Recommendations for Pacific halibut discard mortality rates in the 2016-2018 groundfish fisheries off Alaska

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Abstract

Analysis of 2012-2014 observer data on the release condition of halibut from trawl, longline, and pot vessels fishing groundfish off Alaska has resulted in new estimates of discard mortality rates for discarded halibut in each target fishery for those years. The new rates are similar to those determined in previous analyses. The rates were added to the accumulated time series, which serve as the basis for recommendations to the North Pacific Fishery Management Council and the National Marine Fisheries Service for assumed rates to be used in the in-season estimation of halibut bycatch mortality for the 2016-2018 groundfish fisheries off Alaska.

Introduction

Pacific halibut discard mortality rates (DMRs) in the Alaskan groundfish fisheries are estimated from viability (injury and condition) data collected by fishery observers. These data are analyzed each year by staff of the International Pacific Halibut Commission (IPHC). This paper reports on an analysis of viability data collected during the 2012-2014 Community Development Quota (CDQ) and non-CDQ groundfish fisheries off Alaska. The results from these three years are combined with previous years' data to form the basis for recommended DMRs to be used for in-season estimation and management of halibut bycatch mortality in the 2016-2018 CDQ and non-CDQ groundfish fisheries.

Data description and methods

The analysis followed the same approach that has been employed since 1996, which was originally described by Williams (1997). Observer haul data from the NMFS groundfish observer database formed the basis of the analysis. The data records included the catch of groundfish by species or species group, estimates of the number and weight (kg) of halibut, and the number and length of halibut assessed for release viability by category (excellent/poor/dead for trawl and pot gear; minor/moderate/severe/dead for longline gear). Records for all hauls sampled by observers in 2012-2014 were obtained; hauls not sampled for species composition were excluded.

The hauls were assigned to target fishery categories based on the species composition of the catch within the haul, relative to the overall total and retained catches (Table 1). For example, hauls were coded as midwater pollock if pollock comprised 95% or more of the summed total catch for the reporting week (Sunday-Saturday). Flatfish targets in the Bering Sea/Aleutians (BSA) were determined in a succession of comparisons of individual flatfish species compositions in the catch. The determination for the flatfish targets was based on the greatest percentage of the non-arrowtooth flounder catch. Table 1 shows the target codes and definitions used.

Fishery observers examined halibut for release condition or injury immediately before being returned to the sea. Each fish was judged according to a set of criteria (Williams and Chen 2004), which were used to determine the presence and extent of internal and external injuries and body

damage from predators (e.g., amphipods and marine mammals). A dichotomous key, first introduced in 2000, was supplied to observers to reduce subjectivity in the determination of condition and injury. Observers recorded the number of halibut in excellent, poor, and dead condition (trawls and pots) or with minor, moderate, or severe injuries, or dead (longlines) on each haul or set sampled, respectively. Samples were only collected on hauls that were sampled for species composition. The species composition sampling provides an estimate of the total number of halibut caught in the haul, as well as the catch of groundfish necessary for determining the target. Observers were instructed to limit the number of fish examined to a maximum of 20, although this was occasionally exceeded by enthusiastic observers.

Next, the viability distribution for a target fishery was calculated. First, for each haul, the proportion of halibut in each category was extrapolated to the total number of halibut caught. The extrapolated numbers of halibut for each vessel by viability category were then summed within each region/gear/target strata.

The general model for calculating the DMR for halibut caught by gear g is of the form:

$$DMR_g = \sum_{i=1}^{3} \left(m_{i,g} \times P_i \right)$$

where m is the mortality rate for gear g, and P is the proportion of halibut in condition i, where 1 is excellent/minor, 2 is poor/moderate, 3 is dead (trawl or pot)/severe, and 4 is dead (longline).

There are several factors that contribute to release viability, which vary by gear type. With trawl-caught halibut, condition is related to the size of the catch, tow duration, and halibut size. For longline bycatch, injuries are most frequently caused by improper release methods used by vessel crews. Another significant factor is the length of the soak time, which can exacerbate the mortality caused by hooking injuries and also increase the potential for amphipod predation. The condition of halibut caught in pots is affected by soak time and the presence of other animals in the pot, especially crabs, whose spiny carapaces have been observed to scratch and abrade the skin of the captive halibut.

The mortality rate m varies among gear types and represents the aggregate effects of external and internal injuries to the fish and the presence of predation by amphipods or marine mammals. The mortality rates have been determined through long-term tagging studies conducted by IPHC. See Clark et al. (1992) for trawls, Williams (1997) for pots, and Kaimmer and Trumble (1998) for longlines. Estimated halibut mortality rates by gear and condition/injury were as follows:

Gear (g)	m_{exc}	m_{poor}	m_{dead}	
Trawl	0.20	0.55	0.90	
Pot	0.00	1.00	1.00	
	m_{minor}	$m_{moderate}$	m_{severe}	m_{dead}
Longline	0.035	0.363	0.662	1.00

Mean fishery DMRs and associated standard errors were estimated by assuming that each vessel acts as a separate sampling unit, so that a DMR was calculated for each individual vessel in a target fishery. The DMR for a target fishery was then estimated as the mean of vessel DMRs, where the vessel's proportion of the total number of bycaught halibut was used as a weighting factor, as follows:

Let DMR_i = observed DMR on vessel $\boldsymbol{i}$

    p_i = proportion of total number of halibut caught on vessel $\boldsymbol{i}$

Then $\overline{DMR}$ = $\displaystyle\sum_{i=1}^{n} p_i \times DMR_i$

Standard errors of the weighted mean DMR were estimated as:

$$V\left(\overline{DMR}\right) = \sum_{i=1}^{n} p_i^2 \times V(DMR_i)$$

and $SE\left(\overline{DMR}\right) = \sqrt{V\left(\overline{DMR}\right)}$

where $V(DMR_i)$ is the sample variance of all the DMR_i , and $V\left(\overline{DMR}\right)$ and $SE\left(\overline{DMR}\right)$ are the variance and standard error of $\overline{DMR}$, respectively.

Results

Non-CDQ fisheries

  A summary of observer coverage, sampling, and halibut size composition data for 2012-2014 is shown in Table 2. Coverage and sampling in the major targets produced a large number of sampled hauls, and a substantial number of halibut sampled in many fisheries. For example, observers sampled over 10,000 hauls and 4,800 halibut in the BSA midwater pollock fishery in 2012. Two flatfish trawl targets, yellowfin and rock sole, often had some of the largest number of halibut measured than any other target. Sample sizes were generally very high (>1,000 hauls and/or >1,000 halibut measured) in most BSA trawl fisheries. The longline fishery for cod was the only BSA longline fishery to receive significant sampling in 2012-2014. In past years, minimal sampling also occurred on rockfish and turbot vessels and 2012-2014 was no exception. Pot fishing was focused on cod, as in past years.

  Most of the sampling in GOA trawl fisheries occurred in the cod, rockfish, and flatfish targets. The rockfish fishery tallied the largest number of observed tows, likely reflecting the higher observer coverage requirements of the Central Gulf Rockfish Program. The number of halibut sampled in the cod and the bottom trawl pollock fisheries showed significant drops between 2012 and 2013-2014. Sampling of flatfish fishing occurred in the shallow water flatfish, arrowtooth, and rex sole targets. No effort was noted in the deepwater flatfish target, which in past years was primarily directed at Dover sole. The number of sampled longline and pot vessels targeting cod was lower in 2012 than previously seen but increased in 2013-2014.

  Sampling and fishery totals of halibut viability (condition or injury) data by region and fishery are summarized in Table 3. The sample totals represent the summed observations recorded by observers. In most cases, these raw data total less than those shown in Table 2, as the latter include some halibut which were not examined for condition/injury. The observations on each haul were extrapolated upwards to the total number of halibut caught on the haul, and then summed across vessel and target fishery strata. For most fisheries, the distribution of the extrapolated viability data is very similar to the raw data. The complete time series of fishery

DMRs, expressed as percentages, is provided in Tables 4 and 5 for the BSA and GOA, respectively.

In reviewing data from 2012-2014, it is apparent in several instances that the number of halibut examined for viability was lower than previously seen, and in some cases very low. The reasons for the small sample sizes are likely many but it raises the question about the number of samples that is sufficient to accurately represent the fishery. This is a topic which needs to be examined in a broader analysis about halibut sampling but for the purposes of this report, a minimum of 50 fish was adopted as the level necessary for a reliable estimate of a fishery DMR. A number less than 50 was considered to provide an unreliable DMR. For the tables in this report, an underlined DMR value indicates an unreliable estimate.

CDQ fisheries

CDQ fishing is conducted using all three primary gear types. The primary species targeted by trawl operations included pollock, and rock sole and yellowfin sole. Pacific cod were targeted by longline, and sablefish by pots. Sampling levels and injury/viability data for CDQ operations are summarized in Table 6; the time series of mean annual DMRs is shown in Table 7.

Almost all halibut caught in the trawl operations were dead when examined. Typically this condition in halibut occurs in larger haul size and/or longer haul duration, or when the fish are left in the holding tanks for long periods prior to sorting and discard.

Of the DMRs calculated for the 2012-2014 CDQ trawl targets, over half (n=9) had insufficient sampling to provide reliable DMRs (#halibut <50). Additionally, all of the remaining DMRs were greater than 0.80. These results are generally higher than what is seen in non-CDQ fishing for the same target, which suggests that other factors are negatively affecting the condition of the released halibut. For example, different catch processing or handling methods for CDQ hauls may contribute to poorer release viability.

Longline CDQ fishing targeted cod. In previous analyses, the distribution of release injuries to halibut in the CDQ longline cod fishery has been similar to that observed in the non-CDQ cod fishery. Data for 2012-2014 continue this pattern.

The CDQ pot fishery has always targeted sablefish, with 2-3 vessels observed each year. This pattern continued in 2012-2013 but in 2014, some Pacific cod targeting (three vessels) was noted for the first time. Very few halibut were examined by observers, but not many halibut were caught. The sablefish pot fishery DMR has typically been higher than in non-CDQ pot fishing, but the data for the pot cod fishery were dramatically lower, closer to the magnitude seen in non-CDQ cod pot fishing. Halibut mortality in pots is positively correlated with longer pot soak time; long soaks increase the potential for amphipod predation of captured fish in the pot.

Recommendations for 2016-18

The North Pacific Fishery Management Council is using a plan in which the DMRs used to monitor halibut bycatch are an average of data from the most recent 10-year period. These 10-year mean DMRs for each fishery are used for a 3-year period, with the justification being two-fold: 1) interannual variability of fishery DMRs is relatively small, and 2) to provide stability for the industry to better plan their operations. The following table outlines the range of data used for the specific years of application:

10-Year Basis Period	Years of application
1990-1999	2001 - 2003
1993-2002	2004 – 2006
1996-2005	2007 - 2009
1999-2008	2010 - 2012
2002-2011	2013 - 2015
2005-2014	2016 - 2018

As shown, information from 2005-2014 is the basis for the DMR recommendations for 2016-2018. The 10-year mean DMRs for 2005-2014 are shown as the 2016-2018 recommendation in Table 8. For some targets, a full ten years of data were not available, so the recommended DMR is based on the available data for the 2005-2014 basis period.

For CDQ targets with no past observations or data, such as longline turbot and pot cod, DMRs derived from non-CDQ fisheries data are recommended. For the 'other species' and any other target not explicitly noted here in the non-CDQ fisheries, the DMR for the cod fishery in that region/gear stratum is recommended.

In all cases, those instances where fewer than 50 fish were examined were not included in the calculations for the recommendations, due to the unreliable DMRs.

References

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Table 1. Groundfish target definitions and target determination criteria for observer sampled hauls.

	BSA			GOA	
Target	**Definition**		**Target**	**Definition**	
A	Atka mackerel		A	Atka mackerel	
B	Bottom pollock		B	Bottom pollock	
C	Pacific cod		C	Pacific cod	
F	Other flatfish		D	Deep water flatfish	
K	Rockfish		H	Shallow water flatfish	
L	Flathead sole		K	Rockfish	
O	Other spp.		L	Flathead sole	
P	Midwater pollock		O	Other spp.	
R	Rock sole		P	Midwater pollock	
S	Sablefish		S	Sablefish	
T	Greenland turbot		W	Arrowtooth flounder	
W	Arrowtooth flounder		X	Rex sole	
Y	Yellowfin sole				

CDQ and Non-CDQ TARGET FISHERY DETERMINATION

Bering Sea/Aleutians

P	if pollock $\geq$ 95% of total catch, or
W	if arrowtooth flounder $\geq$ 65% of total catch.
Y/R/L/F	if (rock sole + other flatfish + yellowfin sole + flathead) is the largest component of the retained catch using this rule:
Y	if yellowfin sole is $\geq$ 70% of (rock sole + other flatfish + yellowfin sole + flathead sole), or
R	if rock sole > other flatfish and rock sole > flathead sole, or
L	if flathead sole > other flatfish and flathead sole > rock sole, or
F	if none of the three conditions above are met.

Note: If target is not P, W, Y, R, L or F, then target is whichever species or species group (A, B, C, K, O, S, or T) forms the largest part of the total catch.

Gulf of Alaska

P	if pollock $\geq$ 95% of total catch, or
W	if arrowtooth flounder $\geq$ 65% of total catch.

Note: If target is not P or W, then target is whichever species or species group (A, B, C, D, H, K, L, O, S, or X) forms the largest part of the total catch.

Table 2. Summary information on fishery effort, observer sampling, and halibut bycatch size composition in non-CDQ fisheries.

Area/Gear /Target	No. of vsls Sampled	No. of sampled hauls	No. of fish Measured	Mean length (cm)	Percent <65 cm	Percent < 82 cm
2012						
BSA Longline						
Pacific cod	31	6,847	13,173	64.1	57	93
Turbot	6	253	10	78.0	10	70
BSA Pot						
Pacific cod	30	822	1,289	65.5	51	94
BSA Trawl						
Atka mackerel	9	1,355	838	71.5	43	79
Bottom pollock	94	3,047	5,583	51.0	87	98
Pacific cod	54	1,339	4,033	49.2	89	99
Rockfish	13	601	413	69.1	44	83
Flathead sole	9	398	633	64.7	58	89
Midwtr pollock	98	10,481	4,842	54.8	82	97
Rock sole	22	2,468	5,379	45.0	89	97
Turbot	10	471	403	75.6	35	71
Arrowtooth flndr	10	380	918	66.8	42	93
Yellowfin sole	29	6,463	5,891	63.3	55	91
GOA Longline						
Pacific cod	9	383	550	66.4	45	91
GOA Pot						
Pacific cod	18	482	1,150	72.8	15	88
GOA Trawl						
Bottom pollock	35	620	1,591	59.6	69	94
Pacific cod	37	442	2,206	57.3	75	96
Shall wtr flatfish	16	152	598	59.4	72	93
Rockfish	45	1,558	578	71.5	36	77
Flathead sole	11	70	206	65.1	57	84
Midwtr pollock	43	382	3	60.3	67	67
Sablefish	9	53	20	81.2	15	50
Arrowtooth flndr	10	205	490	67.1	47	87
Rex sole	6	178	905	60.1	68	94

Table 2. (cont'd)

			2013			
Area/Gear /Target	No. of vsls Sampled	No. of sampled hauls	No. of fish Measured	Mean length (cm)	Percent <65 cm	Percent < 82 cm
BSA Longline						
Pacific cod	30	7,901	17,142	64.9	53	93
Turbot	3	133	11	89.2	18	36
BSA Pot						
Pacific cod	20	1,035	423	66.1	46	93
BSA Trawl						
Atka mackerel	8	523	225	74.8	29	73
Bottom pollock	88	3,016	5,173	58.5	72	95
Pacific cod	53	2,022	3,900	54.3	84	97
Rockfish	11	942	465	69.3	49	85
Flathead sole	10	931	1,373	63.8	57	92
Midwtr pollock	97	10,588	3,098	60.9	66	94
Rock sole	18	2,240	5,584	48.9	86	98
Turbot	3	58	69	69.3	42	88
Arrowtooth flndr	3	78	191	69.3	31	96
Yellowfin sole	26	7,222	6,682	64.9	50	91
GOA Longline						
Pacific cod	21	1,037	1,362	72.0	31	81
GOA Pot						
Pacific cod	34	505	386	69.9	31	87
GOA Trawl						
Bottom pollock	33	363	845	60.0	68	97
Pacific cod	36	235	516	57.6	77	96
Shall wtr flatfish	7	154	789	56.3	76	96
Rockfish	41	1,299	836	68.6	43	85
Flathead sole	6	91	246	58.9	83	95
Midwtr pollock	42	229	29	69.4	21	90
Sablefish	12	142	75	73.6	25	77
Arrowtooth flndr	11	260	312	67.4	46	86
Rex sole	4	311	1,901	62.1	65	97

Table 2. (cont'd)

Area/Gear /Target	No. of vsls Sampled	No. of sampled hauls	No. of fish Measured	Mean length (cm)	Percent <65 cm	Percent < 82 cm
2014						
BSA Longline						
Pacific cod	29	8,709	10,864	66.6	51	90
Turbot	3	166	1	73.0	0	100
BSA Pot						
Pacific cod	33	828	345	66.4	47	93
BSA Trawl						
Atka mackerel	8	746	324	72.3	35	80
Bottom pollock	92	3,216	3,515	56.1	73	96
Pacific cod	36	2,056	4,784	52.2	88	98
Other flatfish	3	47	51	62.6	63	98
Rockfish	11	840	210	73.8	34	76
Flathead sole	10	983	750	66.9	51	89
Midwtr pollock	95	10,788	2,017	62.3	53	87
Rock sole	20	2,701	7,790	47.2	87	98
Sablefish	0	0	0	-	-	-
Turbot	3	78	102	67.6	47	90
Arrowtooth flndr	4	169	240	67.9	34	95
Yellowfin sole	28	6,505	6,497	61.8	57	91
GOA Longline						
Pacific cod	22	1,074	1,793	71.9	31	82
GOA Pot						
Pacific cod	34	479	203	70.9	29	90
GOA Trawl						
Bottom pollock	39	225	159	55.0	84	96
Pacific cod	33	330	828	54.2	75	97
Dp wtr flatfish	0	0	0	-	-	-
Shall wtr flatfish	9	141	243	49.0	84	98
Rockfish	38	1,595	756	66.5	50	89
Flathead sole	2	12	38	64.6	55	89
Midwtr pollock	49	326	0	-	-	-
Sablefish	12	71	16	84.3	0	31
Arrowtooth flndr	7	704	1,167	67.7	43	94
Rex sole	5	244	799	64.8	58	94

Table 3. Distribution of halibut viability/injury data by target fishery. Underlined DMR values indicate <50 halibut were examined for viability within that target fishery, and are therefore considered unreliable.

2012								
	Sample totals			**Projected fishery totals**				
Target	**Exc**	**Poor**	**Dead**	**Exc**	**Poor**	**Dead**	**DMR**	**SE**
BSA Trawl								
Atka mackerel	0	0	7	0	0	45,086	**0.900**	0.0000
Bottom pollock	23	64	4486	957	2,662	186,562	**0.874**	0.0097
Pacific cod	347	609	1276	45,832	80,438	168,536	**0.632**	0.0559
Rockfish	0	0	7	0	0	19,744	**0.900**	0.0000
Flathead sole	1	0	0	24,347	0	0	**0.200**	0.0000
Midwtr pollock	0	22	4363	0	498	98,693	**0.895**	0.0016
Rock sole	7	27	552	4,970	19,172	391,953	**0.871**	0.0470
Yellowfin sole	38	99	411	27,912	72,717	301,887	**0.823**	0.0508
BSA Pot								
Pacific cod	1153	72	61	3563	222	189	**0.083**	0.723
GOA Trawl								
Bottom pollock	298	251	395	19,267	16,228	25,538	**0.583**	0.0626
Pacific cod	477	402	522	34,298	28,905	37,533	**0.561**	0.0540
Shall wtr flatfish	67	82	214	3,390	4,149	10,828	**0.716**	0.0465
Rockfish	46	97	59	7,068	14,903	9,065	**0.559**	0.0931
Flathead sole	44	31	23	5,935	4,181	3,102	**0.467**	0.0608
Midwtr pollock	2	0	0	200	0	0	**0.200**	0.0000
Arrowtooth fldr	5	15	102	1,404	4,212	28,643	**0.795**	0.1110
Rex sole	34	101	470	2,756	8,187	38,099	**0.800**	0.0845
GOA Pot								
Pacific cod	985	84	55	3,847	328	215	**0.134**	0.1287

	Sample totals				**Projected fishery totals**					
Target	**Minor**	**Mod**	**Severe**	**Dead**	**Minor**	**Mod**	**Severe**	**Dead**	**DMR**	**SE**
BSA Longline										
Pacific cod	10,581	1,037	153	228	705,081	69,102	10,195	15,193	**0.090**	0.0268
Turbot	10	0	0	0	4024	0	0	0	**0.035**	0.0000
GOA Longline										
Pacific cod	326	115	21	9	29,380	10,364	1,893	811	**0.127**	0.646

Table 3. (cont'd)

	2013							
	Sample totals			**Projected fishery totals**				
Target	**Exc**	**Poor**	**Dead**	**Exc**	**Poor**	**Dead**	**DMR**	**SE**
BSA Trawl								
Atka mackerel	0	0	28	0	0	15,544	**<u>0.900</u>**	0.0000
Bottom pollock	80	33	2,730	3,018	1,245	103,000	**0.860**	0.0063
Pacific cod	1,096	582	443	85,672	45,494	34,629	**0.454**	0.0479
Rockfish	0	1	6	0	4,190	25,142	**<u>0.830</u>**	0.0000
Flathead sole	2	11	49	2,085	11,466	51,078	**0.814**	0.1366
Midwtr pollock	5	6	3,395	45	54	30,666	**0.854**	0.0066
Rock sole	23	18	964	8,787	6,877	368,305	**0.885**	0.0204
Arrowtooth flounder	0	0	0	-	-	-	**-**	-
Yellowfin sole	64	214	1,500	14,521	48,554	340,332	**0.844**	0.0585
BSA Pot								
Pacific cod	343	16	7	1301	61	27	**0.050**	0.1395
GOA Trawl								
Bottom pollock	50	46	117	7,097	6,529	16,607	**0.659**	0.1128
Pacific cod	86	64	111	6,009	4,472	7,756	**0.657**	0.0706
Shall wtr flatfish	17	10	60	3,676	2,162	12,974	**0.771**	0.0793
Rockfish	86	42	134	10,343	5,051	16,115	**0.697**	0.0420
Flathead sole	0	5	52	0	1,011	10,513	**0.870**	0.0483
Midwtr pollock	0	0	0	-	-	-	**-**	-
Sablefish	21	7	14	1,462	487	974	**<u>0.527</u>**	0.1616
Arrowtooth fldr	13	20	73	2,533	3,897	14,225	**0.702**	0.0960
Rex sole	6	19	97	3,457	10,946	55,884	**0.799**	0.1531
GOA Pot								
Pacific cod	327	25	23	942	72	66	**0.125**	0.1818

	Sample totals				**Projected fishery totals**					
Target	**Minor**	**Mod**	**Severe**	**Dead**	**Minor**	**Mod**	**Severe**	**Dead**	**DMR**	**SE**
BSA Longline										
Pacific cod	13728	1114	124	363	491,904	39,917	4,443	13,007	**0.086**	0.0229
Turbot	9	1	0	1	32	4	0	4	**<u>0.112</u>**	0.0612
GOA Longline										
Pacific cod	1085	171	49	56	16419	2588	742	847	**0.126**	0.0651

Table 3. (cont'd)

		2014						
	Sample totals			**Projected fishery totals**				
Target	**Exc**	**Poor**	**Dead**	**Exc**	**Poor**	**Dead**	**DMR**	**SE**
BSA Trawl								
Atka mackerel	2	10	38	899	4,496	17,084	**0.860**	0.0038
Bottom pollock	56	53	1,941	3,060	2,896	106,054	**0.856**	0.0000
Pacific cod	1,060	681	1,084	61,901	39,769	63,303	**0.541**	0.0004
Other flatfish	0	0	0	0	0	0	**-**	-
Rockfish	0	0	7	0	0	15,134	**0.900**	0.0000
Flathead sole	0	1	6	0	5,876	35,256	**0.865**	0.0061
Midwtr pollock	3	2	1,717	36	24	20,595	**0.898**	0.0000
Rock sole	20	57	1,242	7,574	12,585	470,325	**0.870**	0.0019
Arrowtooth fldr	0	0	0	0	0	0	**-**	-
Yellowfin sole	21	67	612	12,891	41,127	375,672	**0.828**	0.0005
BSA Pot								
Pacific cod	317	15	10	1,130	53	36	**0.067**	0.0004
GOA Trawl								
Bottom pollock	33	30	21	2,124	1,931	1,352	**0.360**	0.0039
Pacific cod	66	78	168	9,178	10,847	23,363	**0.677**	0.0010
Shall wtr flatfish	5	23	7	2,105	9,683	2,947	**0.584**	0.0207
Rockfish	38	22	99	7,947	4,601	20,703	**0.636**	0.0320
Flathead sole	5	7	18	629	881	2,265	**0.702**	0.0053
Midwtr pollock	0	0	0	-	-	-	**-**	-
Sablefish	3	2	0	268	179	0	**0.345**	0.0021
Arrowtooth fldr	1	3	70	899	2,696	62,910	**0.870**	0.0036
Rex sole	3	23	31	1,765	13,529	18,235	**0.725**	0.0069
GOA Pot								
Pacific cod	162	14	16	703	61	69	**0.152**	0.0025

	Sample totals				**Projected fishery totals**					
Target	**Minor**	**Mod**	**Severe**	**Dead**	**Minor**	**Mod**	**Severe**	**Dead**	**DMR**	**SE**
BSA Longline										
Pacific cod	9,182	759	144	177	337,800	27,923	5,298	6,512	**0.079**	0.0000
Turbot	1	0	0	0	10	0	0	0	**0.035**	0.0000
GOA Longline										
Pacific cod	1,477	216	16	46	46,971	6,869	509	1,463	**0.099**	0.0007

Table 4. Summary of halibut discard mortality rates (DMRs), expressed as percentages, in the non-CDQ Bering Sea/Aleutian (BSA) groundfish fisheries during 1990-2014. Underlined DMR values indicate <50 halibut were examined for viability within that target fishery, and are therefore considered unreliable.

Gear/Target	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14
BSA Trawl																									
Atka mackerel	66	77	71	69	73	73	83	85	77	81	77	73	85	67	63	67	64	89	90	90	87	67	90	90	86
Bottom pollock	68	74	78	78	80	73	79	72	80	74	67	74	78	65	73	79	74	69	79	88	78	85	87	86	86
Pacific cod	68	64	69	67	64	71	70	67	66	69	69	69	69	67	70	81	77	78	61	76	63	65	63	45	54
Other Flatfish	80	75	76	69	61	68	67	71	78	63	76	81	77	79	80	65	82	-	41	-	-	-	-	-	-
Rockfish	65	67	69	69	75	68	72	71	56	81	89	85	73	84	68	79	90	87	73	83	67	87	90	83	90
Flathead sole	-	-	-	-	67	62	66	57	70	79	74	69	60	69	70	83	75	80	79	75	82	55	20	81	87
Midwtr pollock	85	82	85	85	80	79	83	87	86	87	88	89	90	89	88	90	90	90	85	84	87	86	90	85	90
Rock sole	64	79	78	76	76	73	74	77	79	81	75	77	83	82	85	84	83	83	86	88	88	84	87	89	87
Sablefish	46	66	-	26	20	-	-	-	-	90	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbot	69	55	-	-	58	75	70	75	86	70	74	68	75	67	31	82	-	-	-	-	-	-	-	-	-
Arrowtooth fldr	-	-	-	-	-	-	-	-	-	-	-	-	-	67	67	90	-	-	78	-	-	-	-	-	-
Yellowfin sole	83	88	83	80	81	77	76	80	82	78	77	74	77	81	86	85	87	77	87	87	85	79	82	84	83
BSA Pot																									
Pacific cod	12	4	12	4	10	10	7	4	13	9	13	6	5	6	7	3	8	15	4	11	12	13	8	5	7
BSA Longline																									
Pacific cod	19	23	21	17	15	14	12	11	11	12	12	12	10	8	10	8	10	9	8	8	9	9	9	9	8
Rockfish	17	55	-	6	23	-	20	4	52	-	12	10	4	-	-	-	-	-	-	-	-	-	-	-	-
Sablefish	14	32	14	13	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbot	15	30	11	10	14	9	15	22	18	17	14	6	23	7	4	6	8	-	17	35	6	9	4	11	4

Table 5. Summary of halibut discard mortality rates (DMRs), expressed as percentages, in the Gulf of Alaska (GOA) groundfish fisheries during 1990-2014. Underlined DMR values indicate <50 halibut were examined for viability within that target fishery, and are therefore considered unreliable.

Gear/Target	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14
GOA Trawl																									
Atka mackerel	67	89	81	67	53	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bottom pollock	51	62	66	57	48	66	79	66	55	55	52	58	55	47	73	45	70	69	70	57	54	57	58	66	36
Pacific cod	60	62	66	59	53	64	70	62	64	54	57	67	59	69	63	66	56	61	63	62	70	52	56	66	68
Deep wtr flats	61	58	70	59	60	56	71	61	51	51	62	49	48	31	49	-	-	-	-	-	-	-	-	-	-
Shall wtr flats	66	71	69	65	62	70	71	71	67	81	67	62	66	80	71	77	70	71	66	64	56	52	72	77	<u>58</u>
Rockfish	65	75	79	75	58	71	65	63	68	74	71	61	64	65	73	66	48	77	75	67	66	63	56	70	64
Flathead sole	-	-	-	-	54	64	67	74	39	51	69	68	74	49	62	57	63	83	78	45	73	69	47	87	<u>70</u>
Midwtr pollock	71	82	72	63	61	51	81	70	80	86	80	89	90	34	88	62	66	87	-	-	-	-	<u>20</u>	90	-
Sablefish	70	60	68	59	67	58	80	61	-	68	38	66	62	-	79	-	89	52	-	-	-	-	-	-	<u>35</u>
Arrowtooth fldr	-	-	-	-	-	-	66	48	62	73	75	86	76	70	65	66	76	64	73	69	90	81	80	-	87
Rex sole	-	-	-	-	56	76	63	47	58	70	71	62	57	69	67	61	45	57	85	84	80	82	80	-	73
GOA Pot																									
Pacific cod	12	7	16	24	17	21	7	11	16	13	8	33	19	21	22	13	15	17	10	31	13	10	13	13	15
GOA Longline																									
Pacific cod	15	18	13	7	11	13	11	22	11	17	16	11	11	13	16	8	13	7	10	10	9	8	13	13	10
Rockfish	6	-	-	7	-	4	13	-	9	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sablefish	17	27	28	30	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6. Summary of vessel sampling and halibut viability data from the 2012-2014 Bering Sea/Aleutian Community Development Quota (CDQ) fisheries. Underlined DMR values indicate <50 halibut were examined for viability within that target fishery, and are therefore considered unreliable.

			Sample totals			**Projected fishery totals**					
	# of	**# of**									
Target	**Vsls**	**Hauls**	**Exc**	**Poor**	**Dead**	**Exc**	**Poor**	**Dead**		**DMR**	**SE**
CDQ Trawl											
Atka m	1	186	14	16	16	1,390	1,589	1,589		**0.584**	0.1982
B poll	7	102	3	2	100	222	148	7,408		**0.850**	0.0119
P cod	1	69	1	0	4	1,915	0	7,659		**0.813**	0.1750
Rckfsh	1	77	1	1	0	1,204	1,204	0		**0.375**	0.0000
Fl sole	1	8	4	12	13	152	455	493		**0.682**	0.2108
M poll	13	1134	2	3	810	13	20	5,317		**0.896**	0.0107
R sole	2	275	0	1	22	0	2,222	48,895		**0.873**	0.0951
CDQ Pot											
Sable	2	64	0	0	0	-	-	-		**-**	-
CDQ Longline			**Minor**	**Mod**	**Sev**	**Dead**	**Minor**	**Mod**	**Sev**	**Dead**	**DMR**	**SE**
P cod	8	1,039	1,427	112	4	22	92,258	7,241	259	1,422	**0.072**	0.0387

2013

Target	**Vsls**	**Hauls**	**Exc**	**Poor**	**Dead**	**Exc**	**Poor**	**Dead**		**DMR**	**SE**
CDQ Trawl											
B poll	17	235	0	2	297	0	24	3,556		**0.868**	0.0002
P cod	4	72	0	0	7	0	0	1,551		**0.798**	0.0248
M poll	14	946	1	0	521	6	0	3,304		**0.899**	0.0000
R sole	6	269	0	1	57	0	494	28,145		**0.882**	0.0020
YF sole	6	1,008	2	20	47	1123	11231	26,393		**0.800**	0.0199
CDQ Pot											
Sable	1	16	37	4	8	113	12	24		**0.530**	0.1085

CDQ Longline			**Minor**	**Mod**	**Sev**	**Dead**	**Minor**	**Mod**	**Sev**	**Dead**	**DMR**	**SE**
P cod	13	1,034	1643	118	6	47	72123	5180	263	2063	**0.082**	0.0009

2014

Target	**Vsls**	**Hauls**	**Exc**	**Poor**	**Dead**	**Exc**	**Poor**	**Dead**		**DMR**	**SE**
CDQ Trawl											
Atka m	5	111	0	0	1	0	0	1,736		**0.900**	0.0000
B poll	19	272	0	2	338	0	52	8,749		**0.896**	0.0110
P cod	5	85	0	0	23	0	0	3,787		**0.900**	0.0000
M poll	14	1,104	1	0	623	7	0	4,078		**0.900**	0.0004
R sole	6	222	0	1	1	0	16,011	16,011		**0.725**	0.0000
Turbot	2	10	0	0	0	-	-	-		**-**	-
YF sole	5	664	0	6	62	0	2,545	26,303		**0.860**	0.0874
CDQ Pot											
P cod	3	160	104	0	1	364	0	3		**0.006**	0.0000
Sable	1	15	0	0	0	-	-	-		**-**	-
CDQ Longline			**Minor**	**Mod**	**Sev**	**Dead**	**Minor**	**Mod**	**Sev**	**Dead**	**DMR**	**SE**
P cod	17	1,329	1,087	104	34	69	42,099	4,028	1,317	2,672	**0.110**	0.0621

Table 7. Summary of halibut discard mortality rates (DMRs), expressed as percentages, in the Community Development Quota (CDQ) Bering Sea/Aleutian (BSA) groundfish fisheries during 1998-2014. Underlined DMR values indicate <50 halibut were examined for viability within that target fishery, and are therefore considered unreliable.

Gear/Target	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14
CDQ Trawl																	
Atka mackerel	-	82	89	80	90	86	87	89	80	79	90	-	-	90	<u>58</u>	-	<u>90</u>
Bottom pollock	90	88	90	90	66	-	84	90	88	83	90	74	90	82	85	87	90
Pac cod	-	-	-	-	-	-	-	-	-	-	90	90	-	90	<u>81</u>	80	<u>90</u>
Rockfish	-	88	-	90	-	-	-	-	69	82	89	-	-	-	<u>38</u>	-	-
Flathead sole	-	-	83	90	-	-	-	-	-	79	-	-	-	-	68	90	-
Midwtr pollock	90	90	88	89	89	90	90	90	90	90	89	90	89	90	90	90	90
Rock sole	-	-	-	-	-	-	-	-	86	89	86	-	90	89	<u>87</u>	88	<u>73</u>
Turbot	-	-	-	-	-	-	-	-	-	-	88	90	-	-	-	-	-
Yellowfin sole	-	83	-	-	81	89	88	88	73	87	89	-	-	90	-	80	86
CDQ Pot																	
Pacific cod	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sablefish	-	-	38	46	25	22	18	56	40	24	22	50	50	31	-	<u>53</u>	-
CDQ Longline																	
Pacific cod	10	10	13	11	9	9	9	10	10	8	9	8	18	10	7	8	11
Turbot	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 8. Recommended Pacific halibut discard mortality rates (DMRs), expressed as percentages, for 2016-2018 CDQ and non-CDQ groundfish fisheries off Alaska. Values noted with an asterisk (*) indicate the use of the Pacific cod target DMR for that fishery, as data for 2005-2014 were unavailable. Underlined DMR values from Tables 4, 5 and 7 not used in calculating these recommendations.

Non-CDQ

	Bering Sea/Aleutians			Gulf of Alaska	
Gear/Target	Used in 2013-2015	2016-2018 Recommendation	Gear/Target	Used in 2013-2015	2016-2018 Recommendation
Trawl			*Trawl*		
Atka mack	77	80	Bottom poll	60	58
Bottom poll	77	81	Pacific cod	62	62
Pacific cod	71	66	Dpwtr flats	43	62*
Other Flats	71	63	Shallwtr flats	67	67
Rockfish	79	81	Rockfish	66	65
Flathead sole	73	76	Flathead sole	65	67
Midwtr poll	88	88	Midwtr poll	71	72
Rock sole	85	86	Sablefish	71	71
Sablefish	75	66*	Arr. fldr	73	76
Turbot	64	82	Rex sole	69	72
Arr. fldr	76	84			
YF sole	83	84			
Pot			*Pot*		
Pacific cod	8	9	Pacific cod	17	15
Longline			*Longline*		
Pacific cod	9	9	Pacific cod	11	10
Rockfish	4	9*	Rockfish	9	10*
Turbot	13	14			

Bering Sea/Aleutians CDQ

Gear/Target	Used in 2013-2015	2016-2018 Recommendation
Trawl		
Atka mackerel	86	81
Bottom pollock	83	86
Pacific cod	90	90
Rockfish	80	80
Flathead sole	79	79
Midwtr pollock	90	90
Rock sole	88	88
Turbot	89	89
Yellowfin sole	86	85
Pot		
Pacific cod	-	1
Sablefish	34	39
Longline		
Pacific cod	10	10
Turbot	4	10*