters

ANNEX IV

- A. All-nation catch in the Bering Sea/Aleutian Regon, by major species groups, for the last 10 years of record.
- B. Detailed statistics of the foreign fisheries in the Aleutian area, 1962-77.
- C. Detailed statistics of the foreign fisheries in the eastern Bering Sea, 1954-77.

Annex IV-A. All-nation catches in the Bering Sea/Aleutian Region, by major species groups, for the last 10 years of record (1000's mt)^{1/}.

Species/	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978 ^{2/}
Pollock	702	863	1,257	1,744	1,875	1,759	1,588	1,357	1,238	888.2	921.3
Pacific cod	63.7	53.3	74.6	50.5	47.0	58.6	67.0	55.1	57.8	36.5	37.3
Pacific ocean perch	76.4	53.3	76.8	31.6	38.9	15.5	36.5	25.2	32.6	10.8	7.4
Sablefish	20.5	20.4	13.8	18.0	19.0	10.6	7.7	5.0	8.2	4.6	1.6
Halibut	7.1	6.3	7.7	8.6	5.9	4.3	2.2	1.6	1.2	0.6	4/
Flounders	149.9	236.2	234.9	323.4	237.7	207.1	196.3	200.4	187.2	121.9	208.3
Atka mackerel	3/	3/	1.0	3/	4.7	1.7	1.4	13.3	20.7	21.0	22.4
Others	31.5	14.4	25.9	41.5	134.7	62.3	79.9	61.9	45.6	57.3	73.9
All species	1,051.1	1,247.1	1,691.7	2,216.6	2,362.9	2,119.1	1,979.0	1,719.5	1,591.3	1,140.9	1,272.2

1/ Values in this table may differ slightly from those used elsewhere in this document because of differences in apportioning between species not clearly listed in foreign statistical reports or differences in treating estimates based on U.S. surveillance when catches were not reported.

2/ Preliminary.

3/ Catch, if any, included under "Others".

4/ Unknown at this time

—Seasons of growth in the Aleutian Island region (170°W to 170°E) by calendar year, 1963-76. $1/2$ (MC)

- 1/ Catch statistics up to 1941 from Forrester et al. 1972 and for 1944-76 from data on file, Minnesota and Alaska Flounder Center, with the following exceptions: Pacific north-west and other catches - USSR catches for 1961-66 (from Chisaki 1975); all flounders except halibut - all national catches, 1963-75 (from Masabayashi and Ishikawa 1977).
- 2/ 0 indicates no fishing - no catches recorded, but no catch reported.
- 3/ Japanese catches for November and December 1976 not included; 1976 catches of flounders (verreine halibut) by USSR and ROK presented to Sweden based on species' composition in Japanese catch.

ANNEX IV B (Cont'd)

Foreign catches of groundfish in the Aleutian Island region (170°W to 170°E)
by calendar year, 1976-77. ^{1/} 2/

<u>Species</u>	<u>Nation</u>	<u>1976</u>	<u>1977^{3/}</u>
Pollock	Japan	1,015	5,870
	USSR	3,673	1,619
	ROK	344	325
	ROC	0	15
	Total	5,032	7,829
Pacific cod	Japan	3,862	3,162
	USSR	312	100
	ROK	16	-
	ROC	0	-
	Total	4,190	3,262
Pacific ocean perch and other rockfish	Japan	11,204	12,708
	USSR	6,951	786
	ROK	33	87
	ROC	0	2
	Total	18,188	13,583
Blackcod	Japan	1,569	1,768
	USSR	61	-
	ROK	71	86
	ROC	0	-
	Total	1,701	1,854
Atka mackerel	Japan	5	585
	USSR	20,092	20,971
	ROK	-	-
	ROC	0	-
	Total	20,097	21,556
Yellowfin sole	Japan	14	100
	USSR	110	-
	ROK	-	-
	ROC	0	-
	Total	124	100
Rock sole	Japan	23	75
	USSR	71	3
	ROK	-	-
	ROC	0	-
	Total	94	78

ANNEX IV B (Cont'd)

Flathead sole	Japan	7	37
	USSR	55	1
	ROK	-	-
	ROC	0	-
	Total	<u>62</u>	<u>38</u>
Alaska plaice	Japan	-	-
	USSR	-	-
	ROK	-	-
	ROC	0	-
	Total	<u>-</u>	<u>-</u>
Pacific halibut	Japan	15	1
	USSR	2	-
	ROK	-	-
	ROC	0	-
	Total	<u>17</u>	<u>1</u>
Arrowtooth flounder	Japan	1,375	2,297
	USSR	-	9
	ROK	5	-
	ROC	0	1
	Total	<u>1,380</u>	<u>2,307</u>
Greenland turbot	Japan	1,953	2,981
	USSR	112	57
	ROK	6	-
	ROC	0	3
	Total	<u>2,071</u>	<u>3,041</u>
Other groundfish	Japan	5,410	10,723
	USSR	326	4,661
	ROK	241	-
	ROC	0	-
	Total	<u>5,977</u>	<u>15,384</u>
All groundfish total	Japan	26,452	40,307
	USSR	31,765	28,207
	ROK	716	498
	ROC	<u>0</u>	<u>21</u>
All nation total		58,933	69,033

Annex IV-C — Foreign catches of groundfish in the eastern Bering Sea (east of 180°)
by calendar year, 1954-76 1/2 (mt)

Species	Nation	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Pollock	Japan	---	---	---	---	6,924	32,793	26,097	24,216	58,765	103,353	171,957	229,275
	USSR	0	0	0	0	---	---	---	---	---	---	---	---
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	6,924	32,793	26,097	24,216	58,765	103,353	171,957	229,275
Pacific cod	Japan	---	---	---	---	171	2,864	5,679	2,448	6,054	3,879	13,408	14,722
	USSR	0	0	0	0	---	---	---	---	---	---	---	---
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	171	2,864	5,679	2,448	6,054	3,879	13,408	14,722
Pac. ocean perch and other rockfish	Japan	---	---	---	---	---	---	1,100	13,000	12,900	17,500	13,588	8,723
	USSR	0	0	0	0	---	---	5,000	34,000	7,000	7,000	7,000	9,000
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	---	---	6,100	47,000	19,900	24,500	20,588	17,723
Blackcod	Japan	---	---	---	---	32	393	1,861	26,183	28,521	18,404	6,165	5,001
	USSR	0	0	0	0	---	---	---	---	---	---	---	---
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	32	393	1,861	26,183	28,521	18,404	6,165	5,001
Yellowfin sole	Japan	12,562	14,690	24,697	24,145	39,153	123,121	360,103	399,542	281,103	20,504	48,880	26,039
	USSR	0	0	0	0	5,000	62,200	96,000	154,200	139,600	65,306	62,297	27,771
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	12,562	14,690	24,697	24,145	44,153	185,321	456,103	553,742	420,703	85,810	111,177	53,810
Rock sole	Japan	---	---	---	---	---	---	---	---	---	1,196	1,432	1,780
	USSR	0	0	0	0	---	---	---	---	---	3,806	1,806	1,892
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	---	---	---	---	---	5,002	3,238	3,672
Flathead sole	Japan	---	---	---	---	---	---	---	---	---	7,079	11,121	3,287
	USSR	0	0	0	0	---	---	---	---	---	22,546	14,167	3,426
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	---	---	---	---	---	29,625	25,288	6,713
Alaska plaice	Japan	---	---	---	---	---	---	---	---	---	233	808	474
	USSR	0	0	0	0	---	---	---	---	---	742	1,030	505
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	---	---	---	---	---	975	1,838	979
Pacific halibut	Japan	---	---	---	---	196	674	6,931	3,480	7,865	7,452	1,271	1,369
	USSR	0	0	0	0	---	---	---	---	---	---	---	---
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	196	674	6,931	3,480	7,865	7,452	1,271	1,369
Arrowtooth flounder	Japan	---	---	---	---	---	---	---	---	---	---	---	---
	USSR	---	---	---	---	---	---	---	---	---	---	---	---
	ROK	---	---	---	---	---	---	---	---	---	---	---	---
	TOTAL	---	---	---	---	---	---	---	---	---	---	---	---
---Catches of arrowtooth flounder and Greenland turbot combined until 1970---													
Greenland turbot	Japan	---	---	---	---	---	---	36,843	57,348	58,226	31,565	33,729	7,947
	USSR	0	0	0	0	---	---	---	---	---	---	---	1,800
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	---	---	36,843	57,348	58,226	31,565	33,729	9,747
Other groundfish	Japan	---	---	---	---	147	380	10,260	554	5,931	1,102	736	2,218
	USSR	0	0	0	0	---	---	---	---	---	---	---	---
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	---	---	---	---	147	380	10,260	554	5,931	1,102	736	2,218
All groundfish total	Japan	12,562	14,690	24,697	24,145	46,623	160,225	448,874	526,771	459,365	212,267	303,095	300,835
	USSR	0	0	0	0	5,000	62,200	101,000	188,200	146,600	99,400	86,300	44,400
	ROK	0	0	0	0	0	0	0	0	0	0	0	0
All nation total		12,562	14,690	24,697	24,145	51,623	222,425	549,874	714,971	605,965	311,667	389,395	345,235

Annex IV-C (cont'd)

Species	Nation	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 ¹	1977 ²
Flatfish	Japan	261,694	330,132	701,124	830,323	1,231,347	1,314,030	1,616,532	1,471,189	1,250,654	1,063,870	912,728	
	USSR	—	—	—	33,571	35,590	233,511	213,895	280,005	309,613	216,567	175,539	
	ROK	0	0	1,200	1,000	1,000	10,000	9,000	1,100	74,000	1,474	44,987	
	TOTAL	261,694	330,132	702,324	864,894	1,271,937	1,757,541	1,839,627	1,754,294	1,634,267	1,285,851	1,133,254	
Pacific cod	Japan	18,200	31,982	37,915	30,487	70,078	40,555	25,877	40,817	45,915	33,322	29,086	
	USSR	—	—	—	—	—	2,486	7,028	12,569	16,547	18,229	17,756	
	ROK	0	0	—	—	—	—	—	—	—	—	716	
	TOTAL	18,200	31,982	37,915	30,487	70,078	43,041	42,895	53,386	62,462	51,551	47,558	
Pac. ocean perch and other rockfish	Japan	16,786	20,398	26,214	16,130	10,392	10,369	5,837	3,147	6,811	3,716	3,163	
	USSR	9,000	—	3,087	—	—	—	150	475	31,877	16,465	12,124	
	ROK	0	0	—	—	—	—	—	—	—	—	173	
	TOTAL	25,786	20,398	29,301	16,130	10,392	10,369	5,987	3,622	38,688	20,181	15,460	
Blackcod	Japan	9,302	10,330	10,143	14,454	8,897	12,304	10,643	4,769	4,189	2,776	2,569	
	USSR	—	1,237	4,256	1,379	2,874	2,830	2,137	1,192	77	38	29	
	ROK	0	0	—	—	—	—	—	—	—	—	114	
	TOTAL	9,302	11,567	14,399	15,833	11,771	15,134	12,780	5,961	4,266	2,814	2,713	
Yellowfin sole	Japan	45,423	60,429	40,834	81,449	59,851	82,179	34,846	75,724	37,947	39,715	33,328	
	USSR	56,930	101,799	43,355	85,685	73,228	78,220	13,010	2,516	4,288	6,060	3,343	
	ROK	0	0	—	—	—	—	—	—	—	—	535	
	TOTAL	102,353	162,228	84,189	167,134	133,079	160,399	47,856	78,240	42,235	65,775	37,306	
Rock sole	Japan	4,037	1,390	2,633	4,283	9,616	27,159	43,055	22,840	17,311	9,682	7,828	
	USSR	5,067	2,872	2,617	4,955	10,507	20,260	17,769	995	2,664	1,463	783	
	ROK	0	0	—	—	—	—	—	—	—	—	150	
	TOTAL	9,104	4,262	5,250	9,240	20,123	40,419	60,824	23,835	19,975	11,145	8,763	
Flathead sole	Japan	4,994	10,621	11,851	9,168	20,088	25,538	9,850	17,190	12,189	4,873	6,911	
	USSR	6,024	12,816	9,724	9,395	21,064	25,486	5,840	951	2,028	672	692	
	ROK	0	0	—	—	—	—	—	—	—	—	132	
	TOTAL	11,020	23,437	21,575	18,563	41,152	51,024	15,690	18,141	14,917	5,545	7,735	
Alaska plaice	Japan	2,054	1,340	1,223	3,127	1,326	517	171	1,082	2,168	2,407	2,084	
	USSR	2,579	2,513	1,396	3,813	2,076	475	119	35	220	207	207	
	ROK	0	0	—	—	—	—	—	—	—	—	40	
	TOTAL	4,633	3,853	2,619	6,942	3,402	992	290	1,117	2,388	2,614	2,331	
Pacific halibut	Japan	2,199	3,756	2,775	2,764	1,735	4,861	955	644	81	137	87	
	USSR	—	—	—	—	—	—	490	296	123	137	58	
	ROK	0	0	—	—	—	—	—	—	—	—	—	
	TOTAL	2,199	3,756	2,775	2,764	1,735	4,861	1,445	940	204	274	145	
Arrowtooth flounder	Japan	—	—	—	—	9,354	11,603	3,823	4,929	2,823	1,241	1,652	
	USSR	—	—	—	—	3,244	7,189	9,301	4,288	18,650	19,591	16,132	
	ROK	—	—	—	—	—	—	—	—	—	—	72	
	TOTAL	—	—	—	—	12,598	18,792	13,124	9,217	21,473	20,832	17,816	
Greenland turbot	Japan	10,842	21,230	19,980	19,231	14,715	30,193	49,813	43,354	58,834	52,625	17,583	
	USSR	2,200	2,639	15,252	16,798	4,976	10,271	14,697	11,926	10,820	12,194	8,867	
	ROK	0	0	—	—	—	—	—	—	—	—	133	
	TOTAL	13,042	23,869	35,232	36,029	19,691	40,464	64,510	55,280	69,654	64,819	26,783	
Other groundfish	Japan	2,239	4,378	2,984	4,182	9,227	29,617	32,370	39,911	47,491	42,531	44,504	
	USSR	—	—	19,074	6,277	6,068	3,879	78,523	15,915	12,770	12,314	12,294	
	ROK	0	0	—	—	—	—	—	—	—	—	132	
	TOTAL	2,239	4,378	22,058	10,459	15,295	33,496	110,893	55,826	60,261	54,845	57,120	
All groundfish total	Japan	377,972	718,706	877,676	1,035,822	1,446,626	1,781,925	1,843,772	1,725,596	1,487,113	1,278,103	1,061,503	
	USSR	81,800	123,876	98,761	162,075	159,827	184,607	362,919	331,163	409,677	303,937	217,826	
	ROK	0	0	1,200	3,000	3,000	10,000	9,200	3,100	26,000	3,438	88,042	
	TOTAL	459,772	842,582	977,637	1,202,897	1,611,253	1,975,532	2,215,731	2,059,859	1,922,790	1,585,478	1,367,371	

^{1/} Catch statistics up to 1963 from Forrester et al., 1974, and for 1964-76 from data on file, Northwest and Alaska Fisheries Center, Seattle, with the following exceptions: Pacific ocean perch and other rockfish—Japanese catches 1960-63 and USSR catches 1960-66 from Chikuni 1975; blackcod—Japanese catches 1958-63 from Sasaki 1976; and all flounders except halibut—all nation catches, 1954-75 from Watanabe and Sakabe 1977.

^{2/} 0 means no fishing, — means fishing, but no reported catch.

^{3/} Japanese catches for November and December 1976 not included; USSR and ROK catches of flounders (except halibut) presumed to be based on species composition of Japanese catches.

ANNEX IV C (cont'd)

Foreign catches of groundfish in the eastern Bering Sea (east of 180°)
by calendar year, 1976-77.^{1/ 2/}

<u>Species</u>	<u>Nation</u>	<u>1976</u>	<u>1977^{3/}</u>
Pollock	Japan	986,696	774,450
	USSR	175,539	63,383
	ROK	84,987	39,895
	ROC	0	1,334
	Total	1,247,222	879,062
Pacific cod	Japan	32,009	33,141
	USSR	17,756	178
	ROK	716	-
	ROC	0	2
	Total	50,481	33,321
Pacific ocean perch and other rockfish	Japan	3,300	7,761
	USSR	12,124	90
	ROK	578	478
	ROC	0	-
	Total	16,002	8,329
Blackcod	Japan	2,815	2,801
	USSR	29	-
	ROK	115	9
	ROC	0	53
	Total	2,959	2,863
Yellowfin sole	Japan	52,673	58,139
	USSR	2,908	284
	ROK	655	-
	ROC	0	55
	Total	56,236	58,478
Rock sole	Japan	8,598	4,906
	USSR	1,328	805
	ROK	107	-
	ROC	0	5
	Total	10,033	5,716
Flathead sole	Japan	7,379	7,025
	USSR	795	1,069
	ROK	90	-
	ROC	0	6
	Total	8,264	8,100
Alaska plaice	Japan	3,519	3,118
	USSR	102	516
	ROK	44	-
	ROC	0	3
	Total	3,665	3,637

ANNEX IV C (Cont'd)

Pacific halibut	Japan	88	-
	USSR	58	-
	ROK	-	-
	ROC	0	2
	Total	146	2
Arrowtooth flounder	Japan	1,717	6,758
	USSR	16,132	669
	ROK	2	-
	ROC	0	4
	Total	17,851	7,431
Greenland turbot	Japan	51,677	31,942
	USSR	8,867	3,082
	ROK	425	-
	ROC	0	18
	Total	60,969	35,042
Other groundfish	Japan	13,527	26,950
	USSR	12,294	614
	ROK	322	1,445
	ROC	0	-
	Total	26,143	29,009
All groundfish total	Japan	1,163,998	956,991
	USSR	247,932	70,690
	ROK	88,041	41,827
	ROC	0	1,482
All nation total		1,499,971	1,070,990

Updated footnotes for Annex 4B and 4C , Bering Sea Groundfish MP

- 1/ Catch statistics up to 1963 from Forrester et al. 1974 and for 1964-76 from data on file, Northwest and Alaska Fisheries Center, with the following exceptions: Pacific ocean perch and other rockfish - USSR catches for 1963-66 from Chikuni 1975; all flounders except halibut - all national catches, 1963-76 from Wakabayashi and Bakkala, 1978.
- 2/ 0 indicates no fishing, -- indicates fishing, but no catch reported.
- 3/ Catches of flounders by USSR and ROK are preliminary.

ANNEX V

INFORMATION ON MARINE MAMMAL POPULATIONS

Information on distribution and migration, abundance and trends, feeding habits, and any problems induced by fisheries on seven marine mammal populations in the Bering Sea/Aleutian Region was provided by the Marine Mammal Division of the Northwest and Alaska Fisheries Center and included in this annex. The information is summarized mainly from the annual report of the Department of Commerce on the Administration of the Marine Mammal Protection Act of 1972 for the period of April 1, 1977 through March 31, 1978 (DOC, 1978) and the Final Environmental Impact Statement on Consideration of a Waiver of the Moratorium and Return of Management of Certain Marine Mammals to the State of Alaska, Volumes I and II (DOC and DOI, 1977).

NORTHERN SEA LION (Eumetopias jubatus)

Distribution and Migration: The northern (stellar) sea lion is found in continental shelf water from the Sea of Japan and northern Honshu, Japan, northward around the North Pacific Ocean rim to Okhotsk and Bering Sea and southward to the California Channel Islands. Some seasonal movements occur in parts of its range.

Abundance and Trends: Mate (1976) estimated a world population of 250,000 to 325,000 animals. Alaska has 202 known rookeries and hauling grounds. The Alaska population has increased since exploitation diminished in the early 1900's and now exceeds 200,000 according to a 1973 ADFG estimate. However, recent studies in the eastern Aleutian Islands indicate a 50% decline in population sizes since the late 1950's (Braham et al, 1977).

Factors which may have caused this decline include (1) a westward shift in distribution, (2) commercial fisheries interaction, (3) leptospirosis and/or (4) unidentified population control factors.

Feeding Habits: Northern sea lions eat a variety of fish and cephalopods.

Based on frequency of occurrence, one study revealed that fish composed 74.2% of the diet, cephalopod - 17.2%, and decapod crustaceans - 8.6%.

Analysis based on percentage of total individuals provided a somewhat different picture. Fishes completely dominated the diet at 97.6% of total individuals. Cephalopods followed at 2.0% and decapod crustaceans at 0.6%. Groundfishes constituted 57.7% of the sea lion diet based on frequency of occurrence and 90.8% based on percentage of total individuals (Calkins and Pitcher, 1977). Pollock was the dominate groundfish. Details of the diet are summarized as follows:

Area: Cape Spencer to Scotch Cap on Unimak Island
Northern Sea Lions - 68 Samples

<u>Prey Item</u>	<u>No. of Occurrences</u>	<u>% Occurrences</u>	<u>No. of Individuals</u>	<u>% of Total Individuals</u>
Gadidae	57	49.1	1135	89.2
Pollock	47	40.5	1072	84.3
Pacific cod	6	5.2	33	2.6
Other Gadidae	4	3.4	30	2.3
Scorpaenidae				
Rockfishes	2	1.7	6	0.5
Pleuronectidae	8	6.9	14	1.1
Starry flounder	1	0.9	1	0.2
Rock sole	1	0.9	1	0.1
Yellowfin sole	1	0.9	2	0.2
Flathead sole	2	1.7	2	0.2
Other Pleuronectidae	3	2.5	8	0.4
Total Groundfish	67	57.7	1155	90.8

Problems: Northern sea lions have damaged gear and destroyed fish in halibut longline, salmon purse seine, gillnet, and troll fisheries. Because groundfish make up such a large part of the sea lion's diet, this species will probably be one of the marine mammals most impacted by the groundfish fisheries and will be the species which should bear close watching as groundfish policies are considered. This is important in light of recent declines in populations in the eastern Aleutian Islands.

NORTHERN FUR SEAL (*Callorhinus ursinus*)

Distribution and Migration: Northern fur seals are found at sea along the continental shelf from the Bering Sea south along both sides of the North Pacific Ocean to latitude 32°N. Most animals are on their breeding grounds from May through November to bear young and to breed.

Abundance and Trends: A program of reducing the population of Pribilof Island fur seals was begun in 1956 with the expectation that the rate of survival would improve and result in an increased yield of pelts. By 1968, the population had been reduced below levels which would yield the maximum sustainable yield. Thus female fur seals were excluded from harvest in expectation that there would be an increase in pup production. However, expected increases have not been observed. The population level of the northern fur seal is estimated to be 1,765,000. There are in excess of 700,000 adults in the eastern Bering Sea in summer.

Feeding Habits: The northern fur seal is an opportunistic feeder, taking squid and a variety of fishes including herring, anchovy, salmon, capelin, saury, walleyed pollock, and mackerel. Fishes are estimated to constitute about 80% of the fur seal diet. Average size of pollock (the dominant food

item) observed in fur seal stomachs is 20 cm. Some figures, from McAlister and Perez (1977) indicated the following consumption of groundfish by northern fur seals.

	<u>In the Aleutians</u>	<u>In the Bering Sea</u>
Walleye pollock	9.4%	39.4%
Sablefish	4.6%	1.0%
Other Gadidae		5.7%
Pleuronectidae		1.4%
% Groundfish	14.2%	47.5%
% Other fish	75.0%	31.8%
Total Fish	89.2%	79.3%
Total Squid	10.8%	20.7%

Problems: Fur seals and commercial fisheries may compete for the same species of fish.

BEARDED SEAL (Erignathus barbatus)

Distribution and Migration: The bearded seal is found in the North Pacific region in the Bering, Okhotsk, and northern Japan Seas. Bearded seals migrate seasonally in association with the advance and retreat of the ice packs. These seals do not normally come ashore.

Abundance and Trends: No satisfactory method of accurately censusing bearded seals has been attempted to date. A 1971 Soviet estimate places the level of the bearded seal populations of the East-Siberian, Chukchi, Bering, Okhotsk, and Japan Seas at 450,000. The Alaska Department of Fish and Game (1973) estimated a population of 300,000 animals in the Bering, Chukchi, East-Siberian, and Beaufort Seas. The population appears to be high and stable (DOC, 1978).

Feeding Habits: The bearded seal consumes several species of invertebrates, primarily crabs, shrimps, clams, and amphipods, and some demersal fishes. One study indicates that fishes constitute about 10% of the bearded seal's diet and another study, performed in the Beaufort Sea, stated that about 25% of this animal's diet is fishes, in this case primarily polar cod.*

Problems: None at the present. Bearded seals consume commercially important pandalid and crangoid shrimps and lithods crabs; however, they do not compete directly for commercial fish nor do they damage fishing gear.

*Lowry, Frost, and Burns. Trophic Relationships Among Ice Inhabiting Seals.

Environmental Assessment of the Alaska Continental Shelf, PI Annual Report, March 77, Vol. 1, p. 226.

Area: North and east of Pt. Barrow

Bearded seals: 3 samples

Of the three samples, one consisted of only one shrimp. One of the seals was taken in November and 64% of the contents were invertebrates and 36% of the contents were fish, mostly saffron cod, but also polar cod, sea snail and eelpout. The third seal was taken in August and it contained 83% invertebrates, mostly isopods. Of the fish in the stomach, 53% were polar cod, 38% were sculpins, and 5% were sea snails. The authors concluded that bearded seals eat a diverse diet but the bulk of it is bivalve mollusk, crabs, shrimps, and sculpins.

RINGED SEAL (Phoca hispida)

Distribution and Migration: The ringed seal is circumarctic in distribution throughout the ice pack. In the North Pacific Ocean it is found in the Bering, Chukchi, and Okhotsk Seas and in the permanent ice pack of the Polar Basin. In winter, most ringed seals occupy areas of land-fast ice, but non-breeding adults and juveniles may be found wherever ice occurs. Apparently, animals wintering in the Bering and Chukchi Seas move northward in spring as the ice recedes and southward in autumn as it advances again. In western Alaska, the ringed seal is the dominant nearshore seal during ice-free months.

Abundance and Trends: No satisfactory method of accurately censusing ringed seals, throughout their range, has been attempted to date. The Alaska Department of Fish and Game (1973) estimated the ringed seal population in the Bering-Chukchi Seas to be about 250,000. Annual harvest by both Soviets and Americans in this area are between 12,000 and 16,000 animals per year. Overall, the population in the Bering-Chukchi Seas appears to be high and is probably stable.

Feeding Habits: In western Alaska, this seal feeds mainly on mysids, amphipods, euphasiids, shrimps, saffron cod, polar cod, and sculpin. A recent stomach analysis of ringed seals in the Beaufort Sea reported that about 83% of the ringed seal's diet was invertebrates and about 17% was fish, almost exclusively polar cod.*

Problems: None at present. Little competition is known to exist between ringed seals and man for fishery resources.

*Lowry, Frost, and Burns. Trophic Relationships Among Ice Inhabiting Seals. Environmental Assessment of the Alaska Continental Shelf, PI Annual

Report. March 1977. Vol. 1, p. 226.

Ringed seals - 21 samples.

Fish constituted from 00.0-13% of the food material in various sub-samples. There were 73 polar cod (Boreagradus saida), one saffron cod (Eleginus gracillus), and two capelin (Mallotus villosus) found in all the samples. Invertebrates were the bulk of the contents. The authors concluded that ringed seals eat primarily nektonic creatures, small benthic crustaceans, and small to medium-size schoolingfish. Benthic fish are the minor food item.

HARBOR SEAL (Phoca vitulina)

Distribution and Migration: The harbor seal is found in the North Pacific Ocean from the Bering Sea south to Baja California and southern Japan and Korea. The harbor seal is the predominant nearshore seal in ice-free waters north of latitude 35°N.

Abundance and Trends: Overall, the world population of harbor seals appears to be high and stable. A 1976 estimate indicated a population of 312,500 to 317,500 in the Pacific (Adv. Comm. Mar. Resour. Res., 1976).

Feeding Habits: The diet of the harbor seal, which varies according to season and location of specific populations, includes primarily pelagic, demersal, and anadromous fishes, cephalopods, and crustaceans. About half of this seal's diet is fish.

Problems: These seals damage commercial fishing gear and compete with man for such fish as herring, salmon, smelt, and whitefish. These animals are extremely sensitive to disturbance and may leave an area after continual harassment by people, equipment, or aircraft.

LARGA SEAL (*Phoca largha*)

Distribution and Migration: The larga seal is found in the Bering, Chukchi, Western Beaufort, Okhotsk, northern Sea of Japan, and the Po Hai Seas. These seals are seasonally dependent upon sea ice for the birth and nurture of their pups. During winter and early spring the entire population is concentrated along the southern edge of the seasonal pack ice, usually in central Bering Sea. These seals move northward and toward the coasts as the seasonal retreat and disintegration of sea ice progresses. During ice-free summer and early fall they occur along the entire coast of northern Alaska.

Abundance and Trends: No satisfactory method of accurately censusing larga seals has been attempted to date. Indirect methods and relative indices of abundances indicate that the population level of this species is high and probably stable. In 1976, the Bering Sea larga seal population was estimated to contain from 135,000 to 200,000 animals. The Okhotsk Sea population estimate is 135,000 to 200,000 animals (DOC, 1978).

Feeding Habit: The diet of these seals, which varies with the season and location, includes primarily pelagic, demersal and anadromous fishes, cephalopods and crustaceans.

Ecological Problems: Competition presently exists between these seals and man with respect to commercially important fishes (i.e., herring, smelt, whitefish, and salmon) and with respect to fishing gear. These seals are extremely responsive to disturbance and will leave a hauling area after only minor harassment.

RIBBON SEAL (*Phoca fasciata*)

Distribution and Migration: Geographically, the ribbon seal is separable into Okhotsk and Bering-Chukchi Sea populations and interchanges between the two groups are not known to occur. During winter and spring, the entire population is concentrated along the southern edge of the seasonal ice pack. Only a few ribbon seals remain with the ice edge of the seasonal ice pack. Only a few ribbon seals remain with the ice edge as it retreats northward through the Bering Strait. In summer and autumn, ribbon seals are believed to be pelagic, mainly in the ice-free Bering Sea.

Abundance and Trends: The population of ribbon seals is relatively low, having been markedly reduced by commercial sealers of the Soviet Union during the 1960s. In recent years the species has been afforded increased protection by Soviet sealing regulations and its numbers may be increasing again. U.S. citizens harvest very few ribbon seals. The Alaska Department of Fish and Game (1973) estimated that the population probably numbers between 90,000 and 100,000 animals. Soviet estimates indicate a population of 133,000 in the Okhotsk in 1969 (Popov, 1976). Soviet sealers took less than 3,000 ribbon seals in 1973 from Bering and Okhotsk Seas. In Alaska, the native harvest is usually less than 250 per year.

Food Habits: The diet of the ribbon seal during late winter and early spring (in the ice edge zone) includes mainly pelagic and demersal fishes, cephalopods, and small crustaceans. About 40% of this animal's summer diet is fishes and about 90% of its winter diet is fishes.

Problems: Little competition is known to exist between ribbon seals and Man for fishery resources.

ANNEX V: LITERATURE CITED

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MARINE MAMMAL COMMISSION

1625 EYE STREET, N. W.
WASHINGTON, DC 20006

18 January 1979

Mr. J. H. Branson
Executive Director
North Pacific Fishery
Management Council
P.O. Box 3136 - DT
Anchorage, Alaska 99510

Dear Mr. Branson:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the Fishery Management Plan and Draft Environmental Impact Statement for the Groundfish Fishery in the Bering Sea/Aleutian Islands Area and offers the following comments.

General Comments

① As you know, the Fishery Conservation and Management Act (FCMA) and Marine Mammal Protection Act (MMPA) call for an integrated, ecosystem approach to management in order to conserve fishery resources at optimum yield levels and marine mammals at optimum sustainable population levels. While we appreciate the difficulty of the task, we believe that the development of a Plan for the substantial groundfish resources of the Bering Sea/Aleutian Islands Area offers a challenging opportunity to develop and implement such an ecosystem-oriented approach and, as noted below, that the Plan and DEIS could and should be modified to better reflect the currently available data and theory, including uncertainties, that provide a basis for such efforts.

The desirable approach and difficult challenge are identified in the document on page 144 which notes that: "(1) in the ecosystem sense, there is no 'surplus' production in the sea for man to take. The question is mainly one of balance between ecosystem components, i.e. changes in

JAN 23 1979

target species biomasses and the resultant changes in the biomasses of prey, predator, and competitor species." Although it is noted that the determination of such fishery-induced changes is one of the major objectives of the DYNAMES model, neither the Plan nor the discussion reflect any attempt to account for such changes, provide for uncertainties relating to the nature and extent of those changes, or otherwise attempt to strike or even articulate the criteria that will be employed in maintaining the necessary balance among the various components of the ecosystem. As the quoted language indicates, these changes may affect populations of marine mammals and other components of the ecosystem, as well as the target species of fish, themselves. It is therefore in the best interests of all concerned to develop a Plan that calls for sufficiently conservative actions and research to detect significant changes, and, whenever possible, provide for corrective measures before significant changes occur.

Specific Comments

Although relevant theory and data are discussed in several sections of the document, the discussion is not developed or organized so as to yield a clear explanation of the rationale for the Plan. Relevant ecosystem-oriented considerations do not appear to have been incorporated into the actual management regime that is proposed. The comments set forth below address several portions of the discussion in the order in which they appear and are meant to illustrate the need to modify the discussion to better reflect a conservative, ecosystem-oriented approach.

Page 02:

① The statement at the bottom of the page indicates that the Plan forms the major component of an environmental impact statement "which assesses the effect that implementation of this Plan is expected to have on the environment of the region ...". However, the discussion on page 153 indicates that the authors of the document were "unable to predict the long-term effect on the ecosystem of the current, single species management strategies ..." which form the basis of the Plan.

Pages 03-04:

② In light of this inability to predict the long-term effect of the management strategies, it would appear that there is no basis for confidence that the Plan meets the goal of avoiding irreversible or long-term adverse effects upon fishery resources and the marine environment which is included in paragraph 1 on page 04. Similarly, with respect to the secondary objectives that are identified, we have been unable to find any evidence in the Plan or discussion that the allowable catch limits established by the Plan are based upon "due consideration of other impacted resources" as suggested in paragraph (b) on page 03 or that fishing strategy has been designed "to have minimal impact" on the environment as suggested in paragraph (f) on page 04.

③ Finally, the document contains numerous statements indicating the inadequacy of available data on the effects of single species management strategies upon the ecosystem and its various components. Notwithstanding these statements, the management Plan does not appear to include a margin of safety in the determination of allowable biological catches or a mechanism for accessing information and research to remedy the inadequacies, in accordance with the objectives identified in paragraph (e) on page 04.

Page 05:

④ Although the discussion of the determinants of catch levels indicates that ecological objectives, such as preventing adverse impacts upon marine mammals and other associated species, are to be included in the determination of the acceptable biological catch (ABC), the discussion of ABC considers only the dynamics of the target species. The discussion in the remainder of the document appears to make no adjustment in ABC to account for impacts on other species.

⑤ The discussion of optimum yield (OY) indicates that it, in turn, may deviate from ABC for purposes of ecological objectives but, again, there is no evidence that there have been any adjustments for such reasons. As you know, the goal of maintaining marine mammals at optimum sustainable population levels is established by the MMPA and, as such, should be considered an ecological objective "established by law" under the criteria discussed in paragraph (d).

Page 104:

The discussion of the socio-economic characteristics of the domestic commercial fishery indicates that the total

⑥ domestic commercial catch "is believed to have been no more than 1,500 mt tons in any recent year." Although we recognize that it is not the only relevant consideration, the fact that the total domestic catch amounts to only 10% of the total catch permitted by the Plan indicates that reduction in the total permissible catch to account for uncertainties and other factors in the determination of OY, as suggested below, would not be apt to result in a significant impact upon the domestic fishery.

Page 133:

⑦ Here, again, the discussion indicates that fishery-induced changes in the abundance and distribution of one species affect the abundance and distribution of other species and that "single species population dynamics" approaches are no longer fully adequate for modern fisheries management." We are, however, unable to determine what, if anything, has been done to account for such changes by adjusting the OY levels.

Page 143:

② Some of the information concerning marine mammals which is contained in Table 22 is erroneous or misleading. Walrus do not feed on salmon; harbor seals do not, to our knowledge, feed extensively on the benthos; bearded seals do not, to our knowledge, feed extensively on fishes; and ringed and ribbon seals are not ecological equivalents as is suggested by grouping them together. The discussion should be supplemented with an explanation of how these estimates of consumption levels were derived to provide a basis for evaluating their utility and reliability.

Page 151:

⑨ The discussion on previous pages of the document have indicated the inadequacies in the biological data base concerning the potential effects of fishery-induced changes on both target and associated species. The discussion in the last paragraph of this page recognizes the need for a conservative approach and suggests that catch levels can be set at levels that are equal to or less than the low end of the MSY/EY ranges and that catch levels so established can be "considered relatively free from the risk of overexploitation." Our review of Table I.1 on page I-2 indicates that the OY has been set at less than EY only for "other included species" and that it is set at or above the low end of the range of MSY values in all but one case. Moreover, the document

contains no explanation of the rationale supporting the determination that exploitation of stocks of fish at MSY levels will be free from the risk of "overexploitation", especially if that term is intended to include, as it should, exploitation at levels that result in adverse impacts upon associated species.

Page 153:

⑩ As noted earlier, the discussion in the last paragraph on the page indicates that the authors of the document are unable to predict the long-term effect on the environment of the current, single species management strategies which form the basis of the OY determinations in the Plan. This discussion provides additional reason to question the determination set forth on page 151 that exploitation at MSY levels is "relatively free from risk". The discussion should, at least, be modified to more adequately explain what is meant by "relatively free from risk" and to identify the known risks associated with the management strategies that are proposed.

Page 155:

⑪ This discussion of the MMPA illustrates the need to modify the discussion and Plan to reflect and account for the fact that there is a complex relationship between target species of fish, marine mammals, and other associated species in the ecosystem and that the maintenance of the integrity of that relationship is the primary objective of the MMPA and a goal of the FCMA.

The brief discussion on this page suggests, without supporting documentation, that restrictions on killing or harassing seals and sea lions results in an "unknown but probably significant economic loss to setline fishermen", that "large numbers" of seals and sea lions often congregate around trawlers and have been observed attacking halibut, salmon, and crabs, and that the maintenance of large populations of marine mammals -- seals, sea lions, porpoises, and whales -- has a profound impact on the abundance of commercial fish species. The discussion should be supplemented not only to provide more supporting information for these statements, but also to recognize and discuss the obvious fact that maintenance of substantial fisheries may well have had and most probably will have a profound impact upon the abundance of marine mammals that are dependent upon those fish. This, among other issues, is precisely the kind of balancing question that the discussion on page 144 identifies. There is no indication, however, that the authors recognized

the need to strike a balance or attempted to determine the relevant factors that must be weighed in achieving it. The discussion should be modified to articulate what, if anything, is proposed with respect to marine mammals and how implementation of the Plan is expected to directly or indirectly affect marine mammals in the area.

Page 163:

(12) This discussion indicates that "having identified no social or economic reasons for reducing the yield of stocks in this fishery below ABC, Optimum Yield for all species will be considered equal to ABC ...". As noted above, the applicable law and the preceding discussion itself clearly indicate that ecological considerations may dictate setting OY at less than ABC. The discussion ignores those considerations as relevant criteria in determining OY and also ignores the discussion in other portions of the document that identify reasons for reducing the yield below ABC levels. The point is that even if there are no social or economic reasons for reducing the yield, there are clear ecological reasons which have already been identified.

Page 195A:

(13) For the reasons set forth above, we believe that the statement in the second paragraph that the management regime is considered to be in conformance with the seven national standards set forth in Section 301 of the FCMA is unsupported and contrary to the discussion in other portions of the document.

Pages 196-198:

(14) The discussion of research needs is confined to a total of less than three pages, all but the last paragraph of which address research on target species of fish, notwithstanding the need for consideration of the associated species and the ecosystem which is acknowledged at various places throughout the document. This discussion should be supplemented to include a list and discussion of specific information needs and a detailed description of the studies (including priorities, methodology, and time schedules) needed to effectively assess and monitor the impacts of the Plan and other factors on the status of non-target species and the ecosystem itself.

Pages 200-204:

(15) As further evidence of the need for a more intensive, integrated approach to the development of an ecosystem-oriented management plan and assessment of its potential impacts, we note that it appears that only one of the listed references deals with marine mammals and that it deals only with the Alaskan fur seal industry through 1950.

Pages 223-224:

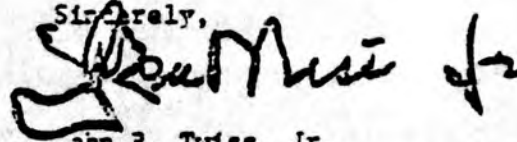
(16) The discussion of the unavoidable adverse impacts of the proposed action and alternatives to it, the discussion of the relationship between local short-term use and maintenance and enhancement of long-term productivity, and the discussion of irreversible and irretrievable commitments of resources should all be modified in accordance with the comments set forth above. These modifications should include, but not be limited to, a consideration of alternatives to the proposed action other than continuation of a preliminary fishery management plan. Management by a PFMP does not appear to be the only alternative consistent with the FCMA. It seems to us that OY can and should be reduced so as to account for the effects of fishery-induced changes on target and associated species and the uncertainties relating thereto. The discussion should evaluate the relative value of various adjustments in OY for the several target stocks and clearly explain the reasons for any determination that such adjustments are not consistent with the FCMA.

Conclusion

(17) In summary, the Commission feels that the Plan has not been developed from an ecosystem perspective, that the calculations of allowable catch levels have not included adequate consideration of the complex interactions among ecosystem components, and that required research may be inadequate either to identify optimum yield levels or to detect adverse impacts on target species, dependent species, associated species, or the ecosystem(s) of which they are a part. Consequently, we are concerned that implementation of the Plan, as presently formulated, may result in the depletion of one or more target, dependent, or associated species. While we recognize that available data and theory are inadequate to construct a fully reliable ecosystem model, we do feel that available data and theory have not been fully and adequately considered. Therefore, we recommend that relevant data and theory be re-evaluated to better identify uncertainties associated with the lack of knowledge or understanding and that the allowable catch levels be adjusted, as necessary, to reflect the degree of uncertainty concerning the possible first order and second order impacts of multi-species harvesting on target species, dependent species, associated species, and the ecosystem(s) of which they are a part.

I hope that these comments are helpful. Should members of your staff have any questions concerning either the comments or recommendations, I would suggest that they get in touch with Dr. Robert J. Hofman, the Commission's Scientific Program Director, (202/653-6237).

Sincerely,

A handwritten signature in dark ink, appearing to read "John R. Twiss, Jr.", with a stylized flourish at the end.

John R. Twiss, Jr.
Executive Director

MARINE MAMMAL COMMISSION COMMENT RESPONSE

General Comments

Response

1

The integrated, ecosystem approach to management of the fishery to be conducted in the Bering Sea/Aleutian area is a requirement of both the FMA and the MMPA. Such an approach is thought to allow the conservation of fishery resources at optimum yield levels and marine mammals at optimum sustainable population levels. While one may debate the wisdom of creating biological conflicts which would appear to inhibit fisheries development for the purpose of enhancing marine mammal populations, the integrated approach is not yet sufficiently developed to the point where the appropriate model can be relied upon for resource management. It is stated (Sec. 10.2, p 130) that such development is from 3-5 years in the future. The FMP is developed, on the basis of available information and research methods, for the conduct of a fishery that will retain balance among the various fish components, be generally conservative and not be detrimental to current marine mammal populations.

Specific comments

1

The assessment of the effect of the implementation of the plan on the environment is made on page 128 (9.7). Given the present effort level which is known, the anticipated level based on surveys taken and the condition of fish stocks present, the short-term outlook is described as "good".

The long-term effects on the ecosystem are not possible to predict with the single-species management strategies in use. The generally conservative nature of the FMP with respect to the ABC's of individual species is thought to allow the development of a domestic fishery on a scale which will allow the development of the integrated ecosystem approach to more accurately predict the interactions of the fishing effort.

2

See below

3

Refer to Sec. 10.2, p 130. ("The manner in which MSY, EY and ABC were derived for each fish stock... has indirectly taken into consideration the volume of fish needed by marine mammals for their sustenance. For example, natural mortality of fish stocks is taken into consideration...(and)...includes the predation component by marine mammals.")

Specific Comments

Response

4

Where the comment is applicable to the effects of the stated ABC of species on the various marine mammals, the optimum sustainable population has not been clearly determined. Without an estimate of the eventual, optimum sustainable population of the seven marine mammals present in the fishery, the determination of ABC for fish species must be predicated on the best information available. In this case, one of the considerations in the setting of ABC is the marine mammal population trend. Marine mammal experts at the Northwest & Alaska Fisheries Center say trends show the level of six species (fur seals excepted) to be above the lower level of OSP. Fur seals may be at or above that level. Having the range for OSP for the marine mammals would be of good value in the determination of ABC for specific fish species.

5

The authors are aware of the ecological objective established by law (MMPA) of maintaining marine mammals at optimum sustainable population levels. The problem posed is the biological conflict which appears to inhibit fisheries development for the purpose of enhancing marine mammal populations (see Response #1 under General Comments): the resolution of OSP for mammals would be a constant with which to work as this conflict is dealt with.

6

The argument that the domestic catch has only been 10% of the allowable catch stated in the FMP, and that a reduction in the total catch permitted can be made, presumably to benefit marine mammals, without interfering with the development of the fishery, fails to take into account the initial assessment of ABC which includes mortality by mammal predation. Past-year averages are a poor indicator of present processor intent.

7

OY levels take into account fishery induced changes in the abundance and distribution of species. MSY is a function of past catches and takes into account trends of distribution and abundance.

8

The Plan Development Team solicited expert advice from the Marine Mammal Division of the Northwest and Alaska Fisheries Center, Seattle, on distribution and migration, abundance and trends, feeding habits and problems induced by fisheries. An ecosystem simulation model is being developed to determine the effects of fisheries interaction on marine mammals; better information from marine mammal experts would result in refining the model for management purposes. (Ref. Sec. 10.2., p 130, FMP).

Specific Comments

Response

9

The stated OY's indicate the considered, conservative approach necessary, utilizing the best available information, to conduct the fishery with adequate safeguards against depletion risks for target and associated species.

10

The term "relatively free from risk" is taken to mean that the fishery will be conducted in a manner that will retain balance among the various fish components, be generally conservative according to information known concerning the fishery, and not be detrimental to current marine mammal populations. The word "relatively" within the term indicates an awareness of the lack of baseline biological data from which to deduce biological certainties. It is hoped that the single species management strategies which form the OY basis can, at some future date, give way to the integrated ecosystem strategy which will allow the general use of the term "free from risk," thereby indicating a level of confidence in the FMP conclusions which is not at this time available.

11

See revised Sec. 10.2, pp 129-134. Supporting documentation could conceivably be derived from fishermen interviews to account for the statement that seals and sea lions congregate around trawlers. As for the maintenance of large populations of marine mammals and their effect on the abundance of commercial fish species, marine mammal experts have said that an adult harbor seal can weigh 300 lbs., a bull Steller sea lion nearly a ton (2,000 lbs), and each eats 5 to 7% of its body weight daily. Other statistics are available. As for the economic loss to fishermen, it is estimated by the State of Alaska, Department of Fish and Game, that the statewide dollar loss to fishermen's gear is nearly \$1 million. Estimated damage can include lost time from fishing in addition to gear destruction.

12

As stated in the FMP, the effect on marine mammals of the implementation of the plan should be beneficial since the total catch is set below previous years, thereby leaving more fish for the mammals.

See #13 response

General Comments

Response

13

The comment refers to ecological considerations which may dictate setting OY at less than ABC. If the presence of marine mammals in the fishery management area is one of those considerations, every attempt has been made to gather and assess information concerning that presence and to include that assessment in the determination of MSY, ABC, EY and OY.

14

If the ecological reasons include those of a possible but non-predictable nature, ranging from abnormal to cataclysmic, no method has yet been devised to deal with possible eventualities. The FMP conforms, so far as can be determined, to the national standards set forth in Sec. 301 of the FMA.

If it were possible to identify specific information needs and to detail a description of the studies, including priorities, methodology and time schedules, needed to effectively assess and monitor the impacts of the plan and other factors on the status of non-target or associated species and the ecosystem, the modeling for the integrated ecosystem approach would be complete and there would be no questions, only answers. As stated in the FMP, Sec. 10.2, p. 130, that development is 3-5 years in the future.

15

Refer to revised Sec. 10.2 and Annex V.

16-17

The Plan Development Team is aware of the concern in the Marine Mammal Commission members comments that the fishery management plan not incorporate into the proposed conduct of the fishery, any measures which would result in the diminution of marine mammal stocks. The plan has been drawn using the single species management strategy pending the development and refinement of more precise research and management methods. The present state of the art does not allow the development of a plan based on an integrated ecosystem model which replaces the present tentative, conservative approach with a more positively dynamic statement.

-End-

Clément V. Tillon, Chairman
Jim H. Branson, Executive Director

Suite 32, 333 West 4th Avenue
Post Office Mail Building



Mailing Address: P.O. Box 31300
Anchorage, Alaska 99510

Telephone: (907) 274-4563
FTS 265-5435

F36

September 4, 1979

Mr. William G. Gordon, Director
Office of Resource Conservation & Management
National Marine Fisheries Service
3300 Whitehaven Street, Page #2
Washington, D.C. 20235

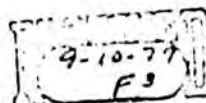
Dear Bill:

I am enclosing the revisions to the Fishery Management Plan for the Groundfish fishery of the Bering Sea/Aleutian Island Area (FMP) approved by the Council on August 24th. They are being submitted in the form of errata changes requiring replacement of full pages in the plan you are currently reviewing. I believe that these revisions respond fully to your comments and objections to the plan as originally submitted for Secretarial review.

The section on domestic annual harvest has been completely revised. Since we had no new figures to work with for the 1980 plan year we continued to use the original figure of 24,600 mt for DAP. In addition we have established two more categories within DAH; the nonprocessed market (DNP) and expected joint venture processing needs (JVP). Annex II, pages A-58 through A-59c fully explain the derivation of those figures and establish DAH at 56,100 mt.

The procedure for deriving DAH and a new section providing for periodic reevaluation and release of DAH to TALFF during the plan year is found in Section 12.2. 'Expected Domestic Annual Harvest (DAH)' pages 150 and 150-A. Establishment of that evaluation and release procedure required a change in Section 13.2 'Total Allowable Level of Foreign Fishing (TALFF)' on page 151.

The preceding changes, combined with additional reporting requirements for U. S. processors, joint venture fishermen, and nonprocessed fish fishermen, found on page 157 of the revisions, should respond fully to P. L. 95-354. The reporting requirements in the plan are very general and are intended to be supported by regulations similar to those proposed in the Secretary's amendment to the Gulf of Alaska Groundfish FMP. The Council does not expect the regulations to be very specific on the types of information that must be reported by American processors. They feel that the present system of canvassing American and joint venture



processors, combined with fishermen interviews and village surveys, will be adequate for estimating future DAH needs, particularly when they can be combined with the current catch reporting system established by the plan so that past performance can be accurately measured. To date, of course, there is little or no past performance to be reviewed so surveys will continue to be important in the near future.

The revision of Section 14.3.2.3 A(1) 'Area Closures,' permits joint venture processing operations to within three miles of the baseline from which the territorial sea is measured.

The ABC/OY for "other species" has been raised from 55,500 mt to 74,248 mt. No change was considered necessary in MSY which remains at 89,400 mt. The language affecting these changes is in Annex I.11 'Other Included Species ("Others").' Since it appears that calculating the OY for "others" at 4% of the combined ABC for specified species might conflict with the attainment of the OY's for some of the target species, and recognizing that the category "other" can sustain a catch at least as high as 4% of total MSY, the scientists consider it safe to base ABC for "others" on 5% of the combined ABC for specified species, rather than the 4% originally provided in the plan.

In addition to raising the ABC for "others" the revisions establish a fourth category of species, hereafter referred to as "nonspecified species." That concept is explained in Section 11 'Optimum Yield (OY),' pages 140 through 140b and in Annex VI (new), page A-81. It should be noted that the listing of nonspecified species in Annex VI is not exclusive. Those groups listed are intended to serve as examples of those found in this category. Removal of these groups from the category "other" increases the amount of "other" species that can be caught in the process of attaining OY for a targeted species.

In summary, we have redefined DAH and the reporting requirements to respond to P. L. 95-354; added a review and release mechanism for DAH during the plan year, similar to that now used for reserve; allowed joint venture processing within 12 miles but outside of 3 miles; established a higher ABC for "other species" so that the incidental catch of those species will not hamper the attainment of allocations for other species; and established a fourth category under OY to be called "nonspecified species."

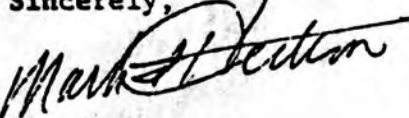
These revisions to the FMP were reviewed by the Scientific and Statistical Committee and the Advisory Panel and were the subject of considerable comment during a public hearing period at the Council meeting. They were advertised in the Federal Register, in the news media and in a Council Newsletter sent out prior to the Council meeting.

We will work closely with NOAA General Counsel in developing the regulations to implement these revisions. Some of the plan revisions are left deliberately vague so that there is some latitude allowed in the regulatory process. The reassessment and release of DAH is described as periodic

in the FMP. The Council felt that tying the Regional Director to a bi-monthly or other review schedule was not particularly necessary but would have no objection if the regulations specified exact times and release procedures within those guidelines set out in the plan.

Please continue your review of this FMP. The proposed schedule in your letter of August 21, 1979 will be great if we can attain it.

Sincerely,



for: Jim H. Branson
Executive Director

Enclosures

cc: Terry Leitzell, AA
Roland Finch, F
Harry Rietze, FAK
H.A.Larkins, F111
Richard Marasco, F111

**ERRATA FOR THE GROUND FISH FISHERY
IN THE
BERING SEA/ALEUTIAN ISLAND AREA**

Page 140 - 11.0 Optimum Yield (OY)

1. Remove both paragraphs
Insert new material as pages 140, 140a, 140b.

Page 150 - 12.2 Expected Domestic Annual Harvest (DAH)

1. Remove page 150
Replace with change 1, page 150 and 150a

Page 151 - 13.2 Total Allowable Level of Foreign Fishing (TALFF)

1. Remove page 151
Replace with change 1, page 151

Page 157-58 - (14.3.1.5 Statistical Reporting Requirements)

1. Remove page 157-158
Replace with change 1, page 157 and insert original
page 158

Page A-2 - Table I-1

1. Remove Page A-2
Replace with change 1, page A-2, Table I-1

Page A-55 - I.11 Other Included Species ("Others")

1. Remove Page A-55
Replace with change 1, page A-55

Page A-58 - Annex II (Title Page)

1. Remove Page A-58
Replace with change 1, page A-58

Page A-59 - Annex II

1. Remove page A-59
Replace with change 1, page A-59, A-59a, and A-59b

Page A-60 - Annex III

1. Remove page A-60 (Table)
Replace with change 1, page A-60 (Table)

Page A-81 - (new page)

1. Add new page A-81 - Annex VI - establishing
4th category of species "Unspecified"

Page vi - (Table of Contents)

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ANNEX VI -- SPECIES CATEGORIES WHICH APPLY TO THE BERING
SEA/ALEUTIAN GROUND FISH FISHERY.