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Pacific Halibut Individual Bycatch Quota Calculations for Use in the NOAA West Coast Region Individual Fishing Quota (IFQ) Program: Methods for Estimating Pacific Halibut Discards for In-season Reporting and Special Cases

January 2020

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Pacific Halibut Individual Bycatch Quota Calculations for Use in the NOAA West Coast Region Individual Fishing Quota (IFQ) Program: Methods for Estimating Pacific Halibut Discards for In-season Reporting and Special Cases

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Background

Pacific halibut (*Hippoglossus stenolepis*) is found in coastal waters throughout the North Pacific. Off the U.S. West Coast of the United States, it inhabits continental shelf areas (<150 fth) from Washington to central California (Clark and Hare 1998). Pacific halibut has long supported a directed commercial fishery in the U.S. and Canada, but it is also caught as bycatch in other fisheries that target demersal species inhabiting similar depths and seafloor habitat types (IPHC & Gustafson 2019, Jannot et al. 2020).

This NWFSC Processed Report presents the methods used for estimating P. halibut discards on Individual Fishing Quota (IFQ) vessels. The methods presented here are for making estimations for in-season reporting and when special cases arise. Estimates from these methods are reported in-season to the NOAA Fisheries West Coast Region's (WCR) IFQ Program for Pacific Coast Groundfish, also known as the Vessel Account System.¹ This report presents methods only—no data are presented. Detailed descriptions of data sources, collection, and reporting for these fisheries in relation to P. halibut bycatch are given in Jannot et al. (2020).

The Vessel Account System (VAS) is a WCR database that allows fishers to manage their IFQ quota pounds. On a weekly basis, WCGOP provides trip-level estimates of discarded P. halibut individual bycatch quotas (IBQ) to the Pacific States Marine Fisheries Commission (PSMFC). PSMFC then uploads the data to the VAS (Figure 1). Occasionally, special circumstances required alternative calculations of P. halibut IBQ. Alternative calculations of P. halibut IBQ were identified by observer program staff and incorporated into the VAS. Scenarios triggering an alternative calculation and the equations used for those calculations are given in Table 1.

In-season reporting to the Vessel Account System

The WCGOP database calculates IBQ weight at the haul level when the observer collects all the required data elements. The calculation is dependent on the gear fished.

In-season IBQ weight calculations for bottom trawl gear

The sampled P. halibut lengths are converted to weight using the International Pacific Halibut Commission's (IPHC) length–weight conversion table (Table 2). The total weight of P. halibut in the haul is calculated as:

$$W = \frac{w}{n} \times N$$

where, for each haul:

- W = total weight of P. halibut,
- w = sampled weight of P. halibut,
- n = sampled number of P. halibut, and
- N = total number of P. halibut.

¹ <https://www.webapps.nwfsc.noaa.gov/apex/ifq/f?p=155:1:::NO:::>

IBQ weight for each haul is then calculated as:

$$W_{IBQ} = \sum_c \left(\frac{w_c}{\sum_c w_c} \times W \times m_c \right)$$

where, for each haul:

- c = viability condition category,
- W_{IBQ} = IBQ weight (mortality rate applied) of P. halibut,
- W = total weight of P. halibut in haul,
- w = sampled weight of P. halibut, and
- m = mortality rate (from [Table 3](#)).

In-season IBQ weight calculations for pot gear

The sampled P. halibut lengths are converted to weight using the IPHC length–weight conversion table ([Table 2](#)). Observers are not always able to sample 100% of all gear units due to time constraints and logistics, therefore sample weights need to be expanded to the haul/set level. The total weight of P. halibut in the set is calculated as:

$$W = \left(\frac{w}{n} \times N \right) \times \left(\frac{P}{p} \right)$$

where, for each set:

- W = total weight of P. halibut,
- w = sampled weight of P. halibut,
- n = sampled number of P. halibut,
- N = total number of P. halibut,
- P = total number of pots fished, and
- p = sampled number of pots.

IBQ weight for each haul is then calculated as:

$$W_{IBQ} = \sum_c \left(\frac{w_c}{\sum_c w_c} \times W \times m_c \right)$$

where, for each set:

- c = viability condition category,
- W_{IBQ} = IBQ weight (mortality rate applied) of P. halibut,
- W = total weight of P. halibut in set,
- w = sampled weight of P. halibut, and
- m = mortality rate (from [Table 4](#)).

In-season IBQ weight calculations for hook & line gear

The visual estimates of Pacific halibut length (10-cm increments) are converted to weight using the IPHC length–weight conversion table (Table 2). Observers are not always able to sample 100% of all gear units due to time constraints and logistics, therefore sample weights need to be expanded to the haul/set level. The total weight of P. halibut in the set is calculated as:

$$W_{IBQ} = \left(\frac{H}{h} \times w \right) \times 0.16$$

where, for each set:

- W_{IBQ} = IBQ weight (mortality rate applied) of P. halibut,
- w = sampled weight of P. halibut,
- H = total number of hooks fished,
- h = sampled number of hooks, and
- 0.16 = IPHC mortality rate applied to hook & line gear.

In-season IBQ weight alternative calculation scenarios

The most prevalent causes for alternative IBQ calculations were due to pre-sorting of P. halibut by the crew and improper sampling. In these scenarios, observer program staff reviewed the trip and calculated IBQ weight manually.

To determine the most appropriate method to calculate IBQ weight, the observer program data management team consulted with IPHC. For bottom trawl and pot gear, IPHC preferred the use of manually measured fish from other properly sampled hauls within the same trip, rather than the use of visually estimated lengths from the haul. All calculations utilized data from the same trip or a different trip from the same vessel. In other words, there was never a circumstance where data from Vessel A were used to calculate IBQ weight for Vessel B.

In addition to scenarios where the observer did not collect all required data, there were also instances of hauls where P. halibut was not sampled by the observer or all the gear was lost. In these instances, properly sampled hauls were used to estimate IBQ weight for the unsampled haul. Methods for expanding P. halibut weight to unsampled or partially sampled hauls varied by gear type.

To calculate P. halibut IBQ weight for unsampled trawl hauls, the sum of all IBQ weight from other properly sampled hauls is divided by the sum of tow duration (hours) from sampled hauls and multiplied by tow duration of the unsampled haul:

$$W_{IBQ} = \left(\frac{\sum_t w_{IBQ}}{\sum_t d} \right) \times D$$

where, for each tow:

- t = tow,
- W_{IBQ} = unsampled IBQ weight (mortality rate applied) of P. halibut,
- w_{IBQ} = sampled IBQ weight (mortality rate applied) of P. halibut,
- d = tow duration (hr) of sampled haul, and
- D = tow duration (hr) of unsampled haul.

To calculate P. halibut IBQ weight when trawl gear is lost (i.e., entire net or codend is lost), the sum of all P. halibut expanded species weight from other properly sampled hauls is divided by the sum of tow durations from sampled hauls, multiplied by the tow duration of the unsampled haul. For lost trawl gear, a mortality rate for the “dead” P. halibut viability condition (0.90) is applied:

$$W_{IBQ} = \left(\frac{\sum_t w_{IBQ}}{\sum_t d} \right) \times D \times 0.90$$

where, for each tow with lost gear:

- t = tow,
- W_{IBQ} = unsampled IBQ weight (mortality rate applied) of P. halibut,
- w_{IBQ} = sampled IBQ weight (mortality rate applied) of P. halibut,
- d = tow duration (hr) of sampled haul, and
- D = tow duration (hr) of unsampled haul.

To calculate P. halibut IBQ weight in unsampled fixed gear sets, the sum of all P. halibut IBQ weight from sets with similar properties (i.e., date, depth, target, gear type, area; as determined by WCGOP data managers) is divided by the sum of the number of gear units sampled, and the result is multiplied by the total number of gear units fished from the unsampled set:

$$W_{IBQ} = \left(\frac{\sum_t w_{IBQ}}{\sum_t g} \right) \times G$$

where, for each set:

- t = tow,
- W_{IBQ} = unsampled IBQ weight (mortality rate applied) of P. halibut ,
- w_{IBQ} = sampled IBQ weight (mortality rate applied) of P. halibut ,
- g = number of sampled gear units (e.g., hooks, pots), and
- G = total number of gear units (e.g., hooks, pots) fished in the unsampled set.

To calculate P. halibut IBQ weight when fixed gear is lost, the sum of P. halibut weight from the sampled portion of the set, or, if all gear is lost, from sets with similar properties, is divided by the sum of units sampled, and the result is multiplied by the total hooks from the unsampled set. For any lost fixed gear, a mortality rate for the “dead” P. halibut viability condition (1.0) is applied:

$$W_{IBQ} = \left(\frac{\sum_t w_{IBQ}}{\sum_t g} \right) \times G \times 1.0$$

where, for each set with lost gear:

- t = tow,
- W_{IBQ} = unsampled IBQ weight (mortality rate applied) of P. halibut,
- w_{IBQ} = sampled IBQ weight (mortality rate applied) of P. halibut,
- g = number of sampled gear units (e.g., hooks, pots), and
- G = total number of gear units (e.g., hooks, pots) fished in the unsampled set.

Special case scenarios

Scenario 1: *Missing length or viability data.*

Resolution: Determine an average mortality weight per individual P. halibut in the trip from all sampled hauls. Multiply that average by the total count of P. halibut to determine an IBQ.

Scenario 2: *Missing viability data; length measurements were collected.*

Resolution: Determine catch weight for P. halibut using the lengths in the haul and then apply that to the total count for a total weight. Determine catch weight for all viabilities (E, P, D) from all other properly sampled hauls in the trip and apply it to the catch weight for the IBQ estimate.

Scenario 3: *Missing viability data; visual estimates of lengths were collected.*

Resolution: The use of visual lengths was discouraged by IPHC, so the most appropriate method is to determine an average IBQ per individual P. halibut in the trip from all sampled hauls. Multiply that average by the total count of P. halibut to determine an IBQ.

Scenario 4: *Visual estimates of lengths; viability data were collected.*

Resolution: The use of visual lengths was discouraged by IPHC, so the most appropriate method here would be to determine an average IBQ per individual P. halibut in the trip from all sampled hauls. Multiply that average by the total count of P. halibut to determine an IBQ.

Scenario 5: *Missing counts of individuals and viability; actual length measurements were collected.*

Resolution: Catch weight of the haul will be determined by taking the measured P. halibut sample, converted to weight, divided by the number of fish sampled, multiplied by the average number of P. halibut for all sampled hauls in the trip. Then the average mortality rates from the sampled hauls are applied to the calculated P. halibut weight. To date, this scenario has never occurred.

Scenario 6: *Missing counts of individuals; actual lengths and viabilities were collected.*

Resolution: P. halibut catch weight for the haul will be determined by taking the length of the P. halibut sample, converted to weight, divided by the number of fish sampled, multiplied by the average number of P. halibut for all sampled hauls in the trip. Because viabilities and lengths exist, IBQ can be determined using normal protocols and the calculated catch weight.

Scenario 7: *Missing counts of individuals; visual estimates of lengths and viabilities were collected.*

Resolution: Determine an average IBQ per haul for all sampled hauls in the trip and apply to the unsampled haul(s).

Scenario 8: *Observer encounters predated fish that are dead and too badly damaged for accurate biological data to be collected.*

Resolution: If properly sampled P. halibut exist in the haul, they can be used to determine the portion of the catch weight attributed to the predated and non-predated fish. The IBQ for the P. halibut not predated would be calculated separately using the data collected in the haul. The IBQ for the predated fish would be the portion of the P. halibut catch weight attributed to the predated fish multiplied by the mortality rate for “dead” from the IPHC viability tables for that gear.

If all P. halibut in the haul are heavily predated, then a catch weight for the haul will need to be determined. This can be done by taking the total count of P. halibut in the haul times an average catch weight (not IBQ estimates) per P. halibut from other hauls in the trip (or like “sets” if P. halibut doesn’t exist in any other hauls). The estimated catch weight will then be multiplied by the mortality rate for “dead” from the IPHC viability tables for that gear to determine IBQ. In 2011, there were two instances where a P. halibut IBQ was manually calculated due to sand flea predation.

Fishery Data Flow From Collection by Observer to IFQ Vessel Account System

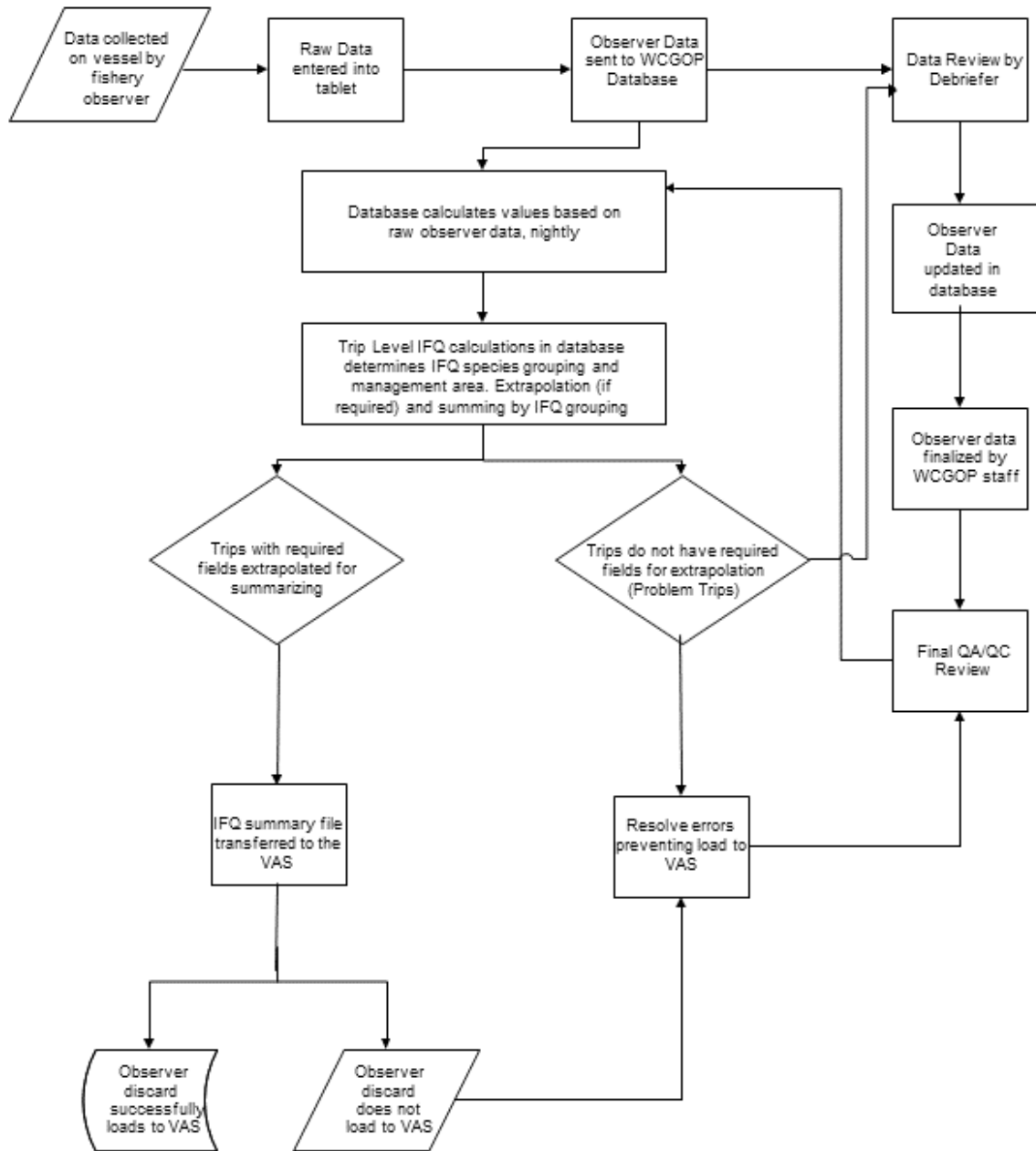


Figure 1. IFQ groundfish fishery data flow from the Northwest Fisheries Science Center’s Fisheries Observation Science Program to the Vessel Account System (VAS) of the NOAA Fisheries West Coast Region.

Table 1. Calculations used by the Vessel Account System (VAS) to determine Pacific halibut IBQ weight for unsampled or partially sampled fishing events in the U.S. West Coast groundfish IFQ fishery. The calculated values, $\widehat{W}_{IBQ_{u,p}}$, are added to the sampled P. halibut to obtain total IBQ weight. Note that these calculations differ slightly from the methods used in this report.

Scenario(s)	Calculation
1, 3, 4	$\widehat{W}_{IBQ_u} = \left(\frac{\sum_{h,v} (l_{h,v} \times r_v)}{\sum_h c_h} \right) \times c_u$
2	$\widehat{W}_{IBQ_u} = \left(\frac{\sum_{h,v} l_{h,v}}{\sum_h l_h} \times r_v \right) \times \left(\frac{\sum_f l_f}{\sum_f c_f} \right)$
5,6	$\widehat{W}_{IBQ_u} = \left[\left(\frac{\sum_f l_f}{\sum_f l_f} \times r_v \right) \times \frac{\sum_h c_h}{h} \right] \times \left(\frac{\sum_{h,v} l_{h,v}}{\sum_h l_h} \right)$
7	$\widehat{W}_{IBQ_u} = \frac{\sum_h w_{IBQ_h}}{\sum_h t_h} \times \sum_u t_u$
8	$\widehat{W}_{IBQ_p} = \frac{\sum_h l_h}{\sum_h c_h} \times c_p$

Table 2. IPHC length–weight conversion table (centimeters to pounds) for Pacific halibut.

Length (cm)	Weight (lb)	Length (cm)	Weight (lb)	Length (cm)	Weight (lb)	Length (cm)	Weight (lb)	Length (cm)	Weight (lb)	Length (cm)	Weight (lb)
10	0.02	40	1.43	70	8.77	100	27.87	130	65.17	160	127.71
11	0.02	41	1.59	71	9.19	101	28.77	131	66.82	161	130.32
12	0.02	42	1.68	72	9.61	102	29.70	132	68.48	162	132.96
13	0.04	43	1.81	73	10.05	103	30.67	133	70.17	163	135.65
14	0.04	44	1.94	74	10.49	104	31.64	134	71.89	164	138.36
15	0.07	45	2.09	75	10.98	105	32.63	135	73.66	165	141.12
16	0.07	46	2.25	76	11.44	106	33.64	136	75.44	166	143.90
17	0.09	47	2.43	77	11.95	107	34.68	137	77.25	167	146.72
18	0.11	48	2.58	78	12.46	108	35.74	138	79.08	168	149.54
19	0.13	49	2.76	79	12.99	109	36.84	139	80.95	169	152.49
20	0.15	50	2.95	80	13.51	110	37.94	140	82.87	170	155.45
21	0.18	51	3.15	81	14.07	111	39.07	141	84.79	171	158.42
22	0.20	52	3.35	82	14.64	112	40.21	142	86.75	172	161.44
23	0.24	53	3.57	83	15.23	113	41.38	143	88.76	173	164.51
24	0.26	54	3.79	84	15.83	114	42.59	144	90.79	174	167.60
25	0.31	55	4.01	85	16.45	115	43.81	145	92.84	175	170.75
26	0.35	56	4.25	86	17.09	116	45.06	146	94.93	176	173.92
27	0.40	57	4.52	87	17.75	117	46.32	147	97.05	177	177.14
28	0.46	58	4.76	88	18.41	118	47.62	148	99.21	178	180.40
29	0.51	59	5.05	89	19.09	119	48.94	149	101.39	179	183.71
30	0.57	60	5.31	90	19.80	120	50.29	150	103.62	180	187.06
31	0.62	61	5.62	91	20.53	121	51.65	151	105.87	181	190.46
32	0.71	62	5.93	92	21.25	122	53.07	152	108.16	182	193.87
33	0.77	63	6.24	93	22.02	123	54.48	153	110.50	183	197.36
34	0.84	64	6.57	94	22.80	124	55.93	154	112.83	184	200.86
35	0.93	65	6.90	95	23.59	125	57.41	155	115.24	185	204.43
36	1.01	66	7.25	96	24.41	126	58.91	156	117.66	186	208.03
37	1.10	67	7.61	97	25.24	127	60.43	157	120.13	187	211.67
38	1.21	68	7.98	98	26.08	128	61.99	158	122.62	188	214.71
39	1.32	69	8.38	99	26.96	129	63.56	159	125.16	189	218.50

Table 2 (continued). IPHC length–weight conversion table (centimeters to pounds) for Pacific halibut.

Length (cm)	Weight (lb)	Length (cm)	Weight (lb)	Length (cm)	Weight (lb)	Length (cm)	Weight (lb)	Length (cm)	Weight (lb)	Length (cm)	Weight (lb)
190	222.89	200	263.17	210	308.25	220	358.38	230	413.91	240	475.09
191	226.70	201	267.46	211	313.03	221	363.69	231	419.76	241	481.55
192	230.56	202	271.79	212	317.86	222	369.05	232	425.69	242	488.05
193	234.48	203	276.17	213	322.73	223	374.45	233	431.66	243	494.60
194	238.45	204	280.60	214	327.67	224	379.92	234	437.68	244	501.24
195	242.44	205	285.10	215	332.65	225	385.45	235	443.76	245	507.92
196	246.50	206	289.62	216	337.70	226	391.03	236	449.91	246	514.66
197	250.60	207	294.21	217	342.79	227	396.67	237	456.13	247	521.48
198	255.74	208	298.84	218	347.93	228	402.36	238	462.39	248	528.36
199	258.93	209	303.51	219	353.13	229	408.09	239	468.72	249	535.28
										250	542.29

Table 3. Mortality rates used for each of the condition categories for IFQ bottom trawl vessels (Clark et al. 1992).

Condition	Mortality rate
Excellent	0.20
Poor	0.55
Dead	0.90

Table 4. Mortality rates used for each of the condition categories for IFQ pot gear vessels (IPHC 2019).

Condition	Mortality rate
Excellent	0
Poor	1
Dead	1

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