

## **Estimates of Pacific Halibut Bycatch and Mortality in IPHC Area 2A in 2001**

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This report updates the estimate of Pacific halibut bycatch and mortality in the bottom trawl fishery through the calendar year 2001. The estimate of halibut bycatch and mortality in the bottom trawl fishery is based upon the method developed in the report for 1999 which uses halibut bycatch rates observed during 1995-1999 in the Enhanced Data Collection Program (EDCP). These rates are stratified by season, depth, latitude, and level of arrowtooth flounder catch, then multiplied by the amount of trawl effort in each stratum determined from Oregon and Washington trawl logbooks in 2001. Estimated halibut bycatch and mortality in other gear types has not been updated for 2001.

### **GROUNDFISH FISHERY BACKGROUND**

Changes in the groundfish fishery and its management affect the amount of groundfish fishing effort and the geographic and temporal distribution of this effort. These changes will affect the calculated halibut bycatch amount because of the differences in bycatch rate between the several time and area strata. Here we briefly describe the management changes that occurred in 2000 and 2001.

For the 2000 season, bottom trawl trip limits for shelf and nearshore rockfish were reduced by over 90% from 1999 levels. Further, the use of small footrope gear (rollers of 8" or less) was required in 2000 to land any shelf or nearshore rockfish species. Substantial limits for widow, yellowtail, and chilipepper rockfish remained available, but only when using mid-water gear. The intent of the new gear restriction and lower bottom trawl limits was to eliminate targeting on and reduce the bycatch of shelf species that had been declared overfished. While these changes could have shifted effort from rockier habitat into lower-relief bottom areas, landings of flatfish other than Dover sole actually fell by more than 2,100 mt in 2000, with most of the reduction occurring in Oregon and Washington. This response was likely influenced by processors inability to market the same amount of flatfish with dramatically lesser amounts of rockfish.

The restrictive rockfish limits and gear restrictions designed to protect overfished shelf species were maintained during the 2001 fishery. Additionally, north of 40°10' N. Lat. slope rockfish limits were reduced to protect darkblotched rockfish. While most fishing for flatfish species other than Dover sole in 2000 was not subject to trip limits, limits were imposed on landings of these species in 2001, from May through the end of the year. A bycatch allowance for yellowtail rockfish caught with flatfish was also added. Despite closure of the DTS complex from October through the end of the year, which could have redirected considerable effort into shelf flatfish fisheries, landings of flatfish species other than Dover fell by another 500 mt between 2000 and 2001.

## 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).

### Shrimp Trawl

Halibut bycatch in shrimp trawls in 1987, 1992, and 1995 reported by Williams, et al (1998), are shown in Table 2 and the methods are briefly described below. Bob Hannah (ODFW, personal communication) produced three estimates of the 1998 halibut bycatch for PSFMC Areas 2B-3C and these are given in Table 3. The three bycatch estimates were based on three different 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. (1996); 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). Given the range of estimates and the data limitations, Hannah estimates that the 1998 bycatch mortality of legal-sized halibut (>81 cm) from Oregon is about 16,000 lbs, net weight.

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. Bycatch from vessels landing shrimp into Washington ports is not included.

## UPDATED BYCATCH ESTIMATES FOR 2001

### 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 (see below), 4,816 halibut were measured by observers. The length frequency breakdown of these halibut can be seen in Table 4. Washington records in the EDCP data include individual lengths, but no individual weights. Also, since there were also some anomalies in the Oregon state landings of individual weights the 'net pounds per length interval' information in Table 4 is from a length-weight relationship for Pacific halibut (IPHC, personal communication).

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 fathoms), area (five latitude ranges) and catch of arrowtooth flounder (0-20 lbs per hour and >20 lbs). Numbers of tows, halibut catches, halibut catch rates, and proportion of legal-sized halibut (>81 cm) are given for each of these strata in Table 5. 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.

#### Bottom Trawl Effort from Logbooks

Logbook data for Oregon and Washington in 2001 was obtained from PacFIN. Trawl effort from logbooks was accumulated into each of the strata identified in the EDCP analyses. Port and Month were added as factors for Oregon logbooks to avoid any potential bias created by unequal collection of logbooks in the three major ports (Astoria, Newport, and Coos Bay). ODFW collects logbook data for 70-80% of the trawl deliveries during a typical year, thus the need to avoid collection bias.

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. Expansion ratios, by port and month, were derived by dividing aggregate catch on fish tickets by aggregate catch in the logbook data. 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 combined into the strata based on the EDCP analysis.

Such an 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 2001 is reported in Table 6.

Halibut bycatch for each stratum is estimated by multiplying total (expanded) effort by the halibut bycatch rate for that stratum. Bycatch by the bottom trawl fleet is estimated by summing across strata. If there was effort within a strata, but no EDCP tows, the average bycatch rate

was used: 1.795 halibut per hour by number and 13.652 kg per hour for weight. Likewise, the average proportion legal was used when no other estimate was available: 0.7444 by weight. Preliminary work with more a sophisticated approach to imputing these missing data had very little effect on the calculated total bycatch.

As in earlier years, half of the released halibut are assumed to survive capture, and therefore, bycatch mortality of halibut is assumed to be 50% of total bycatch. The bycatch mortality of legal-sized halibut (> 81cm) is estimated from the length frequencies of halibut measured in the EDCP study. 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 in the EDCP analysis. Updated results for 2001 are presented in Table 7 and added to the long-term time series in Tables 8 and 9. Although the total trawl effort decreased 5% from 2000 to 2001, the estimated halibut bycatch increased by 1.9%, due to redistribution of the effort into strata with higher halibut bycatch rates.

It is not possible to make a forecast at this time for the 2002 fishery. In the future, the observer program, started by the NWFSC in the autumn of 2001, will provide a more complete and timely view of the bycatch of Pacific halibut in the west coast bottom trawl fishery.

**REFERENCES**

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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., Jan. 23, 1998 document.

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. Halibut bycatch and mortality in the bottom trawl fishery for pink shrimp off the west coast, reported by Williams, et al., Jan. 23, 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 3. 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).

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)
Pikitch (1)	---	1.22	34,543	19,155	15,839	9,820
Hannah (2)	236.5	2.60	34,543	40,824	33,756	20,929
EDCP (3)	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. 1 kg, round = 1.65375 pounds, net weight.

Table 4. Length frequency and net pounds per length interval for Pacific halibut from the EDCP database. (The upper limits on the length intervals are inclusive, the lower limits are not.)

Length Interval (cm)	Length Freq.	Percent Length Freq.	Net lbs per Interval	Percent net lbs per
20-25	1	0.02	0	0.00
25-30	2	0.04	1	0.00
30-35	2	0.04	1	0.00
35-40	0	0.00	0	0.00
40-45	4	0.08	5	0.01
45-50	7	0.15	13	0.02
50-55	10	0.21	25	0.04
55-60	17	0.35	61	0.09
60-65	123	2.55	572	0.87
65-70	379	7.87	2199	3.33
70-75	777	16.13	5614	8.51
75-80	754	15.66	6725	10.19
80-85	624	12.96	6815	10.33
85-90	561	11.65	7438	11.27
90-95	447	9.28	7125	10.80
95-100	356	7.39	6680	10.12
100-105	266	5.52	5901	8.94
105-110	151	3.14	3903	5.91
110-115	126	2.62	3748	5.68
115-120	71	1.47	2440	3.70
120-125	57	1.18	2237	3.39
125-130	39	0.81	1746	2.65
130-135	19	0.39	971	1.47
135-140	9	0.19	511	0.77
140-145	2	0.04	128	0.19
145-150	4	0.08	294	0.45
150-155	4	0.08	320	0.49
155-160	1	0.02	88	0.13
160-165	0	0.00	0	0.00
165-170	1	0.02	110	0.17
170-175	0	0.00	0	0.00
175-180	1	0.02	135	0.20
180-185	0	0.00	0	0.00
185-190	0	0.00	0	0.00
190-195	0	0.00	0	0.00
195-200	1	0.02	184	0.28
Total	4816	100.00	65992	100.00



Table 5. Numbers of tows, halibut catches, and halibut catch rates, by strata, observed during the Enhanced Data Collection Program of the bottom trawl fishery for groundfish. (The upper limits on the all intervals are inclusive, the lower limits are not.)

SEASON: JANUARY - AUGUST

Arrow-tooth Catch (lbs/h)	Latitude	Depth (Fathoms)	Number of Observed Tows	Number of Tows with $\geq 1$ Halibut	Total Number of Halibut	Number of Halibut per Hour	Wgt. (kg., rnd) Halibut per Hour	Proportion Legal by Weight	Proportion Legal by Number
< 20	40.667 - 41.667	0 - 100	0						
		100 - 300	0						
		300 - 700	2	0	0	0.00	0.00		
41.667 - 42.667	41.667 - 42.667	0 - 100	2	1	7	1.99	16.61	0.837	0.714
		100 - 300	9	0	0	0.00	0.00		
		300 - 700	14	1	1	0.01	0.14	1.000	1.000
42.667 - 46.667	42.667 - 46.667	0 - 100	147	64	236	0.55	5.25	0.825	0.633
		100 - 300	164	81	590	0.80	8.12	0.792	0.604
		300 - 700	137	3	5	0.00	0.03	0.670	0.600
46.667 - 47.667	46.667 - 47.667	0 - 100	68	40	238	3.81	32.65	0.793	0.601
		100 - 300	24	14	83	0.81	6.47	0.728	0.549
		300 - 700	37	2	2	0.02	0.11	0.618	0.500
47.667 - 48.667	47.667 - 48.667	0 - 100	98	57	571	2.48	16.41	0.474	0.290
		100 - 300	76	52	1196	4.29	26.71	0.643	0.450
		300 - 700	57	14	312	0.64	4.05	0.679	0.482
> 20	40.667 - 41.667	0 - 100	0						
		100 - 300	0						
		300 - 700	0						
41.667 - 42.667	41.667 - 42.667	0 - 100	0						
		100 - 300	1	1	1	1.33	8.83	1.000	1.000
		300 - 700	0						
42.667 - 46.667	42.667 - 46.667	0 - 100	58	32	295	1.55	14.15	0.760	0.560
		100 - 300	89	54	658	1.45	13.07	0.804	0.621
		300 - 700	8	3	5	0.10	1.10	1.000	1.000
46.667 - 47.667	46.667 - 47.667	0 - 100	10	9	161	2.98	21.24	0.682	0.453
		100 - 300	17	16	486	8.01	70.71	0.751	0.570
		300 - 700	2	1	12	1.09	7.00	0.455	0.286
47.667 - 48.667	47.667 - 48.667	0 - 100	36	35	1179	10.63	68.60	0.442	0.254
		100 - 300	50	43	2157	16.37	114.68	0.600	0.376
		300 - 700	0						

Table 5. Continued.

SEASON: SEPTEMBER - DECEMBER

Arrow-tooth Catch (lbs/h)	Latitude	Depth (Fathoms)	Number of Observed Tows	Number of Tows with $\geq 1$ Halibut	Total Number of Halibut	Number of Halibut per Hour	Wgt. (kg, rnd) Halibut per Hour	Proportion Legal by Weight	Proportion Legal by Number
< 20	40.667 - 41.667	0 - 100	1	0		0.00	0.00		
		100 - 300	5	0		0.00	0.00		
		300 - 700	9	0		0.00	0.00		
	41.667 - 42.667	0 - 100	19	9	32	0.53	9.37	0.981	0.938
		100 - 300	6	3	5	0.20	2.03	0.745	0.600
		300 - 700	19	0		0.00	0.00		
	42.667 - 46.667	0 - 100	198	50	145	0.29	2.48	0.775	0.560
		100 - 300	124	52	518	1.14	12.48	0.861	0.716
		300 - 700	65	3	4	0.01	0.04	0.392	0.250
	46.667 - 47.667	0 - 100	37	22	83	0.64	7.02	0.845	0.632
		100 - 300	11	4	25	0.42	3.03	0.631	0.429
		300 - 700	12	1	5	0.04	0.46	0.795	0.600
	47.667 - 48.667	0 - 100	31	13	133	2.52	18.68	0.636	0.481
		100 - 300	26	20	444	5.87	36.85	0.641	0.484
		300 - 700	6	1	23	0.38	3.73	0.771	0.600
> 20	40.667 - 41.667	0 - 100	0						
		100 - 300	0						
		300 - 700	0						
	41.667 - 42.667	0 - 100	0						
		100 - 300	0						
		300 - 700	0						
	42.667 - 46.667	0 - 100	16	4	6	0.12	1.89	0.872	0.667
		100 - 300	19	9	57	0.85	8.00	0.781	0.632
		300 - 700	0						
	46.667 - 47.667	0 - 100	0						
		100 - 300	7	6	11	0.27	2.97	0.857	0.727
		300 - 700	0						
	47.667 - 48.667	0 - 100	0						
		100 - 300	11	8	53	1.41	14.75	0.916	0.806
		300 - 700	0						

Table 6. Trawl effort (hours) from Oregon and Washington logbook data for catch of arrowtooth flounder less than or equal to 20 lbs per hour. (The upper limits on the all intervals are inclusive, the lower limits are not.)

		Jan-Aug Effort	Sept-Dec Effort
Latitude	Depth	2001	2001
40.667- 41.667	(0-100]	4	3
40.667- 41.667	100-300	159	41
40.667- 41.667	300-700	611	107
41.667- 42.667	0-100	367	459
41.667- 42.667	100-300	1625	164
41.667- 42.667	300-700	2201	371
42.667- 46.667	0-100	5797	2321
42.667- 46.667	100-300	10751	1950
42.667- 46.667	300-700	9332	1712
46.667- 47.667	0-100	941	399
46.667- 47.667	100-300	916	110
46.667- 47.667	300-700	1321	382
47.667- 48.667	0-100	2563	867
47.667- 48.667	100-300	1600	158
47.667- 48.667	300-700	1628	268

Table 6. (Continued.) Trawl effort (hours) from Oregon and Washington logbook data for catch of arrowtooth flounder greater than 20 lbs per hour. (The upper limits on the all intervals are inclusive, the lower limits are not.)

Latitude	Depth	Jan-Aug Effort	Sept-Dec Effort
		2001	2001
40.667- 41.667	0-100	0	0
40.667- 41.667	100-300	0	0
40.667- 41.667	300-700	0	0
41.667- 42.667	0-100	0	23
41.667- 42.667	100-300	87	36
41.667- 42.667	300-700	13	0
42.667- 46.667	0-100	1262	356
42.667- 46.667	100-300	7882	1064
42.667- 46.667	300-700	406	10
46.667- 47.667	0-100	491	290
46.667- 47.667	100-300	767	66
46.667- 47.667	300-700	28	0
47.667- 48.667	0-100	1148	334
47.667- 48.667	100-300	3060	539
47.667- 48.667	300-700	204	4

Table 7. Halibut bycatch and mortality in the Oregon and Washington bottom trawl fisheries for groundfish off the west coast, estimated from the Enhanced Data Collection Program (EDCP).

Year	Trawl Effort (hours)	Estimated Halibut Bycatch (numbers)	Estimated Halibut Bycatch (kg., round)	Estimated Halibut Bycatch (lbs, net)	Est. Total Halibut Mortality (lbs, net)	Estimated Legal-Sized Halibut Mortality (lbs, net)
1998	92,294	164,961	1,259,374	2,082,690	1,041,345	691,755
1999	81,420	147,995	1,144,236	1,892,280	946,140	638,091
2000	70,363	122,234	944,120	1,561,338	780,669	523,097
2001	67,199	124,969	962,348	1,591,482	795,741	532,912

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 in EDCP. 1 kg, round = 1.65375 pounds, net weight.

Table 8. 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	---	---	---

**Note:** Bycatch mortality by groundfish trawls in 1998-2000 does not include fisheries off California. Bycatch mortality by shrimp trawls in 1998 does not include fisheries off California and Washington.

Table 9. Summary of estimated legal-sized mortality of legal-sized Pacific halibut, in thousands of pounds, net weight, by fishery in 2A. Legal-sized mortality for 1977-1997 is estimated as 62% of total mortality for these years (as given in Table 8). Bycatch mortality estimates for legal-sized halibut for 1999 and 2000 are from this report. (Sums across fisheries may not always equal 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	---	---	---

**Note:** Bycatch mortality by groundfish trawls in 1998-2000 does not include fisheries off California. Bycatch mortality by shrimp trawls in 1998 does not include fisheries off California and Washington. The value for groundfish trawls in 1998, 1999 and 2000 is revised upwards from previous estimates due to an updated estimate of percent legal.

