

Pacific Halibut Bycatch in IPHC Area 2A in the 2004 Groundfish Trawl Fishery

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ABSTRACT

This report updates the estimates of Pacific halibut bycatch and mortality in the bottom trawl fishery through the calendar year 2004. The estimates of halibut bycatch and mortality in the bottom trawl fishery are based upon the method developed in the report for 1999 (Wallace, 2000). The current report uses halibut bycatch rates observed for the 2004 calendar year by the West Coast Groundfish Observer Program. These rates are stratified by season, depth, latitude, and amount of arrowtooth flounder catch, and then multiplied by the amount of trawl effort in each stratum determined from Oregon and Washington trawl logbooks in 2004. Estimated halibut bycatch and mortality in other gear types has not been updated for 2004. The estimate for the 2004 bottom trawl fishery is 245,000 lbs net weight of total halibut bycatch mortality, of which 172,000 lbs is legal-sized. The net weight is 47.0 percent lower than in 2003. As in past reports, forecast of bycatch for the current year (2005) or future years is not attempted.

GROUND FISH FISHERY BACKGROUND

Changes in the groundfish fishery and its management affect not only the amount of groundfish fishing effort, but also its geographic and temporal distribution. Since halibut bycatch rates vary among time and area strata, changes in the amount and distribution of effort will alter the amount of halibut bycatch that is estimated for the trawl fleet. Here we briefly describe the management changes that occurred in 2004.

As in 2003, the trawl fishery was managed throughout 2004 using closed Rockfish Conservation Areas (RCA) to restrict fishery access to some areas. North of 40°10' N. Lat., the seaward boundary of the closed area was set at line approximating 200 fm during the first 4 months, and at 150 fm from May through September. During the last 3 months of the year, groundfish trawling was closed from the shore out to the 250 fm line, in order to minimize bycatch of darkblotched rockfish. The shoreward boundary was set at 75 fm during the first 2 months and from July through September, and at 60 fm from March through June. Special areas for winter petrale fishing during the first 2 months were designated between 150 and 200 fm. The use of small footrope gear (rollers of 8" or less) was required for all fishing shoreward of the RCA. In addition to having shoreward RCA boundaries no deeper than the 75 fm line throughout the year, 2-month limits for flatfish, thornyheads, and sablefish were lower for small footrope gear. These differential limits were intended to reduce trawl effort on the shelf, and in turn the bycatch of several rebuilding species.

HISTORICAL BYCATCH ESTIMATES

Bottom Trawl Fishery for Groundfish

Estimated bycatch and mortality of halibut in 1987, 1992, and 1995 are summarized in Table 1. As described by Williams, et al. (1998), these halibut bycatch and mortality estimates were based upon catch rates observed during a voluntary fisheries observer program conducted during the late 1980s. Approximately 1,062 tows by bottom trawl fisheries off Oregon and Washington were observed during 1985-1987. An additional 65 tows were observed off California during 1988-1990. Catch rates were stratified by fishing strategy, depth, season, and area as described by Pikitch, et al. (1998).

Analysis of Enhanced Data Collection Program

From November 1995 through December 1998, observers quantified halibut catches on the west coast bottom trawl fisheries during the Enhanced Data Collection Program (EDCP). In addition, skippers participating in the EDCP filled out enhanced logbooks on which aggregate halibut catch information was recorded. During the program, when no observer was onboard, skippers continued to fill out the enhanced logbooks.

In the 1,825 EDCP tows from both Washington and Oregon, an estimated 11,434 halibut were caught. However, using only observed EDCP tows with complete strata information, 4,816 halibut were measured by observers. Wallace (2000) used similar methods to those in Pikitch (1998) to analyze the EDCP data and identify appropriate strata for bycatch estimation. These strata are season (Jan-Aug and Sept-Dec), depth (0-100, 100-300, 300-700 fm), area (five latitude ranges) and catch of arrowtooth flounder (0-20 lbs per hour and >20 lbs). These methods and preliminary results were reviewed and approved by the Pacific Fishery Management Council's Scientific and Statistical Committee during the June and September 2000 meetings.

Shrimp Trawl

Halibut bycatch in shrimp trawls in 1987, 1992, and 1995 was reported by Williams, et al (1998) and are presented in Table 4. For 1998, Bob Hannah (ODFW, personal communication) produced estimates of halibut bycatch in Oregon shrimp trawls for PSMFC Areas 2B-3C (Table 5). He used three data sources:

1) bycatch rates observed during 128 tows by Pikitch, et al., during 1985-87; 2) control net catch rates from 166 tows observed by Hannah, et al.; and 3) data compiled from shrimp fishing trips observed during 1996-99 by the EDCP, combined with control net catches from ODFW research charters during the same time period (for a total of 203 observed tows). The approximate number of tows in the 1998 Oregon shrimp fishery was over 10,000. The halibut bycatch estimates for this fishery are based on expanding the encounter rates (pounds of halibut per single-rig equivalent hour (sreh)) by the effort expended by vessels landing shrimp in Oregon ports only. The estimates are not stratified by depth because the depth range of the shrimp fishery is very restricted and the amount of data is very limited. The percent legal-sized (62 percent) and the percent survival (50 percent) was assumed to be the same as in the bottom trawl fishery. Given the range of estimates and the data limitations, Hannah estimates that the 1998 bycatch mortality of legal-sized halibut from Oregon is about 16,000 lbs, net weight and about 25,000 lbs. round weight. Halibut bycatch from vessels landing shrimp into Washington and California ports is not included.

Analysis of data collected during first year of the West Coast Groundfish Observer Program (WCGOP)
The WCGOP began collecting at-sea trawl discard data in September of 2001. Data collected through August 2002 were checked and evaluated in the winter of 2002. A report of findings from the first year of observation was published at the NMFS Northwest Fisheries Science Center website in January 2003. Estimates of halibut bycatch in the 2002 trawl fishery were developed in the summer of 2003 using observer data from the first year of collection. Because observer data from the last four months of 2002 were not yet available, halibut bycatch during that period was estimated using data collected during the last four months of 2001.

A total of 2,812 observed bottom trawl tows off Washington and Oregon were included in the estimation of 2002 halibut bycatch. Methods similar to those in Pikitch (1998) were used to analyze the observer data and identify appropriate strata for bycatch estimation. The strata used to estimate 2002 halibut bycatch were: season (Jan-Aug and Sept-Dec), depth (0-100, 100-300, 300-700 fm), area (four latitude ranges) and catch of arrowtooth flounder (0-20 lbs per hour and >20 lbs). The correlation between arrowtooth and halibut witnessed in the observer data was also confirmed by an examination of bottom trawl survey data. Bycatch rates for these strata were, in turn, applied to trawl effort summarized from logbooks, and the resulting bycatch amounts expanded to account for landings not captured in logbooks. The total estimated halibut mortality for 2002 was 512,000 net pounds, which was a 36 percent reduction from the estimate for 2001.

Analysis of data from the West Coast Groundfish Observer Program's second year

The second year of data released by the West Coast Groundfish Observer Program (WCGOP) includes observations from 01 September 2002 through 31 August 2003. Because of the current unavailability of observer data from the last four months of 2003, the September-December 2002 data were included to form a 12-month bycatch data set. There were 2,770 bottom trawl tows between 48.667 and 40.667 degrees latitude (all of Washington to just north of the Oregon-California border) used for this study. An estimated total weight of 163,363 lbs of halibut was caught in those tows.

The existence of the Oregon Flatfish Trawl EFP complicated analysis of the 2003 fishery. Because the WCGOP observed all the 2003 Oregon Flatfish Trawl EFP trips, the halibut discard observed during this program was treated as a census for that set of trips. Observations from this EFP, whose purpose was to evaluate bycatch associated with a selective flatfish gear design, were not applied to trips outside this EFP. For the remainder of the limited-entry groundfish trawl fishery, including the Washington Arrowtooth EFP (which was not fully observed), methods similar to those in Pikitch (1998) were used to analyze the observer data and identify appropriate strata for bycatch estimation. These strata are season (Jan-Aug and Sept-Dec), depth (0-75, 75-150, 150-250, 250-700 fm), area (four latitude ranges) and catch of arrowtooth flounder (0-20 lbs per hour and >20 lbs). Bycatch rates for these strata were, in turn,

applied to trawl effort summarized from logbooks, and the resulting bycatch amounts expanded to account for landings not captured in logbooks. The total estimated halibut mortality for 2003 was 462,000 net pounds, which was a 9.8 percent reduction from the estimate for 2002.

BYCATCH ESTIMATES FOR 2004

Analysis of 2004 data from the West Coast Groundfish Observer Program

The WCGOP is in the process of moving to a new reporting cycle for their observations. Consequently, they were able to provide data for the complete calendar year of 2004 for this assessment. There were 2,883 bottom trawl tows between 48.667 and 40.667 degrees latitude (all of Washington to just north of the Oregon-California border) included in this study. An estimated total weight of 164,508 lbs of halibut was caught in those tows. The vast majority of these weights are 'actual weights' from the entire catch, i.e. not estimated or extrapolated. The number of halibut in a tow was recorded only 21% of the time, and therefore those data were not used in this report. In the observer program, lengths are taken when halibut are selected as 'biological samples'. For the data used in this report, on a tow basis, halibut were selected to be a biological sample 20 percent of the time when Pacific halibut were caught in the tow. Halibut have a lower priority for biological sampling than groundfish species that have been declared overfished. Additionally, crews attempt to return halibut to the ocean as quickly as possible, in order to promote survival of the discards. As a consequence, it can be difficult for observers to obtain length measurements for all discarded halibut.

The 2004 Oregon Flatfish Trawl EFP trips accounted for only 2.7 percent of the tows observed by the WCGOP and consequently, was not split out in this analysis.

For all of the Limited-Entry groundfish trawl activity, including the Washington Arrowtooth EFP and the Oregon Flatfish Trawl EFP trips, methods similar to those in Pikitch (1998) were used to analyze the observer data and identify appropriate strata for bycatch estimation. These strata are season (Jan-Aug and Sept-Dec), depth (0-75, 75-150 150-250, 250-700 fm), area (four latitude ranges) and catch of arrowtooth flounder (0-20 lbs per hour and >20 lbs). Depth strata were adjusted in 2003, so as to better align with management boundaries for the RCA. Numbers of tows, halibut catches, halibut catch rates, and the proportions of legal-sized halibut (>81 cm) are listed for each of these strata in Table 3.

Bottom Trawl Effort from Logbooks

Logbook data for Oregon and Washington in 2004 were obtained from PacFIN. Since ODFW collects logbook data for only 70-80 percent of the trawl deliveries during a typical year, Oregon logbook effort (hours towed) was expanded using fish tickets on a port and month basis. This approach was used in order to avoid any potential bias created by unequal collection of logbooks in the three major ports (Astoria, Newport, and Coos Bay). WDFW's "extrapolated and expanded" trawl effort was used for Washington trips.

Total trawl effort (hours) for the entire Oregon fleet was based on expanding the groundfish catch in logbook data by the total groundfish catch reported on fish tickets, as follows. Dividing aggregate catch on fish tickets by aggregate catch in the logbook data creates expansion ratios, by port and month. These expansion ratios were applied to the tow effort (hours) to arrive at the expanded effort for Oregon's trawl fleet. The expanded effort was then stratified, based on the observer data analysis. A similar effort expansion was not conducted for the Washington fleet because WDFW expands their effort, so total fleet effort is equal to reported logbook effort. The total fleet effort for each stratum in 2004 is reported in Table 3.

Halibut bycatch in each stratum was estimated by multiplying total (expanded) stratum effort by the stratum halibut bycatch rate. Bycatch by the bottom trawl fleet is estimated by summing across strata. If there was effort within a stratum, but no observer tows, the coast-wide average bycatch rate (10.161 kg per hour) was used. This value is calculated as the unweighted average of the stratum means.

As in earlier years, half of the released halibut are assumed to survive capture (Gregg Williams, IPHC, personal communication). Therefore, bycatch mortality of halibut is assumed to be 50 percent of total bycatch. The proportion of legal-sized halibut (> 81cm) is estimated from the length frequencies of halibut measured in the observer data (Table 2). All measurements of fish lengths were converted to fish weight based on a length-weight relationship for Pacific halibut (IPHC, personal communication), and the proportion of legal-sized fish (by weight) was computed for each stratum (Table 3). Average proportion legal (calculated as the unweighted average of the stratum means) was used when no other estimate was available: 60.42 percent by weight. A more sophisticated approach of imputing the missing data shows that the unweighted average is more appropriate than weighting either by effort or weight. This value is low compared with an average proportion legal of 74.44 percent and weighted logbook estimate of 67 percent that were found in the EDCP data. However, a more comparable value of 62 percent was estimated in early studies (Williams et al., 1998) and used for 1977-1997.

For comparison purposes, 2004 totals are shown together with annual totals since 1998 in Table 6. Estimated mortalities of all and of legal-sized halibut since 1977 are listed in Tables 7 and 8, respectively. Following from a 35.7 percent decrease in trawl effort, total discard mortality of halibut during 2004 is estimated to be 47.0 percent lower than in 2003. The fact that halibut mortality declined by a greater percentage than trawl effort reflects a shift in trawl effort to deeper waters where halibut bycatch is lower. The percentage of discard comprised by legal-sized fish was down from the high seen in 2003, but still higher than any of the other years. Nearly 49 percent of the estimated discard of legal-sized fish occurred in just four of the 64 strata used in the analysis, i.e. the four depth strata for the January-August time period in the area between 47.67° and 48.67° N. latitude.

It is not possible to make a forecast for the 2005 fishery given lack of a methodology to project the distribution of effort among model strata prior to the complete availability of a year's logbook data.

REFERENCES

- Pikitch, E.K., Wallace, J.R., Babcock, E.A., Erickson, D.L., Saelens, M., and Oddsson, G. (1998) Pacific halibut bycatch in the Washington, Oregon, and California groundfish and shrimp trawl fisheries. *North American Journal of Fisheries Management*. Volume 18, pp. 569-586.
- Wallace, J.R. (2000) Unpublished report. Pacific halibut discard in the EDCP Observer Program. June 2000. 18 pg.
- Williams, G. H., G. Stauffer, H. Weeks, M. Saelens, J. Scordino, D. Bodenmiller, and T. Northup (1998). Pacific halibut bycatch in Area 2A: Bycatch rates and current estimates of bycatch mortality. *Int. Pac. Halibut Comm. Rep. of Assess. and Res. Activ.* 1998: 269-282.

Table 1. Halibut bycatch and mortality in the bottom trawl fisheries for groundfish off the west coast, estimated from Pikitch et al., (1998) and reported by Williams et al., (1998).

Year	Trawl Effort (hours)	Estimated Halibut Bycatch (numbers)	Estimated Halibut Bycatch (kg., round)	Estimated Halibut Bycatch (lbs, net)	Estimated Total Halibut Mortality (lbs, net)	Estimated Legal-Sized Halibut Mortality (lbs, net)
1987	135,075	78,765	372,911	616,702	308,351	191,178
1992	182,155	89,756	465,595	769,979	384,989	238,693
1995	72,295	113,702	663,262	1,096,870	548,435	340,030

Note: For 1995, bycatch estimates for Areas 1B-2A off California are not included. Mortality estimated at 50% of bycatch. Legal-sized mortality (>81 cm) estimated at 62%, by weight, of total mortality. 1 kg, round = 1.65375 lbs, net weight.

Table 2. Length frequencies for Pacific halibut from the West Coast Groundfish Observer Program data. (The upper limits on the length intervals are inclusive, the lower limits are not.)

Length Interval (cm)	Length Freq.	Percent Length Freq.
25-30	0	0.00
30-35	0	0.00
35-40	0	0.00
40-45	5	0.19
45-50	5	0.19
50-55	14	0.53
55-60	79	3.02
60-65	198	7.56
65-70	367	14.01
70-75	467	17.83
75-80	465	17.75
80-85	285	10.88
85-90	205	7.83
90-95	175	6.68
95-100	105	4.01
100-105	87	3.32
105-110	56	2.14
110-115	25	0.95
115-120	24	0.92
120-125	22	0.84
125-130	12	0.46
130-135	8	0.31
135-140	3	0.11
140-145	3	0.11
145-150	6	0.23
150-155	2	0.08
155-160	0	0.00
160-165	1	0.04
165-170	0	0.00
170-175	0	0.00
175-180	0	0.00
180-185	0	0.00
Total	2619	100.00

Table 3. Numbers of tows, halibut catches, halibut catch rates and effort, by strata, observed in the bottom trawl fishery by the West Coast Groundfish Observer Program. The last two columns, from 2003, are for comparison purposes. (The upper limits are inclusive for all intervals; the lower limits are not.)

SEASON: JANUARY - AUGUST

Arrowtooth Catch (lbs/h)	Latitude	Depth (Fathoms)	Number of Observed Tows	Number of Tows with ≥ 1 Halibut	Weight. (kg., rnd) of Halibut per Hour	Trawl Effort (hours) from OR & WA	Proportion Legal by Weight	Number of Observed Tows 2003	Wgt. (kg., rnd) Halibut per Hour 2003
≤ 20	40.667 - 42.667	0 - 75	1	1	17.86	196		6	0.00
		75 - 150	0	0		0		1	12.48
		150 - 250	16	0	0.00	245	0.000	6	0.00
		250 - 700	43	0	0.00	1055	0.000	109	0.05
42.667 - 46.667	42.667 - 46.667	0 - 75	523	116	1.78	3442	0.796	154	4.83
		75 - 150	19	6	1.51	156	0.955	46	10.27
		150 - 250	84	20	2.11	1787	0.729	78	2.15
		250 - 700	191	5	0.07	3087	0.562	282	0.10
46.667 - 47.667	46.667 - 47.667	0 - 75	245	89	4.47	2442	0.655	36	6.03
		75 - 150	3	1	2.69	69		6	15.24
		150 - 250	11	1	0.38	532	0.589	44	1.24
		250 - 700	18	0	0.00	479	0.882	50	0.13
47.667 - 48.667	47.667 - 48.667	0 - 75	266	207	30.66	2271	0.715	105	25.64
		75 - 150	23	10	46.25	66	0.937	29	26.73
		150 - 250	18	5	6.78	388		23	3.39
		250 - 700	19	2	1.07	717	0.722	49	0.45
> 20	40.667 - 42.667	0 - 75	0	0		18		0	
		75 - 150	0	0		0		1	9.50
		150 - 250	4	1	1.43	64		0	
		250 - 700	2	0	0.00	15		0	
42.667 - 46.667	42.667 - 46.667	0 - 75	71	23	2.04	682	1.000	25	7.30
		75 - 150	4	2	0.40	93		54	10.96
		150 - 250	245	114	4.24	3368	0.669	78	2.66
		250 - 700	115	31	1.67	1387	0.464	59	0.88
46.667 - 47.667	46.667 - 47.667	0 - 75	48	17	6.97	479	0.934	27	13.75
		75 - 150	12	8	18.16	70	0.912	12	137.85
		150 - 250	57	35	7.68	511	0.571	16	18.05
		250 - 700	8	3	1.57	194		3	2.37
47.667 - 48.667	47.667 - 48.667	0 - 75	123	104	53.55	1006	0.808	123	62.37
		75 - 150	25	21	106.81	161		31	130.67
		150 - 250	123	92	40.50	1068	0.620	27	16.78
		250 - 700	19	10	94.85	279	0.765	16	6.37

Table 3. Continued.

SEASON: SEPTEMBER - DECEMBER

Arrowtooth Catch (lbs/h)	Latitude	Depth (Fathoms)	Number of Observed Tows	Number of Tows with ≥ 1 Halibut	Weight. (kg., rnd) of Halibut per Hour	Trawl Effort (hours) from OR & WA	Proportion Legal by Weight	Number of Observed Tows 2003	Wgt. (kg., rnd) Halibut per Hour 2003
≤ 20	40.667 - 42.667	0 - 75	0	0		86		0	
		75 - 150	0	0		0		0	
		150 - 250	2	2	5.62	49		0	
		250 - 700	7	0	0.00	620		5	0.00
	42.667 - 46.667	0 - 75	72	8	0.55	749	0.644	144	1.24
		75 - 150	0	0		23		15	1.98
		150 - 250	22	8	5.14	580	0.896	12	2.46
		250 - 700	170	11	0.25	3827	0.728	104	0.25
	46.667 - 47.667	0 - 75	2	0	0.00	335	0.00	9	3.48
		75 - 150	0	0		10		0	
		150 - 250	1	0	0.00	110		0	
		250 - 700	34	4	0.24	373	0.750	4	0.00
	47.667 - 48.667	0 - 75	12	9	5.73	480	0.186	86	4.02
		75 - 150	1	1	2.32	39	0.000	7	16.96
		150 - 250	1	1	4.31	42		17	69.34
		250 - 700	20	5	0.52	326	0.567	16	0.79
> 20	40.667 - 42.667	0 - 75	0	0		0		0	
		75 - 150	0	0		0		0	
		150 - 250	3	0	0.00	79		0	
		250 - 700	1	0	0.00	17		0	
	42.667 - 46.667	0 - 75	37	3	0.42	245	0.389	14	5.48
		75 - 150	0	0		61		24	1.54
		150 - 250	78	50	6.96	1035	0.448	2	0.00
		250 - 700	44	10	0.90	1052	0.291	2	3.14
	46.667 - 47.667	0 - 75	0	0		44		13	28.20
		75 - 150	0	0		27		0	
		150 - 250	12	9	4.87	126		0	
		250 - 700	3	0	0.00	97		0	
	47.667 - 48.667	0 - 75	1	1	12.85	65		0	
		75 - 150	2	0	0.00	28		4	2.14
		150 - 250	15	12	18.87	301	0.754	11	48.72
		250 - 700	7	6	3.29	344		1	5.99

Table 4. Halibut bycatch and mortality in the bottom trawl fishery for pink shrimp off the west coast, reported by Williams et al. (1998).

Year	Trawl Effort (hours)	Estimated Halibut Bycatch (numbers)	Estimated Halibut Bycatch (kg., round)	Estimated Halibut Bycatch (lbs, net)	Estimated Total Halibut Mortality (lbs, net)	Legal-sized Bycatch Mortality (lbs, net)
1987	193,694	20,536	98,983	163,693	81,847	50,745
1992	107,015	10,244	51,671	85,450	42,725	26,490
1995	----	----	----	100,000	50,000	31,000

Note: For 1995, bycatch estimates for Areas 1B-2A off California are not included. Mortality estimated at 50% of bycatch. Proportion of legal-sized mortality (>81 cm) is assumed to be 62% by weight. 1 kg, round = 1.65375 lbs, net weight.

Table 5. Estimated 1998 halibut bycatch and mortality in the bottom trawl fishery for pink shrimp (landings into Oregon ports only). (Bob Hannah, personal communication, October 8, 1999 memo). The data sources numbered 1-3 are described in the text.

Data Source	Single-rig Equivalent Hours (sreh) Observed	Bycatch Rate (lbs/sreh)	Fishing Effort (sreh) in Oregon Landings	Bycatch Estimate (kg., round)	Bycatch Mortality (lbs, net)	Legal-sized Bycatch Mortality (lbs, net)
1 - Pikitch	---	1.22	34,543	19,155	15,839	9,820
2 - Hannah	236.5	2.60	34,543	40,824	33,756	20,929
3 - EDCP	551.1	2.12	34,543	33,287	27,524	17,065

Note: Mortality estimated at 50% of bycatch. Proportion of legal-sized mortality (>81 cm) is assumed to be 62% by weight, as in the bottom trawl fishery. 1 kg, round = 1.65375 pounds, net weight.

Table 6. Halibut bycatch and mortality in the Oregon and Washington bottom trawl fisheries for groundfish off the west coast. The new 2004 data are estimated from bycatch rates observed by the West Coast Groundfish Observer Program and applied to annual total groundfish bottom trawl effort (Table 3). All estimates in this table (except the last column) are derived from a sum over strata cells; see the text for details.

Year	Trawl Effort (hours)	Estimated Halibut Bycatch (numbers)	Estimated Halibut Bycatch (kg, round)	Estimated Halibut Bycatch (lbs, net)	Estimated Total Halibut Mortality (lbs, net)	Estimated Legal-Sized Halibut Mortality (lbs, net)	Estimated Legal-Sized divided by Total Halibut Mortality
1998	92,294	164,961	1,259,374	2,082,690	1,041,345	691,755	0.6643
1999	81,420	147,995	1,144,236	1,892,280	946,140	638,091	0.6744
2000	70,363	122,234	944,120	1,561,338	780,669	523,097	0.6701
2001	67,199	124,969	962,348	1,591,482	795,741	532,912	0.6697
2002	52,168	NA	618,913	1,023,527	511,764	286,221	0.5593
2003	58,339	NA	558,544	923,693	461,847	366,745	0.7941
2004	37,495	NA	296,225	489,882	244,941	171,754	0.7012

Note: Halibut bycatch by California bottom trawl fishery is not included. Mortality estimated at 50% of bycatch. Proportion of legal-sized mortality (>81 cm) estimated from length frequencies of fish measured by the West Coast Groundfish Observer Program. 1 kg, round = 1.65375 pounds, net weight.

Table 7. Summary of total estimated bycatch mortality of Pacific halibut, in thousands of pounds, net weight, by fishery in 2A. Bycatch mortality estimates for 1977-1997 are reported from Table 6 in Williams, et al. 1998.

Year	Foreign, JV & Catcher-Proc.	Groundfish Trawls	Shrimp Trawls	Hook & Line	TOTAL
1977	3	308	82	16	409
1978	2	308	82	16	408
1979	1	308	82	16	407
1980	1	308	82	16	407
1981	Trace	308	82	16	406
1982	Trace	308	82	16	406
1983	1	308	82	16	407
1984	Trace	308	82	16	406
1985	Trace	308	82	16	406
1986	1	308	82	16	407
1987	1	308	82	16	407
1988	1	308	82	16	407
1989	2	308	82	16	408
1990	2	308	82	16	408
1991	2	308	82	16	408
1992	0	385	43	16	444
1993	0	385	43	16	444
1994	0	385	43	16	444
1995	0	548	50	16	614
1996	0	548	50	16	614
1997	0	548	50	16	614
1998	0	1,041	25	---	---
1999	---	946	---	---	---
2000	---	781	---	---	---
2001	---	796	---	---	---
2002	---	512	---	---	---
2003	---	462	---	---	---
2004	---	245	---	---	---

Note: Bycatch mortality by groundfish trawls in 1998-2004 does not include fisheries off California. Bycatch mortality by shrimp trawls in 1998 does not include fisheries off California and Washington.

Table 8. Summary of estimated mortality of legal-sized Pacific halibut, in thousands of pounds, net weight, by fishery in 2A. The bycatch mortality estimate for legal-sized halibut for 2004 is from this report. (Sums across fisheries may not always equal the TOTAL due to rounding.)

Year	Foreign, JV & Catcher-Proc.	Groundfish Trawls	Shrimp Trawls	Hook & Line	TOTAL
1977	2	191	51	10	254
1978	1	191	51	10	253
1979	0.6	191	51	10	252
1980	0.6	191	51	10	252
1981	Trace	191	51	10	252
1982	Trace	191	51	10	252
1983	0.6	191	51	10	252
1984	Trace	191	51	10	252
1985	Trace	191	51	10	252
1986	0.6	191	51	10	252
1987	0.6	191	51	10	252
1988	0.6	191	51	10	252
1989	1	191	51	10	253
1990	1	191	51	10	253
1991	1	191	51	10	253
1992	0	239	27	10	275
1993	0	239	27	10	275
1994	0	239	27	10	275
1995	0	340	31	10	381
1996	0	340	31	10	381
1997	0	340	31	10	381
1998	0	692	16	---	---
1999	---	638	---	---	---
2000	---	523	---	---	---
2001	---	533	---	---	---
2002	---	286	---	---	---
2003	---	367	---	---	---
2004	---	172	---	---	---

Note: Bycatch mortality by groundfish trawls in 1998-2004 does not include fisheries off California. Bycatch mortality by shrimp trawls in 1998 does not include fisheries off California and Washington.