MEMORANDUM

TO: Council, SSC and AP Members

FROM: Clarence G. Pautzke
Executive Director

DATE: December 2, 1999

SUBJECT: Final GOA Groundfish Specifications for 2000

ESTIMATED TIME
8 HOURS
(for all D-1 items)

ACTION REQUIRED

(c) Review 2000 GOA EA and Stock Assessment and Fishery Evaluation (SAFE) document.
(d) Approve final GOA groundfish and bycatch specifications for 2000.
(e) Approve halibut discard mortality rates.

BACKGROUND

At this meeting, the Council sets final recommendations for groundfish and bycatch specifications. The final SAFE report, groundfish OFLs, ABCs and TACs, bycatch apportionments, and halibut discard mortality rates need to be approved. These final specifications will be used for managing the 2000 groundfish fisheries and will supercede the Council's preliminary specifications upon implementation.

(c) GOA SAFE Document

The groundfish Plan Teams met in Seattle during the week of November 15-19 to prepare the final SAFE documents provided at this meeting. This SAFE report forms the basis for final groundfish specifications for the 2000 fishing year. The final GOA SAFE contains the Plan Team's estimates of biomass, OFLs, and ABCs for all groundfish species covered under the FMP and information concerning PSC bycatch to provide guidance to the Council in establishing PSC apportionments. The attached tables from the SAFE report lists the Plan Team's recommended 2000 ABCs and corresponding OFLs for each species or species complex. Item D-1(c)(1) contains the minutes of the GOA Plan Team meeting.

(d) Final ABCs and TACs

At this meeting the SSC and AP will provide recommendations on ABCs and TACs to the Council and the Council will establish final catch specifications for the 2000 fisheries. Tables 1-4 from the SAFE summary chapter listing groundfish OFLs and ABCs are attached as Item D-1(d)(1). The Plan Team's sum of recommended ABCs for 2000 is 451,000 mt, a decrease of approximately 81,500 mt from the total ABCs of 532,590 mt in 1999.

Overall, the status of the stocks in the Gulf of Alaska continues to be relatively favorable, although some stocks remain below target stock size. The Plan Team recommended the same ABC for pollock (103,020 mt) in 2000 as was recommended in 1999. It recommended a lower ABC of 76,400 mt for Pacific cod, compared to 84,400 mt in 1999. ABC recommendations for flatfish decreased slightly, with the exception of rex sole and flathead sole, which increased slightly. Slope rockfish recommendations were also adjusted only slightly. Both PSR and thornyhead rockfish recommendations increased from 4,880 mt and 1,990 mt in 1999 to 5,980 mt and 2,360 mt in 2000, respectively. The DSR ABC recommendation decreased from 560 mt in 1999 to 340 mt in 2000. The sablefish recommended ABC increased to 13,400 mt. Arrowtooth flounder decreased by about 7% from 217,100 mt in 1999 to 145,360 mt in 2000. Catches totaled approximately 74% of the 1999 TAC, as of December 2, 1999.

TAC considerations for State waters Pacific cod fishery

Beginning in 1997, the Council has reduced the GOA Pacific cod TAC to account for removals from the State P. cod fisheries. In December 1998, the Council allowed for the automatic increase in the Kodiak and Chignik subareas and reduced the Central area TAC accordingly. The Council also allowed for the automatic increase in the South Alaska Peninsula and consequently reduced the Western area TAC.

According to ADF&G, the South Alaska Peninsula likely will take its full allocation in 1999, and will automatically ramp up in 2000 to 25% of the Federal ABC for the Western area (Item D-1(d)(2)). Cook Inlet, Kodiak, Chignik, and Prince William Sound are predicted to not attain their GHLs in 1999. Using the projected increase in the state water GHL for the Western area and the Plan Team's recommended ABC for 2000, the federal TAC for P. cod would be adjusted as listed at right.

1999 Gulf Pacific cod ABC, TAC and State guideline harvest level (mt).

Specifications	Western	Central	Eastern	Total
ABC	29,540	53,170	1,690	84,400
BOF GHL	5,910	10,235	420	16,565
(%)	20	19.25	25	19.6
TAC	23,630	42,935	1,270	67,835
	Cook Inlet	1,196	2.25%	
	Kodiak	5,317	10.00%	
	Chignik	3,722	7.00%	
	Central	10,235	19.25%	

2000 Gulf Pacific cod ABC, TAC and State guideline harvest level (mt).

Specifications	Western	Central	Eastern	Total
ABC	27,500	43,550	5,350	76,400
BOF GHL	6,875	8,384	1,338	16,597
(%)	25	19.25	25	21.7
TAC	20,625	35,166	4,012	59,803
	Cook Inlet	980	2.25%	
	Kodiak	4,355	10.00%	
	Chignik	3,049	7.00%	
	Central	8,384	19.25%	

PSC Limits for Halibut

The PSC limits for halibut in the Gulf of Alaska in 1999 are:

Trawl gear			Hook and Line		
1st quarter	600 mt	(30%)	1st trimester	250 mt	(86%)
2nd quarter	400 mt	(20%)	2nd trimester	15 mt	(5%)
3rd quarter	600 mt	(30%)	3rd trimester	25 mt	(9%)
4th quarter	400 mt	(20%)	DSR	10 mt	
	2,000 mt			300 mt	

Trawl apportionments

Quarter	Shallow water Complex	Deep water Complex	Total
1	500 mt	100 mt	600 mt
2	100 mt	300 mt	400 mt
3	200 mt	400 mt	600 mt
4	No apportionment		400 mt

(e) Halibut Discard Mortality Rates

The GOA and BSAI SAFE reports contain recommendations by IPHC staff for managing halibut bycatch in 1999. Item D-1(e)(1) lists the IPHC recommendations for setting discard mortality rates for the 2000 fishery in the BSAI and GOA. Gregg Williams, IPHC, will present this report.

GOA Plan Team Meeting Minutes
November 16-19, 1999

Sandra Lowe (NMFS-AFSC, Chair)	*Jim Ianelli (NMFS-AFSC)*
Bill Bechtol (ADF&G)	*Tory O'Connell (ADF&G)*
Jeff Fujioka (NMFS-ABL)	*Tom Pearson (NMFS-AKRO)*
Lew Haldorsen (UAF)	*Farron Wallace (WDF)*
Jon Heifetz (NMFS-ABL)	*Gregg Williams (IPHC)*
Dave Jackson (ADF&G)	*Nicole Kimball for Jane DiCosimo (NPFMC)*

EGOA Split. The Chair reviewed last year's recommendations to separate Eastern Gulf area ABCs for some species for West Yakutat and East Yakutat/Southeast Outside as a result of the 1998 trawl prohibition east of 140 degrees W. Concern about disproportionate removals from West Yakutat by trawl gear prompted the recommendations for splits. In 1998, the Team considered a range of splits for POP and PSR, including the point estimate and the upper 95% confidence interval. To calculate the 2000 ABCs, the Team decided to use point estimates for DWF, SWF, rex sole, sablefish, ATF, flathead sole, and OSR and the upper 95% confidence interval for POP and PSR.

1999 GOA Survey. The Chair noted that there were no changes in the 1999 survey design. However, changes in effort allocation may impact the east/west split in the Gulf, and species with highly aggregated populations may have greater variances (pollock, POP). Michael Martin briefed the Team on the survey design changes, noting that although the survey was done about 2 weeks earlier and ocean temperatures were colder than in previous years, there is no general explanation for some unusually large tows which resulted in large variances in biomass estimates.

BSAI Pollock. The GOA Plan Team sat in on the BSAI pollock presentation and agreed that although useful, it is probably not necessary to sit in every year.

Research Priorities. The Team was asked to compile research priorities throughout the Plan Team meeting. These priorities are listed in a separate document.

Pollock. Michael Martin presented the results of the 1999 trawl survey and the results derived from the current assessment model. Projected exploitable biomass for age-3+ pollock in 2000 is 588,000 mt. Seventy percent of the trawl survey biomass came from the Shumagin area, mostly from one unusually large tow. About 20% and 10% came from Kodiak and Chirikof, respectively. The survey also noted a high density of juveniles in a small area of Southeast. The author stated that the Team has seen distributional variation between the Shumagin and Kodiak areas in previous years, although not to this extent. The bottom temperature was also colder than in previous years; 2 degrees colder in shallow areas (<200 m) in the Shumagin area, with a less significant change in Chirikof and Kodiak. The author noted that cooler temperatures may signify patchier distribution, but the general effects are unknown.

The Team evaluated the stock assessment model and discussed the current trends. Stock size has declined, as expected. The model projected recruitment based on 1977-1998 recruitment estimates.

High recruitment was observed in 1972, and there have been strong year classes every 4-5 years since. After 1982, recruitment is fairly consistent. The Team discussed using either *average* or *current* estimates of recruitment to determine $B_{40\%}$, since using years of high recruitment (1979 and 1980) will result in a more conservative $B_{40\%}$. Using a shorter time series would lower $B_{40\%}$ and increase the fishing mortality rate.

The author recommended the maximum permissible harvest rate of $F_{40\%}$ adjusted = 0.34, with a recommended ABC of 111,306 mt. The Team disagreed, stating a strong concern with increasing the ABC with a declining stock. They discussed reasons to use a more conservative rate, primarily because the stock continues to decline and biomass is at the lowest level ever recorded, with no signs of significant recruitment. Coupled with the large variability around the biomass estimate from the 1999 trawl survey, the Team felt it was inappropriate to increase the ABC relative to 1999. The Plan Team recommended the 1999 ABC of 94,400 mt be applied as the 2000 ABC for the Western/Central area. The author also presented the option of using an $F_{45\%}$ harvest rate, which is fairly close to the 1999 ABC. After much discussion, the Team agreed that debate about using $F_{45\%}$ or the 1999 ABC is inconsequential, since the yields were almost equivalent. To avoid the unintended significance of using an $F_{45\%}$ harvest rate, the Team chose the 1999 ABC of 94,400 mt for the Western/Central area, and the 1999 upper 95% confidence interval of 2,160 mt for Western Yakutat, resulting in a Western/Central/West Yakutat combined ABC of 96,560 mt. The 2000 OFL is based on an $F_{35\%}$ adjusted rate of 130,758 mt.

In Eastern Yakutat/Southeast Outside, the Plan Team concurred with the author's recommendation for ABC (6,460 mt) and OFL (8,613 mt) based on Tier 5 calculations. Actual pollock catch in EY/SEO did not exceed 100 mt during 1991-1998.

Apportionment in Western/Central received much discussion. In past years, the Team used the most recent triennial survey biomass estimate. Because the 1999 survey had such high variances due to an unusually large tow in Shumagin, the author recommended using an unweighted average of the last 4 surveys (covering a 12-year period) to find an equilibrium by which to apportion pollock. The Team agreed that until we have better biomass estimates and explore alternative weighting schemes, an unweighted 4-survey average is appropriate. This method results in an apportionment of: Shumagin 41% (39,590 mt), Chirikof 24.4% (23,560 mt), Kodiak 32.1% (31,000 mt), and West Yakutat 2.5% (2,410 mt). The Team also agreed that since the PWS biomass was included in the assessment, it would be appropriate to take the PWS harvest level off the top of the Western/Central/West Yakutat ABC of 96,560 mt. Preliminary estimates of the PWS harvest are approximately 1,420 mt. The Team did not adjust the ABC as they did not have a final PWS harvest level.

Pacific Cod. The assessment author presented the methodology for calculating an ABC for Pacific cod that would incorporate the following new information: size composition data from the 1999 GOA bottom trawl survey; size composition data from the 1998 and January-August 1999 commercial fisheries; biomass estimate from the 1999 GOA bottom trawl survey; and weight-at-length data from recent GOA bottom trawl surveys. Both the model and the1999 trawl survey suggest spawning biomass is declining; the survey biomass estimate of 305,823 mt is down about 43% from the 1996 survey estimate. Maximum permissible values of ABC and OFL under Tier 3a are the $F_{40\%}$ and $F_{35\%}$ yields, 86,000 mt and 102,000 mt, respectively.

The author used a Bayesian meta-analysis to obtain a recommended 2000 ABC of 76,400 mt. In 1999, the author recommended an ABC of 84,400 mt, but the Plan Team chose an ABC of 77,900 (the previous year's ABC) because the assessment indicated a decreasing stock trend. Using the same model, this year's assessment also estimates a decreasing stock trend, but the Plan Team concurred with the recommended ABC of 76,400 mt, as it does not represent an increase over last year's ABC.

The author noted that if the TAC is to be distributed between regulatory areas in proportion to the biomass estimates from the most recent trawl survey, the proportions are: Western-36%, Central-57%, and Eastern-7%, resulting in area ABCs of 27,500 mt, 43,550 mt, and 5,350 mt, respectively.

The Team also discussed a general request to include observer data (catch) in the assessment tables in order to compare the TAC with reported catch. It was noted that observer data would not necessarily represent fleet-wide behavior.

Flatfish. The 2000 exploitable biomass for each category of flatfish is based on abundance estimates from the 1999 triennial trawl survey. For 2000, ABCs were determined by applying Tier 5 calculations (ABC = 0.75M) to all but rock sole (Tier 4), deepsea sole and Greenland turbot (both Tier 6). The rock sole ABC, separated into Northern and Southern rock sole, was estimated using $F_{40\%}$ calculated using the Bering Sea rock sole maturity schedule. The ABC for Dover sole was estimated using the 1999 survey biomass, which is more appropriate than the 1996 survey, which did not cover the population depth range of Dover sole (to 1000 m). The author noted that the survey showed most flatfish biomass was found at depths of 100-200 m.

The Team concurred with the authors' recommendations for ABCs for each group, with the area apportionments to the Western, Central, and Eastern Gulf estimated by applying the average fraction of the catch in each area from 1991-1995. The Eastern Gulf split was calculated using the point estimates from the 1999 survey biomass estimates.

Arrowtooth Flounder. The model was revised in the way it accounts for higher proportions of females in the larger size intervals. The past model used different selectivities for males and females as size increased. The present model raises the natural mortality of males higher than that of females, from 0.2 to 0.35, to better fit the sex ratio pattern actually observed in both the Bering Sea and the GOA survey and commercial catches. The Team agreed that, rather than a selectivity issue, the difference is due to the actual population ratio and the increasing fraction of females with age. This change to the model is primarily responsible for the significant drop in the exploitable biomass estimate for 2000 (1,289,000 tons from 2,126,714 tons in 1999). The Team concurred with the authors' ABC recommendation of 145,360 mt ($F_{40\%}$ = 0.134) and recommended that area apportionments be based on biomass distributions in the 1999 trawl survey.

Slope Rockfish. The assessment authors noted that both POP and northern rockfish biomass estimates had high variances due to a couple unusually large tows in the 1999 survey. One haul in the

Chirikof area had a 16 mt catch of POP. (All other areas showed a substantial decline in POP survey biomass estimates compared to the 1996 survey.) These large catches are responsible for the high variance associated with the Gulfwide biomass estimate (CV = .53).

Pacific Ocean perch. The authors presented and chose a model that treated survey biomass as an index of abundance rather than absolute abundance to determine Pacific ~~O~~ocean perch ABC. Biomass estimates and size composition data from the 1999 trawl survey and size composition and catch from the 1999 fishery were incorporated into last year's model. Survey catchability (q) was estimated in the current stock assessment at 2.97, higher than last year's q = 2.78. The Team debated the higher value of q, and agreed to look at the uncertainty of q for future assessments. The Team also discussed whether there was enough information in the 1999 survey to justify adjusting it from last year. The author noted that while the survey didn't reduce uncertainty in the biomass estimates, it did add size composition data. The Team agreed that using what little information the survey provided, by applying Model 3 as recommended by the authors, is appropriate as long as the Team recognizes the continued difficulty in setting ABCs with the current survey methodology. The Team discussed the need for better survey methods for rockfish and added it to the list of research priorities.

The Team concurred with the authors' recommendations for ABC and OFL, 13,020 mt and 15,390 mt, respectively, and also agreed with the Western/Central/Eastern apportionment, based on a weighted average (4:6:9) of the last 3 surveys. The Team agreed on the following recommended ABCs: Western-1,240 mt (9.5%), Central-9,240 mt (71.0%), and Eastern-2,540 mt (19.4%). The Eastern Gulf was further split between WY and EY/SEO, based on the upper 95% confidence interval for WY. The Team discussed exploring the use of alternative weighting schemes for future assessments, in order to account for large variances that may occur in an individual survey year.

Shortraker/rougheye rockfish. Current estimates of exploitable biomass from the average of the three most recent surveys are 22,480 mt for shortraker rockfish and 48,400 mt for rougheye rockfish. Applying the definitions for ABC and OFL places shortraker rockfish in Tier 5 and rougheye rockfish in Tier 4, resulting in ABCs of 520 mt for shortraker and 1,210 mt for rougheye. The Team recommended using a weighted average, as in the POP assessment, to apportion the ABC. The Team agreed that an Eastern split is unnecessary because it is a bycatch-only fishery and is harvested by both trawl and longline gear.

Northern rockfish. Instead of using the unweighted average of the three most recent surveys, the authors weighted the biomass estimates of the last three surveys by the inverse of the variances to determine current exploitable biomass (85,360 mt). The Team agreed that the uncertainty of the 1999 survey estimate warrants this methodology. The resulting ABC is 5,120 mt. Using the same method of apportionment as used for POP results in ABCs of 630 mt for Western, 4,485 mt for Central, and 5 mt for Eastern. The 5 mt of Eastern Gulf northern rockfish is combined with the WY ABC for other slope rockfish.

Sablefish. The combined sablefish stock assessment was reviewed during a joint session of the GOA and the BSAI but is reported in the GOA Team's minutes. The survey abundance index showed that sablefish increased 5% in weight and 10% in abundance relative to 1998. The authors constructed a probability curve on the odds of the year 2004 spawning biomass dropping below the 2000 projected level. They used this figure to evaluate the effects of different fixed harvest levels over a 5-year period. The authors recommended an ABC that corresponds to a 5-year constant catch scenario of 17,000 mt, although the maximum permissible F_{ABC} corresponds to a catch scenario of 17,300 mt. The decision analysis projected that using the more conservative harvest level over the next 5 years is likely to keep spawning biomass stable through 2004.

Uncertainty in the 1997 year class (the class appears large according to the recent survey) and low stock abundance were the primary considerations in setting the ABC. There was much discussion about the use of the probability figure and a decision analysis that evaluates one harvest scenario and accounts only for recent recruits. While the Team agreed that the risk assessment/probability approach taken by the author is a valuable tool, the Team was not ready to adopt it as a standard approach. However, the author recommended ABC value did not differ much from the maximum permissible F_{ABC} (Tier 3, $F_{40\%}$). The Team selected the $F_{40\%}$ adjusted rate that used the split gears for setting an ABC of 13,400 mt.

Apportionment has been based on a 5-year weighted average of survey data since 1993. By Council member request, the Team considered alternative apportionment schemes to determine whether they would have biological consequences. The Team did not have significant biological concerns with the following: survey-based apportionment; including fishery information/CPUE; or using a fixed-average method. The Team suggested that the exploitation of fish should be proportional to the distribution of fish, and because the 5-year weighted average based on survey data is currently the best estimate of distribution, it is appropriate to continue using this method. It was suggested that the Team examine the effects of using fishery data/CPUE to apportion the stock, and look at alternative models for calculating CPUE to reduce bias.

Pelagic Shelf Rockfish. The Team concurred with the authors' recommended ABC of 5,980 mt, which is more conservative than the maximum permissible F_{ABC} of 7,309 mt. The Team agreed that a more conservative harvest level is appropriate until there is a higher comfort level with the parameters and the assessment can move to an age-structured model. The Western/Central/ Eastern apportionment followed the same weighted 3-year survey method as in previous years, and the Eastern Gulf was further split using the upper 95% confidence interval.

Demersal Shelf Rockfish. The assessment author reviewed the changes in the estimates of rock bottom habitat: a 34% overall decrease, which lowers the biomass estimate by about 40%. The Team concurred that the area and biomass estimates will continue to change in the future, as we gain more information. The Team agreed that because of continued uncertainty in the biomass estimates and because that uncertainty is difficult to include in the assessment model, it is appropriate to continue using the lower 90% confidence interval as a reference number for setting ABCs. Mapping bottom habitat for the Gulf upper slope and shelf was added as a research priority.

Thornyheads. The 1999 NMFS survey was conducted in deeper water, resulting in a more representative sample of the current stock. The model did not change from last year, and while the 1999 survey estimates show an increase in stock abundance, the model suggests a stable or slightly declining trend. This discrepancy concerned the Team and they suggested the authors evaluate model runs where the 1999 biomass estimate was derived from only shallower tows, in order to provide insight on the significance of the deeper stations. The team noted the author's concern that there is no age composition data available for this species. The Team accepted the author's ABC recommendation of 2,360 mt. Apportionment was based on the 1999 survey estimate, and there was no split in the Eastern Gulf.

Atka Mackerel. The assessment authors reported that the trawl survey still does not provide a reasonable estimate for GOA Atka mackerel. Because none of the previous years' concerns have been alleviated, the authors continue to recommend a bycatch-only fishery, with an ABC of 600 mt. The Team examined the results of a Tier 6 ABC definition equal to 75% of the average catch from 1978-95 and determined that an ABC of 4,700 mt is inappropriate because there are no reliable biomass estimates and this species has exhibited vulnerability to fishing pressure in the past.

Other Species. There is currently no ABC recommendation for this category. The Team reviewed a proposal to separate ABCs for individual species, based on the concern that new directed fisheries could evolve and potentially deplete an individual species if they continue to be managed in the aggregate. Biomass from the 1999 trawl survey suggested that total biomass is increasing. The Team supported the idea of an FMP amendment to manage each species group separately, with the exception of octopus, and to add grenadiers to the list of managed species. The Team has concerns about setting an ABC for octopus because there is not a good biomass estimate due to the difficulty in surveying its habitat (nearshore and rocky). In the interim, the Team concurred with the author's recommendation of no directed fishing for any of the species. The Team suggested the Council consider placing the "other species" assemblage on bycatch status until the FMP amendment is in place.

The Plan Team also endorses the proposed alternative in Amendment 63 to prohibit the finning of sharks. Adoption of this alternative is consistent with the action the Council has taken previously with respect to improved utilization of pollock, Pacific cod, and shallow-water flatfish in the GOA.

Adjourn. The meeting was adjourned on Friday, November 19, 1999, at 11 am.

Table 1. Gulf of Alaska groundfish 1999 and 2000 ABCs, 1999 TACs, and 1999 catches reported through November 6, 1999. MSY is unknown for all species.

SPECIES		ABC (mt) 2000		ABC (mt) 1999	TAC 1999	CATCH 1999
Pollock	W (61)	39,590	W (61)	23,120	23,120	23,387
	C (62)	23,560	C (62)	38,840	38,840	38,135
	C (63)	31,000	C (63)	30,520	30,520	30,095
	WYAK	2,410	E	8,440	2,110	1,759
	EYAK/SEO	6,460			6,330	4
	TOTAL	103,020	TOTAL	100,920	100,920	93,380
Pacific Cod	W	27,500	W	29,540	23,630	23,154
	C	43,550	C	53,170	42,935	44,559
	E	5,350	E	1,690	1,270	857
	TOTAL	76,400	TOTAL	84,400	67,835	68,570
Deep water flatfish[1]	W	280	W	240	240	22
	C	2,710	C	2,740	2,740	1,865
	WYAK	1,240	E	1,720	1,720	389
	EYAK/SEO	1,070		1,350	1,350	9
	TOTAL	5,300	TOTAL	6,050	6,050	2,285
Rex sole	W	1,230	W	1,190	1,190	603
	C	5,660	C	5,490	5,490	2,391
	WYAK	1,540	E	850	850	41
	EYAK/SEO	1,010		1,620	1,620	22
	TOTAL	9,440	TOTAL	9,150	9,150	3,057
Shallow water flatfish[2]	W	19,510	W	22,570	4,500	252
	C	16,400	C	19,260	12,950	2,282
	WYAK	790	E	250	250	6
	EYAK/SEO	1,160		1,070	1,070	5
	TOTAL	37,860	TOTAL	43,150	18,770	2,545
Flathead sole	W	8,490	W	8,440	2,000	184
	C	15,720	C	15,630	5,000	680
	WYAK	1,440	E	1,270	1,270	16
	EYAK/SEO	620		770	770	11
	TOTAL	26,270	TOTAL	26,110	9,040	891
Arrowtooth flounder	W	16,160	W	34,400	5,000	3,656
	C	97,710	C	155,930	25,000	11,787
	WYAK	23,770	E	13,260	2,500	383
	EYAK/SEO	7,720		13,520	2,500	236
	TOTAL	145,360	TOTAL	217,110	35,000	16,062
Sablefish	W	1,960	W	1,820	1,820	1,487
	C	6,030	C	5,590	5,590	5,828
	WYAK	1,920	WY	5,290	2,090	1,704
	EYAK/SEO	3,490	EY/SEO		3,200	3,080
	TOTAL	13,400	TOTAL	12,700	12,700	12,099
Other Slope rockfish	W	20	W	20	20	40
	C	740	C	650	650	615
	WYAK	250 [3]	E	470	470	122
	EYAK/SEO	3,890		4,130	4,130	12
	TOTAL	4,900	TOTAL	5,270	5,270	789

(Table 1 continued)

SPECIES		ABC (mt) 2000		ABC (mt) 1999	TAC 1999	CATCH 1999
Northern rockfish	W	630	W	840	840	573
	C	4,490	C	4,150	4,150	4,825
	E	0 [3]	E			0
	TOTAL	5,120	TOTAL	4,990	4,990	5,398
Pacific ocean perch	W	1,240	W	1,850	1,850	1,935
	C	9,240	C	6,760	6,760	7,914
	WYAK	840	E	1,350	820	627
	EYAK/SEO	1,700		3,160	3,160	0
	TOTAL	13,020	TOTAL	13,120	12,590	10,476
Shortraker/rougheye	W	210	W	160	160	194
	C	930	C	970	970	577
	E	590	E	460	460	531
	TOTAL	1,730	TOTAL	1,590	1,590	1,302
Pelagic shelf rockfish	W	550	W	530	530	130
	C	4,080	C Inshore	3,370	3,370	3,835
	WYAK	580	C Offshore	740	740	672
	EYAK/SEO	770	E	240	240	20
	TOTAL	5,980	TOTAL	4,880	4,880	4,657
Demersal Shelf Rockfish		340		560	560	262
Atka Mackerel	GW	600	GW	600	600	262
Thornyhead rockfish		430	Western	260	260	282
		990	Central	700	700	582
		940	Eastern	1,030	1,030	410
	TOTAL	2,360	TOTAL	1,990	1,990	1,274
Other Species	GW	NA	GW	NA	14,600	3,735
TOTAL		451,100		532,590	306,535	227,044

1/ Deep water flatfish includes dover sole, Greenland turbot and deepsea sole.
2/ "Shallow water flatfish" includes rock sole, yellowfin sole, butter sole, starry flounder, English sole, Alaska plaice, and sand sole.
3/ The EGOA ABC of 5 mt for northern rockfish has been included in the WYAK ABC for other slope rockfish.

NOTE:
ABCs and TACs are rounded to nearest 10, except for Pacific ocean perch.
GW means Gulfwide.
Catch data source: NMFS Blend Reports.

Table 2. Gulf of Alaska 2000 ABCs and overfishing levels, and estimated trends and abundance for Western, Central, Eastern, Gulfwide, West Yakutat, and Southeast Outside regulatory areas.

		2000			
SPECIES		ABC	Biomass	Overfishing Level	Abundance,[2] Trend
Pollock	W (61)	39,590	(W/C + WYAK)		Below,
	C (62)	23,560	588,000	130,760	Increasing
	C (63)	31,000			
	WYAK	2,410	(EYAK/SEO)		
	EYAK/SEO	6,460	28,710	8,610	
	TOTAL	103,020		139,370	
Pacific Cod	W	27,500			Above,
	C	43,550			Declining
	E	5,350			
	TOTAL	76,400	567,000	102,000	
Deep water flatfish	W	280			Unknown,
	C	2,710			Unknown
	WYAK	1,240			
	EYAK/SEO	1,070			
	TOTAL	5,300	74,370 [4]	6,980	
Rex sole	W	1,230			Unknown,[3]
	C	5,660			Stable
	WYAK	1,540			
	EYAK/SEO	1,010			
	TOTAL	9,440	74,600	12,300	
Shallow water flatfish	W	19,510			Unknown,[3]
	C	16,400			Stable
	WYAK	790			
	EYAK/SEO	1,160			
	TOTAL	37,860	299,100	45,330	
Flathead sole	W	8,490			Unknown,[3]
	C	15,720			Stable
	WYAK	1,440			
	EYAK/SEO	620			
	TOTAL	26,270	207,520	34,210	
Arrowtooth flounder	W	16,160			Above,
	C	97,710			Declining
	WYAK	23,770			
	EYAK/SEO	7,720			
	TOTAL	145,360	1,571,670	173,910	
Sablefish	W	1,960			Low,
	C	6,030			Declining
	WYAK	1,920			
	EY/SEO	3,490			
	TOTAL	13,400	169,000	16,660	
Other Slope rockfish	W	20			Unknown,
	C	740			Unknown
	WYAK	250 [1]			
	EYAK/SEO	3,890			
	TOTAL	4,900	102,510	6,390	

(Table 2 continued)

				2000	
SPECIES		ABC		Overfishing Level	Abundance,[2] Trend
Northern rockfish	W	630			Unknown, Unknown
	C	4,490			
	E	[1]			
	TOTAL	5,120	85,360	7,510	
Pacific ocean perch	W	1,240		1,460	Below, Increasing
	C	9,240		10,930	
	WYAK	840			
	EY/SEO	1,700		3,000	
	TOTAL	13,020	200,310	15,390	
Shortraker/ rougheye	W	210			Unknown, Unknown
	C	930			
	E	590			
	TOTAL	1,730	70,880	2,510	
Pelagic shelf rockfish	W	550			Unknown, Unknown
	C	4,080			
	WYAK	580			
	EY/SEO	770			
	TOTAL	5,980	66,440	9,040	
Demersal shelf rockfish	SEO	340	15,100	420	Unknown, Unknown
Atka mackerel	GW	600	Unknown	6,200	Unkown, Unknown
Thornyhead rockfish	Western	430			Above, Stable
	Central	990			
	Eastern	940		2,820	
	Total	2,360	52,950		
Other species					TAC = 5% of the sum of TACs.

1/ The EGOA ABC of 5 mt for northern rockfish has been included in the WYAK ABC for other slope rockfish.

2/ Abundance relative to target stock size as specified in SAFE documents.

3/ Historically lightly exploited therefore expected to be above the specified reference point.

4/ Biomass of Dover sole; biomass of Greenland turbot and deep-sea sole is unknown.

NOTE:

ABCs are rounded to nearest 10.

Overfishing is defined Gulf-wide, except for pollock and POP.

Table 3. Summary of fishing mortality rates and overfishing levels for the Gulf of Alaska, 2000.

Species	Tier	F_{ABC}[1]	Strategy	F_{OFL}[2]	Strategy
Pollock	3b	0.29	F_{ABC}	0.40	$F_{35\%\ adjusted}$
Pacific cod	3a	0.33	F_{ABC}	0.46	$F_{35\%}$
Deepwater flatfish	5,6[3]	NA	F_{ABC}[3]	NA	F_{OFL}[4]
Rex sole	5	0.15	F=.75M	0.20	F=M
Flathead sole	5	0.15	F=.75M	0.20	F=M
Shallow water flatfish	4,5[5]	0.15-0.17	F=.75M, $F_{40\%}$[5]	0.2-0.209	$F_{35\%}$, F=M[6]
Arrowtooth	3a	0.134	$F_{.40\%}$	0.159	$F_{35\%}$
Sablefish	3b	.109	$F_{40\%\ adjusted}$	0.136	$F_{35\%adjusted}$
Pacific ocean perch	3b	0.065	$F_{40\%\ adjusted}$	0.078	$F_{35\%\ adjusted}$
Shortraker/rougheye	4,5[7]	0.23/0.025	F=.75M, F=M[7]	0.03/.038	F=M, $F_{35\%}$[8]
Rockfish (other slope)	4,5[9]	0.03-0.75-_	F=.75M, F=M[9]	0.04-0.10	$F_{35\%}$, F=M[10]
Northern rockfish	4	0.06	F=M	0.088	$F_{35\%}$
Pelagic Shelf Rockfish	4	0.09	F=M	0.136	$F_{35\%}$
Demersal Shelf Rockfish	4	0.02	F=M	0.028	$F_{35\%}$
Thornyhead rockfish	3a	0.77	$F_{40\%}$	0.092	$F_{35\%}$
Atka mackerel	6	NA	F_{ABC}[11]	NA	F_{OFL}[12]

1/ Fishing mortality rate corresponding to acceptable biological catch.
2/ Maximum fishing mortality rate allowable under overfishing definition.
3/ F_{ABC}=.75M for Dover sole (Tier 5), ABC=.75 x average catch (1978-1995) for other deepwater flatfish (Tier 6).
4/ F=M for Dover sole, average catch (1978-1995) for other deepwater flatfish.
5/ $F_{40\%}$ for rocksole (Tier 4), F=.75M for remaining shallowater flatfish (Tier 5).
6/ $F_{35\%}$ for rocksole, F=M for remaining shallow water flatfish.
7/ F=.75M for shortraker (Tier 5), F=M for rougheye (Tier4).
8/ F=M for shortraker, $F_{35\%}$ for rougheye.
9/ F=M for sharpchin rockfish (Tier 4), F=.75M for other species (Tier 5).
10/ $F_{35\%}$ for sharpchin, F=M for other species.
11/ ABC for Atka mackerel is 600 mt for bycatch in other target fisheries.
12/ OFL for Atka mackerel is equal to average catch from 1978 to 1995.

Table 4. Maximum permissible fishing mortality rates and ABCs as defined in Amendment 56 to the GOA and BSAI Groundfish FMPs, and the 2000 Plan Team recommended fishing mortality rates and ABCs, for those species whose recommendations were below the maximum.

Gulf of Alaska

Species	Tier	2000 Max. Permissible F_{ABC}	2000 Max. Permissible ABC	2000 F_{ABC}	2000 ABC
Pollock[1]	3b	0.34	111,310	0.290	96,560
Pacific cod	3a	0.380	86,000	0.330	76,400
Rougheye rockfish	4	0.032	1,550	0.025	1,210
Shortraker rockfish	5	0.023	520	0.023	520
Total Shortraker/Rougheye	4,5		2,070		1,730
Northern rockfish	4	0.075	6,400	0.060	5,120
Other slope rockfish (sharpchin)	4	0.055	1,980	0.050	1,800
Other slope rockfish (redstripe)	5	0.075	1,240	0.075	1,240
Other slope rockfish (harlequin)	5	0.045	560	0.045	560
Other slope rockfish (silvergrey)	5	0.030	780	0.030	780
Other slope rockfish (redbanded)	5	0.045	290	0.045	290
Other slope rockfish (minor species)	5	0.045	220	0.045	220
Total other slope rockfish	4,5		5,070		4,890
Pelagic shelf rockfish	4	0.110	7,310	0.090	5,980
Demersal shelf rockfish	4	0.025	420	0.020	340
Atka mackerel	6	NA	4,700	NA	600

1/ Western, Central and West Yakutat area.

STATE OF ALASKA PACIFIC COD The following is an update through November 30, 1999.

Prince William Sound The GHL is 0.930 million pounds which is 25% of the Eastern Gulf of Alaska total allowable harvest of cod. The state waters fishery opened at noon March 21 and harvest by both pot and jig gear through November 30, was 327,673 pounds from 6 vessels in 23 landings. The parallel federal fishery reopened to pot and jig gear on September 1 and closed October 5. At that time the state waters fishery reopened. Both gear types will remain open until approximately 602,327 pounds is taken or December 31, whichever occurs first. With a decrease in participation in the pot and jig fisheries it appears that the GHL will not be achieved.

Cook Inlet The GHL is 2.6 million pounds which is equal to 2.25% of the Central Gulf of Alaska total allowable harvest of Pacific cod. The guideline is split equally between pot and jig gear. The state waters fishery was opened throughout the course of the summer. Total harvest by both gear types through November 30, was 1.4 million pounds from 38 vessels in 306 landings. The state waters fishery reopened on October 5, at the completion of the parallel federal fishery which began on September 1. Both gear types will remain open until approximately 1.2 million pounds is taken or December 31, whichever occurs first. If weekly catch rates continue to remain low it appears that the fishery will remain at 2.25% of the Central Gulf ABC for the 2000 season.

Kodiak The GHL is 11.7 million pounds which is 10% of the Central Gulf of Alaska total allowable harvest of cod. The guideline is split equally between pot and jig gear. The harvest through November 29, is 9.3 million pounds. Seventy nine pot vessels harvested 7.0 million pounds. One hundred thirty jig vessels harvested 2.3 million pounds. The fishery is expected to remain open throughout the calendar year. To achieve step-up provisions, from 10% to 12.5%, the fishery must achieve 90% of the guideline harvest level or an additional 1.2 million pounds. At the current weekly harvest rate it appears that the fishery will not step-up to 12.5% of the Central Gulf for the 2000 season. However, previous fisheries have shown an increase in effort during December which could increase the harvest rate enough to achieve the step up level of production.

Chignik The GHL is 8.2 million pounds which is 7% of the Central Gulf of Alaska total allowable harvest of cod. The guideline is allocated 85 percent to pot gear and 15 percent to jig gear. The harvest through November 29, is 6.4 million pounds. Thirty seven pot vessels have harvested 6.2 million pounds. Fourteen jig vessels have taken 0.2 million pounds. The fishery is expected to remain open throughout the calendar year. To achieve step-up provisions, from 7% to 8.75%, the fishery must achieve 90% of the guideline harvest level or an additional 950,000 pounds. At the current weekly harvest rate it appears that the fishery will remain at 7% of the Central Gulf ABC for the 2000 season.

South Alaska Peninsula The GHL is 13.0 million pounds which is 20% of the Western Gulf of Alaska total allowable harvest of cod. The guideline is allocated 85 percent pot gear and 15 percent jig gear. Fifty eight pot vessels harvested 11.0 million pounds. Twenty two jig vessels have taken 0.72 million pounds. The fishery is expected to remain open throughout the calendar year. To enact step-up harvest provisions, from 20% to 25%, the fishery must achieve 90% of the guideline harvest level. The fishery has reached that level and the South Alaska Peninsula fishery will step-up to 25% of the Western Gulf ABC for the 2000 season.

Table 13. Summary of halibut discard mortality rates (DMRs) in the Bering Sea/Aleutian Islands (BSAI) groundfish fisheries during 1990-1998 and recommendations for Preseason Assumed DMRs in monitoring halibut bycatch mortality in 2000.

Gear and Target	1990	1991	1992	1993	1994	1995	1996	1997	1998	Trend?	2-Year Mean	Used in 1999	Recommendations for 2000
Trawl													
Atka mackerel	66	77	71	69	73	73	83	85	77	No	81	85	81
Bottom pollock	68	74	78	78	80	73	79	72	80	No	76	76	76
Pacific cod	68	64	69	67	64	71	70	67	66	Yes/dn	67	69	66
Other Flatfish	80	75	76	69	61	68	67	71	78	No	75	69	75
Rockfish	65	67	69	69	75	68	72	71	56	No	64	72	64
Flathead sole	-	-	-	-	67	62	66	57	70	No	64	62	64
Other species	-	-	-	-	-	-	-	-	-	-	-	69	66
Pelagic pollock	85	82	85	85	80	79	83	87	86	No	87	85	87
Rock sole	64	79	78	76	76	73	74	77	79	Yes/up	78	76	79
Sablefish	46	66	-	26	20	-	-	-	-	No	23	23	23
Turbot	69	55	-	-	58	75	70	75	86	No	81	73	81
Yellowfin sole	83	88	83	80	81	77	76	80	82	No	81	78	81
Pot													
Pacific cod	12	4	12	4	10	10	7	4	13	No	9	4	9
Other species	-	-	-	-	-	-	-	-	-	-	-	4	9
Longline													
Pacific cod	19	23	21	17	15	14	12	11	11	No	11	11	11
Rockfish	17	55	-	6	23	-	20	4	52	No	28	12	28
Other species	-	-	-	-	-	-	-	-	-	-	-	11	11
Sablefish	14	32	14	13	38	-	-	-	-	-	-	-	-
Turbot	15	30	11	10	14	9	15	22	18	No	20	19	20
CDQ Trawl													
Bottom pollock	-	-	-	-	-	-	-	-	90	-	-	76	90
Pelagic pollock	-	-	-	-	-	-	-	-	90	-	-	81	90
CDQ Longline													
Pacific cod	-	-	-	-	-	-	-	-	10	-	-	11	10

Table 14. Summary of halibut discard mortality rates (DMRs) in the Gulf of Alaska (GOA) groundfish fisheries during 1990-1998 and recommendations for Preseason Assumed DMRs in monitoring halibut bycatch mortality in 2000.

Gear and Target	1990	1991	1992	1993	1994	1995	1996	1997	1998	Trend?	2-Year Mean	Used in 1999	2000 Recommendation
Trawl													
Atka mackerel	67	89	81	67	53	-	60	-	-	No	57	57	57
Bottom pollock	51	62	66	57	48	66	79	66	55	No	61	73	61
Pacific cod	60	62	66	59	53	64	70	62	64	No	63	66	63
Deep wtr flats	61	58	70	59	60	56	71	61	51	No	56	66	56
Shallow wtr flats	66	71	69	65	62	70	71	71	67	No	69	71	69
Rockfish	65	75	79	75	58	71	65	63	68	No	66	64	66
Flathead sole	-	-	-	-	54	64	67	74	39	No	57	**	57
Other species	-	-	-	-	-	-	-	-	-	-	-	66	66
Pelagic pollock	71	82	72	63	61	51	81	70	80	No	75	76	75
Sablefish	70	60	68	59	67	58	80	61	-	No	71	71	71
Arrowtooth fldr	-	-	-	-	-	-	66	48	62	No	55	57	55
Rex sole	-	-	-	-	56	76	63	47	58	No	53	55	53
Pot													
Pacific cod	12	7	16	24	17	21	7	11	16	No	14	6	14
Other species	-	-	-	-	-	-	-	-	-	-	-	6	14
Longline													
Pacific cod	15	18	13	7	11	13	11	22	11	No	17	16	17
Rockfish	6	-	-	7	-	4	13	-	9	No	11	9	11
Other species	-	-	-	-	-	-	-	-	-	-	-	16	17
Sablefish	17	27	28	30	22	-	-	-	-	-	-	-	-

**Catcher vessel fleet = 58%; Catcher/Processor fleet = 74%.

APPENDIX E

IMPACTS ON ESSENTIAL FISH HABITAT

December 2, 1999

National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99801

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

The area affected by this action has been identified as EFH for all managed species in the BSAI and GOA. The following EFH Assessment will address the mandatory requirements of an assessment, incorporating the information required in 50 CFR 600.920(i) and enumerated in the Interim Final Rule (IFR)(62 FR 66531, December 19, 1997) implementing the EFH provisions of the Magnuson-Stevens Act. These requirements are:

(i) a description of the proposed action;
(ii) an analysis of the effects, including cumulative effects, of the proposed action on EFH, the managed species, and associated species, such as major prey species, including affected life history stages;
(iii) the Federal agency's view of the action on EFH; and
(iv) proposed mitigation, if applicable.

An EFH assessment may incorporate by reference other relevant environmental assessment documents, such as an ESA Biological Assessment, another NEPA document, or an EFH Assessment prepared for a similar action.

EFH is defined in the Magnuson-Stevens Act as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." (16 U.S.C. 1802 Sec. 3, 104-297). The IFR defines adverse effect as "any impact which reduces quality and/or quantity of EFH. Adverse effects may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, or reduction in species' fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions" (62 FR, 66551, December 19, 1997).

2.0 DESCRIPTION OF ACTION

For a description of the proposed action, please see Section 2 of this EA/RIR/IRFA. A list of the regulatory changes in the Groundfish Fisheries in 1999 that have had an effect on the TAC-setting process for 2000 are listed in Section 1.2 of the document.

3.0 ANALYSIS OF EFFECTS

The North Pacific groundfish fishery is very large by any standards. The domestic groundfish fishery off Alaska accounted for 46.1% of the catch and 16.5 % of the ex-vessel value of U.S. domestic landings, and the value of the 1997 catch after primary processing was estimated at $1.18 billion dollars (O'Bannon 1997). While the foreign fleet which began fishing the eastern Bering Sea in the early 1950s has been replaced over the past two decades by a domestic fleet, total groundfish catch has been maintained within a steady range since 1969, when it reached 1.2 million metric tons (mt). The catch has fluctuated between 1.2 million mt and 2.1 million mt–the 1998 catch is estimated at 1.6 million mt. The smaller Gulf of Alaska groundfish catch has similarly fluctuated in a range, over the past fifteen years, between 142,000 mt (1986) and 358,000 mt (1984); in 1998 the GOA groundfish catch is estimated at 244,000.

Clearly, such an enterprise will have impacts on the marine environment. Removal of the targeted catch itself, and the associated bycatch, affects predator/prey relationships within the ecosystem. Some of the fishing gear directly and indirectly affects fish habitat in numerous ways. These effects cannot, however, be simply categorized as "adverse" or "beneficial." The fishery affects different species, in different life stages, in different ways.

3.1 Description of EFH for Species Affected by Action

The area affected by the proposed action, since it consists of the entire EEZ under management by the Council, by definition includes EFH for all of the FMP managed species, at all life stages. EFH for these species at each life stage, to the extent that it is understood, is described and identified in five FMP amendments which were approved January 20, 1999. These are: Amendment 55 to the FMP for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area; Amendment 55 to the FMP for Groundfish of the Gulf of Alaska; Amendment 8 to the FMP for the Commercial king and Tanner Crab Fisheries in the Bering Sea/Aleutian Islands; Amendment 5 to the FMP for Scallop Fisheries off Alaska; and Amendment 5 to the FMP for the Salmon Fisheries in the Exclusive Economic Zone off the Coast of Alaska.

The species under management are categorized as follows in the FMPs: walleye pollock, Atka mackerel, Pacific cod, deep water flatfish, Rex sole, shallow water flatfish, flathead sole, arrowtooth flounder, sablefish, other slope rockfish, Pacific ocean perch, shortraker and rougheye rockfish, pelagic shelf rockfish, demersal shelf rockfish, thornyhead rockfish, and "other species": sharks, skates, sculpins, squid and octopus.

Prohibited species taken incidentally in groundfish fisheries include seven species: Pacific salmon, steelhead trout, Pacific halibut, Pacific herring, Alaska king crab, Tanner crab, and snow crab.

Forage fish species must also be considered in an EFH assessment. These are abundant fishes that are preyed upon by commercially important groundfish species, marine mammals and seabirds. They are defined in NMFS regulations (CFR 50 Sec. 679.2) to include all fish of the following families: *Osmeridae, Myctophidae, Bathylagidae, Ammodytidae, Trichodontidae, Pholidae, Stichaeidae, Gonostomatidae*; and species in the Order *Euphausiacea* (krill). If an activity negatively affects these species, it would be considered an indirect effect on EFH, since they are prey for managed species.

3.2 Direct Impacts of Fishery on EFH

3.2.1 Gear Use in the North Pacific

Direct effects to the substrate and water are primarily caused by fishing gear which touches the bottom. This section will first discuss the groundfish fisheries in the North Pacific and the fishing gear that is used to pursue them, and then the impacts of the different types of fishing gear on EFH.

Most species (or species groups) are harvested predominately by one type of gear, which typically accounts for 85% or more of the catch. The one exception is Pacific cod. In 1998, 47.9% of the P. cod catch was taken by trawls, 42.8% by hook and line gear, and 9.3% by pots.[1] The percentage of P. cod taken by trawl gear in 1994 was 58.5%; the decrease is accounted for by a 5% increase in pot gear use, and a 3% increase in the percentage taken by longliners over the past five years. Table 1 gives the groundfish catch off Alaska by area, gear and species over the 1994-1998 period (Hiatt and Terry 1999).

---

[1]Pacific cod is the only groundfish caught with pots.

The principal gear types used in the domestic groundfish fishery are trawls, hook and line gear, and pots. In the past five years (1994-1998), the trawl catch averaged 90.9% of total catch, while hook and line gear catch accounted for 7.55% -- up from the 1992-1996 average of 6.9%. Of the trawl catch, a large percentage is caught by pelagic gear, which generally is fished in midwater, although it can be fished on the bottom. The pollock fishery is the largest fishery, accounting in 1998 for 65% of the groundfish catch. The directed pollock catch was allocated 100% to pelagic trawl gear in the BSAI in 1999, and the Council has approved a permanent prohibition on nonpelagic trawl gear in the BSAI which is currently under regulatory review. Approximately 98% of the directed trawl fishery in the GOA in 1998 was conducted by pelagic gear. The pollock trawl catch has averaged, over the past five years, 47% of the total groundfish trawl catch in the GOA, 73% in the BSAI, and 71% overall. In other words, the bottom trawl fishery, which has attracted the most attention for its possible effects on EFH, accounts for a little under a third of the total groundfish fishery in terms of catch.

3.2.2 Bottom Trawl Gear

Bottom trawl gear is the focus of most of the concern about fishing gear used in the North Pacific. Following are discussions of trawl use and its effects in the Bering Sea, the Aleutian Islands and the Gulf of Alaska, followed by a more general discussion of the impacts of trawl gear on benthic habitat.

Patterns of Bottom Trawling in the Bering Sea[2]

The Bering Sea has experienced rapid and intensive development of commercial bottom trawl fisheries. Because of good recordkeeping and the relatively brief period that the area has been fished, it is possible to reconstruct the spatial and temporal patterns of exploitation. For purposes of this discussion, the Bering Sea is comprised of catch reporting areas north of the Alaska Peninsula, excluding the western Aleutian Islands (areas 541, 542, 543).

For the period 1973-1997, a total of 412,040 records of bottom trawls were obtained from the NMFS Observer database (NORPAC). Bottom trawls by the domestic trawl fleet (1986-1997; n=182,705) were selected using gear type information recorded in the field. Bottom trawls by the joint venture (1980-1990; n=101,376) and foreign (1973-1989; n=127,959) fleets were selected based on presence of benthic organisms (e.g. crabs, snails and sea stars) in the catch, because gear information is not available.

[2]The Bering Sea discussion is quoted, with some editorial changes, from "Groundfish fishing effort in the eastern Bering Sea," by Bob McConnaughey, in *Ecosystems Considerations for 2000* (P. Livingston 1999).

Table 1. Groundfish catch off Alaska by area, gear and species groups, 1994-1998 (1,000 mt, round weight)(NPFMC 1999).

	GOA	BSAI	All Alaska		GOA	BSAI	All Alaska
All gear				**Trawl**			
All groundfish				*Pollock*			
1994	233	1,947	2,180	1994	107	1,385	1,492
1995	212	1,930	2,141	1995	70	1,326	1,396
1996	201	1,849	2,050	1996	50	1,219	1,270
1997	228	1,831	2,059	1997	88	1,146	1,234
1998	244	1,621	1,865	1998	123	1,122	1,245
Hook and Line							
Sablefish				*Sablefish*			
1994	19	2	21	1994	2	1	3
1995	16	2	18	1995	2	0	3
1996	14	1	15	1996	2	0	2
1997	12	1	13	1997	2	0	2
1998	12	1	13	1998	1	0	1
Pacific cod				*Pacific cod*			
1994	7	86	93	1994	2	99	131
1995	11	103	114	1995	2	122	163
1996	10	95	105	1996	2	113	159
1997	11	124	135	1997	2	111	160
1998	10	100	110	1998	1	82	123
Flatfish				*Flatfish*			
1994	1	6	7	1994	31	99	282
1995	2	7	8	1995	42	122	256
1996	1	8	9	1996	46	113	268
1997	1	10	11	1997	48	111	335
1998	1	11	11	1998	41	82	211
Rockfish				*Rockfish*			
1994	2	0	3	1994	14	18	32
1995	2	0	2	1995	17	16	34
1996	2	0	2	1996	16	23	40
1997	2	0	2	1997	18	17	34
1998	2	1	2	1998	17	15	32
Hook and Line: All Groundfish				*Atka mackerel*			
1994	29	108	137	1994	4	65	69
1995	32	127	158	1995	1	81	82
1996	27	117	144	1996	2	104	105
1997	25	154	180	1997	0	66	66
1998	25	130	155	1998	0	57	57
Trawl: All groundfish				*Pot: Pac. Cod*[1]			
1994	195	1,829	2,025	1994	--	8	--
1995	164	1,782	1,946	1995	16	20	36
1996	162	1,699	1,860	1996	12	33	45
1997	193	1,654	1,847	1997	9	22	31
1998	208	1,476	1,685	1998	10	14	24

Two general spatial patterns are apparent from the historical trawl data, mapped on a 10 km grid (Figure 1). First, virtually all areas of the Bering Sea have experienced some degree of exposure to bottom trawls. Second, the intensity of exposure, measured in trawls made per unit area, varies substantially. These patterns reflect the non-random behavior of fishing fleets, which is based on historical patterns of performance and regulatory restrictions. Relatively heavy trawling has occurred in three places: along the shelf edge, along the Alaska Peninsula near Unimak Island, and in Togiak Bay. The primary composition of the catch in these three areas, respectively, was pollock, Pacific cod and Greenland turbot; Pacific cod and pollock; and yellowfin sole (Fritz *et al.* 1998).

Effects of Bottom Trawling in the Bering Sea

In order to study the long-term effects of trawling on the benthos in the eastern Bering Sea, in 1996 a study was conducted on megafauna populations in a shallow, soft-bottom area of the eastern Bering Sea (McConnaughey *et al.*, 1999). The researchers collected samples of 92 taxa at 84 shallow (48-m average), soft-bottom, heavily fished sites, each one square nautical mile in size, and all straddling the boundary of a closed area, Crab and Halibut Protection Zone 1. The following generalizations were drawn from running multi- and univariate statistical tests and examining raw patterns in the data: (1) sedentary megafauna (e.g., anemones, soft corals, sponges, whelk eggs, ascidians), neptunid whelks and empty shells were more abundant in the unfished (UF) area; (2) mixed responses were observed in motile groups (e.g., crabs, sea stars, whelks); and (3) overall diversity and niche breadth of sedentary organisms (e.g., sponges, anemones, soft corals, stalked tunicates) indicates that long-term exposure to bottom trawling, at least in the experimental area, reduces diversity and increases patchiness of this epibenthic community (see Figure 2).

In 1997, chronic effects of bottom trawls on infauna were investigated at 40 of the highly fished and unfished stations occupied during the 1996 megafauna study. Samples were collected under contract with the University of Alaska; analysis of potential population and community-level effects are pending.

Patterns of Trawling in the Gulf of Alaska and Aleutian Islands[3]

Coon et al. (1999) determined the spatial and temporal patterns of bottom trawl effort in the Gulf of Alaska and Aleutian Islands from 1990-1998 by analyzing domestic observer data. The greatest bottom trawl effort in the Gulf of Alaska has taken place in the Kodiak region, where directed fisheries have targeted Pacific ocean perch (*Sebastes alutus*), Pacific cod (*Gadus macrocephalus*), and flatfish (Figure 3). In the Aleutian Islands, intense bottom trawl efforts have been directed at Atka mackerel (*Pleurogrammus monopterygius*) and *S. alutus* (Figure 4). From 1990-1998, a total of 57,948 tows were observed in the Gulf of Alaska and 35,498 in the Aleutian Islands. If expanded to include unobserved tows, the total number of trawl tows were estimated at 116,288 for the Gulf of Alaska and 41,015 for the Aleutian Islands. The total bottom trawl effort, in 24 hour days, was estimated at 11,829 for the Gulf of Alaska, and 4,427 for the Aleutian Islands. The highest estimated number of bottom trawls in both the Aleutian Islands and the Gulf of Alaska were on the continental shelf at a depth of 101-200 m. The density value of trawling (number of trawls per km^2) for the Gulf of Alaska overall was calculated at $0.35/km^2$. The highest density was in the Kodiak region, at $1.43/km^2$ in an area of 4,657 km^2 at a depth of

[3] This discussion is paraphrased from "Groundfish fishing effort in the Gulf of Alaska and Aleutian Island," by Jon Heifitz, in *Ecosystems Considerations for 2000* (P. Livingston 1999).

301-500 m. The highest bottom trawl duration in the Gulf of Alaska was at a depth of 101-200 m, with the highest number of days trawled/km^2 in the Chirikof area at 0.74 days/km^2 in 301-500m.

Density of trawling in the entire Aleutian Island region was 0.56 trawls/km^2. The Eastern Aleutian area had the highest density, 1.56 trawl/km^2 in an area of 7,909 km^2 at a depth of 101-200 m depth. Overall there have been some temporal changes in bottom trawl effort (Figure 5). Bottom trawl effort in the Aleutian Islands declined from a peak in 1990 of 855 days to a low in 1997 of 321 days. In the Gulf of Alaska, bottom trawl effort peaked at 1,710 days in 1990, declined to 739 days in 1994, increased to 1,490 days in 1996, and then declined to 934 days in 1998. Most of the changes in effort occurred in the eastern Aleutian Islands and Eastern Gulf of Alaska. The reduction of fishing effort in these areas was related to fishery closures and reduction of allowable catch quotas.

Effects of Trawling in the Gulf of Alaska

Little work has been done on the effects of trawling on seafloor habitat and biological communities in the northeastern Pacific Ocean, particularly in the Gulf of Alaska. A study by Freese *et al.* (1999)[4] trawled eight sites in August 1996, using a chartered trawler with a Nor'eastern bottom trawl, modified with 0.6-m tires in the bosom and fitted with 0.45-m rockhopper discs and steel bobbins along the wings. From a research submersible, the researchers videotaped each trawl path and a nearby reference transect to obtain quantitative data. They found that a single trawl pass affected the dominant features on the seafloor, displacing a significant number of boulders and removing or damaging large epifaunal invertebrates. A significantly lower density of sponges and anthozoans was found in the trawled transects than the reference transects, and more of these organisms were damaged in the trawled transects. Close to 70% of vase sponges, 55% of sea whips, over 20% of brittle stars and 13% of finger sponges were damaged. The study detected no change in the density of most motile invertebrates, nor damage to them. A subsequent survey at these sites will address longer-term issues, including whether delayed mortality of apparently undamaged invertebrates may have resulted in greater impact than the study detected, or, or the other hand, whether some invertebrate may recover from the damage. The authors note that the study addressed only single tows to seafloor habitats, and that areas subjected to multiple impacts would probably show a greater reduction in density of the affected taxa and increased damage to these organisms.

There are implications for managed species in the observed effects to invertebrates. Epifaunal invertebrates are structural components of fish habitat, providing cover for demersal fishes. When boulders are displaced, they can still provide cover, but displacing piles of boulders reduces the number and complexity of crevices The researchers observed that various taxa, primarily *Sebastes* spp., use cobble-boulder and epifaunal invertebrates for cover, but it was not clear to them which elements of the habitat are required. Other studies have noted the preference of rockfish for different kinds of cover. Krieger (1993) noted that adult (>25 cm) Pacific ocean perch (*S. alutus*) are associated with pebble substrate on flat or low relief bottom; that juvenile *S. alutus* exhibit a preference for rugged areas containing cobble-boulder and epifaunal invertebrate cover; and that shortraker rockfish, *S. borealis*, strongly prefer rugged, high-profile habitat interspersed with boulders (Krieger 1992). Carlson and Straty (1981), Straty (1987) and Pearcy et al. (1989) also noted that juvenile *Sebastes* spp. exhibit a preference for high-relief habitat.

---

[4] Quoted, with editorial changes, from Freese *et al.* (1999).

Although reducing the number of sponges and associated invertebrate taxa reduces the shelter value of the invertebrate community, it is not known whether this change produces a measurable difference in recruitment for any taxon. Freese and his co-authors speculate however that extensive trawling over wide areas could impact the spatial patterns of invertebrate diversity for species which are vulnerable to trawl damage.

Motile invertebrates in the areas trawled for this study were not obviously damaged, except for the brittlestar *A. ponderosa*. An increase in density of scavenging organisms occurred, and was expected. Echinoderms, gastropods, and arthropods are attracted to baits. It has been speculated (Kaiser and Spencer 1996a) that scavenger abundance could be related to trawling intensity and frequency.

<u>Effects of trawling in the Aleutian Islands</u>

The Aleutian Islands area has not been studied specifically to determine effects of trawling. Harold Zenger of AFSC has begun one study, to examine the question of why gorgonian corals, which twenty years ago were a major component of the bycatch of the Atka mackerel fishery in Seguam Pass in the Aleutian Islands, is now infrequently caught. The study will employ a towed underwater camera apparatus to examine whether the corals in the heavily trawled areas of Seguam Pass are more damaged and less abundant than in nearby, less trawled, areas, and to investigate whether fish and invertebrates use coral forests for shelter.

<u>General observations on trawling applicable to North Pacific</u>

Some general conclusions drawn from studies of trawling worldwide can be applied to Alaska. Actions that affect one species adversely may benefit another species. In a review of 22 studies worldwide, Auster and Langton (1999) found that despite their wide geographic range, from tropical to boreal, all studies showed similar classes of impacts. They found that mobile fishing gear reduced habitat complexity in three ways: (1) the epifauna is removed or damaged; (2) sedimentary bedforms are smoothed and bottom roughness is reduced, and (3) taxa are removed which produce structure, including burrows and pits. These findings are consistent with the findings of the studies in the North Pacific detailed above. Also applicable to the Alaska situation is the idea that environmental variables, including the make-up of the bottom, depth of the water column, oxygen content in bottom layers (Krost 1993), and natural wind stress (Riemann and Hoffman 1991), will play a role in determining the severity and direction of impacts. Some of the physical effects of trawling, and their potential impacts on the North Pacific, are discussed in more detail below:

Resuspension of sediments

Trawling an area kicks up both inorganic and organic sediments, contributing significantly to the average suspended sediment load in the trawled area, especially at depths where bottom stress due to tidal and current action is weak (Churchill 1989). Compared to the Gulf of Alaska, the Bering Sea has relatively weak currents but relatively strong tidal action, accounting for up to 95% of all flow as deep as 200 m. Unlike the Gulf of Alaska, which has a greater variety of bottom types, the Bering Sea has a bottom mostly comprised of sand and mud.

Sediment resuspension can have a long-term effect on benthic communities. An increase of sediment reduces light levels on the seabed, can smother the benthos when it resettles, create anaerobic conditions near the seabed, and reintroduce toxins that may have settled out of the water column (Churchill 1989, Jones 1992, Messieh et al. 1991). Sediment resuspension may also have the beneficial effect of enhancing the food supply to the water column (Churchill 1989). Effects both beneficial and negative would probably be greater in the deep ocean where the bottom is relatively unaffected by natural disturbances, but minimal in areas with significant current or tidal transport, because organisms in such areas are adapted to such events (International Council for the Exploration of the Sea 1988, Jones 1992). The eastern Bering Sea with its winter storms, whose effects are in some ways similar to that of trawling, falls in the latter category, especially in the shallower areas.

The resuspension of sediments can lead to a recomposition of the ocean floor, in an effect called winnowing. In winnowing, small particles which are resuspended by a trawl pass may move with the currents to another area instead of resettling, so that the texture of the bottom coarsens. Again, areas subject to storm activity may naturally experience this phenomenon, so that trawling would not make much difference, especially in shallower waters. But in waters at a depth exceeding storm-related effects, the resuspension caused by trawls could have a stronger impact on the composition of the bottom.

Alteration of the seabed due to contact with the gear

The extent to which the gear penetrates the substrate depends on the makeup of the bottom, the speed with which the gear is being towed, the strength of tides and currents, the gear configuration, and the component of the gear encountered. Otter trawl doors can penetrate the substrate as little as 1 cm, on sand and rock substrata, or as much as 30 cm in some mud strata (Jones 1992). Heavier doors create deeper troughs.

The length of time that the benthic troughs last is also variable. In sand or mud substrata with strong tidal action or currents, the troughs can be washed away within a few hours or days (Caddy 1973, Jones 1992). But in very deep seabeds (deeper than 100 m) with weak currents and a mud or sandy-mud substrate, the troughs can last for much longer, from a few months to over five years (Brylinsky *et al.* 1994, Jones 1992, Krost et al. 1990).

While trawl doors cause the most intensive effects over relatively narrow paths (< 3 m wide),[5] the aweeps and footropes may have a more profound effect on the environment, as they impact a much larger area, due to their greater width (Jones 1992, Kaiser and Spencer 1996b, Reise 1982). Different types of footropes cause different levels of disruption. Footropes designed to skim over the seafloor, which are typically used in the BSAI on soft bottoms, cause little physical alteration aside from smoothing of the substrate and minor compression. However, if the area is trawled repeatedly, by the same vessel or different vessels, the cumulative effect of these minor compressions can cause a "packing" of the substrate (Schwinghammer et al. 1996). This packing effect can be further exacerbated when the net fills up and the codend is dragged along the bottom.

Alteration of species mix

The survival of benthic organisms in the path of trawl gear is also very variable. Factors include the species, age, and size of the organism, type of gear, component of gear encountered, size of the haul, substrate morphology, and ocean conditions. The sedentary organisms living in the upper 5 cm of the

[5]Craig Rose, AFSC biologist, per.comm., Oct. 15, 1999.

seabed are especially vulnerable (Rumohr and Krost 1991). Thin-shelled bivalves and starfish tend to sustain heavy damage from the trawl doors, while thick-shelled bivalves are less likely to be damaged. Diatoms, nematodes and polychaetes have been found to be affected by the passage of trawls (Brylinsky et al. 1994). Hard-shelled red king crab seem to fare better; in one experiment the crab were tethered in the path of an Aleutian combination trawl, and only 2.6% of the crabs that interacted with the trawl, but were not retained, were injured (Donaldson 1990). In another experiment, an estimate was made of the rate of injuries sustained by red king crabs passing under three types of bottom trawl footropes commonly used in the bottom trawl fisheries of the eastern Bering Sea. Injury rates of 5%, 7% and 10% were estimated for crab passing under the three types of commercial footropes (Rose *in press*).

Some studies have found that recolonization in disturbed habitat can occur over a relatively short period. Brylinsky et al. (1994) found that nematodes and polychaetes returned to their pre-trawled levels in less than seven weeks, and diatoms increased in abundance in trawl troughs within 80 days; in a study by Rumohr and Krost (1991), small epibenthic species recovered to pre-trawl densities in 24 hours.

Several studies have observed increases in scavenging in the wake of beamtrawls. These short-term changes in individual species distribution, however, are not likely to affect the ecosystem in any profound sense. The more important question is whether bottom trawl fishing causes long-term changes in the benthic community structure. Intensive fishing in an area can possibly result in such changes by promoting populations of opportunistic fish species that migrate into fished areas in order to feed on animals that have been disturbed in the wake of a trawl tow (Caddy 1973, Kaiser and Spencer 1994, 1996a).

Another potential long-term effect on the species mix is the smoothing caused by multiple trawls in the same area. Boulders are moved, patchy biogenic depressions are removed (both important habitat for juvenile fish), the exchange capacity is reduced, and species diversity may suffer.

<u>Cumulative and long-range effects from bottom trawl gear</u>

Some evidence exists that the effect of trawling on both bedforms and invertebrates who live on them is cumulative. Some studies (e.g., Prena et al. 1999) indicate that invertebrate "habitat organisms" become more patchy and decrease in abundance with multiple trawls. The smoothing caused by multiple trawls removes patchy biogenic depressions, which are important habitat features for juvenile fish. It also moves boulders, which are an important characteristic in the GOA, but not the Eastern Bering Sea. Multiple trawls in an area also pack down the substrate and reduce its complexity, which is likely to reduce the exchange capacity and may lead to less species diversity (Jones 1992, Kaiser and Spencer 1996b, Reise 1982). The probability of a particular spot being dragged over by a full net might also increase in a densely trawled area. Finally, multiple trawls in an area could increase the cumulative effect of the winnowing phenomenon described above.

Studies of the long-range effects of trawling are in their early stages. In their review of trawl studies, Auster and Langton (1999) caution that it is not easy to characterize the long-term effects of fishing on the benthic community structure. The authors write: "The pattern that does appear to be emerging from the available literature is that communities that are subject to variable environments and are dominated by short-lived species are fairly resilient. Depending on the intensity and frequency of fishing, the impact of such activity may well fall within the range of natural perturbations. In communities that are dominated by long-lived species in more stable environments, the impact of fishing can be substantial and longer term."

A recent study (Thrush *et al* 1998), designed to evaluate the magnitude of fishing effects on benthic habitat, casts doubt on some of the studies showing resilience. Thrush points out, first of all, that small-scale experiments (such as most of those examined by Auster and Lang) are usually done in reasonably homogeneous habitats and over small time scales and could miss chronic, cumulative effects of fishing. Second, the recovery rates of benthic organisms are highly dependent on proximity to areas from which new organisms can be recruited. Broader areas of fishing disturbance would be expected to recover much more slowly than small, isolated experimental areas.

Little work has been done showing a direct connection between the effects of trawling on habitat complexity and the population of managed fish. None has been done in the North Pacific. A study in western Australia (K. J. Sainsbury 1988) concluded that alteration of the area of different types of habitat would be likely to alter community composition. This conclusion was based on an analysis of the catch per unit effort of certain fish species in the paths of photographed trawl paths which had classified into habitat types by cluster analysis of the presence and approximate size of the epibenthic fauna in each photograph.

Thrush *et al* conclude that, although unequivocally linking structural changes to changes in ecosystem function is difficult, the weight of evidence should be of concern. Auster and Lang (1999) similarly conclude that primary information is lacking which would be necessary to strategically manage fisheries without invoking precautionary measures. More research is needed in three areas, according to Auster and Langton: (1) the spatial extent of fishing-induced disturbances; (2) the effects of specific gear types, along a gradient of effort, on specific habitat types; and (3) the role of seafloor habitats in the population dynamics of fishes. A fourth area of needed research[6] involves investigating the life histories of affected non-commercial invertebrates, their relationships to one another, and to managed stocks of fish and shellfish. Little is known about these invertebrates. Until more is known, it is difficult to judge the affects of observed reductions in diversity and structural heterogeneity on the mortality, growth, and recruitment rates of important species.

3.2.3 Pelagic trawl gear

Pelagic trawl gear, when used in midwater, has no known direct effects on the substrate or water column, although as with any fishing gear the removal of targeted species and bycatch could have indirect effects on EFH by altering predator/prey relationships. Loss of prey, or adverse affects to growth and fecundity, are considered in the IFR to be indirect effects on EFH.

Pelagic trawl gear can also be fished on the bottom and sometimes is fished that way.[7] The pelagic trawls used off Alaska are generally designed to fish downward from the depth of the doors and the doors themselves are not designed for contact with the seafloor, although the footropes can come in contact with and affect the bottom. The gear itself can be damaged from contact with rough bottom, so it is unlikely to be fished hard on substrate with complex structures, and more likely to be fished on smooth bottom

---

[6] Robert McConnaughey, pers. comm., Sept 15, 1999

[7] Pers. Comm., John Gauvin, Groundfish Forum, Oct. 9, 1999.

habitat. [8] Potential damage from pelagic gear being fished on the bottom is limited further by a performance standard which goes into effect whenever nonpelagic trawl is used while directed fishing for pollock is prohibited (50 CFR 679.7(a)(14)). The performance standard prohibits a vessel engaged in directed fishing for pollock from having 20 or more crabs of any species, with a carapace width of more than 1.5 inches at the widest dimension, onboard at any time. In the BSAI, this performance standard was in effect throughout 1999, because directed fishing for pollock was prohibited, and it will go into effect permanently if Amendment 57, prohibiting nonpelagic trawling for pollock in the BSAI. is approved by the Secretary of Commerce.

3.2.4 Longline Gear[9]

Very little information exists regarding the effects of longlining on benthic habitat. Observations of halibut gear made by NMFS scientists during submersible dives off southeast Alaska provide some information (NPFMC 1992). The following is a summary of these observations: "Setline gear often lies slack on the sea-floor and meanders considerably along the bottom. During the retrieval process, the line sweeps the bottom for considerable distances before lifting off the bottom. It snags on whatever objects are in its path, including rocks and corals. Smaller rocks are upended, hard corals are broken, and soft corals appear unaffected by the passing line. Invertebrates and other lightweight objects are dislodged and pass over or under the line. Fish, notably halibut, frequently moved the groundline numerous feet along the bottom and up into the water column during escape runs disturbing objects in their path. This line motion was noted for distances of 50 feet or more on either side of the hooked fish."

Some crabs are caught incidentally by longline gear in pursuit of groundfish, and a portion of these crabs die. No field or laboratory studies have been made to estimate mortality of crab discarded in longline fisheries. However, based on information from the trawl survey, mortality of crab bycatch has been estimated and used in analyses (NPFMC 1993). Discard mortality rates were estimated at 37% for red king crab and 45% for *C. bairdi* Tanner crab taken in longline fisheries. No observations were made for snow crab, but mortality rates may be similar to those of Tanner crab.

Mortality of groundfish discarded in longline fisheries has not been studied extensively in Alaska. Studies with Pacific halibut have shown that discards may have high mortality if not released carefully from hooks. Additionally, some species such as rockfish may not survive changes in pressure when they are hauled up quickly from the bottom. Mortality of discarded halibut has been estimated to be about 15% for most longline fisheries (Williams 1997).

A potential problem that does occur with longline gear is ghost fishing of lost gear. The extent to which this occurs and its effects on habitat have not been analyzed.

---

[8] Pers. comm., Craig Rose, Alaska Fisheries Science Center biologist, Oct 15, 1999.
[9] This section is from the EA for the EFH amendments (NMFS 1998, p. 319); there are some minor edits.

3.2.5 Pot Gear[10]

Pot gear is used in the North Pacific to harvest crabs and groundfish. This gear type likely affects habitat during the process of settling and retrieving pots; however, no research has been conducted to date.

Like other fisheries, pot fisheries incur some bycatch of incidental fish and crab. The groundfish pot fishery targets Pacific cod, but takes other species such as crab and flatfish which are discarded. Mortality of incidental fish catch in groundfish pot fisheries has not been studied, with the exception of Pacific halibut. Based on viability data, it has been estimated that mortality of halibut bycatch in groundfish pot fisheries averages about 7% (Williams 1997).

Like longline gear, lost pot gear has the potential to cause ghost fishing. Biodegradable panels are required on pots to limit this effect, but they will continue to fish until the pot deteriorates.

3.3 Indirect Effects on the Fishery

3.3.1 Loss of Prey

Loss of prey for a managed species is listed in the Interim Final Rule as an indirect adverse effect on EFH. Actions that significantly reduce the availability and population of a major prey species, either through direct harm, capture, or adverse impacts to the prey species' habitat, may be considered to have adverse effects on a managed species and its EFH. This action, since it involves fishing and changes to fishing patterns, will change the proportions of species caught in different areas both in the directed fishery and as bycatch. It is possible that some adverse impacts to prey for managed species could occur in some areas.

3.3.2 Effect of action on species growth and fecundity

An effect on species fecundity might be expected if food intake to support reproduction for any managed species were affected. No such effect is expected from the proposed TAC specifications. It is possible however, that the direct impacts to the substrate and water column caused by fishing gear could change the benthic community and the food web in such a way as to indirectly affect the fecundity of one or more managed species.

4.0 AGENCY VIEWS OF PROPOSED ACTION

The National Marine Fisheries Service acknowledges that the activities of the fishing industry, as authorized by the annual specification process and under authority of the FMPs for the groundfish fisheries of the BSAI and the GOA, may have substantial adverse impacts on fish habitat essential to the spawning, breeding, feeding and growth to maturity of managed and unmanaged species. The greatest public focus has been on the effects of bottom trawl gear, which is also the major focus of this assessment. The Council has taken numerous actions to protect vulnerable areas, or to protect sensitive life stages of species by curtailing fishing at different times and in different areas. These are enumerated in the environmental assessment for the EFH amendments (NPFMC 1998). Updates to that list include the following:

---

[10]Ibid., p. 320.

Table 2. Time series of groundfish trawl closure areas in the BSAI and GOA, 1995-1999.
CSSA = chum salmon savings area; HSA = herring savings area; RKCSA = red king crab savings area; SSL = Steller sea lion; COBLZ = C. opilio bycatch limitation zone.

Bering Sea/Aleutian Islands

Year	Location	Season	Area Size	Notes
1995	Area 512	year-round	8,000 nm^2	closure in place since 1987
	Area 516	3/15-6/15	4,000 nm^2	closure in place since 1987
	CSSA	8/1-8/31	5,000 nm^2	re-closed if 42,000 chum salmon are taken as bycatch
	CHSSA	trigger	9,000 nm^2	closed if 48,000 chinook salmon are taken as bycatch
	HSA	trigger	30,000 nm^2	closed to specified fisheries when trigger reached
	Zone 1	trigger	30,000 nm^2	closed to specified fisheries when trigger reached
	Zone 2	trigger	50,000 nm^2	closed to specified fisheries when trigger reached
	Pribilofs	year-round	7,000 nm^2	established in 1995
	RKCSA	year-round	4,000 nm^2	established in 1995; pelagic trawling allowed
	Walrus Islands	5/1-9/30	900 nm^2	12 mile no-fishing zones around 3 haulouts
	SSL Rookeries	year-round	5,800 nm^2	10 mile no-trawl zones around 27 rookeries
	SSL Rookeries	year-round	5,100 nm^2	20 mile extensions around 8 rookeries
1996	same closures in effect as in 1995			
1997	same closures in effect as in 1995 and 1996, with two additions:			
	Location	**Season**	**Area Size**	**Notes**
	Bristol Bay	year-round	19,000 nm^2	expanded area 512 closure
	COBLZ	trigger	90,000 nm^2	closed to specified fisheries when trigger reached
1998	same closures in effect as in 1995, 1996, and 1997			
1999	additional closures to protect Steller sea lion critical habitat			

Table 2 cont: Gulf of Alaska

Year	Location	Season	Area size	Notes
1995	Kodiak	year-round	1,000 nm^2	closures in place since 1987
	Kodiak	2/15-6/15	500 nm^2	closures in place since 1987
	SSL Rookeries	year-round	3,000 nm^2	10 mile no-trawl zones around 14 rookeries
	SSL Rookeries	seasonal ext.	1,900 nm^2	20 mile extensions around 3 rookeries
1996	same closures in effect as in 1995			
1997	same closures in effect as in 1995 and 1996			
1998	same closures in effect as in 1995, 1996, and 1997, with one addition:			
	Location	**Season**	**Area Size**	**Notes**
	Southeast AK	year-round	52,600 nm^2 (11,929 nm^2	adopted as part of license limitation program is the area actually on the shelf)
1999	additional closures to protect Steller sea lion critical habitat a 3.1 nm^2 closure to all fishing gear on a pinnacle off Sitka			

Proposed: a 7,000 nm^2 closure to bottom trawling in Cook Inlet

1. In June, 1998, the Council adopted a regulation prohibiting all fishing on a highly productive pinnacle off Cape Edgecumbe, near Sitka, Alaska, which is also being considered for designation as a Habitat Area of Particular Concern.

2. At the same meeting, the Council adopted a regulation to prohibit the use of bottom trawls in the BSAI pollock fishery. As part of this regulation, the Council reduced bycatch limits for BSAI trawl fisheries by 3,000 red king crab, 50,000 Tanner crab, 150,000 snow crab, and 100 mt of halibut mortality. Both of these regulations await approval by the Secretary of Commerce.

3. In February 1999, the Council adopted new trawl bycatch limits and areas for BSAI chinook salmon. Bycatch limits would be year-round, and will be reduced to 29,000 by the year 2003. Area I was removed, and a block was added to Area 3.

4. In 1999, all pollock fishing was prohibited in the Aleutian Islands region to eliminate any potential competition with sea lions. Numerous additional protection measures were also implemented to reduce the impact of the pollock fishery on sea lions. Pollock fishing around haulouts was prohibited, removal of pollock from other critical habitat areas was limited, and steps were taken to spread out the catch over time. NMFS is currently in the process of developing permanent measures implementing temporal and spatial changes to the pollock fishery in the BSAI and GOA in order to protect the western population of endangered Steller sea lions and to avoid adversely modifying the sea lions' critical habitat

The IFR directed Councils to designate EFH that was judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation, as Habitat Areas of Particular Concern (HAPC). An action to designate HAPC is currently under development by Council staff. HAPC would be given special consideration in the management process, and activities which could adversely impact habitat in these areas would be avoided.

Areas closed to bottom trawling in the EBS/AI and GOA[11]

Since 1987, the Council has put many different groundfish trawl closures into effect (Table 2). Some of the closures are year-round, while others may only last a few months. A measure of time*area closure for each major area was derived by putting each closure into units of sq km*months in each year and adding these separate closure measures together within each year and area (Figure 6). Starting in 1995, there has been an increase in the amount of area*time groundfish trawl closures in both the EBS/AI and the GOA. The amount of sq km months closed per year in each area can be compared with an estimate of total potential sq km months in each year that could be closed. The latter estimate was derived by multiplying by 12 (months) the shelf and slope area estimates of the EBS/AI and GOA that are surveyed by NMFS bottom trawl surveys. This amounts to approximately 1.89 million sq nmi. months that could potentially be closed for the EBS/AI area and 1.05 million sq. nmi months for the GOA (including southeast) As of the end of 1998, about 28.9% of the potential total sq. nmi. months in the EBS/AI are closed to groundfish trawling, and 65% of the potential total sq. nmi. months in the GOA are closed.

---

[11]taken from "Areas closed to bottom trawling in the EBS/AI and GOA," by Pat Livingston and Dave Witherell (P. Livingston 1999).

Research into the effects of different kinds of fishing gear in different areas of the North Pacific are continuing. Trying to correlate evidence of damage to the substrate with possible effects on the proportion of species within fish communities is not a simple task and most research is still concentrated on the first stage, that of establishing the direct effects of different types of gear on the substrate and water column. NMFS welcomes public input on further ways to improve research and fish management so that EFH receives the consideration that it should in formulating fishery management policy.

The changes from 1999 to 2000 TAC specifications are not anticipated to have a significant adverse impact on EFH. Changes in levels of fishing are determined through a process which considers the impacts on managed species and, increasingly, takes complex ecosystem effects into account. However, in this assessment we have gone beyond discussing the incremental change to the fishery from 1999 to 2000, and focused on the larger question of the effects of the ongoing BSAI and GOA groundfish fisheries on EFH. It is possible that the fishery does have significant adverse impacts on EFH for some life stages of managed species, although this has not been proven. The Council and NMFS are taking a precautionary approach to this question.

5.0 MITIGATION

Numerous measures to mitigate the effects of the North Pacific groundfish fisheries have been taken in recent years and are under development, as detailed above. A consultation with the NMFS Alaska Region Habitat Conservation Division has taken place on this action.

6.0 LITERATURE CITED IN APPENDIX E

Auster, P. J. and R. W. Langton. 1999. The effects of fishing on fish habitat. In: L. Benaka (ed), *Fish habitat: Essential Fish Habitat and Rehabilitation.* American Fisheries Society. Bethesda, MD.

Brylinsky, M., J. Gibson and D. C. Gordon, Jr. 1994. Impacts of flounder trawls on the intertidal habitat and community of the Minas Basin, Bay of Fundy. *Canadian Journal of Fisheries and Aquatic Science..* 51:650-661.

Caddy, J. F. 1973. Underwater observations on tracks of dredges and trawls and some effects of dredging on a scallop ground. *Journal of the Fisheries Research Board of Canada* 30: 173-180.

Carlson, H. R. and R. R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, Sebastes spp., in rocky coastal areas of southeastern Alaska. *Mar Fish Rev* 43(7):13-19.

Churchill, J. H. 1989. The effect of commercial trawling on sediment resuspension and transport over the Middle Atlantic Bight continental shelf. *Continental Shelf Research.* 9:841-864.

Coon, C., T. C. Shirley, and J. Heifetz. 1999. Spatial and temporal patterns of bottom trawling in the Gulf of Alaska and Aleutian Islands. NOAA Tech. Rep. (Submitted).

Donaldson, W. E. 1990. Determination of experimental induced non-observable mortality on red king crab. Alaska Dept. of Fish and Game Regional Information Report 4K90-13.

Freese, L., P. J. Auster, J. Heifetz and B. L. Wing. 1999. Effects of trawling on seafloor habitat and associated invertebrate taxa in the Gulf of Alaska. *Mar. Ecol. Prog. Ser.* 182:119-126.

Fritz, L. W., A. Greig and R. F. Reuter. 1998. Catch-per-unit-, length, and depth distributions of major groundfish and bycatch species in the Bering Sea, Aleutian Islands, and Gulf of Alaska regions based on groundfish fishery observer data. U. S. Dept. Commerce, NOAA tech. Memo. NMFS-AFSC-88, 179 pp.

Hiatt, T. and J. Terry. 1999. Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Gulf of Alaska and Bering Sea/Aleutian Island area: Economic status of the groundfish fisheries off Alaska, 1998. Unpubl. Manuscr. AFSC, NMFS, 7600 Sand Point Way N.E., BIC C15700, Seattle, WA 98115. 68p.

International Council for the Exploration of the Sea. 1988. Report of the Study Group on the Effects of Bottom Trawling. In CM 1988/B International Council for the Exploration of the Sea.

Jones, J. B. 1992. Environmental impact of trawling on the seabed: a review. *New Zealand Journal of Marine and Freshwater Research.* 26:59-67.

Kaiser, M. J. and Spencer, B. E.. 1994. Fish scavenging behaviour in recently trawled areas. *Marine Ecology Progress Series* 112: 41-49.

Kaiser, M. J. and B. E. Spencer. 1996a. Behavioural responses of scavengers to beam trawl disturbance. In: Greenstreet, S. P. R. and M. L. Tasker (eds). *Aquatic predators and their prey*. Blackwell Scientific, Oxford, pp. 117-123.

Kaiser, M. J. and Spencer, B. E. 1996b. The effects of beam-trawl disturbance on infaunal communities in different habitats. *Journal of Animal Ecology*. 65:348-358.

Krieger, K. J. 1992. Shortraker rockfish, Sebastes borealis, observed from a manned submersible. *Mar Fish Rev* 54(4):34-37.

Krieger, K. J. 1993. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. *Fish Bull US* 91:87-96. Mar Fish Rev 54(4):34-37.

Krost, P. 1993. The consequences of bottom trawl fisheries for the sediment and its exchange processes as well as for the benthic communities of Kiel Bight. *Arbeiten Des Deutschen Fischerei-Verbandes* 57: 43-60.

Krost, P., M. Bernhard, F. Werner, and W. Hukriede. 1990. Otter trawl tracks in Kiel Bay (Western Baltic) mapped by side-scan sonar. Meereforschung 32: 344-353

Livingston, P. 1999. Ecosystems Considerations for 2000. In: Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions. Compiled by the Plan Team for the Groundfish Fisheries (2000 SAFE). North Pacific Fisheries Management Council, 605 W. 4th Ave. Anchorage, AK 99501.

McConnaughey, R. A., K. L. Mier and C. B. Dew. 1999. An examination of chronic trawling effects on soft-bottom benthos of the eastern Bering Sea. *ICES J. Mar. Sci.* (in press).

Messieh, S. N., T. W. Rowell, D. L. Peer and P. J. Cranford. 1991. The effects of trawling, dredging and ocean dumping on the eastern Canadian continental shelf. *Cont. Shelf Res.* 11:1237-1263.

National Marine Fisheries Service (NMFS). 1998. *Fisheries of the United States, 1997.* Washington, D.C.: U.S. Government Printing Office.

NPFMC. 1992. Final Supplemental Impact Statement and Regulatory Impact Review/Initial Regulatory Flexibility Analysis of Proposed Inshore/Offshore Allocation Alternatives (Amendment 18/23) to the Fishery Management Plans for the Groundfish Fishery of the Bering Sea and Aleutian Islands and the Gulf of Alaska. North Pacific Fisheries Management Council, 605 W. 4th Ave. Anchorage, AK 99501.

NPFMC. 1993. Environmental Assessment and Regulatory Impact of Amendment 37 to the Fishery Management Plans for the Groundfish Fishery of the Bering Sea and Aleutian Islands.. North Pacific Fisheries Management Council, 605 W. 4th Ave. Anchorage, AK 99501.

NPFMC. 1998. Environmental Assessment/Regulatory Impact Review/Initial Regulatory Flexibility Analysis for Amendment 55 to the FMP for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area; Amendment 55 to the FMP for Groundfish of the Gulf of Alaska;

Amendment 8 to the FMP for the Commercial king and Tanner Crab Fisheries in the Bering Sea/Aleutian Islands; Amendment 5 to the FMP for Scallop Fisheries off Alaska; and Amendment 5 to the FMP for the Salmon Fisheries in the Exclusive Economic Zone off the Coast of Alaska. North Pacific Fisheries Management Council, 605 W. 4th Ave. Anchorage, AK 99501.

NPFMC. 1999. Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions (2000 SAFE). Compiled by the Plan Team for the Groundfish Fisheries. North Pacific Fisheries Management Council, 605 W. 4th Ave. Anchorage, AK 99501.

Pearcy, W. G., D. L. Stein, M. A. Hixon, E. K. Pikitch, W. H. Barss, and R. M. Starr. 1989. Submersible observations of deep-reef fishes of Heceta Bank, Oregon. *Fish Bull, US* 87:955-965.

Prena, J., P. Schwinghammer, T. W. Rowell, D. C. Gordon, Jr., K. D. Gilkinson., W. P. Vass, and D. L. McKeown. 1999. Experimental otter trawling on a sandy bottom ecosystem of the Grand Banks of Newfoundland: analysis of trawl bycatch and effects on epifauna. *Marine Ecology Progress Series*, 181:107-124.

Reise, K. 1982. Long-term changes in the macrobenthic invertebrate fauna of the Wadden Sea: are polychaetes about to take over? *Netherlands Journal of Sea Research.* 16:29-36.

Riemann, B. and Hoffmann E. 1991. Ecological consequences of dredging and bottom trawling in the Limfjord, Denmark. Marine Ecology Progress Series 69(1-2): 171-178.

Rose, C. S. 1999. Injury rates of red king crab, *Paralithodes camtschaticu*, passaging under bottom trawl footropes. *Mar. Fisher. Review.*

Rumohr, H. and P. Krost. 1991. Experimental evidence of damage to benthos by bottom trawling with special reference to *Artica islandica. Meeresforschung.* 33:340-345.

Sainsbury, K. J. The ecological basis of multispecies fisheries in tropical Australia. In: *Fish Population Dynamics, the Implications for Management.* Guilland, J. A. (ed), 1988, John Wiley and Sons.

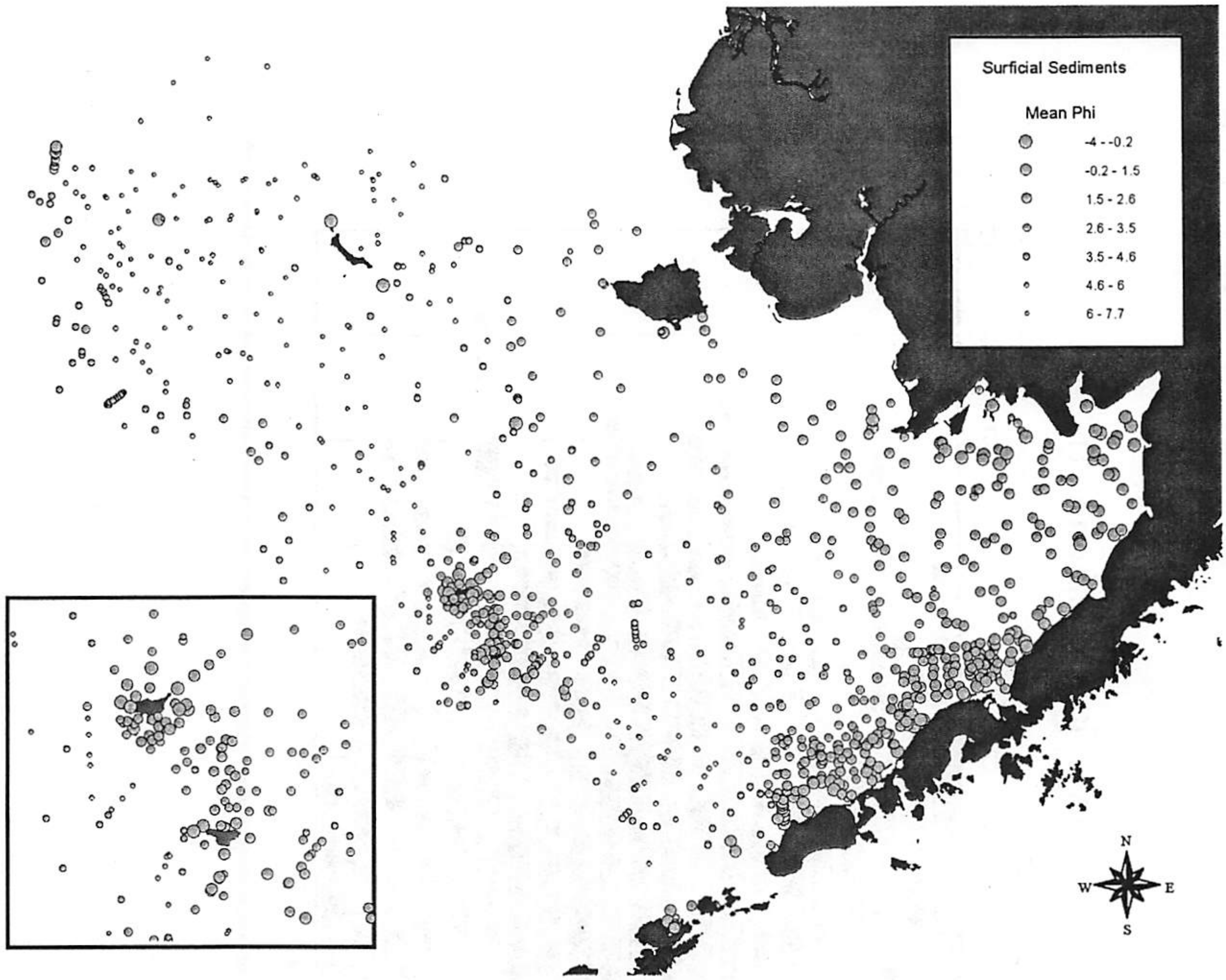
Schwinghammer, P., J. Y. Guigne, and W. C. Siu. 1996. Quantifying the impact of trawling on benthic habitat structure using high resolution acoustics and chaos theory. *Canadian Journal of Fishery and Aquatic Science* 53: 288-296.

Straty, R. R. 1987. Habitat and behavior of juvenile Pacific rockfish (*Sebastes* spp. and *Sebastolobus alascanus*) off southeastern Alaska. *NOAA Symp Ser Undersea Res* 2(2):109-123.

Thrush, S. F., J. E. Hewitt, V. J. Cummings, P. K. Dayton, M. Cryer, S. J. Turner, G. A. Funnell, R. G. Budd, C. J. Milburn, and M. R. Wilkinson. 1998. Disturbance of the marine benthic habitat by commercial fishing: impacts at the scale of the fishery. *Ecological Applications*, 8(3), pp. 866-879.

Williams, G. H. 1997. Pacific halibut discard mortality rates in the 1990-1996 Alaskan groundfish fisheries, with recommendations for monitoring in 1998. In: Preliminary Stock Assessment and fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions. NPFMC 1997.

Figure 1. Locations and intensity of bottom trawl effort in the Bering Sea, 1973-1997.[12]



[12] All figures were taken from the Ecosystems Considerations for 2000 chapter of the 2000 SAFE (Livinston 1999) Figures 1 and 2 are from "Groundfish fishing effort in the Bering Sea" by Bob McConnaughey; figures 3, 4 and 5 are from "Groundfish fishing effort in the Gulf of Alaska and Aleutian Islands," by Jon Heifetz, and Figure 6 is from "Areas closed to bottom trawling in the EBS/AI and GOA," by Pat Livinston and Dave Witherell.

Figure 2. Species diversity of benthic invertebrate megafauna in heavily fished (HF) and unfished (UF) areas by station pairs in the eastern Bering Sea. Overall, diversity in the UF area was significantly greater than in the HF area.

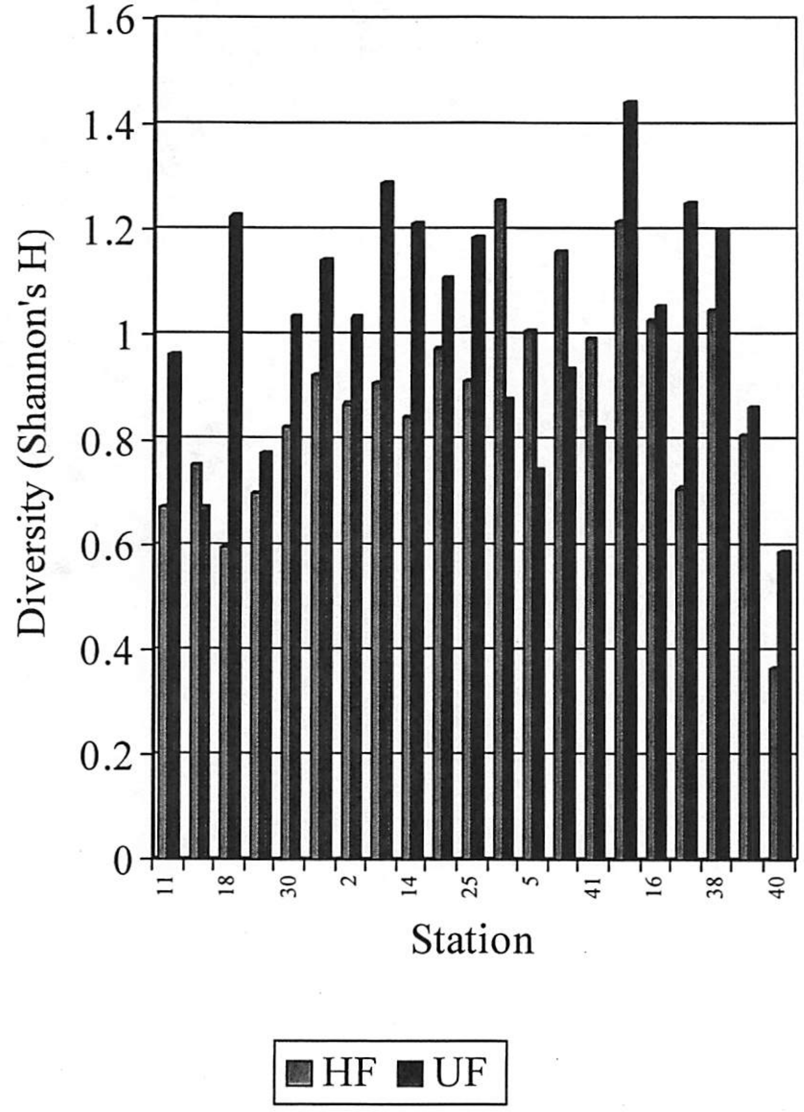


Figure 3. Locations and density of bottom trawl effort in the Gulf of Alaska, 1990-1998.

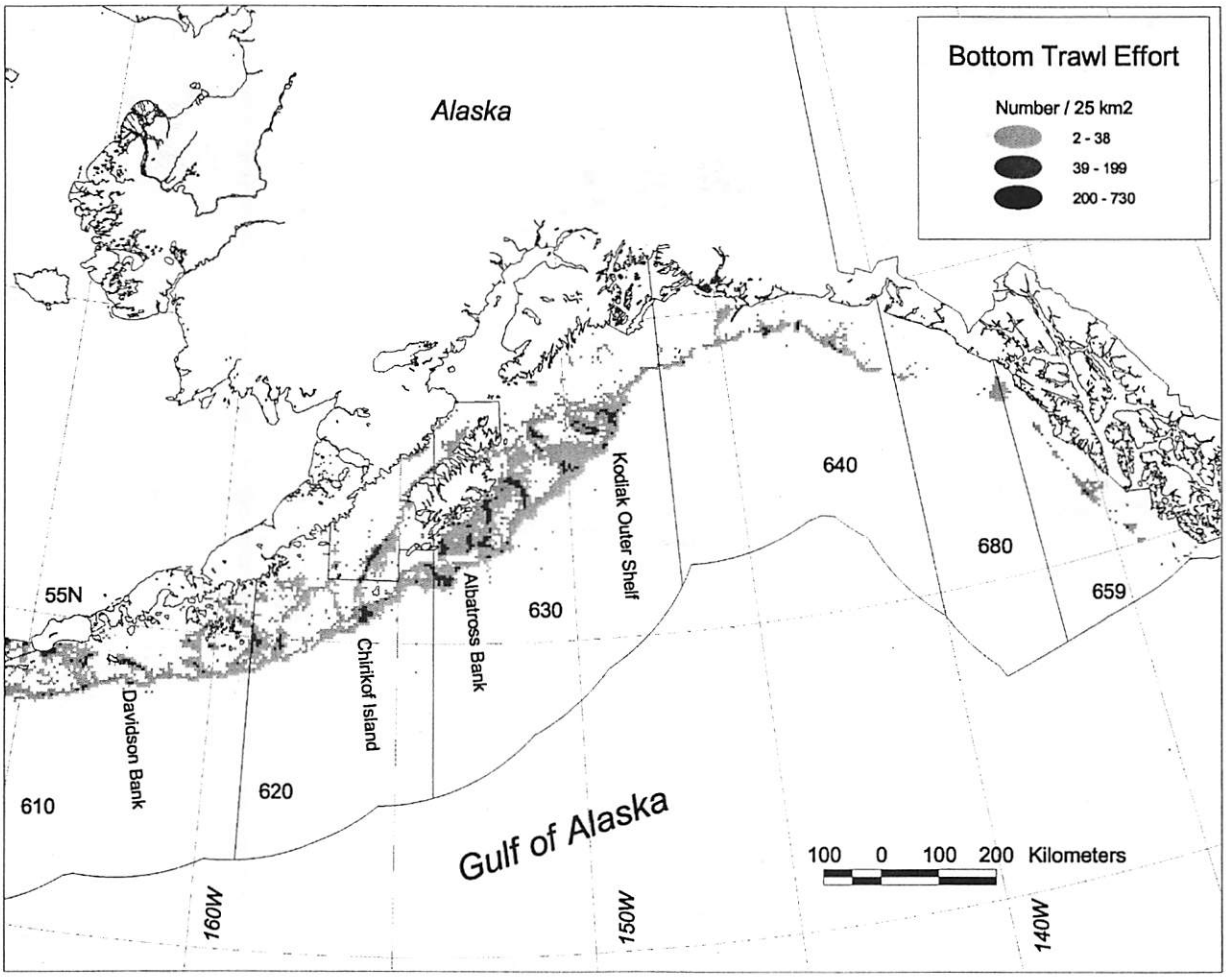


Figure 4. Locations and density of bottom trawl effort in the Aleutian Islands, 1990-1998.

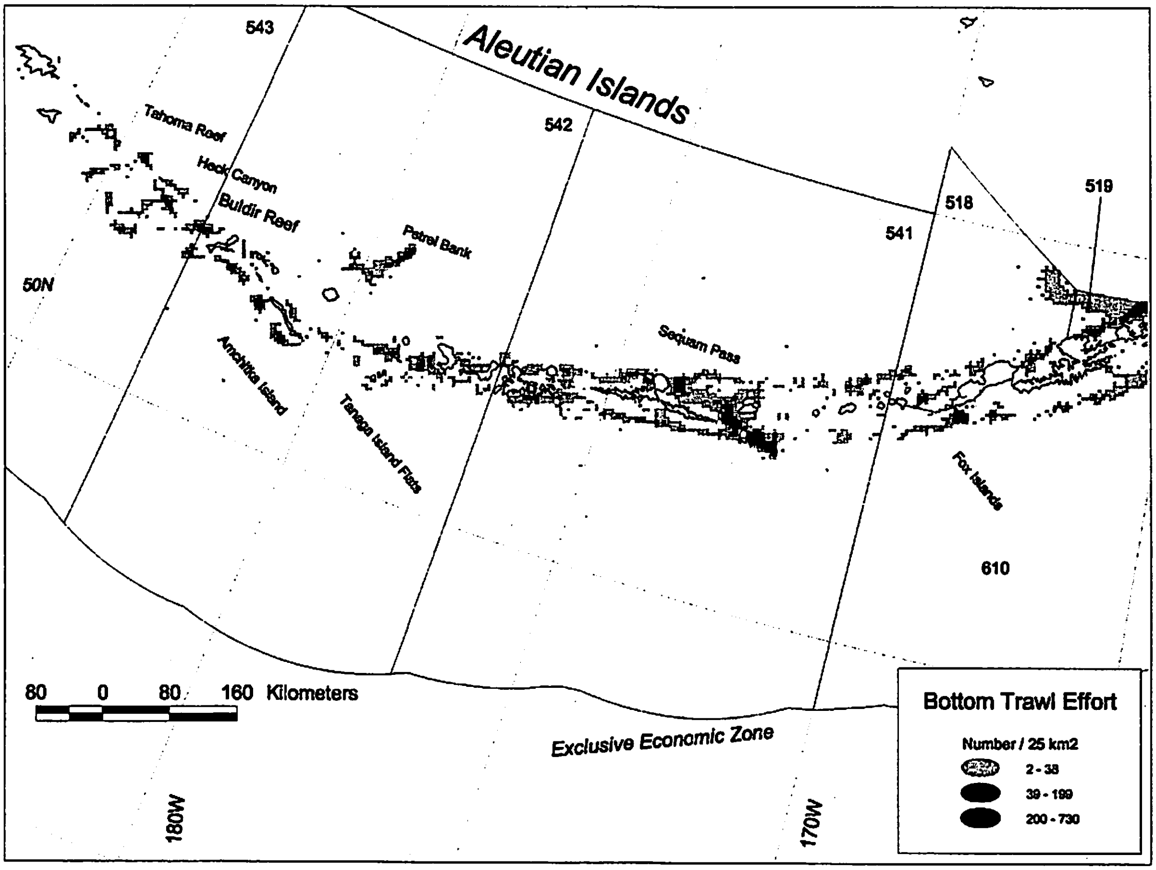


Figure 5. Estimated bottom trawl time in the Gulf of Alaska and Aleutian Islands, 1990-98.

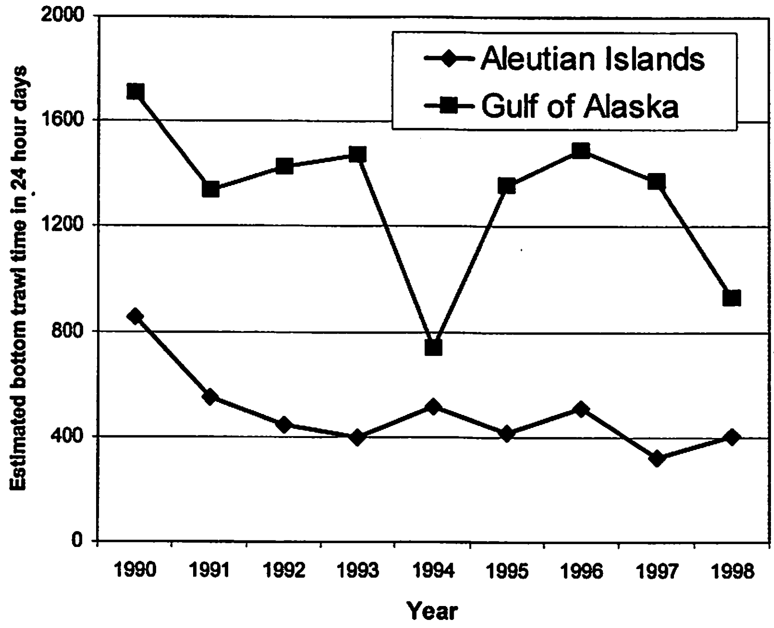


Figure 6. Estimates of time*area closures to groundfish trawling in the Bering Sea/Aleutian Islands and Gulf of Alaska, 1987-1998 (not including trigger closures or seasonal extensions around selected sea lion rookeries).