

Pacific Halibut Bycatch in U.S. West Coast Groundfish Fisheries, 2002 - 2021

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Summary

Pacific halibut (*Hippoglossus stenolepis*, henceforth P. halibut) is found in coastal waters throughout the North Pacific. Off the West Coast of the United States, it inhabits continental shelf areas (<150 fm) from Washington to central California (Clark and Hare 1998, Keith et al. 2014). 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).

The objective of this report is to provide estimates of P. halibut bycatch in the U.S. West Coast groundfish fisheries. Bycatch estimates are required for domestic and international management of P. halibut. The International Pacific Halibut Commission (IPHC), a body founded through treaty agreement between the U.S. and Canada, sets the P. halibut annual total constant exploitation yield (TCEY) which is converted to total allowable catch (TAC) for IPHC Area 2A, the collective U.S. marine waters bordering the states of Washington, Oregon and California. The TAC is based, in part, on bycatch mortality, which takes into account potential survival after being discarded. Regulations for IPHC Area 2A are set by NOAA Fisheries West Coast Regional Office. Pacific halibut catch in Area 2A is divided between tribal and non-tribal fisheries, between commercial and recreational fisheries, and between recreational fisheries in different states (Washington, Oregon and California). The Pacific Fishery Management Council (PFMC) describes this P. halibut catch division each year in a catch-sharing plan.

Pacific halibut bycatch in U.S. West Coast groundfish fisheries is estimated from data collected by fisheries observers, from fish sales information, and from review of video imagery from electronic monitoring equipment. The Northwest Fisheries Science Center (NWFSC) Fisheries Observation Science Program (FOS) has collected discard data from commercial fishing vessels since 2002³. Pacific halibut mortality estimates in this report are provided for the years 2002 through 2021 from all fishery sectors observed by the NWFSC Observer Program (Table 1). This report is updated annually by the NWFSC Observer Program and presented to the PFMC and the IPHC for use in P. halibut management. This 2022 report represents an abbreviated version of reports from previous years, consisting of this summary and an accompanying supplemental spreadsheet. For more detailed background and methods, see Jannot et al (2022).

³ Prior to 2001, at-sea hake fisheries were observed by the Alaska Fisheries Science Center.

Table 1: Pacific halibut mortality estimates for 2021 and the years of observation, for all fishery sectors observed by the Northwest Fisheries Science Center Fisheries Observation Science Program. Estimates include both individuals discarded at the dock and with mortality rates applied, where appropriate. * = confidential

Sector	Years_Observed	2021 Total Discard Mortality (mt)
Individual Fishing Quota (IFQ) fisheries ¹	2011-2021	27.07
IFQ Electronic Monitoring (EM) EFP ²	2015-2021	2.39
At-sea Pacific hake	2002-2021	0.67
Non-nearshore fixed gear targeting groundfish	2002-2021	18.34
P. halibut directed	2017-2021	8.61
Nearshore fixed gear	2003-2021	1.87
Pink shrimp trawl	2004-2021	0
California halibut trawl	2002-2021	0
CA Ridgeback Prawn	2017-2021	0
CA Sea Cucumber	2017-2021	*

¹Does not include estimates from IFQ vessels with Electronic Monitoring, includes all gears

²EFP = Exempted Fishing Permit, includes all gears

In 2021 Individual Fishing Quota (IFQ) fisheries had the largest estimated P. halibut discard mortality of any sector (27.07 metric tons [mt], Tables 1, 2, and 3). The 2021 IFQ fishery estimate of P. halibut discard mortality, coastwide, was 27.07 mt ⁴. In 2021, 2.39 mt was caught by IFQ EM EFP vessels (Table 1 and Supplemental Tables 52, 54, 55, 56) which is included in the IFQ estimate in Tables 2 and 3. The IFQ total (IFQ + IFQ EM EFP: 29.46 mt) is 2.99 mt less than the 2020 estimate (32.45 mt, see Table 3) and, as in past years, below the individual bycatch quota (IBQ) allocation for P. halibut North of 40° 10' N. lat (2021 IBQ allocation = 67.77 mt). As in prior years, bottom trawl gear produced the largest component of IFQ discard mortality (bottom trawl IFQ + IFQ EM = 27.22 mt), more than 40% of which was from bottom trawl vessels fishing between Point Chehalis, WA and 40° 10' N. lat. (11.97 mt, Supplemental Table 19). The percent of legal-sized P. halibut (> 82 cm) discard mortality, by weight (mt) in the IFQ Bottom Trawl fishery north of 40° 10' N. lat. is presented in Table 4.

In past years, we have compared alternative methods for calculating discard mortality rates (DMRs) in the IFQ EM EFP fishery (Supplemental Table 53). Electronic monitoring does not allow for accurate assessments of Pacific halibut injuries and viabilities. For in-season P. halibut IBQ management, the Pacific States Marine Fisheries Commission (PSMFC), who administer the EM program, apply a time-on-deck model (PFMC 2017, Smith 2017) to estimate the mortality of individual P. halibut caught on bottom trawl IFQ vessels carrying EM. For final end-of-year estimates in this report, we apply a 0.90 mortality rate to

⁴ Summarized estimates presented here and in the tables might exclude small amounts of data to ensure summarized values maintain confidentiality.

all *P. halibut* bycatch in the IFQ EM bottom trawl fishery (Supplemental Table 52). As an alternative to the 0.90 rate, we also present mortality estimates for 2015-2020 based on observer assessed viabilities and the PFMC Groundfish Management Team's Time-on-Deck model (see Supplemental Tables 53 and 101). The comparison was not done for 2021 because the 2021 EM video review data was not yet available when this report was prepared. Additionally, small sample sizes preclude definitive conclusions from this analysis. The NWFSC Observer Program might revisit this analysis in future reports.

In 2021, estimated *P. halibut* discard in the non-nearshore fixed gear vessels targeting groundfish was comparable to previous years (18.33 mt, Tables 1, 2, and 3). Nearly all of that bycatch (15.33 mt, or ~84%) occurred on Limited Entry (LE) Sablefish Endorsed vessels. These vessels fish federally permitted sablefish tier quota during the primary season (April-October). Less than half of the LE Sablefish Endorsed bycatch occurred while fishing longline gear north of Point Chehalis, WA (6.42 mt or ~42%, Table 72). A slightly larger amount of *P. halibut* mortality occurred on LE sablefish endorsed vessels fishing longline gear south of Point Chehalis (8.91 mt). Limited entry endorsed pot vessels caught 0.94 mt of *P. halibut* bycatch. Open access (OA) vessels targeting non-nearshore groundfish species with hook and line gear caught 2.01 mt, while the LE sector fishing hook and line gear caught 0.06 mt. Open access vessels fishing with pot gear and LE non-endorsed vessels fishing with pot gear did not catch any *P. halibut* (Table 72).

The Pacific halibut discard mortality estimate for the 2021 IPHC directed Pacific halibut fishery was 8.61 mt (Tables 1 and 3), which is greater than 2017-2019, but lower than 2020. Discard mortality estimates were calculated using the same methods as for the non-nearshore hook and line fishery, which uses observed estimates of *P. halibut* viability. Viabilities of observed *P. halibut* bycatch in the *P. halibut* directed fishery are given in Supplemental Table 83. Observed lengths of discarded *P. halibut* in the directed fishery are given in Supplemental Tables 84 and 85.

Pacific halibut discard in the nearshore fixed gear, pink shrimp trawl, California halibut trawl, (combined as Other Fisheries in Figure 1) and the at-sea Pacific hake pelagic trawl fisheries combined represents a very small component of total *P. halibut* mortality (Table 1; Figure 1). There was zero (0) observed catch of *P. halibut* in the California ridgeback prawn trawl fishery (Supplemental Table 93). Estimates for the 2021 California sea cucumber trawl fishery are confidential and therefore not provided (Supplemental Table 94); however, in the most recent non-confidential year (2017), no *P. halibut* catch was observed in this sector.

Final estimates of discards in observed fishery sectors, including the IFQ EM EFP, are shown in Tables 1, 2 and 3. All three tables (and elsewhere in the report), include the amount of *P. halibut* landed and subsequently discarded at the dock by IFQ bottom and midwater trawl vessels. The midwater trawl vessels operate under maximized retention, so that the large majority of catch is landed and sorted dockside. The amounts landed and then discarded at the dock are listed by strata in Supplemental Tables 9, 10 and 11. Summaries of *P. halibut* catch in the IFQ EM EFP are included in Tables 1, 102, and Supplemental Tables 52, 54, 55, and 56. Summarized estimates presented in both the tables and the text might exclude small amounts of data to ensure summarized values maintain

confidentiality. Note that 2021 EM video review data were not available when this report was prepared; therefore, at-sea discards in the EM pot and bottom trawl sectors were estimated using data from EM trips that carried human observers following methods described in Somers et al. (2022) for non-quota species. EM midwater hake and midwater rockfish at-sea discards were not estimated because these vessels do not carry human observers and because at-sea discard in previous years has been either nonexistent or minimal in these maximized retention sectors. Landed P. halibut in these sectors is included in this report.

Additionally, we provide historical estimates of P. halibut bycatch in the LE bottom trawl fishery for the 2002-2010 period (Tables 2, 3) and P. halibut bycatch estimates for observed, non-IFQ vessels with an EFP targeting groundfish (2002-2021, Supplemental Table 95). For completeness, we also include the P. halibut landed catch from Pacific Fisheries Information Network (PacFIN) fish tickets reported by non-groundfish fisheries that are not observed by the NWFSC Observer Program for the period 2002-2021 (Supplemental Table 96).

The NWFSC Observer Program data used in this report has been updated to include the most recent data available (2002-2021). PacFIN data used in this report were accessed July 2022. The estimates for all sectors and years (except LE Trawl 2002-2010) have been recalculated based on these data. For ease of data access and reporting, the majority of tables have been removed from the written report and provided in the accompanying Microsoft Excel file ⁵. In all other respects, this report uses the same methods as in last year's report (Jannot et al. 2022).

⁵ see NWFSC_Pacific_Halibut_Bycatch_2002_2021_Supplemental_Tables.xlsx

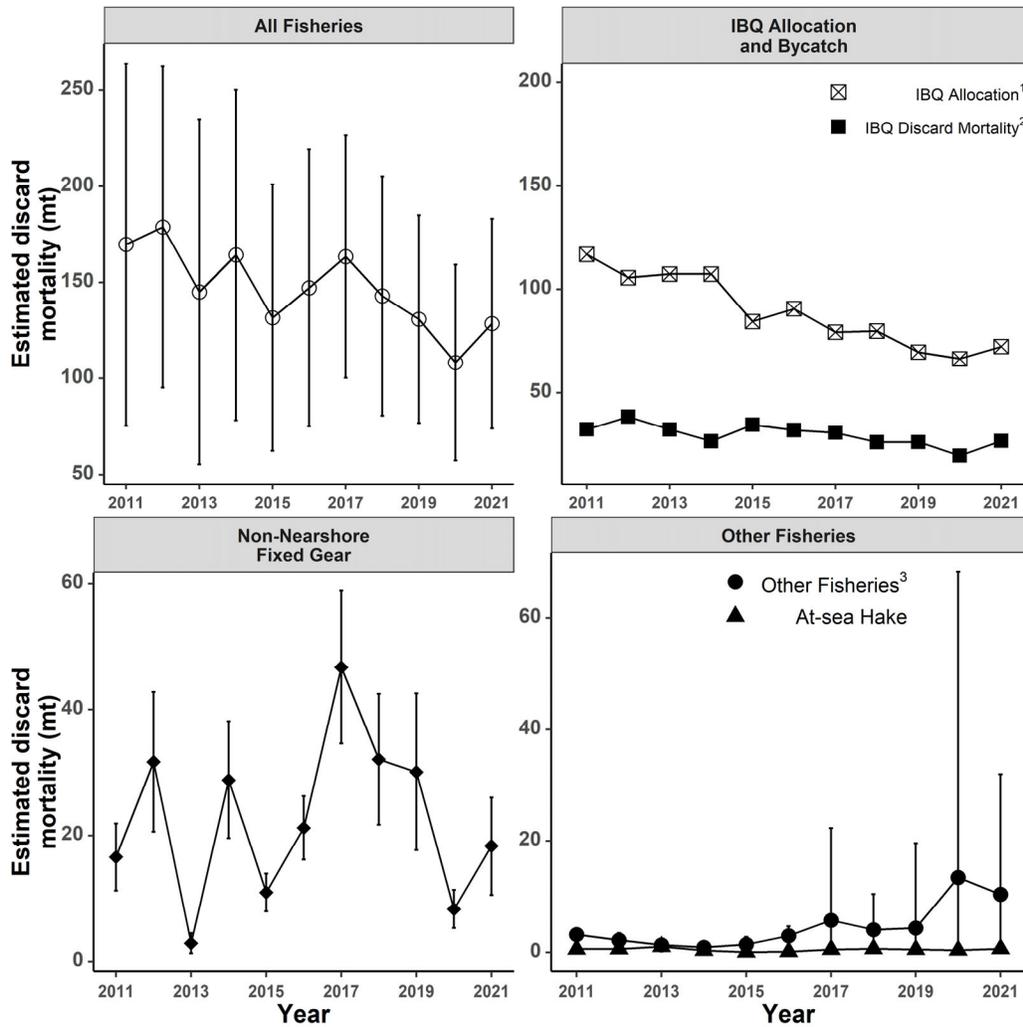


Figure 1: Total estimated *P. halibut* discard mortality (mt \pm 1 SE, with mortality rates applied if applicable) from all sectors observed by the NWFSC Groundfish Observer Program. Estimates are not included for sectors and years where there were insufficient observer data. Values are reported in Table 2.

¹Individual Bycatch Quota (IBQ) allocated north of 40° 10' N. latitude. ²IBQ catch includes all Catch Shares sectors and gears except At-sea Hake which is shown separately. ³Other fisheries includes OR and CA Nearshore, WA, OR, and CA pink shrimp, California halibut, sea cucumber, ridgeback prawn, and IPHC *P. halibut* directed fisheries.

Total discards (mt), mortality rates not applied																	
Year	LE BT 2002-10	IFQ BT ^{abc}	IFQ H&L	IFQ Pot ^c	IFQ MW hake ^{bcd}	IFQ MW rf ^{bcd}	A-S hake ^d	LE sable. end.	LE sable. non- end.	P.hal. directed	OA FG ^f	NS FG ^d	Pink shrimp ^d	CA hal. ^{dg}	All sectors	All w/ <1.0 mort. ^h	All w/ 1.0 mort. ⁱ
2002	524.41	n/a	n/a	n/a	n/a	n/a	1.14	146.90	0.01	-	-	-	-	0.00	708.07	706.93	1.14
2003	186.65	n/a	n/a	n/a	n/a	n/a	2.65	198.89	0.18	-	-	0.00	-	0.00	440.23	437.57	2.65
2004	212.43	n/a	n/a	n/a	n/a	n/a	1.13	238.98	0.01	-	-	1.00	0.00	0.70	498.64	495.81	2.83
2005	460.35	n/a	n/a	n/a	n/a	n/a	1.97	240.47	0.01	-	-	2.21	0.04	0.03	762.88	758.64	4.24
2006	390.91	n/a	n/a	n/a	n/a	n/a	0.83	677.68	0.00	-	-	0.53	-	0.02	1115.31	1113.92	1.39
2007	294.38	n/a	n/a	n/a	n/a	n/a	1.18	132.81	1.72	-	21.66	0.09	0.21	0.03	452.08	450.58	1.51
2008	305.21	n/a	n/a	n/a	n/a	n/a	3.98	260.74	2.95	-	40.25	0.35	0.00	0.22	613.70	609.15	4.55
2009	385.24	n/a	n/a	n/a	n/a	n/a	0.33	322.91	0.24	-	35.18	1.28	0.00	0.00	745.19	743.58	1.61
2010	265.08	n/a	n/a	n/a	n/a	n/a	1.57	138.07	0.39	-	32.56	0.08	0.00	0.00	437.75	436.10	1.65
2011	n/a	64.25	6.13	3.36	0.36	*	0.61	137.45	21.26	-	13.03	3.05	0.19	0.00	249.68	245.48	4.20
2012	n/a	67.05	14.79	1.90	0.62	0.00	0.64	163.42	16.25	-	23.63	2.25	0.00	0.00	290.54	287.03	3.51
2013	n/a	66.30	3.00	0.99	1.31	0.00	1.06	22.27	0.01	-	1.79	1.35	0.00	0.00	98.09	94.36	3.73
2014	n/a	55.96	3.95	0.32	1.36	0.00	0.37	179.89	0.00	-	3.58	0.95	0.00	0.00	246.39	243.71	2.69
2015	n/a	69.20	9.81	1.33	1.81	0.00	0.06	124.41	0.46	-	10.13	1.44	0.01	0.00	218.66	215.34	3.32
2016	n/a	56.48	6.95	1.71	1.99	0.00	0.15	179.06	5.16	-	42.68	3.04	0.00	0.00	297.23	292.05	5.18
2017	n/a	59.43	4.25	1.09	1.43	0.04	0.55	304.36	0.75	25.27	49.31	1.76	0.00	0.00	448.25	444.46	3.79
2018	n/a	45.83	4.93	1.65	3.65	0.03	0.66	231.40	13.07	15.60	41.68	1.57	0.01	0.00	360.07	354.16	5.91
2019	n/a	48.94	3.56	3.16	*	0.04	0.54	232.19	76.51	28.98	39.77	0.57	0.00	0.00	437.41	433.11	4.30
2020	n/a	34.56	-	*	*	0.00	0.39	93.80	0.00	58.68	9.87	1.37	0.00	0.00	204.07	198.13	5.94
2021	n/a	48.30	-	*	*	0.00	0.67	133.13	1.61	33.99	19.79	1.87	0.00	0.00	242.11	237.18	4.94

^aStarting in 2011, LE CA halibut estimates are combined with IFQ BT estimates.

^bIncludes a small amount landed and discarded at the dock.

^cIncludes P. halibut catch from IFQ EM EFP.

^d100% mortality rate.

^eFrom 2011-2014, referred to as "coastal hake."

^fA coastwide discard ratio and coastwide discard estimate could not be computed in the OA FG sector for 2002-2006, because WCGOP only covered OA vessels in CA during this time

^gStarting in 2011, this sector only includes OA CA halibut.

^hLE BT, IFQ BT, IFQ H&L, IFQ Pot, LE sable end., LE sable non-end., P. hal. directed, and OA FG.

ⁱIFQ MW hake, IFQ MW rf, A-S hake, NS FG, pink shrimp, and CA halibut.

Table 2: Pacific halibut gross discard estimates (mt, including a small amount discarded at the dock in IFQ Bottom Trawl, Midwater Rockfish, and Midwater Hake fisheries) for all sectors observed by the NWFSC Groundfish Observer Program. No mortality rates were applied to these estimates. Rounding of values might mask very small weights in some categories and are presented here as zero (0). All landed weights are estimated based on whole fish (a.k.a. 'round weight', not head-and-gut). There was no fishing in the IFQ H&L fishery during 2020 and 2021. The 2020-2021 IFQ Pot, 2019-2021 IFQ MW hake, 2011 IFQ MW rf, and the 2018-2021 Sea Cucumber fishery data are confidential. Totals across all sectors and sectors with and without discard mortality = 1 are shown.

* = confidential data, less than 3 vessels observed; - = no observer coverage or no fishing; n/a = not applicable because fishery did not exist.

Total mortality (mt), mortality rates applied																	
Year	LE BT 2002-10	IFQ BT ^{abc}	IFQ H&L	IFQ Pot ^c	IFQ MW hake ^{bcd}	IFQ MW rf ^{bcd}	A-S hake ^d	LE sable. end.	LE sable. non- end.	P.hal. directed	OA FG ^e	NS FG ^d	Pink shrimp ^d	CA hal. ^g	All sectors	All w/ <1.0 mort. ^h	All w/ 1.0 mort. ⁱ
2002	344.82	n/a	n/a	n/a	n/a	n/a	1.14	23.59	0.00	-	-	-	-	0.00	369.59	368.45	1.14
2003	124.43	n/a	n/a	n/a	n/a	n/a	2.65	31.83	0.03	-	-	0.00	-	0.00	167.25	164.59	2.65
2004	133.12	n/a	n/a	n/a	n/a	n/a	1.13	38.90	0.00	-	-	1.00	0.00	0.70	181.96	179.13	2.83
2005	286.52	n/a	n/a	n/a	n/a	n/a	1.97	38.53	0.00	-	-	2.21	0.04	0.03	338.56	334.31	4.24
2006	242.47	n/a	n/a	n/a	n/a	n/a	0.83	108.76	0.00	-	-	0.53	-	0.02	359.89	358.50	1.39
2007	208.81	n/a	n/a	n/a	n/a	n/a	1.18	21.33	0.28	-	3.48	0.09	0.21	0.03	235.40	233.90	1.51
2008	207.81	n/a	n/a	n/a	n/a	n/a	3.98	41.85	0.47	-	6.45	0.35	0.00	0.22	261.13	256.58	4.55
2009	251.10	n/a	n/a	n/a	n/a	n/a	0.33	51.68	0.04	-	5.63	1.28	0.00	0.00	310.07	308.46	1.61
2010	180.97	n/a	n/a	n/a	n/a	n/a	1.57	22.19	0.06	-	5.22	0.08	0.00	0.00	210.10	208.44	1.65
2011	n/a	30.86	0.98	0.60	0.36	*	0.61	11.70	3.12	-	1.77	3.05	0.19	0.00	53.24	49.04	4.20
2012	n/a	35.70	2.37	0.34	0.62	0.00	0.64	29.52	0.76	-	1.45	2.25	0.00	0.00	73.64	70.13	3.51
2013	n/a	31.83	0.48	0.18	1.31	0.00	1.06	2.85	0.00	-	0.07	1.35	0.00	0.00	39.15	35.41	3.73
2014	n/a	25.96	0.63	0.06	1.36	0.00	0.37	28.58	0.00	-	0.29	0.95	0.00	0.00	58.20	55.52	2.69
2015	n/a	32.92	1.57	0.24	1.81	0.00	0.06	10.59	0.02	-	0.40	1.44	0.01	0.00	49.07	45.74	3.32
2016	n/a	30.76	1.11	0.31	1.99	0.00	0.15	17.34	1.07	-	2.82	3.04	0.00	0.00	58.60	53.42	5.18
2017	n/a	30.08	0.68	0.20	1.43	0.04	0.55	43.14	0.04	2.21	3.59	1.76	0.00	0.00	83.73	79.95	3.79
2018	n/a	25.08	0.79	0.30	3.65	0.03	0.66	27.34	0.46	2.55	4.33	1.57	0.01	0.00	66.75	60.84	5.91
2019	n/a	25.24	0.57	0.57	*	0.04	0.54	24.72	2.68	3.84	2.73	0.57	0.00	0.00	64.65	60.35	4.30
2020	n/a	18.80	-	*	*	0.00	0.39	8.03	0.00	12.11	0.35	1.37	0.00	0.00	45.44	39.50	5.94
2021	n/a	27.01	-	*	*	0.00	0.67	16.27	0.06	8.61	2.01	1.87	0.00	0.00	58.95	54.02	4.94

^aStarting in 2011, LE CA halibut estimates are combined with IFQ BT estimates.

^bIncludes a small amount landed and discarded at the dock.

^cIncludes P. halibut catch from IFQ EM EFP.

^d100% mortality rate.

^eFrom 2011 to 2014, referred to as "coastal hake."

^fA coastwide discard ratio and coastwide discard estimate could not be computed in the OA FG sector for 2002-2006, because WCGOP only covered OA vessels in CA during this time.

^gStarting in 2011, this sector only includes OA CA halibut.

^hLE BT, IFQ BT, IFQ H&L, IFQ Pot, LE sable end., LE sable non-end., P. hal. directed, and OA FG.

ⁱIFQ MW hake, IFQ MW rf, A-S hake, NS FG, pink shrimp, and CA halibut.

Table 3: Pacific halibut discard mortality estimates (mt, including a small amount discarded at the dock in IFQ Bottom Trawl, Midwater Rockfish, and Midwater Hake fisheries) for all sectors observed by the NWFSC Groundfish Observer Program. Mortality rates of less than 100% were applied in the bottom trawl fisheries (LE and IFQ), IFQ hook and line, IFQ pot, and non-IFQ, non-nearshore fixed gear sectors, for which some information regarding gear specific survivorship was available. For all other sectors, a 100% mortality rate was applied because gear specific survivorship information is not available. Rounding of values might mask very small weights in some categories and are presented here as zero (0). All weights are estimated based on whole fish (a.k.a. 'round weight', not head snf gut). Ridgeback Prawn and Sea Cucumber fisheries (both observed from 2017 to 2021) had zero (0) observed P. halibut catch. There was no fishing in the IFQ H&L fishery during 2020-2021. The 2020-2021 IFQ Pot, 2019-2021 IFQ MW hake, 2011 IFQ MW rf, and the Sea Cucumber fishery since 2018 data are confidential. . Totals across all sectors and sectors with and without discard mortality = 1 are shown.

* = confidential data, less than 3 vessels observed; - = no observer coverage or no fishing; n/a = not applicable because fishery did not exist.

Year	% legal-sized P. halibut in IFQ bottom trawl north of 40 deg. 10 min. N. lat.
2011	73.4%
2012	73.5%
2013	70.9%
2014	67.9%
2015	73.9%
2016	72.7%
2017	79.6%
2018	84.3%
2019	79.7%
2020	71.1%
2021	62.2%

Table 4: Percent of legal-sized P. halibut (> 82 cm) mortality, by weight (mt) in the IFQ fishery for vessels fishing bottom trawl gear north of 40 deg. 10 min. N. lat.

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References

Clark, W. G., S. H. Hoag, R. J. Trumble, and G. H. Williams. 1992. Re-estimation of survival for trawl caught halibut released in different condition factors. International Pacific Halibut Commission, Report of Assessment and Research Activities 1992:197-206.

Jannot, J. E., K. E. Richerson, K. A. Somers, V. J. Tuttle, C. M. Colway, and J. T. McVeigh. 2022. Pacific Halibut Bycatch in U.S. West Coast Groundfish Fisheries, 2002–20. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-173.

Somers, K. A., J. E. Jannot, K. E. Richerson, V. J. Tuttle, and J. T. McVeigh. 2022. Estimated Discard and Catch of Groundfish Species in the 2020 U.S. West Coast Fisheries. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-175.
<https://doi.org/10.25923/e6es-0r06>

Trumble, R. J., S. M. Krimmer, and G. H. Williams. 2000. Estimation of discard mortality rates for Pacific halibut bycatch in groundfish longline fisheries. North American Journal of Fisheries Management 20:931-939.

A note about tables:

Tables 1–4 have been typeset and included in this summary. They are also available, together with all the other mentioned tables (5-95), in the accompanying Excel file: NWFSC_Pacific_Halibut_Bycatch_2002_2021_Supplemental_Tables.xlsx. Table captions are included below for reference.

Table Captions

Table 1: Pacific halibut mortality estimates for 2021 and the years of observation, for all fishery sectors observed by the Northwest Fisheries Science Center Fishery Observer Program. Estimates include both individuals discarded at the dock and with mortality rates applied, where appropriate. * = confidential

Table 2: Pacific halibut gross discard estimates (mt, including a small amount discarded at the dock in IFQ Bottom Trawl, Midwater Rockfish, and Midwater Hake fisheries) for all sectors observed by the NWFSC Fishery Observer Program. No mortality rates were applied to these estimates. Rounding of values might mask very small weights in some categories and are presented here as zero (0). All weights are estimated based on whole fish (a.k.a. 'round weight', not head-and-gut). Ridgeback Prawn and Sea Cucumber fisheries (both observed from 2017 to 2021) had zero (0) observed P. halibut catch or were confidential. There was no fishing in the IFQ H&L fishery during 2020-2021. The 2020-2021 IFQ Pot, 2019-2021 IFQ MW hake, 2011 IFQ MW rf, and the Sea Cucumber fishery since 2018 data are confidential. * = confidential data, less than 3 vessels observed; - = no observer coverage or no fishing; n/a = not applicable because fishery did not exist.

Table 3: Pacific halibut discard mortality estimates (mt, including a small amount discarded at the dock in IFQ Bottom Trawl, Midwater Rockfish, and Midwater Hake fisheries) for all sectors observed by the NWFSC Groundfish Observer Program. Mortality rates of less than 100% were applied in the bottom trawl fisheries (LE and IFQ), IFQ hook and line, IFQ pot, and non-IFQ, non-nearshore fixed gear sectors, for which some information regarding gear specific survivorship was available. For all other sectors, a 100% mortality rate was applied because gear specific survivorship information is not available. Rounding of values might mask very small weights in some categories and are presented here as zero (0). All weights are estimated based on whole fish (a.k.a. 'round weight', not head and gut). Ridgeback Prawn and Sea Cucumber fisheries (both observed from 2017 to 2021) had zero (0) observed P. halibut catch or were confidential. There was no fishing in the IFQ H&L fishery during 2020-2021. The 2020-2021 IFQ Pot, 2019-2021 IFQ MW hake, 2011 IFQ MW rf, and the Sea Cucumber fishery since 2018 data are confidential. * = confidential data, less than 3 vessels observed; - = no observer coverage or no fishing; n/a = not applicable because fishery did not exist.

Table 4: Percent of legal-sized P. halibut (> 82 cm) mortality, by weight (mt) in the IFQ fishery for vessels fishing bottom trawl gear north of 40 deg. 10 min. N. lat.

Table 5: Data collected from P. halibut caught on IFQ vessels using different types of gear.

Table 6: Mortality rates used for each of the viability categories for IFQ bottom trawl vessels (Clark et al. 1992).

Table 7: Mortality rates used for each of the viability categories for IFQ pot gear vessels (IPHC 2011).

Table 8: Mortality rates used for each of the injury categories for Non-Nearshore hook & line vessels (Trumble et al. 2000).

Table 9: Number of vessels, trips, and tows observed and metric tons of sampled Pacific halibut discarded at-sea and the P. halibut landed and discarded at the dock (from PacFIN fish tickets) on IFQ bottom trawl vessels. All participating vessels carry an observer on all fishing trips under IFQ management (100% observed). For clarity, the number of hauls with unsampled catch categories is provided. (*) confidential data, (-) not applicable.

Table 10: Number of vessels, trips, and tows observed and metric tons of sampled Pacific halibut discarded at-sea and the P. halibut landed and discarded at the dock (from PacFIN fish tickets) on IFQ midwater trawl vessels. All participating vessels carry an observer on all fishing trips under IFQ management (100% observed). For clarity, the number of hauls with unsampled catch categories is provided. (*) confidential data, (-) not applicable.

Table 11: Number of vessels, trips, and tows observed and metric tons of sampled Pacific halibut discarded at-sea and the P. halibut landed and discarded at the dock (from PacFIN fish tickets) on IFQ midwater trawl vessels. All participating vessels carry an observer on all fishing trips under IFQ management (100% observed). For clarity, the number of hauls with unsampled catch categories is provided. (*) confidential data, (-) not applicable.

Table 12: Number of vessels, trips, and tows observed and metric tons of sampled Pacific halibut discarded at-sea and the P. halibut landed and discarded at the dock (from PacFIN fish tickets) on IFQ pot vessels. All participating vessels carry an observer on all fishing trips under IFQ management (100% observed). For clarity, the number of hauls with unsampled catch categories is provided. (*) confidential data, (-) not applicable.

Table 13: Number of vessels, trips, and tows observed and metric tons of sampled Pacific halibut discarded at-sea and the P. halibut landed and discarded at the dock (from PacFIN fish tickets) on IFQ hook & line vessels. All participating vessels carry an observer on all fishing trips under IFQ management (100% observed). For clarity, the number of hauls with unsampled catch categories is provided. (*) confidential data, (-) not applicable.

Table 14: Values used to calculate the expanded weight of Pacific halibut (PHLB) from each unsampled category on U.S. West Coast groundfish IFQ bottom trawl vessels by year. Unsampled catch weight could be assigned to one of four categories: IFQ flatfish species, IFQ mixed species, non-IFQ species, or unsorted (a mix of both IFQ and non-IFQ species). The sampled weight, discard ratio, unsampled weight and estimated P. halibut gross at-sea discard are presented within each category, as a function of state, management area, depth, year, sector and gear. The sum of expanded weight is the sum of the estimated gross P. halibut discard across categories. The sampled discarded PHLB weight is the sum of sampled PHLB. The total discard (gross) is the sum of the PHLB in unsampled hauls plus the sampled PHLB. All weights are metric tons (mt). (*) confidential data. Note that adding values across columns might give slightly different results because values are rounded to two decimals for reporting.

Table 15: Values used to calculate the expanded weight of Pacific halibut (PHLB) from each unsampled category on U.S. West Coast groundfish IFQ midwater trawl vessels targeting P. hake by year. Unsampled catch weight could be assigned to one of four categories: IFQ flatfish species, IFQ mixed species, non-IFQ species, or unsorted (a mix of both IFQ and non-IFQ species). The sampled weight, discard ratio, unsampled weight and estimated P. halibut gross at-sea discard are presented within each category, as a function of state, management area, depth, year, sector and gear. The sum of expanded weight is the sum of the estimated gross P. halibut discard across categories. The sampled discarded PHLB weight is the sum of sampled PHLB. The total discard (gross) is the sum of the PHLB in unsampled hauls plus the sampled PHLB. All weights are metric tons (mt). (*) confidential

data. Note that adding values across columns might give slightly different results because values are rounded to two decimals for reporting.

Table 16: Values used to calculate the expanded weight of Pacific halibut (PHLB) from each unsampled category on U.S. West Coast groundfish IFQ midwater trawl vessels targeting rockfish by year. Unsampled catch weight could be assigned to one of four categories: IFQ flatfish species, IFQ mixed species, non-IFQ species, or unsorted (a mix of both IFQ and non-IFQ species). The sampled weight, discard ratio, unsampled weight and estimated P. halibut gross at-sea discard are presented within each category, as a function of state, management area, depth, year, sector and gear. The sum of expanded weight is the sum of the estimated gross P. halibut discard across categories. The sampled discarded PHLB weight is the sum of sampled PHLB. The total discard (gross) is the sum of the PHLB in unsampled hauls plus the sampled PHLB. All weights are metric tons (mt). (*) confidential data. Note that adding values across columns might give slightly different results because values are rounded to two decimals for reporting.

Table 17: Values used to calculate the expanded weight of Pacific halibut (PHLB) from each unsampled category on U.S. West Coast groundfish IFQ pot vessels by year. Unsampled catch weight could be assigned to one of four categories: IFQ flatfish species, IFQ mixed species, non-IFQ species, or unsorted (a mix of both IFQ and non-IFQ species). The sampled weight, discard ratio, unsampled weight and estimated P. halibut gross at-sea discard are presented within each category, as a function of state, management area, depth, year, sector and gear. The sum of expanded weight is the sum of the estimated gross P. halibut discard across categories. The sampled discarded PHLB weight is the sum of sampled PHLB. The total discard (gross) is the sum of the PHLB in unsampled hauls plus the sampled PHLB. All weights are metric tons (mt). (*) confidential data. Note that adding values across columns might give slightly different results because values are rounded to two decimals for reporting.

Table 18: Values used to calculate the expanded weight of Pacific halibut (PHLB) from each unsampled category on U.S. West Coast groundfish IFQ hook & line vessels by year. Unsampled catch weight could be assigned to one of four categories: IFQ flatfish species, IFQ mixed species, non-IFQ species, or unsorted (a mix of both IFQ and non-IFQ species). The sampled weight, discard ratio, unsampled weight and estimated P. halibut gross at-sea discard are presented within each category, as a function of state, management area, depth, year, sector and gear. The sum of expanded weight is the sum of the estimated gross P. halibut discard across categories. The sampled discarded PHLB weight is the sum of sampled PHLB. The total discard (gross) is the sum of the PHLB in unsampled hauls plus the sampled PHLB. All weights are metric tons (mt). (*) confidential data. Note that adding values across columns might give slightly different results because values are rounded to two decimals for reporting.

Table 19: Pacific halibut viabilities, weighted percent in each viability category, estimated gross at-sea discard (mt), and at-sea discard mortality (mt) for U.S. West Coast groundfish IFQ bottom trawl vessels by management area, depth, and year. The condition of sampled P. halibut was identified as Excellent (Exc), Poor, or Dead, consistent with IPHC protocol. The number of fish in each category was weighted based on the length-weight relationship

as described in the Methods. Estimates were allocated to the condition categories based on the weighted percent. In addition, all years combined are also shown. After 2012, LE CA Halibut is combined with IFQ. DMR = discard mortality rate, (*) confidential data, (-) no estimate provided, see text for explanation.

Table 20: Pacific halibut viabilities, weighted percent in each viability category, estimated gross at-sea discard (mt), and at-sea discard mortality (mt) for U.S. West Coast groundfish IFQ midwater trawl vessels targeting P. hake by management area, depth, and year. The condition of sampled P. halibut was identified as Excellent (Exc), Poor, or Dead, consistent with IPHC protocol. The number of fish in each category was weighted based on the length-weight relationship as described in the Methods. Estimates were allocated to the condition categories based on the weighted percent. In addition, all years combined are also shown. DMR = discard mortality rate, (*) confidential data, (-) no estimate provided, see text for explanation.

Table 21: Pacific halibut viabilities, weighted percent in each viability category, estimated gross at-sea discard (mt), and at-sea discard mortality (mt) for U.S. West Coast groundfish IFQ midwater trawl vessels targeting rockfish by management area, depth, and year. The condition of sampled P. halibut was identified as Excellent (Exc), Poor, or Dead, consistent with IPHC protocol. The number of fish in each category was weighted based on the length-weight relationship as described in the Methods. Estimates were allocated to the condition categories based on the weighted percent. In addition, all years combined are also shown. DMR = discard mortality rate, (*) confidential data, (-) no estimate provided, see text for explanation.

Table 22: Pacific halibut viabilities, weighted percent in each viability category, estimated gross at-sea discard (mt), and at-sea discard mortality (mt) for U.S. West Coast groundfish IFQ pot vessels by management area, depth, and year. The condition of sampled P. halibut was identified as Excellent (Exc), Poor, or Dead, consistent with IPHC protocol. The number of fish in each category was weighted based on the length-weight relationship as described in the Methods. Estimates were allocated to the condition categories based on the weighted percent. In addition, all years combined are also shown. DMR = discard mortality rate, (*) confidential data, (-) no estimate provided, see text for explanation.

Table 23: Pacific halibut viabilities, weighted percent in each viability category, estimated gross at-sea discard (mt), and at-sea discard mortality (mt) for U.S. West Coast groundfish IFQ hook & line vessels by management area, depth, and year. The condition of sampled P. halibut was identified as Minor (Mi), Moderate (Mo), Serious (S) or Dead (D), consistent with IPHC protocol. The number of fish in each category was weighted based on the length-weight relationship as described in the Methods. Estimates were allocated to the condition categories based on the weighted percent. In addition, all years combined are also shown. DMR = discard mortality rate, (*) confidential data, (-) = no estimate provided, see text for explanation.

Table 24: Estimated Pacific halibut discard (mt), discard mortality (mt), legal-sized (82 cm) mortality (mt), and percent of legal-sized discard by weight for U.S. West Coast groundfish

IFQ bottom trawl vessels by management area, depth, and year. After 2012, LE CA Halibut was combined with IFQ. (*) confidential data, (-) no estimate, see text for explanation

Table 25: Estimated Pacific halibut discard (mt), discard mortality (mt), legal-sized (82 cm) mortality (mt), and percent of legal-sized discard by weight for U.S. West Coast groundfish IFQ midwater trawl vessels targeting P. hake by management area, depth, and year. (*) confidential data, (-) no estimate, see text for explanation

Table 26: Estimated Pacific halibut discard (mt), discard mortality (mt), legal-sized (82 cm) mortality (mt), and percent of legal-sized discard by weight for U.S. West Coast groundfish IFQ midwater trawl vessels targeting rockfish by management area, depth, and year. (*) confidential data, (-) no estimate, see text for explanation

Table 27: Estimated Pacific halibut discard (mt), discard mortality (mt), legal-sized (82 cm) mortality (mt), and percent of legal-sized discard by weight for U.S. West Coast groundfish IFQ pot vessels by management area, depth, and year. (*) confidential data, (-) no estimate, see text for explanation

Table 28: Estimated Pacific halibut discard (mt), discard mortality (mt), legal-sized (82 cm) mortality (mt), and percent of legal-sized discard by weight for U.S. West Coast groundfish IFQ hook & line vessels by management area, depth, and year. (*) confidential data, (-) no estimate, see text for explanation

Table 29: Pacific halibut bycatch discarded at-sea (no mortality rate applied) by month for vessels fishing bottom trawl gear in the 2021 IFQ fishery. We present coastwide estimates across all depths to maintain confidentiality. Note that adding values across columns might give slightly different results because values are rounded to two decimals for reporting. Monthly estimates do not include bycatch from EM vessels.

Table 30: Physical measurements of P. halibut length (cm) for U.S. west coast groundfish IFQ bottom trawl vessels (2011-2021). Length bins include the lower bound and exclude the upper bound.

Table 31: Physical measurements of P. halibut length (cm) for U.S. west coast groundfish IFQ midwater trawl vessels targeting P. hake (2015-2021). Length bins include the lower bound and exclude the upper bound.

Table 32: Physical measurements of P. halibut length (cm) for U.S. west coast groundfish IFQ midwater trawl vessels targeting rockfish (2015-2021). Length bins include the lower bound and exclude the upper bound.

Table 33: Physical measurements of P. halibut length (cm) for U.S. west coast groundfish IFQ pot vessels (2011-2021). Length bins include the lower bound and exclude the upper bound.

Table 34: Physical measurements of P. halibut length (cm) for U.S. west coast groundfish IFQ hook & line vessels (2011-2021). Length bins include the lower bound and exclude the upper bound.

Table 35: Visual estimates of *P. halibut* lengths (cm) from the U.S. West Coast groundfish IFQ fishery (2011-2021) for vessels using bottom trawl, pot, and hook & line gear. Length bins include the lower bound and exclude the upper bound. On IFQ hook & line vessels, only visual estimates are taken on *P. halibut*.

Table 36: Weighted length frequency distributions for Pacific halibut in the IFQ fishery for vessels using bottom trawl gears, by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm. Since 2013, IFQ bottom trawl lengths could also include lengths taken on both IFQ and LE California halibut bottom trawl fisheries.

Table 37: Percentage of weighted length measurements in each viability category, for IFQ vessels by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm.

Table 38: Observed number of dead *P. halibut* in each length bin, summed across viability categories, for IFQ bottom trawl vessels by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm. Since 2013, IFQ bottom trawl lengths could also include lengths taken on both IFQ and LE California halibut bottom trawl fisheries. This analysis assumes that there is no size-dependent mortality within viability categories.

Table 39: Weighted length frequency distributions for Pacific halibut in the IFQ fishery for vessels using midwater trawl gears, by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm.

Table 40: Percentage of weighted length measurements in each viability category, for IFQ vessels by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm.

Table 41: Observed number of dead *P. halibut* in each length bin, summed across viability categories, for IFQ midwater trawl vessels by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm. This analysis assumes that there is no size-dependent mortality within viability categories.

Table 42: Weighted length frequency distributions for Pacific halibut in the IFQ fishery for vessels using midwater trawl gears, by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm.

Table 43: Percentage of weighted length measurements in each viability category, for IFQ vessels by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm.

Table 44: Observed number of dead *P. halibut* in each length bin, summed across viability categories, for IFQ midwater trawl vessels by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm. This analysis assumes that there is no size-dependent mortality within viability categories.

Table 45: Weighted length frequency distributions for Pacific halibut in the IFQ fishery for vessels using pot gears, by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm.

Table 46: Percentage of weighted length measurements in each viability category, for IFQ vessels by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm.

Table 47: Observed number of dead P. halibut in each length bin, summed across viability categories, for IFQ pot vessels by year. Length bins are inclusive of the bin value (lower) and exclude the upper value, e.g., 10 = lengths 10.0 to 11.99 cm. This analysis assumes that there is no size-dependent mortality within viability categories.

Table 48: Coverage information and Pacific halibut bycatch in the At-sea Pacific hake Catcher Processors by year. Gear specific mortality rates cannot be applied to P. halibut bycatch in this fishery because mortality rates have not been determined for midwater trawl gear.

Table 49: Coverage information and Pacific halibut bycatch in the At-sea Pacific hake Catcher Vessels delivering to Motherships by year. Gear specific mortality rates cannot be applied to P. halibut bycatch in this fishery because mortality rates have not been determined for midwater trawl gear.

Table 50: Coverage information and Pacific halibut bycatch in the At-sea Pacific hake Tribal fishery by year. Gear specific mortality rates cannot be applied to P. halibut bycatch in this fishery because mortality rates have not been determined for midwater trawl gear. Tribal At-sea P. hake fishery has not operated since 2012. (*) confidential.

Table 51: Physical measurements of P. halibut length frequencies (cm) collected by A-SHOP observers in the At-sea hake fishery (2002-2021). Length bins include the lower bound and exclude the upper bound.

Table 52: Number of vessels, trips, and tows and gross metric tons of Pacific halibut discarded at-sea, P. halibut discarded at sea with mortality rate applied (Bottom Trawl = 0.90) and the P. halibut landed and discarded at the dock (mortality rate = 1.0) under the IFQ Electronic Monitoring Exempted Fishing Permit (EFP). All participating vessels carry electronic monitoring equipment on all fishing trips. Data from 2015-2020 are summarized from the EM program administered by Pacific States Marine Fisheries Commission. EM discard data from 2021 were not yet available when this report was prepared, so we also include estimates of total mortality based on EM trips that also carried a human observer.

Table 53: P. halibut observed weight, estimated total at-sea gross weight of discards, and estimated mortality (mt, with the mortality rate applied based on observer viability), in each viability category from IFQ bottom trawl vessels carrying both EM and a human at-sea observer. Discard mortality rates are shown for the observer viability method and the Time-on-Deck model as applied by the Pacific States Marine Fisheries Commission. Electronic Monitoring (EM) vessels carried electronic monitoring equipment. Viabilities on EM vessels were obtained by at-sea human observers. EM vessels only fished south of Pt.

Chehalis. All weights are metric tons (mt). Exlnt = Excellent = 0.10 mortality rate; Poor = 0.55 mortality rate; Dead = 0.90 mortality rate; - = not applicable. EM data from 2021 were not yet available when this report was prepared so 2021 estimates are not included.

Table 54: Number of vessels, trips, and tows and gross metric tons of Pacific halibut discarded at-sea, P. halibut discarded at sea with mortality rate applied (Bottom Trawl = 0.90) and the P. halibut landed and discarded at the dock (mortality rate = 1.0) under the IFQ Electronic Monitoring Exempted Fishing Permit (EFP). All participating vessels carry electronic monitoring equipment on all fishing trips. Data from 2015-2020 are summarized from the EM program administered by Pacific States Marine Fisheries Commission. EM discard data from 2021 were not yet available when this report was prepared, so we also include estimates of total mortality based on EM trips that also carried a human observer.

Table 55: Number of vessels, trips, and tows and gross metric tons of Pacific halibut discarded at-sea, P. halibut discarded at sea with mortality rate applied (Midwater Trawl = 1.0) and the P. halibut landed and discarded at the dock (mortality rate = 1.0) under the IFQ Electronic Monitoring Exempted Fishing Permit (EFP). All participating vessels carry electronic monitoring equipment on all fishing trips. Data from 2015-2020 are summarized from the EM program administered by Pacific States Marine Fisheries Commission. EM discard data from 2021 were not yet available when this report was prepared, so information on 2021 at-sea discards is not included here.

Table 56: Number of vessels, trips, and tows and gross metric tons of Pacific halibut discarded at-sea, P. halibut discarded at sea with mortality rate applied (Midwater Trawl = 1.0) and the P. halibut landed and discarded at the dock (mortality rate = 1.0) under the IFQ Electronic Monitoring Exempted Fishing Permit (EFP). All participating vessels carry electronic monitoring equipment on all fishing trips. Data from 2015-2020 are summarized from the EM program administered by Pacific States Marine Fisheries Commission. EM discard data from 2021 were not yet available when this report was prepared, so information on 2021 at-sea discards is not included here.

Table 57: Number of observed vessels, trips, and sets in the Limited Entry Sablefish hook & line fishery.

Table 58: Number of observed vessels, trips, and sets in the Limited Entry Sablefish pot fishery.

Table 59: Number of observed vessels, trips, and sets in the LE Fixed Gear DTL hook & line fishery. The number of observed pot vessels in this fishery is too small to meet confidentiality and thus not reported.

Table 60: Number of observed vessels, trips, and sets in the OA Fixed Gear hook & line fishery. OA Fixed Gear fishery was not observed until 2003.

Table 61: Number of observed vessels, trips, and sets in the OA Fixed Gear pot fishery. OA Fixed Gear fishery was not observed until 2003.

Table 62: Expansion factors and WCGOP observed discard rate by gear type for limited entry (LE) and open access (OA) non-nearshore fixed gear sectors used to expand discard estimates of Pacific halibut to the entire fleet.

Table 63: Total sablefish or groundfish landings (mt) for each sector and gear type in the non-nearshore fixed gear fishery. Sablefish landings were used as the expansion factor in all cases except for the LE Sablefish Non-Endorsed and the OA Fixed Gear sectors, where target species include a variety of groundfish species.

Table 64: Observed discard ratios for each sector and gear type in the non-nearshore fixed gear fishery. Sablefish landings were used as the discard ratio denominator in all cases except for the LE Sablefish Non-Endorsed and the OA Fixed Gear sectors, where target species include a variety of groundfish species.

Table 65: Percent of observed trips that caught Pacific halibut by sector, gear, and area (where applicable). – = No WCGOP observers were deployed for the sector-year-gear type combination.

Table 66: Observed average, minimum and maximum annual catch of P. halibut catch weight discarded by year. – = No WCGOP observers were deployed for the sector-year-gear type combination.

Table 67: The observed percent of P. halibut catch weight discarded by year. – = No WCGOP observers were deployed for the sector-year-gear type combination.

Table 68: Injury assessment of Pacific halibut caught by hook & line vessels in the U.S. west coast, Limited Entry Sablefish fishery by year and area. The condition of sampled P. halibut was identified as Minor (Mi), Moderate (Mo), Serious (Ser) or Dead, consistent with IPHC protocol. Sample sizes allowed for annual weighted rates as described in the Methods. Injury assessments were not used by NWFSC in mortality estimates until 2011; injury data prior to 2011 is shown for informational purposes only. Coastwide discard estimates are calculated as the sum of estimates north and south of Pt. Chehalis, WA.

Table 69: Injury assessment of Pacific halibut caught by hook & line vessels in the U.S. west coast, LE Fixed Gear DTL fishery by year and area. The condition of sampled P. halibut was identified as Minor (Mi), Moderate (Mo), Serious (Ser) or Dead, consistent with IPHC protocol. Sample sizes allowed for annual weighted rates as described in the Methods. Injury assessments were not used by NWFSC in mortality estimates until 2011; injury data prior to 2011 is shown for informational purposes only.

Table 70: Injury assessment of Pacific halibut caught by hook & line vessels in the U.S. west coast, OA Fixed Gear fishery by year and area. The condition of sampled P. halibut was identified as Minor (Mi), Moderate (Mo), Serious (Ser) or Dead, consistent with IPHC protocol. Sample sizes allowed for annual weighted rates as described in the Methods. Injury assessments were not used by NWFSC in mortality estimates until 2011; injury data prior to 2011 is shown for informational purposes only.

Table 71: Estimated gross discard (mt) in the limited entry (LE) sablefish endorsed, LE sablefish non-endorsed, and open access (OA) fixed gear sectors. For the LE sablefish hook

& line fishery, coastwide estimates are calculated as the sum of estimates north and south of Pt. Chehalis, WA.

Table 72: Estimated discard mortality (mt) in the limited entry (LE) sablefish endorsed, LE sablefish non-endorsed, and open access (OA) fixed gear sectors. Estimated discard mortality (mt) on longline and hook-&-line vessels was computed by two methods. For the 2002-2010 period, a 16 % discard mortality rate was applied to gross discard estimates because viability data was not available. Since 2011, mortality rates on longline vessels are based on the viability categories assigned to individuals. For all years, an 18% discard mortality rate was applied to gross discard estimates from pot vessels. For the LE sablefish hook & line fishery, coastwide estimates are calculated as the sum of estimates north and south of Pt. Chehalis, WA.

Table 73: Estimated P. halibut discard mortality (mt, mortality rate applied, see text for description) from each sector of the non-nearshore fixed gear fishery by year.

Table 74: Physical measurements of P. halibut length (cm) from the U.S. west coast Limited Entry Sablefish fishery (2002-2021) for vessels using hook & line gear. Length bins include the lower bound and exclude the upper bound.

Table 75: Physical measurements of P. halibut length (cm) from the U.S. west coast Limited Entry Sablefish fishery (2002-2021) for vessels using pot gear. Length bins include the lower bound and exclude the upper bound.

Table 76: Physical measurements of P. halibut length (cm) from the U.S. west coast LE Fixed Gear DTL fishery (2002-2021) for vessels using hook & line gear. Length bins include the lower bound and exclude the upper bound.

Table 77: Physical measurements of P. halibut length (cm) from the U.S. west coast OA Fixed Gear fishery (2002-2021) for vessels using hook & line gear. Length bins include the lower bound and exclude the upper bound.

Table 78: Physical measurements of P. halibut length (cm) from the U.S. west coast OA Fixed Gear fishery (2002-2021) for vessels using pot gear. Length bins include the lower bound and exclude the upper bound.

Table 79: Visual estimates of P. halibut lengths (cm) from the U.S. West Coast groundfish Non-Nearshore fixed gear fisheries (2002-2021) for vessels using hook & line gear and pot gear. Numbers are the numbers of individuals caught with each gear type. The WCGOP does not observe LE Non-Endorsed Sablefish vessels fishing with pot gear. Length bins include the lower bound and exclude the upper bound.

Table 80: Dates for IPHC P. halibut directed commercial (non-tribal) fishery in area 2A.

Table 81: Observer coverage information for the Pacific halibut directed fishery by year. The WCGOP began observing the Pacific halibut directed fishery in 2017 at the request of the International Pacific Halibut Commission.

Table 82: Discard ratio and gross discard estimate of P. halibut for the P. halibut directed fishery. SE = standard error; ci = confidence interval.

Table 83: Injury assessment of Pacific halibut caught by hook & line vessels in the U.S. west coast, Directed P Halibut fishery by year and area. The condition of sampled P. halibut was identified as Minor (Mi), Moderate (Mo), Serious (Ser) or Dead, consistent with IPHC protocol. Sample sizes allowed for annual weighted rates as described in the Methods. Injury assessments were not used by NWFSC in mortality estimates until 2011; injury data prior to 2011 is shown for informational purposes only.

Table 84: Physical measurements of P. halibut length (cm) from the U.S. west coast Directed P Halibut fishery (2002-2021) for vessels using hook & line gear. Length bins include the lower bound and exclude the upper bound.

Table 85: Visual length estimates of discarded P. halibut from the Pacific halibut directed fishery. Length bins include the lower bound and exclude the upper bound.

Table 86: Pacific halibut physically measured lengths and visual estimates of lengths approximating legal (> 82 cm) versus sublegal definitions (IPHC), collected by the WCGOP in the IFQ fishery (2011-2021), Non-Nearshore fixed gear fisheries (LE sablefish endorsed, LE non-endorsed, OA fixed gear; 2002-2021), the At-sea Hake sectors (2002-2021) and the Directed P. halibut fishery (2017-2021). Note that visual length estimates are not taken in the At-sea Hake sectors.

Table 87: Coverage information, bycatch rates, and bycatch estimates for Pacific halibut in the Oregon nearshore fixed gear fishery. The WCGOP began observing the Oregon nearshore fishery in 2004. Coverage rate in the Oregon nearshore fixed gear fishery is defined as the proportion of P. halibut to nearshore species landings that were observed. Nearshore species are listed in the WCGOP Data Processing Appendix. Gear specific mortality rates cannot be applied to P. halibut bycatch in this fishery because of confidentiality issues. Washington does not allow a state nearshore fishery. (*) = Confidential data; (-) = not observed; lcl/ucl = lower/upper 95% confidence limit.

Table 88: Coverage information, bycatch rates, and bycatch estimates for Pacific halibut in the California nearshore fixed gear fishery. The WCGOP began observing the California nearshore fishery in 2003. Coverage rate in the California nearshore fixed gear fishery is defined as the proportion of P. halibut to nearshore species landings that were observed. Nearshore species are listed in the WCGOP Data Processing Appendix. Gear specific mortality rates cannot be applied to P. halibut bycatch in this fishery because of confidentiality issues. Washington does not allow a state nearshore fishery. (*) = Confidential data; (-) = not observed; lcl/ucl = lower/upper 95% confidence limit.

Table 89: Coverage information, bycatch rates, and bycatch estimates for Pacific halibut in the Washington pink shrimp trawl fishery. The WCGOP began observing the Washington pink shrimp fishery in 2010. Coverage rate in the Washington pink shrimp trawl fishery is defined as the proportion of P. halibut to pink shrimp (mainly *Pandalus jordani*) landings that were observed. Mortality rates are not applied to P. halibut bycatch in these fisheries because mortality rates for shrimp trawl gear have not been estimated. (*) = Confidential data; (-) = not observed; lcl/ucl = lower/upper 95% confidence limit.

Table 90: Coverage information, bycatch rates, and bycatch estimates for Pacific halibut in the Oregon pink shrimp trawl fishery. The WCGOP began observing the Oregon pink shrimp fishery in 2004. Coverage rate in the Oregon pink shrimp trawl fishery is defined as the proportion of *P. halibut* to pink shrimp (mainly *Pandalus jordani*) landings that were observed. The OR pink shrimp fishery was not observed in 2006. Mortality rates are not applied to *P. halibut* bycatch in these fisheries because mortality rates for shrimp trawl gear have not been estimated. (*) = Confidential data; (-) = not observed; lcl/ucl = lower/upper 95% confidence limit.

Table 91: Coverage information, bycatch rates, and bycatch estimates for Pacific halibut in the California pink shrimp trawl fishery. The WCGOP began observing the California pink shrimp fishery in 2003. Coverage rate in the California pink shrimp trawl fishery is defined as the proportion of *P. halibut* to pink shrimp (mainly *Pandalus jordani*) landings that were observed. The CA pink shrimp fishery was not observed in 2006. Mortality rates are not applied to *P. halibut* bycatch in these fisheries because mortality rates for shrimp trawl gear have not been estimated. (*) = Confidential data; (-) = not observed; lcl/ucl = lower/upper 95% confidence limit.

Table 92: Coverage information, bycatch rates, and bycatch estimates for Pacific halibut in the California halibut bottom trawl fishery. The WCGOP began observing the California halibut fishery in 2002. Coverage rate in the California halibut bottom trawl fishery is defined as the proportion of *P. halibut* to California halibut (*Paralichthys californicus*) landings that were observed. The WCGOP recognizes two sectors; a limited entry (LE) sector and an open access (OA) sector. In 2010, the LE and OA sectors are combined to maintain confidentiality. Beginning in 2011, the limited entry sector is observed under the IFQ groundfish fishery and estimates for this sector are included in the IFQ tables. (*) = Confidential data; (-) = not observed; lcl/ucl = lower/upper 95% confidence limit.

Table 93: Observer coverage information and *P. halibut* bycatch and landings for the Ridgeback Prawn fishery by year. The WCGOP began observing the Ridgeback Prawn fishery in 2017. * = confidential.

Table 94: Observer coverage information and *P. halibut* bycatch and landings for the Sea Cucumber fishery by year. The WCGOP began observing the Sea Cucumber fishery in 2017. * = confidential.

Table 95: Metric tons of Pacific halibut discarded at sea and landed and discarded at the dock on observed Exempted Fishing Permit (EFP) vessels. Note: This does not contain the Catch Shares Electronic Monitoring EFP data.

Table 96: Metric tons of Pacific halibut landed in non-groundfish fisheries that are not observed by the NWFSC Observer Program. Data are summarized from the PacFIN fish tickets and do not include any *P. halibut* landed under the IPHC *P. halibut* directed fishery.

Table 97: A description of permits, gears used, target groups, vessel length range, fishing depth range, and management of fishery sectors and subsectors in federally managed and monitored U.S. West Coast groundfish catch share fisheries which use Individual Fishing Quotas (IFQ) to manage certain species. Observer coverage in these fisheries is 100%,

except for vessels using electronic monitoring (EM). The IFQ program began in 2011, regulations prior to 2011 are excluded. For brevity, management descriptors are generalized and are not meant to be complete or comprehensive. Vessel lengths and fishing depths are based on observed vessels and might not represent the fleet as a whole.

Table 98: A description of permits, gears used, target groups, vessel length range, fishing depth range, and management of fishery sectors and subsectors in federally managed and observed U.S. West Coast groundfish non-catch share fisheries. Observer coverage on these vessels is less than 100%. For brevity, management descriptors are generalized and are not meant to be complete or comprehensive. Vessel lengths and fishing depths are based on observed vessels and might not represent the fleet as a whole.

Table 99: A description of permits, gears used, target groups, vessel length range, fishing depth range, and management of fishery sectors and subsectors in state-managed, observed fisheries. Observer coverage on these vessels is less than 100%. For brevity, management descriptors are generalized for the given time period and are not meant to be complete or comprehensive. Vessel lengths and fishing depths are based on observed vessels and might not represent the fleet as a whole.

Table 100: IPHC length-weight conversion table for Pacific halibut. This length frequency table was updated to reflect length-weight relationships in IPHC Area 2A by IPHC in 2022.