

## **Pacific Halibut Bycatch in IPHC Area 2A in the 2008 Groundfish Bottom Trawl Fishery**

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### **ABSTRACT**

This report updates the estimates of Pacific halibut bycatch and mortality in the portion of the limited-entry groundfish bottom trawl fishery that operates between 48°.667 and 40°.667 degrees through the calendar year 2008. 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 during the 2008 calendar year by the West Coast Groundfish Observer Program (WCGOP). These rates are stratified by season, depth, latitude, and amount of arrowtooth flounder catch, and then multiplied by the amount of 2008 trawl effort (hours towed) in each stratum determined from Oregon and Washington trawl logbooks. Estimated halibut bycatch and mortality from other gear types targeting groundfish has not been updated for 2008 at this time. As was done for the first time last year, this analysis continues to use the WCGOP observations of the viability of discarded halibut for determining the mortality rates used in calculating the amounts of mortality. In 2008, the amount of bottom trawl effort increased by 23% relative to 2007, and effort continued to shift to depths seaward of the RCA. The total amount of halibut bycatch (437,689 lb) represents a 35% increase over 2007, although the estimated *halibut mortality* (280,515 lb) increased by only 9%. Although this mortality estimate is lower than those for 2005 and 2006, the estimated amount of legal-sized halibut mortality (182,857) was the highest of all years back through 2004. As in past reports, forecast of bycatch for the current year (2009) or future years is not attempted.



## GROUNDFISH FISHERY BACKGROUND

Pacific halibut is a “prohibited species” for trawl gear on the West Coast; therefore all halibut caught must be discarded. Even though there is no economic incentive to catch halibut, 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.

In 2008, the RCA boundaries North of 48°10'N and between 43°20'.83N and 42°40'.50N closed off all fishing opportunities shoreward of 150 fathoms for the entire year. This included winter (Nov-Feb) closures in areas open in 2007. RCA boundaries in 2008 closed off more area between the shore and 75 fathoms during more periods than RCA boundaries in 2007. These closures had a major impact on trawl effort, shifting more effort to waters deeper than 150 to 200 fathoms.

Trawl Rockfish Conservation Area North of 40°10' in 2008

	Jan - Feb	Mar - Apr	May - June	July - Aug	Sept	Oct	Nov-Dec
North of 48°10.00'N	shore - modified 200 fm <sup>7</sup>	shore - 200 fm	shore - 150 fm	shore - 150 fm	shore - 150 fm		shore - modified 200 fm <sup>7</sup>
48°10.00'N. - 46°38.17'N.	75 - modified 200 fm <sup>7</sup>	60 - 150 fm	60 - 150 fm	60 - 150 fm	60 - 150 fm		75 - modified 200 fm <sup>7</sup>
46°38.17'N. - 46°16.00'N.	75 - modified 200 fm <sup>7</sup>	60 - 150 fm	60 fm - 200 fm	60 fm - 150 fm	60 - 150 fm	75 - 150 fm	75 - modified 200 fm <sup>7</sup>
46°16.00'N. - 45°46.00'N.	75 - modified 200 fm <sup>7</sup>	75 - 200 fm	75 - 200 fm	75 - 200 fm	75 - 200 fm		75 - modified 200 fm <sup>7</sup>
45°46.00'N - 43°20.83'N.	75 - modified 200 fm <sup>7</sup>	75 - 200 fm	75 - 200 fm	75 - 200 fm	75 - 200 fm		75 - modified 200 fm <sup>7</sup>
43°20.83'N. - 42°40.50'N.	75 - modified 200 fm <sup>7</sup>	shore - 200 fm	shore - 200 fm	shore - 200 fm	shore - 200 fm		75 - modified 200 fm <sup>7</sup>
42°40.50'N. - 40°10.00'N.	75 - modified 200 fm <sup>7</sup>	75 - 200 fm	60 fm - 200 fm	60 - 150 fm	60 - 200 fm	75 - 200 fm	75 - modified 200 fm <sup>7</sup>

<sup>7</sup>The "modified 200fm" line is modified to exclude certain petrale sole areas from the RCA.

## 2008 BYCATCH ESTIMATES

### Analysis of 2008 bycatch data from the West Coast Groundfish Observer Program

The WCGOP provided data for the complete calendar year of 2008 for this analysis. There were 2,346 bottom trawl tows between 48.667 and 40.667 degrees N. latitude included in this study (Figure 1). An estimated net total weight of 93,778 lb of halibut was caught in those tows. Sixty-one percent of these weights are estimated by using the Pacific halibut length-weight relationship (IPHC, personal communication), 30% reflect weighed fish, and 9% are from various types of visual estimates. The length frequencies of the halibut measured in the 2008 observer data are given in Table 1.

Methods similar to those in Pikitch (1998) were used to analyze the observer data and identify appropriate strata for bycatch estimation. The strata determined as important are season (Jan-Aug and Sept-Dec), depth (0-150, 150+ -250, 250+ -700 fm), area (three latitudinal ranges: 40.667-46.667 °, 46.667+ -47.667 °, 47.667+ -48.667 ° N. latitude) and catch of arrowtooth flounder (0-20 lb/hour and >20 lb/hour). Note that depth and area now comprise only three strata, not four each as in previous years. This change reduced the number of strata lacking, or with few, observations. As a result of management efforts to shift trawling to areas seaward of the RCA in recent years, it has become increasingly common for there to be small numbers of bycatch observations in one or both of the '0-75 fm' and '75-150 fm' depth ranges, given the area, season, and arrowtooth dimensions of the stratification. So these strata, where bycatch of smaller halibut is more common, were combined. The combining of strata also provided a level of stratification that was more suitably matched to the stratification possible with the more limited viability data. In particular, because of the more sparse bycatch and viability observations between 40.667° and 42.667° N. latitude, that area was combined with the adjacent area, extending northward to 46.667° N. latitude. The numbers of observed tows and trawl logbook tow hours, halibut catch rates, and the proportions of legal-sized halibut (>81 cm) are summarized for each of these strata in Table 2. Note that Table 2 does not report strata with fewer than three observed vessels and/or ten observed tows.

Although the distribution of observed tows between arrowtooth catch categories remained similar from 2008 to 2007, a reduction in the percentage of tows with arrowtooth and Pacific halibut catch occurred in both arrowtooth catch categories during the January – August season. In tows with up to 20 pounds per hour of arrowtooth catch, the percentage of observed tows with Pacific halibut decreased from 33% to 24% between 2007 and 2008. In tows with greater than 20 pounds per hour of Arrowtooth catch, the percentage of observed tows with Pacific halibut decreased from 63% to 54% between 2007 and 2008. The opposite trend was seen during the September – December season, with the number of observed tows which contained Pacific halibut increasing from 24% to 27% in tows with up to 20 pounds per hour of arrowtooth catch and from 38% to 57% in tows with greater than 20 pounds per hour of arrowtooth catch.

### Bottom Trawl Effort from Logbooks

Trawl logbook data for 2008 were obtained from PacFIN. Since ODFW does not collect logbook data for 100 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). Oregon logbook trawl effort (hours) was expanded to that entire fleet using the ratio of total groundfish catch reported on fish tickets divided by logbook groundfish catch, for each port and month. These expansion ratios were applied to the trawl effort (tow hours) to arrive at the expanded effort for Oregon's trawl fleet. WDFW's "extrapolated and expanded" trawl effort was used for Washington trips, which is calculated to account for logbooks that were not submitted to the agency. For more information on this method and WDFW logbook processing, see Sampson and Crone (1997).

The stratification scheme identified through analysis of observer data was then applied to the expanded logbook effort observations. Total fleet effort for each stratum in 2008 is reported in Table 2. A comparison of trawl effort in 2007 and 2008 is presented in Table 3, with depth strata compressed into two categories for tows conducted shallower and deeper than 150 fm. In all of the shallow strata (with the exception of that including tows with catch of more than 20 lb of arrowtooth per hour conducted between 47.667 and 48.667° N. latitude), effort fell sharply (by 38% to 54%) between 2007 and 2008. Conversely, trawl effort increased (by 30% to 94%) in all strata between 150 and 700 fathoms.

### Viability Analyses

Since 2004, WCGOP observers have collected viability data on discarded Pacific halibut, using the same condition key developed by the IPHC for use by observers in North Pacific fisheries. Observations of several external fish characteristics are used to assign each fish that is evaluated to one of three categories: Dead, Poor, or Excellent (Williams and Chen 2004). Last year, (Wallace and Hastie, 2008) we presented an analysis of discard survival based on observer viability data. The analysis was accepted by the Pacific Fishery Management Council on advice from the Statistical and Science Committee (SSC) and is used again in this report.

Pacific halibut pose unique challenges for observer sampling. When a trawl net is dumped on deck, most vessels will scan the catch for Pacific halibut and immediately return them to sea, which is termed “presorting”. Vessels presort halibut to increase the likelihood of survival of the discarded fish. In addition to the need for quickly returning halibut to the sea in order to enhance survival, halibut are often too heavy and/or awkward to weigh in observer baskets. Therefore, in most circumstances observers visually estimate the length of the halibut in ten-centimeter units (40cm, 50cm, 60cm, etc), which are later converted to weight using the IPHC length/weight conversion table. Observers also have the option of directly measuring a halibut and then converting to weight using the IPHC length/weight conversion table or actually weighing the individual fish, but these rarely occur. Regardless of the sampling methodology used, the total weight of discarded Pacific halibut is estimated for all tows sampled by observers.

There are two types of biological data collected on halibut: length and viability. Viability is determined using IPHC dichotomous keys, which use physical characteristics to indicate whether the individual is ‘Excellent’, ‘Poor’, or ‘Dead’. Table 4 summarizes the distribution of observed halibut among viability and unassessed categories, by year and depth zone since 2004. In most years, fish amounting to at least 20,000 lb of halibut have been evaluated for viability. From 2004 through 2008, roughly 20% of the observed estimated weight of halibut has been evaluated for viability. Table 5 summarizes the distribution of the assessed weight among the three condition categories, for several alternative stratifications of each year’s data. The percentages of assessed weight categorized as ‘Dead’, by year and depth category, are depicted in Figure 2.

Values in the top row of Table 5 indicate the mortality rates assigned to each of the condition categories by the IPHC (Williams and Chen 2004). [Note that only 90% of the fish assigned to the ‘Dead’ category are assumed to die following release.] The percentage of halibut weight assigned to the ‘Dead’ category usually increases with depth, as the percentage assigned to the

'Excellent' category diminishes. The weighted average mortality rate for each depth interval is reported in the last three columns of Table 5, and was calculated as a weighted mean of the halibut condition mortality rates, with the weights being the poundage within each condition category. From 2004 through 2006, the average mortality rate in the 0-150 fm depth zone ranged from 0.48 to 0.58. However, in 2007, the value rose to 0.68, and again in 2008 to 0.75. Average mortality rates in the two deeper zones the last two years have been more consistent with prior values. At this time, it is not known why mortality rates in waters shoreward of the RCA have increased so dramatically in the last two years. Table 6 summarizes the observed amounts and distribution of viability observations in a similar manner for combined data from 2007 and 2008. These mortality rates for the combined years are used to examine the effects of alternative stratification of viability data on the overall estimates of halibut mortality.

### Method of Estimating Pacific Halibut Bycatch

Amounts of halibut bycatch in each stratum are estimated by the following equations:

$$\text{Tow Hours in stratum} \times \text{Stratum bycatch rate} = \text{Stratum weight of } P. \text{ Halibut}$$

$$\text{Stratum weight of } P. \text{ Halibut} \times \text{Stratum mortality rate} = \text{Stratum } P. \text{ Halibut mortality}$$

Estimates of bycatch and discard mortality for the entire bottom trawl fleet are then obtained by summing values across strata.

If there is logbook effort but no observed tows, the 2008 coast-wide average bycatch rate (11.42 kg per hour) is used. This value is calculated as the un-weighted average of the stratum means. Preliminary work done in 2001 using a sophisticated approach of imputing missing data showed little difference in the calculated total bycatch, when using the un-weighted average of the stratum means and the imputed values.

### Results

The proportion of legal-sized halibut (> 81cm) is estimated from the length frequencies of halibut measured in the observer data (Table 1). All measurements of fish lengths are converted to fish weight based on a length-weight relationship for Pacific halibut, and the proportion of discard that is of legal size (by weight) is computed for each stratum (Table 2). The average legal-sized proportion (calculated as the un-weighted average of the stratum means) is used when no other estimate was available. The proportion of legal-sized total halibut mortality, shown in Table 7, is the highest since 2003. Table 7 summarizes the average length of observed halibut, by year and depth interval. Prior mortality results, based on the assumed mortality rate of 50% are presented in Table 8 for historical perspective, but are not updated for 2008.

The estimated total amount of *discarded halibut* increased by 24% between 2007 and 2008 (Table 9), but decreased 22% from the average discarded amount from 2004-07 (336,006 lb). Two key factors in the change from 2007 to 2008 was the 23% increase in overall trawl hours

and an increase in the percent legal-sized *P. halibut*. The estimate of total halibut mortality, calculated using only 2008 viability data, did not rise as much as total bycatch between 2007 and 2008, due to the reduction in the average rate of mortality per trawl hour. The estimated mortality ratio of 5.5 pounds of halibut per tow hour is also the lowest of all years presented. Conversely, the amount of legal-sized halibut mortality increased by 43% from 2007, due to the large increase in the overall percentage of legal-sized Pacific halibut encountered, along with the shift of fishing effort seaward of the RCA (>150 fm) (Table 3). In 2008, roughly 65% of the total estimated mortality weight was from legal-sized fish, whereas the proportion had not exceeded 50% the preceding three years. Confidence limits in Table 7 should be viewed as minimum estimates, since trawl effort is assumed known without error.

In Table 10, the results for 2007 and 2008, based on year-specific viability data (from Table 9), are presented along with three different estimates for each year, developed using combined viability data from both years. Three depth zones are used in each of the alternatives. In the second, 3 latitude zones are added. In the third alternative, latitude zones are replaced by the two seasonal periods previously described. The largest differences are associated with the pooling of observer data across years. Across the three alternatives with pooled observer data, differences in the estimates are negligible.

### Summary of Results

- Trawl effort decreased shoreward of the RCA and increased seaward of the RCA in 2008
- Pacific halibut viability decreases with increased depth of capture and in higher latitudes.
- The Pacific halibut mortality estimate for the 2008 limited entry bottom trawl fishery, based solely on 2008 fish viability observations is 280,515 lb. The estimated amount was roughly 315,000 lb when viability data were pooled across 2007 and 2008.
- Annual estimates developed using the pooled 2007-2008 data were very insensitive to the alternative stratification schemes examined.
- Estimated Pacific halibut mortality per trawl hour in 2008 was 5.5 lb per trawl hour which is a slight decrease from the 2007 estimate of 6.1 lbs per trawl hour.
- The proportion of legal-sized Pacific halibut mortality has increased since 2005 and is estimated to be 0.6513 in 2008.

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Table 1. Pacific halibut length frequencies collected by the West Coast Groundfish Observer Program during 2008. 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	1	0.03
35-40	0	0.00
40-45	0	0.00
45-50	0	0.00
50-55	5	0.17
55-60	33	1.12
60-65	185	6.26
65-70	369	12.49
70-75	569	19.26
75-80	516	17.47
80-85	376	12.73
85-90	278	9.41
90-95	216	7.31
95-100	166	5.62
100-105	102	3.45
105-110	67	2.27
110-115	36	1.22
115-120	16	0.54
120-125	9	0.30
125-130	3	0.10
130-135	3	0.10
135-140	2	0.07
140-145	1	0.03
145-150	1	0.03
150-155	0	0.00
155-160	0	0.00
160-165	0	0.00
165-170	0	0.00
170-175	0	0.00
175-180	0	0.00
180-185	0	0.00
Total	2,954	100

Table 2. Numbers of observed tows and Pacific halibut catch rates by strata, observed in the 2008 LE groundfish bottom trawl fishery by the West Coast Groundfish Observer Program, with overall fleet trawl effort from Oregon and Washington logbook data. The upper limits are inclusive for all intervals; the lower limits are not.

SEASON: JANUARY – AUGUST

Arrowtooth Catch (lb/h)	Latitude	Depth (Fathoms)	Number of Observed Tows	Number of Tows with $\geq 1$ Halibut	Wgt. (kg., rnd) Halibut per Hour	Trawl Effort (hours) from OR & WA	Proportion Legal by Weight
$\leq 20$	40.667 - 46.667	0 - 150	123	39	1.78	2,182.99	0.33
		150 - 250	201	59	1.17	4,895.31	0.79
		250 - 700	367	14	0.08	10,631.17	0.83
	46.667 - 47.667	0 - 150	88	66	5.71	1,190.00	0.13
		150 - 250	25	15	3.62	507.16	0.79
		250 - 700	93	12	0.34	2,145.02	0.86
	47.667 - 48.667	0 - 150	0	0	11.42 <sup>1</sup>	246.05	0.63
		150 - 250	28	22	29.91	535.35	0.80
		250 - 700	92	16	0.92	2,567.30	0.82
$> 20$	40.667 - 46.667	0 - 150	3	2	*	360.63	0.84
		150 - 250	257	134	4.92	4,469.03	0.55
		250 - 700	110	21	1.22	2,775.95	0.78
	46.667 - 47.667	0 - 150	7	7	*	150.50	0.73
		150 - 250	55	44	9.95	804.89	0.61
		250 - 700	23	9	3.75	383.76	0.91
	47.667 - 48.667	0 - 150	5	5	*	51.60	0.63
		150 - 250	52	46	84.04	1,081.73	0.72
		250 - 700	35	27	37.08	678.19	0.65

\* Bycatch rates for strata with fewer than 10 tows are not reported.

<sup>1</sup> Coast-wide average rate, applied in the absence of observer data in a stratum.

Table 2. Continued.

## SEASON: SEPTEMBER - DECEMBER

Arrowtooth Catch (lb/h)	Latitude	Depth (Fathoms)	Number of Observed Tows	Number of Tows with $\geq 1$ Halibut	Wgt. (kg., rnd) Halibut per Hour	Trawl Effort (hours) from OR & WA	Proportion Legal by Weight
$\leq 20$	40.667 - 46.667	0 - 150	139	39	2.01	753.11	0.19
		150 - 250	68	25	8.06	2,068.97	0.51
		250 - 700	164	18	0.22	4,978.60	0.86
46.667 - 47.667	46.667 - 47.667	0 - 150	52	22	2.71	486.78	0.27
		150 - 250	5	2	*	97.31	0.63
		250 - 700	12	0	0.00	410.75	0.63
47.667 - 48.667	47.667 - 48.667	0 - 150	20	18	10.23	126.10	0.15
		150 - 250	9	2	*	168.77	0.63
		250 - 700	22	6	1.03	718.97	0.63
$> 20$	40.667 - 46.667	0 - 150	12	2	1.64	301.19	0.00
		150 - 250	158	93	7.06	3,072.58	0.56
		250 - 700	47	18	1.55	1,527.63	0.59
46.667 - 47.667	46.667 - 47.667	0 - 150	10	7	13.13	78.33	0.63
		150 - 250	12	4	1.90	203.29	0.73
		250 - 700	0	0	11.42 <sup>1</sup>	56.57	0.63
47.667 - 48.667	47.667 - 48.667	0 - 150	5	4	*	19.76	0.93
		150 - 250	27	23	6.40	483.54	0.92
		250 - 700	20	14	39.37	225.40	0.77

\* Bycatch rates for strata with fewer than 10 tows are not reported.

<sup>1</sup> Coast-wide average rate, applied in the absence of observer data in a stratum.

Table 3. Trawl effort (hours) in the 2007 and 2008 limited entry groundfish bottom trawl fisheries off Oregon and Washington.

Arrowtooth Catch (lb/h)	Latitude	Depth (fathoms)	Trawl effort (hours)		% change from 2007 to 2008
			2007	2008	
≤ 20	40.667 - 46.667	0 - 150	5,724	2,936	-49%
		150 - 700	15,651	22,574	44%
	46.667 - 47.667	0 - 150	2,710	1,677	-38%
		150 - 700	1,660	3,160	90%
	47.667 - 48.667	0 - 150	812	372	-54%
		150 - 700	2,054	3,990	94%
Total	Total	0 - 150	9,247	4,985	-46%
		150 - 700	19,365	29,724	53%
		All depths	28,612	34,709	21%
> 20	40.667 - 46.667	0 - 150	1,101	662	-40%
		150 - 700	9,096	11,845	30%
	46.667 - 47.667	0 - 150	428	229	-46%
		150 - 700	1,047	1,448	38%
	47.667 - 48.667	0 - 150	61	71	16%
		150 - 700	1,531	2,469	61%
Total	Total	0 - 150	1,589	962	-39%
		150 - 700	11,673	15,762	35%
		All depths	13,262	16,724	26%
Total	Total	0 - 150	10,836	5,947	-45%
		150 - 700	31,038	45,486	47%
		All depths	41,874	51,434	23%

Table 4. Weight of WCGOP observed halibut within viability categories for 2004-2008.

	Weight of observed halibut (lb)						
	Viability assessed					Unknown condition	Total
	Dead	Poor	Exc.	All	% of total		
2004 0 - 150 fm	3,019	2,728	5,299	11,045	12%	80,749	91,794
150-250 fm	8,533	2,965	1,940	13,438	25%	39,780	53,218
> 250 fm	2,091	221	646	2,958	15%	16,538	19,496
<b>Total</b>	<b>13,642</b>	<b>5,914</b>	<b>7,885</b>	<b>27,441</b>	<b>17%</b>	<b>137,067</b>	<b>164,508</b>
2005 0 - 150 fm	13,932	9,328	11,254	34,514	20%	140,663	175,177
150-250 fm	9,194	2,639	2,865	14,698	41%	21,432	36,130
> 250 fm	1,955	893	611	3,459	34%	6,843	10,302
<b>Total</b>	<b>25,081</b>	<b>12,860</b>	<b>14,731</b>	<b>52,671</b>	<b>24%</b>	<b>168,938</b>	<b>221,609</b>
2006 0 - 150 fm	4,726	2,396	6,363	13,485	11%	112,868	126,353
150-250 fm	3,415	696	1,220	5,331	24%	16,736	22,067
> 250 fm	2,560	233	303	3,096	68%	1,425	4,521
<b>Total</b>	<b>10,702</b>	<b>3,325</b>	<b>7,885</b>	<b>21,912</b>	<b>14%</b>	<b>131,029</b>	<b>152,941</b>
2007 0 - 150 fm	4,026	548	1,712	6,285	19%	26,088	32,373
150-250 fm	8,790	930	1,384	11,103	29%	26,703	37,806
> 250 fm	1,396	233	151	1,780	11%	14,129	15,909
<b>Total</b>	<b>14,212</b>	<b>1,711</b>	<b>3,246</b>	<b>19,169</b>	<b>22%</b>	<b>66,919</b>	<b>86,088</b>
2008 0 - 150 fm	2,431	628	454	3,513	26%	9,763	13,276
150-250 fm	10,246	2,664	3,659	16,570	19%	68,579	85,149
> 250 fm	4,434	793	1,204	6,431	24%	20,181	26,612
<b>Total</b>	<b>17,111</b>	<b>4,086</b>	<b>5,317</b>	<b>26,514</b>	<b>21%</b>	<b>98,523</b>	<b>125,037</b>

Table 5. Weighted average mortality rate by area and season strata for 2004-08. The mortality rate average is weighted by the percent of halibut weight within categories.

Category mortality rate		0 to 150 fm			150 to 250 fm			Greater than 250 fm			Average mortality rate		
		Viability assessed			Viability assessed			Viability assessed			0 -	150 -	
		Dead	Poor	Exc.	Dead	Poor	Exc.	Dead	Poor	Exc.	150 fm	250 fm	> 250 fm
Category mortality rate		0.9	0.55	0.2	0.9	0.55	0.2	0.9	0.55	0.2			
2004	40.67° - 46.66°	28%	27%	45%	67%	18%	15%	82%	7%	11%	0.491	0.734	0.796
	46.67° - 47.66°	22%	24%	53%	47%	32%	21%	64%	3%	32%	0.442	0.640	0.663
	North of 47.66°	31%	22%	47%	63%	37%		39%	10%	51%	0.493	0.771	0.508
	January - August	25%	25%	49%	70%	18%	12%	70%	9%	22%	0.468	0.753	0.719
	Sept. - Dec.	61%	11%	28%	51%	30%	19%	72%	6%	22%	0.663	0.662	0.723
	<b>Total</b>	<b>27%</b>	<b>25%</b>	<b>48%</b>	<b>63%</b>	<b>22%</b>	<b>14%</b>	<b>71%</b>	<b>7%</b>	<b>22%</b>	<b>0.478</b>	<b>0.722</b>	<b>0.721</b>
2005	40.67° - 46.66°	43%	29%	29%	62%	17%	21%	51%	27%	22%	0.599	0.696	0.652
	46.67° - 47.66°	40%	25%	36%	66%	16%	18%	57%	32%	12%	0.564	0.720	0.706
	North of 47.66°	38%	26%	36%	54%	34%	12%	71%	8%	21%	0.558	0.696	0.726
	January - August	36%	29%	35%	62%	18%	20%	52%	30%	17%	0.551	0.696	0.673
	Sept. - Dec.	83%	9%	8%	73%	18%	9%	80%	0%	20%	0.814	0.772	0.761
	<b>Total</b>	<b>40%</b>	<b>27%</b>	<b>33%</b>	<b>63%</b>	<b>18%</b>	<b>19%</b>	<b>57%</b>	<b>26%</b>	<b>18%</b>	<b>0.577</b>	<b>0.701</b>	<b>0.686</b>
2006	40.67° - 46.66°	40%	24%	37%	62%	15%	23%	80%	7%	13%	0.559	0.686	0.784
	46.67° - 47.66°	29%	9%	62%	49%	16%	34%	77%	23%		0.434	0.602	0.820
	North of 47.66°	9%	21%	70%	86%	2%	12%	86%	7%	7%	0.335	0.808	0.824
	January - August	35%	18%	47%	66%	12%	21%	81%	8%	10%	0.505	0.709	0.797
	Sept. - Dec.	48%	11%	41%	61%	14%	25%	96%	0%	4%	0.572	0.674	0.872
	<b>Total</b>	<b>35%</b>	<b>18%</b>	<b>47%</b>	<b>64%</b>	<b>13%</b>	<b>23%</b>	<b>83%</b>	<b>8%</b>	<b>10%</b>	<b>0.508</b>	<b>0.694</b>	<b>0.805</b>
2007	40.67° - 46.66°	69%	9%	21%	78%	10%	12%	85%	10%	5%	0.718	0.778	0.830
	46.67° - 47.66°	56%	4%	40%	88%	4%	8%	100%			0.607	0.829	0.900
	North of 47.66°	24%	38%	38%	54%	15%	31%	10%	49%	41%	0.502	0.629	0.442
	January - August	65%	8%	27%	84%	5%	10%	84%	12%	4%	0.683	0.809	0.831
	Sept. - Dec.	43%	25%	32%	45%	29%	26%	51%	18%	31%	0.585	0.619	0.618
	<b>Total</b>	<b>64%</b>	<b>9%</b>	<b>27%</b>	<b>79%</b>	<b>8%</b>	<b>12%</b>	<b>78%</b>	<b>13%</b>	<b>8%</b>	<b>0.679</b>	<b>0.783</b>	<b>0.795</b>
2008	40.67° - 46.66°	61%	10%	30%	65%	13%	23%	71%	8%	21%	0.659	0.697	0.725
	46.67° - 47.66°	90%	8%	2%	44%	16%	40%	87%	5%	8%	0.855	0.562	0.826
	North of 47.66°	63%	28%	9%	68%	22%	9%	63%	17%	21%	0.740	0.757	0.698
	January - August	75%	7%	18%	59%	17%	24%	67%	14%	19%	0.750	0.672	0.717
	Sept. - Dec.	65%	26%	9%	67%	15%	19%	77%	7%	16%	0.744	0.719	0.764
	<b>Total</b>	<b>69%</b>	<b>18%</b>	<b>13%</b>	<b>62%</b>	<b>16%</b>	<b>22%</b>	<b>69%</b>	<b>12%</b>	<b>19%</b>	<b>0.747</b>	<b>0.689</b>	<b>0.726</b>

Table 6. Weight (lb), percentages, and weighted average mortality rates for 2007-08 aggregate amounts for three depth strata by area and season.

		0 to 150 fathoms				150 to 250 fathoms				Greater than 250 fathoms			
		Viability assessed				Viability assessed				Viability assessed			
		Dead	Poor	Exc.	Total	Dead	Poor	Exc.	Total	Dead	Poor	Exc.	Total
2007-08	40.67° - 46.66°	3,547	492	1,193	5,231	10,854	1,813	2,853	15,519	2,547	282	443	3,272
combined	46.67° - 47.66°	1,807	135	742	2,684	4,618	634	1,494	6,745	955	54	83	1,091
	North of 47.66°	1,103	549	231	1,884	3,565	1,147	696	5,408	2,329	691	829	3,849
	January - August	5,020	584	1,881	7,485	14,303	2,279	3,526	20,108	4,725	889	1,061	6,674
	Sept. - Dec.	1,437	592	285	2,314	4,734	1,315	1,516	7,565	1,106	138	294	1,537
	Total	6,456	1,176	2,166	9,799	19,037	3,594	5,043	27,673	5,831	1,026	1,355	8,212
Category mortality rate		category distribution of weight assessed for fish viability			average mortality rate	category distribution of weight assessed for fish viability			average mortality rate	category distribution of weight assessed for fish viability			average mortality rate
		0.9	0.55	0.2		0.9	0.55	0.2		0.9	0.55	0.2	
2007-08	40.67° - 46.66°	68%	9%	23%	0.707	70%	12%	18%	0.730	78%	9%	14%	0.775
combined	46.67° - 47.66°	67%	5%	28%	0.689	68%	9%	22%	0.712	87%	5%	8%	0.830
	North of 47.66°	59%	29%	12%	0.712	66%	21%	13%	0.736	61%	18%	22%	0.686
	January - August	67%	8%	25%	0.697	71%	11%	18%	0.738	71%	13%	16%	0.742
	Sept. - Dec.	62%	26%	12%	0.724	63%	17%	20%	0.699	72%	9%	19%	0.735
	Total	66%	12%	22%	0.703	69%	13%	18%	0.727	71%	12%	16%	0.741

Table 7. Average length (cm) of Pacific halibut observed in the west coast bottom trawl fishery by year and depth interval from 2004-2008.

Year	Depth interval (fm)					Proportion of Legal-Sized Total Halibut Mortality from Table 7
	0+ thru 75	75+ thru 150	150+ thru 250	250+ thru 700	All Depths	
2004	75.60	82.13	84.72	87.71	80.59	0.5902
2005	73.34	76.58	81.64	88.48	76.36	0.4265
2006	72.25	77.34	79.78	88.48	74.38	0.4587
2007	70.03	78.50	82.06	81.79	77.42	0.4961
2008	72.16		82.38	83.29	80.97	0.6513



Table 8. Halibut bycatch and mortality in the Oregon and Washington limited entry bottom trawl fisheries for groundfish off the U.S. West Coast, **using a 50% rate of mortality for discards**. Estimates from 2002-2007 are based on observations by the West Coast Groundfish Observer Program. All estimates in this table (except the seventh and last column) are derived from a sum over strata cells; see the text for details. The 95% confidence limits, based on the variability in discard of halibut per trawl hour, are given in parentheses. Note that the trawl effort is assumed known without error; hence these confidence limits are a minimum estimate.

Year	Trawl Effort (hours)	Estimated Halibut Bycatch (numbers)	Estimated Halibut Bycatch (kg, round)	Estimated Halibut Bycatch (lb, net)	Estimated Total Halibut Mortality (lb, net)	Est. Mortality (lb) per Trawl Hour	Estimated Legal-Sized Halibut Mortality (lb, net)	Proportion of Legal-Sized Total Halibut Mortality
1998	92,294	164,961	1,259,374	2,082,690	1,041,345	11.3	691,755	0.6643
1999	81,420	147,995	1,144,236	1,892,280	946,140	11.6	638,091	0.6744
2000	70,363	122,234	944,120	1,561,338	780,669	11.1	523,097	0.6701
2001	67,199	124,969	962,348	1,591,482	795,741	11.8	532,912	0.6697
2002	52,168	NA	618,913	1,023,527	511,764	9.8	286,221	0.5593
2003	58,339	NA	558,544	923,693	461,847	7.9	366,745	0.7941
2004	37,495	NA	296,225 (192k-464k)	489,882 (317k-768k)	244,941 (158k-384k)	6.5	136,691 (87k-220k)	0.5581
2005	39,377	NA	432,806 (255k-655k)	715,752 (421k-1,084k)	357,876 (210k-542k)	9.1	152,264 (87k-236k)	0.4254
2006	42,602	NA	403,194 (163k-688k)	666,782 (269k-1,137k)	333,391 (134k-569k)	7.8	134,394 (57k-251k)	0.4031
2007	41,874	NA	211,801 (95k- 349k)	350,266 (157k-577k)	175,133 (78k-288k)	4.2	84,036 (31k-146k)	0.4798

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

Table 9. Halibut bycatch and mortality in the Oregon and Washington LE bottom trawl fisheries for groundfish off the west coast. **The rates of discard mortality, derived from observer assessment of fish viability, are used and the results derived using the 2007 methodology with its larger number of strata.** All estimates in this table, except the “Halibut Bycatch Mortality divided by Halibut Bycatch” and “Legal-sized divided by Total Halibut Mortality” columns, are derived from a sum over strata cells; see the text for details. The 95% confidence limits, based on the variability in discard of halibut per trawl hour, are given in parentheses. Note that the trawl effort is assumed known without error; hence these confidence limits are a minimum estimate.

Year	Trawl Effort (hours)	Estimated Halibut Bycatch (kg, round)	Estimated Halibut Bycatch (lb, net)	Estimated Total Halibut Mortality (lb, net)	Mortality (lb) per Trawl Hour	Halibut Bycatch Mortality divided by Halibut Bycatch	Est. Legal-sized Halibut Mortality (lb, net)	Legal-sized divided by Total Halibut Mortality
2004	37,495	296,225 (192k-464k)	489,882 (317k-768k)	260,590 (169k-423k)	6.9	0.5319	153,804 (98k-254k)	0.5902
2005	39,377	432,806 (255k-655k)	715,752 (421k-1,084k)	417,863 (246k-635k)	10.6	0.5838	178,218 (102k-278k)	0.4265
2006	42,602	403,194 (163k-688k)	666,782 (269k-1,137k)	345,648 (139k-593k)	8.1	0.5184	158,570 (59k-281k)	0.4587
2007	41,874	211,801 (95k- 349k)	350,266 (157k-577k)	257,338 (1115k-425k)	6.1	0.7347	127,677 (48k-222k)	0.4961
2008	51,434	264,665 (128k- 433k)	437,689 (211k-716k)	280,515 (135k-463k)	5.5	0.6409	182,857 (87k-303k)	0.6519

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

Table 10. Halibut bycatch and mortality in the Oregon and Washington LE bottom trawl fisheries for groundfish off the west coast, **using combined 2007-2008 rates of discard mortality derived from observer assessment of fish viability, under alternative data stratifications.** The 95% confidence limits, based on the variability in discard of halibut per trawl hour, are given in parentheses. Note that the trawl effort is assumed known without error; hence these confidence limits are a minimum estimate.

Year	Based on halibut viability data collected in:	Stratification of halibut mortality rates	Estimated Halibut Bycatch (lb, net)	Estimated Total Halibut Mortality (lb, net)	Mortality (lb) per Trawl Hour	Halibut Bycatch Mortality divided by Halibut Bycatch	Est. Legal-sized Halibut Mortality (lb, net)	Legal-sized divided by Total Halibut Mortality
2007	2007	4 depth zones	350,266 (157k-577k)	257,338 (1115k-425k)	6.1	0.7347	127,677 (48k-222k)	0.4961
	2007-08	3 depth zones	367,892 (163k-602k)	263,555 (116k-432k)	6.3	0.7164	125,489 (47k-215k)	0.4761
	2007-08	3 depth zones; 3 latitude zones	367,892 (163k-602k)	266,184 (118k-436k)	6.4	0.7235	127,094 (48k-218k)	0.4775
	2007-08	3 depth zones 2 seasons	367,892 (163k-602k)	262,418 (116k-429k)	6.3	0.7133	125,091 (47k-214k)	0.4767
2008	2008	4 depth zones	437,689 (211k-716k)	280,515 (135k-463k)	5.5	0.6409	182,857 (87k-303k)	0.6519
	2007-08	3 depth zones	434,027 (193k-703k)	315,270 (140k-510k)	6.1	0.7264	205,985 (90k-335k)	0.6534
	2007-08	3 depth zones; 3 latitude zones	434,027 (193k-703k)	316,028 (141k-511k)	6.1	0.7281	206,752 (90k-336k)	0.6542
	2007-08	3 depth zones 2 seasons	434,027 (193k-703k)	318,628 (142k-518k)	6.2	0.7341	208,317 (91k-340k)	0.6538

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

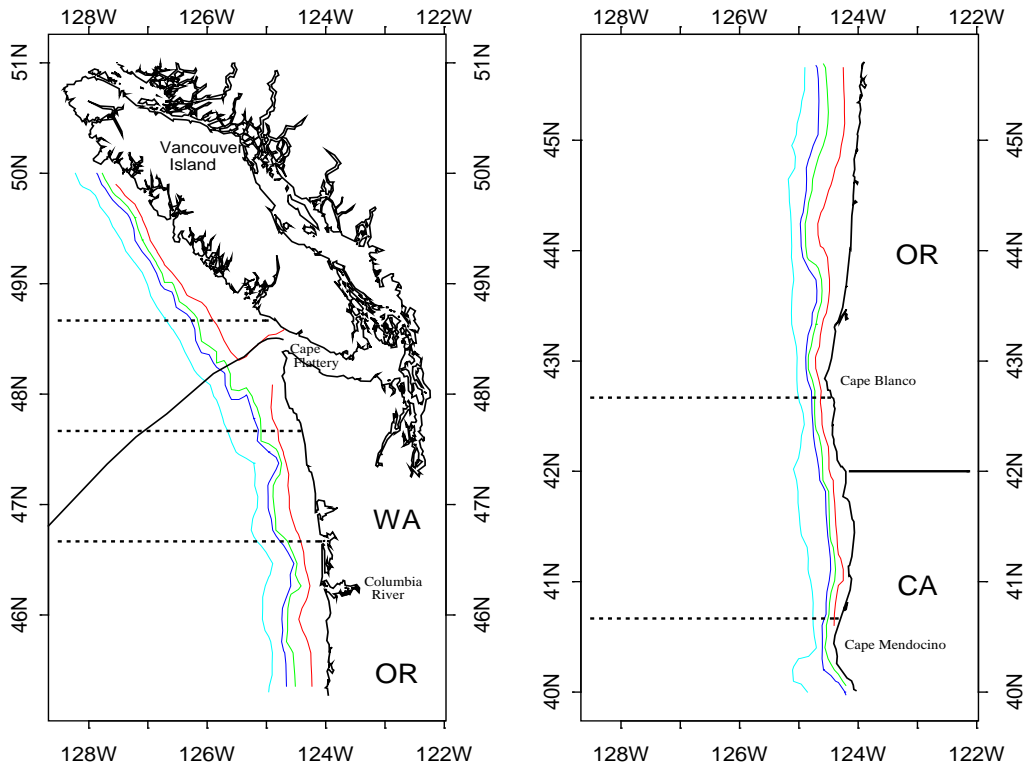


Figure 1. A map of IPHC area 2A with the latitudinal strata demarcated by dotted lines. In the most northerly strata only the area east of the EEZ line is covered by this report. Depth contours are plotted for 75, 150, 250, and 700 fathoms.

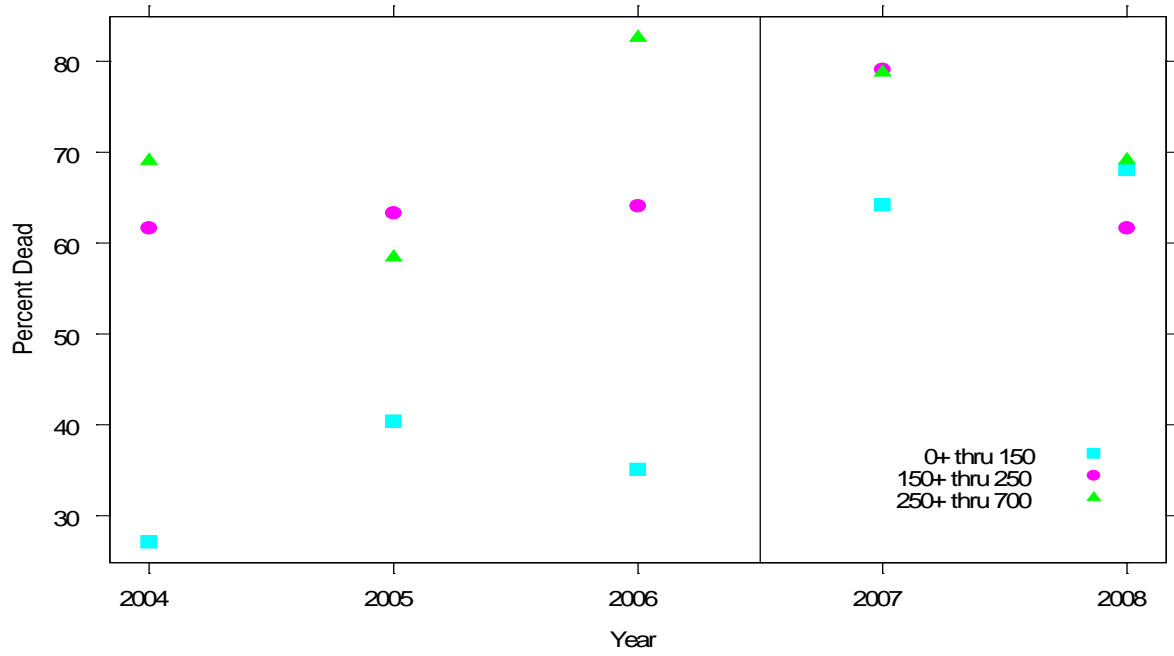


Figure 2. Percent 'Dead' viability by year and depth category.