

Pacific Halibut Discard Mortality Rates in the 2006 Open Access and CDQ Groundfish Fisheries, and Recommendations for Discard Mortality Rates Needed for Monitoring Halibut Bycatch in 2008 CDQ Fisheries

Gregg H. Williams

International Pacific Halibut Commission

Abstract

Observations of the physical condition and injuries of halibut caught as bycatch in the groundfish fisheries off Alaska were used to determine discard mortality rates (DMRs). DMRs were calculated for each target fishery (open access and CDQ) in the Gulf of Alaska and the Bering Sea/Aleutians regions. The resultant 2006 fishery DMRs differed very little from 2005. Bycatch management in for 2007-2009 is based on DMRs adopted by the North Pacific Fishery Management Council in September, 2006. Recommendations for CDQ fisheries in 2008 are based on mean DMRs calculated from 1998-2006 data.

Introduction

Pacific halibut discard mortality rates (DMRs) in the Alaskan groundfish fisheries are estimated from viability (injury and condition) data collected by National Marine Fisheries Service (NMFS) observers. Analysis by staff of the International Pacific Halibut Commission (IPHC) results in recommendations to the North Pacific Fishery Management Council (NPFMC or Council) for managing halibut bycatch in subsequent fishing seasons. This paper describes the results from an analysis of data collected from the 2006 open access and Community Development Quota (CDQ) groundfish fisheries, and includes DMR recommendations for monitoring halibut bycatch in the 2008 CDQ fisheries.

Data description and methods

The analysis followed the same approach which has been employed since 1996, which was described by Williams (1996). Observer haul data from the NMFS groundfish observer database forms 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 bycatch, and the number and length of halibut sampled for release condition or injury 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 2006 were obtained; hauls not sampled for species composition were excluded.

The records were assigned to target fishery categories, based on the catch of the particular species within the haul catch composition 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 week (Sunday-Saturday). The determination for the flatfish targets assumes that all arrowtooth flounder caught in a haul were discarded; the remaining species are assumed retained. Target determination was based on the species/species

group comprising the greatest percentage of the “retained” catch. Flatfish targets in the Bering Sea/Aleutians (BSA) were determined in a succession of comparisons of individual flatfish species compositions in the catch. Table 1 shows the target codes and definitions used.

NMFS observers examine halibut for the release condition or injury immediately before being returned to the sea. Each fish is judged according to a set of criteria (Williams and Chen 2003), which are used to determine internal and external injuries, and body damage from predators (e.g., amphipods and marine mammals). Beginning in 2000, a dichotomous key was introduced to reduce subjectivity in the determinations of condition and injury. Observers record the number of excellent, poor and dead condition (trawls and pots) or minor, moderate, severe, and dead (longlines) halibut for each haul/set sampled. Samples are only collected on hauls 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 are instructed to limit the number of fish examined to a maximum of 20, although this is occasionally exceeded by enthusiastic observers.

Next, the viability distribution is calculated. First, for each haul, the proportion of halibut in each category is extrapolated up to the total number of halibut caught. The extrapolated numbers of halibut for each vessel by viability category are 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:

$$DMR_g = \sum_{i=1}^4 (m_{i,g} \times P_i)$$

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/severe, and 4 is dead.

The mortality rate m varies among gear types (see Clark et al. (1992) for trawls, Williams (1996) for pots, and Kaimmer and Trumble (1998) for longlines) and represents the aggregate effects of external and internal injuries to the fish and the presence of predation by amphipods or marine mammals. There can be many sources of injuries, which vary by gear type. For longlines, injuries are most frequently caused by improper release methods used by vessel crews. Other significant factors include the length of the soak time, which can exacerbate the mortality caused by hooking injuries and also increase the potential for amphipod predation. Halibut mortality rates by gear and condition/injury are shown in the following table:

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}
Longlines	0.035	0.363	0.662	1.00

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

Let DMR_v = observed DMR on vessel v
 p_v = proportion of total number of halibut caught on vessel v in a fishery

$$\text{Then } \overline{DMR} = \sum_{v=1}^n (p_v \times DMR_v)$$

Standard errors of the weighted mean DMR were estimated as:

$$V(\overline{DMR}) = \sum_{v=1}^n (p_v^2 \times V(DMR_v))$$

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

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

Results

Open access fisheries

A summary of observer coverage, sampling, and halibut size composition data 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. For example, observers sampled slightly more than 13,000 hauls and 16,000 halibut in the BSA midwater pollock fishery, which represents the largest sample of any target fishery in 2006. Sample sizes were also very high (>1,000 hauls and/or >900 halibut measured) in the BSA cod (trawl), bottom pollock, rock sole, yellowfin sole and Atka mackerel fisheries. More intermediate in sample size were flathead sole. Sampling in the remaining BSA trawl fisheries was relatively low. The longline fishery for cod was the only BSA longline fishery to receive much sampling; only minimal sampling occurred on vessels targeting rockfish and turbot. Pot fishing was focused on cod, as in past years.

Most of the sampling in GOA trawl fisheries occurred in the pollock, cod, rockfish, and flatfish targets, which continues patterns seen in past years. In 2006, the rockfish fishery had the greatest number of vessels (36) and hauls (554) monitored. Sampling of the cod and the two pollock fisheries occurred at similar levels (33-34 vessels; ~200-400 hauls). Sampling of flatfish fishing was concentrated in the shallow water, flathead and rex sole targets. For the second year, no vessel effort was noted in the deepwater flatfish target, which primarily has been directed at Dover sole. In 2005, high catches of Dover sole were most frequently associated with even greater catches of arrowtooth flounder or rex sole, and to a lesser extent flathead sole. Consequently, vessel effort was assigned to those targets and not deepwater flatfish. The number of sampled longline and pot vessels targeting cod was similar to past years.

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

raw data. However, for the GOA bottom pollock fishery, the final, extrapolated data exhibit a different distribution than the raw data.

The complete time series of fishery DMRs is provided in Tables 4 and 5 for the BSA and GOA, respectively.

CDQ fisheries

In 2006, CDQ fishing was conducted using pots, trawls, and longlines. Targeted species included pollock, rockfish, Atka mackerel, rock sole and yellowfin sole by trawls, Pacific cod 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. The resulting DMRs ranged from 0.88 to 0.90, which are generally higher than what is seen in open access fishing for the same target species, with the exception of pelagic pollock and yellowfin sole.

Longline CDQ fishing consisted of 20 vessels targeting cod. Distribution of release injuries to halibut in the CDQ longline cod fishery was similar to that observed in the open access cod fishery, which is reflected by very similar DMRs (0.104 vs. 0.098).

Pot effort in 2006 was focused on sablefish, with four vessels observed, compared to five in 2005. The fishery DMR (0.404) was slightly higher than the long term mean and what has been previously seen in this fishery. Pot soak time is believed to be positively correlated with halibut mortality. The long soaks increase the potential for amphipod predation and injury from hard-shell crab in the pot.

Recommendations for 2008

CDQ fisheries

Until 10 years of data from CDQ fishing has been collected, recommendations will be based on averaging all available data. Thus, a mean annual DMR for all targets was calculated using data from 1998-2006 for the 2008 recommendations. For the major species, there are at least five years of data, and up to eight years for pelagic pollock and longline cod. These recommendations are shown in Table 8.

For those targets with no recent information, such as trawl flathead sole and rockfish, longline turbot, and pot cod, we recommend using DMRs derived from open access fisheries data. The current open access fisheries are probably more alike the current CDQ fishing, than data from fishing conducted over five years ago or more.

Note on open access fisheries

The Council is using a plan in which the DMRs used to monitor halibut bycatch are an average of data from the preceding 10 year period. These 10-year mean DMRs for each fishery are used for a 3-year period, with the justification being two-fold: first, to smooth out small, interannual variability, and second, to avoid annually changing the DMRs by providing stability for the industry to better plan their operations. The following table outlines what has been used thus far. Note that data from 1996-2005 forms the basis for 2007-2009 monitoring.

10-Year Basis Period	Years of application
1990-1999	2001 - 2003
1993-2002	2004 – 2006
1996-2005	2007 - 2009

References

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Table 1. Groundfish target definitions and target determination method used to classify observer sampled hauls in the halibut discard mortality rate analysis.

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	Pelagic pollock	O	Other spp.
R	Rock sole	P	Pelagic pollock
S	Sablefish	S	Sablefish
T	Greenland turbot	W	Arrowtooth flounder
W	Arrowtooth flounder	X	Rex sole
Y	Yellowfin sole		

OPEN ACCESS and CDQ TARGET 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.

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.

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. Information on observer coverage, sampling, and size composition of the halibut bycatch in 2006.

Area/Gear /Target	No. of Vsls Observed	No. of Smpld hauls	No. of fish Measured	Mean Length (cm)	Percent <65 cm	Percent < 82 cm
<i>BSA Longline</i>						
Pacific cod	39	5,875	10,433	67.8	42.5	86.6
Rockfish	3	20	0	-	-	-
Turbot	7	137	20	88.6	5.0	20.0
<i>BSA Pot</i>						
Pacific cod	40	727	747	63.9	52.7	98.7
<i>BSA Trawl</i>						
Atka mackerel	14	1,051	135	65.1	68.9	84.4
Bottom pollock	71	1,464	5,846	55.6	71.0	94.6
Pacific cod	65	1,908	5,720	51.6	86.6	95.9
Other flatfish	1	4	10	61.0	80.0	90.0
Rockfish	6	168	23	90.1	13.0	39.1
Flathead sole	14	842	1,930	59.0	70.1	91.7
Other sp.	1	1	0	-	-	-
Pelagic pollock	96	13,106	16,217	57.9	68.8	93.9
Rock sole	23	1,268	4,725	46.5	87.6	94.9
Sablefish	0	0	0	-	-	-
Turbot	0	0	0	-	-	-
Arrowtooth flndr	0	0	0	-	-	-
Yellowfin sole	29	2,418	2,623	58.8	66.3	78.9
<i>GOA Longline</i>						
Pacific cod	17	658	2,021	67.4	45.4	88.5
<i>GOA Pot</i>						
Pacific cod	24	385	489	74.0	19.6	75.5
<i>GOA Trawl</i>						
Bottom pollock	34	435	658	64.2	55.5	85.0
Pacific cod	32	213	1,018	62.7	64.5	93.3
Dp wtr flatfish	0	-	0	-	-	-
Shall wtr flatfish	21	186	1,184	53.7	79.9	94.7
Rockfish	36	554	258	77.2	29.5	65.1
Flathead sole	12	139	414	62.0	69.6	86.5
Other sp.	3	4	0	-	-	-
Pelagic pollock	36	238	37	66.9	54.1	81.1
Sablefish	4	20	17	71.5	41.2	70.6
Arrowtooth flndr	18	171	352	68.0	46.9	84.9
Rex sole	5	73	241	64.7	54.4	89.2

Table 3. Distribution of 2006 halibut condition & injury data, by factor and open access target fishery.

Target	Raw Data				Extrapolated Data				
	Exc	Poor	Dead	DMR	Exc	Poor	Dead	DMR	SE
<i>BSA Trawl</i>									
Atka mackerel	27	31	59	0.646	2,430	2,827	5,075	0.640	0.2694
Bottom pollock	253	344	3,806	0.832	8,158	14,857	43,992	0.737	0.1065
Pacific cod	860	816	3,022	0.711	18,653	28,074	126,011	0.768	0.1003
Other flatfish	0	3	7	0.795	0	350	1,138	0.818	-
Rockfish	0	0	22	0.900	0	0	2,598	0.900	0.1820
Flathead sole	205	329	765	0.701	6,866	15,231	44,540	0.748	0.1682
Other sp.	0	0	0	-	0	0	0	-	-
Pelagic pollock	21	62	16,129	0.898	43	139	31,609	0.898	0.0689
Rock sole	207	479	2,840	0.811	9,687	26,679	203,947	0.833	0.1176
Turbot	0	0	0	-	0	0	0	-	-
Arrowtooth flounder	0	0	0	-	0	0	0	-	-
Yellowfin sole	112	150	1,908	0.840	4,374	5,431	130,000	0.865	0.1262
<i>BSA Pot</i>									
Pacific cod	456	21	18	0.079	1,512	63	68	0.080	0.0250
<i>GOA Trawl</i>									
Bottom pollock	68	69	453	0.778	1,498	1,408	4,832	0.701	0.2363
Pacific cod	376	211	293	0.517	9,264	5,892	9,890	0.559	0.0581
Deepwater flatfish	0	0	0	-	0	0	0	-	-
Shallow water flatfish	291	198	542	0.635	5,307	5,182	17,103	0.700	0.1068
Rockfish	112	59	87	0.516	7,117	2,505	4,427	0.483	0.1003
Flathead sole	53	34	79	0.605	2,069	1,198	3,707	0.632	0.1200
Other sp.	0	0	0	-	0	0	0	-	-
Pelagic pollock	10	4	23	0.673	49	15	100	0.659	0.1276
Sablefish	0	1	16	0.879	0	17	473	0.888	0.4509
Arrowtooth flounder	67	55	149	0.656	1,799	2,109	9,836	0.755	0.1992
Rex sole	105	38	52	0.455	1,624	860	737	0.454	0.1955
<i>GOA Pot</i>									
Pacific cod	411	43	34	0.158	1,215	120	89	0.147	0.0728

Target	Raw Data					Extrapolated Data					
	Minor	Mod	Severe	Dead	DMR	Minor	Mod	Severe	Dead	DMR	SE
<i>BSA Longline</i>											
Pacific cod	8,753	1,042	250	207	0.103	212,411	23,341	5,689	4,438	0.098	0.0184
Rockfish	0	0	0	0	-	0	0	0	0	-	-
Turbot	16	4	0	0	0.101	215	38	0	0	0.084	0.0254
<i>GOA Longline</i>											
Pacific cod	1,652	259	37	73	0.123	78,538	12,794	1,956	3,756	0.128	0.0446

Table 4. Summary of halibut discard mortality rates (DMRs) in the open access (non-CDQ) Bering Sea/Aleutian (BSA) groundfish fisheries during 1990-2006.

Gear/Target	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	Used in PSC Mgmt 2007-9
<i>BSA Trawl</i>																		
Atka mackerel	66	77	71	69	73	73	83	85	77	81	77	73	85	67	63	67	64	76
Bottom pollock	68	74	78	78	80	73	79	72	80	74	67	74	78	65	73	79	74	74
Pacific cod	68	64	69	67	64	71	70	67	66	69	69	69	69	67	70	81	77	70
Other Flatfish	80	75	76	69	61	68	67	71	78	63	76	81	77	79	80	65	82	74
Rockfish	65	67	69	69	75	68	72	71	56	81	89	85	73	84	68	79	90	76
Flathead sole	-	-	-	-	67	62	66	57	70	79	74	69	60	69	70	83	75	70
Pelagic pollock	85	82	85	85	80	79	83	87	86	87	88	89	90	89	88	90	90	88
Rock sole	64	79	78	76	76	73	74	77	79	81	75	77	83	82	85	84	83	80
Sablefish	46	66	-	26	20	-	-	-	-	90	60	-	-	-	-	-	-	75
Turbot	69	55	-	-	58	75	70	75	86	70	74	68	75	67	31	82	-	70
Arrowtooth fldr	-	-	-	-	-	-	-	-	-	-	-	-	-	67	67	90	-	75
Yellowfin sole	83	88	83	80	81	77	76	80	82	78	77	74	77	81	86	85	87	80
<i>BSA Pot</i>																		
Pacific cod	12	4	12	4	10	10	7	4	13	9	13	6	5	6	7	3	8	7
<i>BSA Longline</i>																		
Pacific cod	19	23	21	17	15	14	12	11	11	12	12	12	10	8	10	8	10	11
Rockfish	17	55	-	6	23	-	20	4	52	-	12	10	4	-	-	-	-	17
Sablefish	14	32	14	13	38	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbot	15	30	11	10	14	9	15	22	18	17	14	6	23	7	4	6	8	13

Table 5 Summary of halibut discard mortality rates (DMRs) in the open access Gulf of Alaska (GOA) groundfish fisheries during 1990-2006.

Gear/Target	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	Used in PSC Mgmt 2007-9
<i>GOA Trawl</i>																		
Atka mackerel	67	89	81	67	53	-	60	-	-	-	-	-	-	-	-	-	-	60
Bottom pollock	51	62	66	57	48	66	79	66	55	55	52	58	55	47	73	45	70	59
Pacific cod	60	62	66	59	53	64	70	62	64	54	57	67	59	69	63	66	56	63
Deep wtr flats	61	58	70	59	60	56	71	61	51	51	62	49	48	31	49	-	-	53
Shall wtr flats	66	71	69	65	62	70	71	71	67	81	67	62	66	80	71	77	70	71
Rockfish	65	75	79	75	58	71	65	63	68	74	71	61	64	65	73	66	48	67
Flathead sole	-	-	-	-	54	64	67	74	39	51	69	68	74	49	62	57	63	61
Pelagic pollock	71	82	72	63	61	51	81	70	80	86	80	89	90	34	88	62	66	76
Sablefish	70	60	68	59	67	58	80	61	-	68	38	66	62	-	79	-	89	65
Arrowtooth flldr	-	-	-	-	-	-	66	48	62	73	75	86	76	70	65	66	76	69
Rex sole	-	-	-	-	56	76	63	47	58	70	71	62	57	69	67	61	45	63
<i>GOA Pot</i>																		
Pacific cod	12	7	16	24	17	21	7	11	16	13	8	33	19	21	22	13	15	16
<i>GOA Longline</i>																		
Pacific cod	15	18	13	7	11	13	11	22	11	17	16	11	11	13	16	8	13	14
Rockfish	6	-	-	7	-	4	13	-	9	-	9	-	-	-	-	-	-	10
Sablefish	17	27	28	30	22	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6. Observer coverage and halibut viability/injury data collected from the 2006 Bering Sea/Aleutian Community Development Quota (CDQ) fisheries.

Target	No. of Vsls	# of Hauls	Raw Data					Extrapolated data					
			Exc./ Minor	Poor/ Mod.	Dead/ Sev.	Dead	DMR	Exc./ Minor	Poor/ Mod.	Dead/ Sev.	Dead	DMR	SE
<i>CDQ Trawl</i>													
Atka m.	3	147	8	6	26	-	0.708	70	23	471	-	0.798	0.2101
Btm pol	11	76	13	25	258	-	0.840	152	417	3,104	-	0.876	0.2853
Rockfis	3	39	2	5	10	-	0.715	2	82	198	-	0.690	0.3640
Pel pol	12	1,684	3	9	686	-	0.892	10	41	1,996	-	0.895	0.0266
Rocksol	3	160	4	44	201	-	0.827	58	662	12,038	-	0.862	0.1664
YF sole	3	199	0	29	202	-	0.856	0	809	7,395	-	0.730	0.1759
<i>CDQ Pot</i>													
Sable	4	508	146	14	55	-	0.321	430	41	183	-	0.404	0.2537
<i>CDQ Longline</i>													
P cod	20	1,780	1,629	354	32	39	0.120	32,758	6,007	695	821	0.104	0.0370

Table 7. Summary of halibut discard mortality rates (DMRs) in the CDQ Bering Sea/Aleutian (BSA) groundfish fisheries during 1998-2006.

Gear/Target	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean DMR 1998-2006
<i>CDQ Trawl</i>										
Atka mackerel	-	82	89	80	90	86	87	89	80	85
Bottom pollock	90	88	90	90	66	-	84	90	88	86
Rockfish	-	88	-	90	-	-	-	-	69	82
Flathead sole	-	-	83	90	-	-	-	-	-	87
Pelagic pollock	90	90	88	89	89	90	90	90	90	90
Rock sole	-	-	-	-	-	-	-	-	86	86
Yellowfin sole	-	83	-	-	81	89	88	88	73	84
<i>CDQ Pot</i>										
Sablefish	-	-	38	46	25	22	18	56	40	35
<i>CDQ Longline</i>										
Pacific cod	10	10	13	11	9	9	9	10	10	10
Turbot	-	-	4	-	-	-	-	-	-	4

Table 8. Recommended Pacific halibut discard mortality rates (DMRs) for 2008 CDQ fisheries.

CDQ Fisheries	
Gear/Target	Recommended DMR
<i>Trawl</i>	
Atka mackerel	85
Bottom pollock	86
Rockfish	82
Flathead sole	87
Pelagic pollock	90
Rock sole	86
Yellowfin sole	86
<i>Pot</i>	
Sablefish	34
<i>Longline</i>	
Pacific cod	10
Turbot	4