

Pacific Halibut Discard Mortality Rates in the 1990-2002 Alaskan Groundfish Fisheries, With Recommendations For Monitoring in 2004-2006

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Abstract

Results from analysis of halibut release condition and injury data collected in the 2002 groundfish fisheries, both open access and Community Development Quota fisheries, are presented. Halibut discard mortality rates (DMRs) are shown to vary by year, gear, fishery, and region. Recommendations are given for changing the DMRs used in all open access fisheries for 2004-2006. Recommendations are also provided for 2004 CDQ trawl, longline and pot operations in the Bering Sea/Aleutian Islands region.

Introduction

Pacific halibut discard mortality rates (DMRs) in the Alaskan groundfish fisheries are estimated from viability 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 seasons. This paper describes the results from an analysis of data collected from the 2002 fishery and includes DMR recommendations for 2004-2006 open access and 2004 Community Development Quota (CDQ) fisheries.

Data Used and Methods

Observer haul-by-haul data from the NMFS NORPAC database were used for this analysis. The data records included the catch of groundfish by species or species group, estimates of the number and weight of halibut bycatch, and the number and length of halibut sampled for release viability 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 2002 were obtained and appended to data currently on hand for 1990-2001. Hauls not sampled for species composition were excluded.

The first task was to partition the records into target fishery categories, which was accomplished through a "retained catch" approach, using the catch composition for sampled hauls summed during a reporting week. The target is then assigned based on the percentage of particular species within the weekly catch composition (Williams 1997).

The targeting determination was based on a series of assumptions about the total catch and retained catch within a reporting week. Midwater pollock hauls were split out if that species comprised 95% of the total catch. A similar approach was used for an arrowtooth flounder target in the Gulf of Alaska (GOA), but the assignment was made at 65% of the total catch. The determination for the remaining 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/Aleutian Islands (BSAI) were determined in a succession of comparisons of individual flatfish species compositions in the catch. Table 1 shows the target codes and definitions used in this analysis.

The approach was modified slightly for CDQ fisheries. Because of the nature of the CDQ operations, vessels can potentially move from one target to another on every haul, rendering a “weekly” approach meaningless. So a target was assigned to each haul, using the same species composition criteria employed for open access fisheries.

NMFS observers examine halibut for the release viability or injury upon return to the sea. Each fish is judged according to a set of criteria (Tables 2-4), which are used to determine internal and external injuries, and body damage from predators (e.g., sand fleas and others). Beginning in 2000, a dichotomous key was provided to reduce subjectivity in the determinations of condition. 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. Viability 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 excellent, poor, and dead halibut 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 represent 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 was a separate sampling unit, enabling a DMR to be 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_{sv} , and $V(\overline{DMR})$ and $SE(\overline{DMR})$ are the variance and standard error of \overline{DMR} , respectively.

Results for 2002 Fisheries

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The number of halibut examined by observers in a single fishery was, in most cases, substantial. For example, slightly more than 8,000 fish in the BSAI pelagic pollock fishery and more than 15,000 fish in the BSAI cod hook-&-line fishery were examined by observers (Table 5). Five of 11 BSAI trawl fisheries had sample sizes greater than 1,000 fish. In contrast, only one out of three hook-&-line fisheries (BSAI cod) had more than 1,000 halibut sampled. The GOA fishery with the largest number of halibut examined was trawl cod (over 2,500 fish). Shallow water flatfish trawl and cod longline had approximately 2,400 and 1,000 halibut examined, respectively. All other GOA fisheries had less than 1,000 fish examined. Four fisheries had less than 100 measured.

Table 6 reports on the viability/injury strata sample sizes and resulting DMRs calculated in the analysis. In general, the DMRs are consistent with results seen in past analyses. Trawl fishery DMRs ranged from 0.50 to 0.90, with DMRs generally higher in the BSAI. Longline fishery DMRs ranged from 0.10 to 0.25. Pot fisheries for cod generally exhibit lower DMRs than longline or trawl, typically less than 0.10. However, the 2001 GOA pot fishery was quite a bit higher (0.19) than is normally seen in this gear type.

In general, BSAI trawl fishery DMRs exhibited no overall increase or decrease; results were mixed when compared to 2001 estimates. For the BSAI, decreases were noted for other flatfish (0.81 in 2001 to 0.77 in 2002), rockfish (0.85 to 0.73), flathead sole (0.69 to 0.60). All others increased or were unchanged.

In the GOA, results were also mixed, as six trawl fisheries declined and four increased. Decreases were seen in bottom trawl pollock, cod, deep water flatfish, sablefish, arrowtooth

flounder and rex sole, whereas increases occurred in the shallow water flatfish, rockfish, flathead sole and pelagic pollock.

DMRs in the major Pacific cod longline fisheries changed slightly from 2001. The GOA cod fishery was unchanged from 2001, remaining at 0.11. The DMR in the BSAI cod fishery dropped from 0.12 in 2001 to 0.10 in 2002. Since 1996 the BSAI cod fishery has maintained its DMR at 0.11-0.12, which probably reflects the inherent DMR level in major longline fisheries. Other longline targets occasionally go below this level, but are usually small fisheries with only a few vessels involved. For a major fishery like cod, with upwards of 40 vessels fishing annually, stability in a halibut DMR reflects fleet-wide efforts to minimize halibut release injuries.

Pot fishery DMRs displayed much different trends in 2002. In the GOA fishery, the DMR dropped to 0.19, almost half of the 2001 value but still quite high for this gear type. In contrast, the BSAI fishery changed very little from 2001, dropping to 0.05 in 2001. This low value in the BSAI is more typical of what is expected in pot gear, especially when the pots are turned over frequently and have shorter soak times.

CDQ Fisheries

A summary of observer coverage, sampling, and halibut viability data is shown in Table 7. In 2002 pot, trawl, and longline gear was used in CDQ fishing. Applying the target algorithm on the haul species composition resulted in hauls being identified for all possible targets. However, the majority of data were collected on trawl hauls targeting pollock (pelagic), longline sets targeting cod, and pot hauls for sablefish.

For most trawl targets, almost all halibut were dead when examined, a pattern fairly indicative of pelagic pollock fishing. Only yellowfin sole and bottom trawl pollock showed a DMR lower than 0.90.

Longline CDQ fishing in 2002 consisted primarily of cod fishing, with a small amount of effort directed towards sablefish. Very little halibut data were collected from the non-cod targets. Distribution of halibut injuries in the CDQ longline cod fishery was similar to that observed in the open access cod fishery, but had a DMR slightly lower for the CDQ fishery (0.09).

Pot effort in 2002 was focused on sablefish. DMRs were significantly higher than what is seen in the open access fisheries for cod. This is likely a reflection of the greater depths of the fishery and the greater inherent mortality potential from those fishery conditions.

Recommendations for Preseason Assumed DMRs for 2004-2006

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In 2000, IPHC proposed, and the Council adopted, a plan to use a long-term average DMR for all open access fisheries for 2001-2003. At the end of that period, new long-term DMRs would be recalculated using the data collected in subsequent years and revisions recommended. In 2000, DMRs for 2001-2003 were recommended, using an average of 1990-1999, which were the most current data available at that time. This paper provides revised DMRs for managing halibut bycatch during 2004-2006.

Our recommendations for 2004-2006 are based on data from the most recent 10-year period, which is 1993-2002. We averaged the annual fishery DMRs for that period (shown in Tables 8 and 9), and summarized these recommendations in Table 10. Most of the 31 BSAI and GOA groundfish target fisheries in the analysis had a full 10-year data set. Changes in the mean DMRs from the two time periods were small in most cases, on the order of 1-3 percentage

points. In the GOA, five fishery DMRs decreased, four increased, and 3 did not change. In the BSAI, six decreased, five increased, and four did not change.

The DMRs in a couple of fisheries demonstrated large changes, i.e., ≥ 5 percentage points. BSAI trawl rockfish increased from 69 to 74%, largely due to high DMRs in 1999-2001. BSAI longline rockfish declined from 25% to 16% on the strength of lower DMRs since 2000. The fishery is fairly small, contributing to highly variable DMRs. In the GOA, only one fishery showed a large change. The trawl fishery for arrowtooth flounder has shown higher DMRs in the past couple of years, driving the long-term average up from 62% to 69%.

CDQ Fisheries

CDQ trawl effort in 2002 was focused on pollock, atka mackerel, and yellowfin sole. For atka mackerel and the two pollock targets, viability data have been collected for four and five years, respectively. We calculated the mean DMR for these targets, and recommend that the 2004 atka mackerel and pollock CDQ trawl fisheries be managed using these mean DMRs. CDQ fishing for yellowfin sole fishery has been sporadic, occurring only twice in the past four years. In cases like this, we recommend that 2004 fishing be managed using the most recent data point until three years of DMR data have been collected, at which time an average would be used. Any remaining targets that occur in 2004 should be managed using the revised open access long-term means for 1993-2002 found in Table 10.

CDQ longline fishing in 2002 was directed primarily at cod and resulted in a DMR of 0.09 (Table 7). As with the CDQ trawl fisheries, we calculated the mean DMR for the cod fishery and recommend that this be used in 2004. As with trawls, too few halibut were examined to provide meaningful results for the other targets. Longline targets other than cod should use the open access long-term mean DMRs shown in Table 10.

The pot fishery DMR for sablefish CDQ fishing was 0.25 in 2002, and we recommend this be used for 2004 monitoring. Pot fishery targets other than cod that occur in 2004 should use the open access long-term mean DMR until data from these fisheries can be collected and analyzed, and DMRs identified.

All CDQ recommendations are shown in Table 10.

Future Recommendations

IPHC's proposal in 2000 was to manage using long term average DMRs, with revisions on a periodic basis, perhaps every three years or following the implementation of management programs, such as HMAP, which would affect DMRs. In following this proposal, our intent is that the recommendations will be used for 2004-2006. Accordingly, we will provide new recommendations to the Council in 2006 for the 2007 season, unless programs are adopted which would affect DMRs.

References

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Table 1. 2002 groundfish target definitions and target determination method used to classify NORPAC hauls in the halibut viability and discard mortality rate analysis.

BSAI		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
Y	Yellowfin sole	X	Rex sole

OPEN ACCESS and CDQ TARGET DETERMINATION

Bering Sea/Aleutians

- P** if Pollock \geq 95% of total catch, or
- 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, Y, R, L or F, then target is whichever species or species group (A, B, C, K, O, S, 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, X) forms the largest part of the Total Catch.

Table 2. Definition of Pacific halibut discard condition codes for trawl gear in 2002.

Excellent: Fish is alive, showing no stress, and injuries, if any, are slight.

1. External injuries.
 - Superficial nicks or cuts on body.
 - Little (<10% of fin area) or no fraying of dorsal and anal fin.
 - Hemorrhaging (redness) of skin on white side limited to 5-10% of surface area.
2. Operculum pressure.
 - Fish is able to close operculum tightly for at least 5-10 seconds.
3. Muscle tone and physical activity.
 - Strong and lively, perhaps flopping around on deck if provoked.
 - Fish can tightly clench its jaw.
4. Bleeding.
 - No bleeding observed.
5. Gills and gill color.
 - Deep red in color.

Poor: Fish is alive, but showing signs of stress.

1. Injuries are apparent.
 - Body abrasions have damaged the skin but skin is still present, not missing.
 - Cuts and lacerations in body extend through skin just into flesh and are not deep.
 - Between 10 and 50% of dorsal and anal fins are frayed.
 - Slight bleeding from fin edges.
 - Approximately 10-25% of skin on white side of fish shows hemorrhaging.
2. Operculum pressure.
 - Fish closes operculum weakly and not sustained.
3. Muscle tone or physical activity.
 - Weak, intermittent movement. May respond if stimulated or provoked.
 - Body is limp, but not in rigor mortis.
4. Bleeding.
 - Blood is continually flowing from gills, but not profusely.
5. Gills and gill color.
 - Deep to bright red in color.

Dead: No sign of life or, if alive, likely to die from severe injuries or suffocation.

1. Injuries are apparent.
 - Body cavity ripped open.
 - Internal organs exposed and damaged.
 - Cuts and lacerations in body extend deeply into the flesh.
 - Sediment in mouth.
 - Hemorrhaging in skin on 25% or more of white side.
2. Operculum pressure.
 - Fish does not close operculum.
3. Muscle tone and physical activity.
 - No sign of muscle tone (limp) or fish is in rigor (stiff).
 - Physical activity absent or limited to fin ripples or twitches.
 - Little, if any, response to stimuli.
 - Jaw is hanging open.
4. Bleeding.
 - Blood is flowing freely and continuously in large quantity from a torn or severed gill arch, or a body injury.
5. Gills and gill color.
 - Gills appear washed out, e.g., dull red, pink, or white in color.

Table 3. Definition of Pacific halibut discard condition codes for hook-and-line gear in 2002.

Minor injuries: Injuries, if any, are slight and inconsequential to health of the fish.

1. Injuries around the mouth from the hook and hook removal are slight.
 - *A hook entrance/exit hole around the jaw or in the cheek.*
 - *The lip (skin covering the external portion of the jaw) may be torn and hanging.*
 - *The hook and some length of residual gangion may be hanging from the mouth if the gangion was cut.*
2. Very little bleeding, if any.
 - *Bleeding is seen only in the area surrounding the jaw.*
 - *Bleeding may have stopped, or may be continuing very slowly a few drops at a time.*
3. No penetration of the body or head by sand fleas.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body and can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*

Moderate injuries: Injuries are present, but are not severe.

1. Injuries may have been inflicted to the jaw, cheek, eye, or body.
 - *Lower jaw may be broken into 2 pieces at the snout, but each is still attached at the base of the jaw.*
 - *Jaw is torn on one side or the other, possibly extending through the cheek.*
 - *Hook may have punctured the eye or eye socket.*
 - *Wounds on head and abdomen limited to surface scratches on skin.*
 - *No wounds of any kind to abdominal organs. Abdominal cavity wall not punctured.*
 - *Wounds in body consist of puncture holes in skin, with possibly a flesh tear.*
2. Bleeding is occurring but not from gills.
 - *Blood may be seen around mouth and jaw.*
 - *Blood is not flowing profusely, but is oozing continuously.*
3. No penetration of the body or head by sand fleas.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body and can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*

Severe injuries: Severe life-threatening injuries can be seen.

1. Injuries to the head and/or jaw have occurred. Any of the following will be present, individually or in combination:
 - *Skin on head (forward of preopercle) is ripped and torn deeply, exposing tissue and internal organs.*
 - *Side of the head, possibly including the jaw, has been torn loose and missing from the fish.*
 - *Lower jaw has been torn away and is missing.*
 - *No wounds of any kind to abdominal organs. Abdominal cavity wall not punctured.*
2. No penetration of the body or head by sand fleas.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body and can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*

(cont'd)

Table 3. (cont'd) Definition of Pacific halibut discard injury codes for hook-and-line gear in 2002.

Dead/Fleas/Bleeding: Fish is lifeless, sand flea predation, excessive bleeding

1. Fish is already dead when brought to the surface on the gear
 - *Fish is in rigor and lifeless, even if no apparent injuries.*
 - *Gills appear completely devoid of blood (light pink or white in color).*
2. Marine mammals have taken bites out of the fish
 - *Usually taken out of the back of the fish or from the abdominal cavity.*
3. Sand fleas have penetrated the body via the eyes, fins, or anus.
 - *Membrane surrounding eye may be partially or completely missing.*
 - *Dorsal and/or anal fin membranes may be eaten away, leaving fin rays exposed. Skin on the body is separated from tissue where sand fleas have eaten.*
4. Bleeding is excessive, especially from the gills.
 - *Blood is flowing freely and continuously in large quantity.*
 - *Bleeding is occurring from a torn or severed gill arch.*
5. Internal organs are damaged, possibly by a gaff.
 - *Abdominal cavity wall is punctured or torn.*
 - *Viscera are visible and exposed, and may be protruding.*

Table 4. Definition of Pacific halibut discard condition codes for pot gear in 2002.

Excellent: Fish is alive, showing no stress, and injuries, if any, are slight.

1. External injuries.
 - *Superficial nicks or cuts on body.*
 - *Little (<10% of fin area) or no fraying of dorsal and anal fins.*
 - *Hemorrhaging (redness) of skin on white side limited to 5-10% of surface area.*
2. Operculum pressure.
 - *Fish is able to close operculum tightly for at least 5-10 seconds.*
3. Muscle tone and physical activity.
 - *Strong and lively, perhaps flopping around on deck if stimulated.*
 - *Fish can tightly clench its jaw.*
4. Bleeding.
 - *No bleeding from gills, body, or fins observed.*
5. Gills and gill color.
 - *Deep red in color.*
6. No penetration of the body or head by sand fleas. No predation by crabs.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body, but can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*

Poor: Fish is alive, but displaying physical injuries and signs of stress.

1. External injuries are apparent.
 - *Body abrasions have damaged the skin but skin is still present, not missing.*
 - *Cuts and lacerations in body extend through skin just into flesh and are not deep.*
 - *Between 10 and 50% of dorsal and anal fins are frayed.*
 - *Slight bleeding from fin edges.*
 - *Approximately 10-25% of skin on white side of fish shows hemorrhaging.*
2. Operculum pressure.
 - *Fish closes operculum weakly and not sustained.*
3. Muscle tone or physical activity is weak.
 - *Intermittent body movement. May respond if stimulated.*
 - *Body appears limp, but not in rigor mortis.*
4. Bleeding.
 - *Blood is not flowing profusely, but is oozing continuously from fin edges or body wounds.*
5. Gills and gill color.
 - *Gills are deep to bright red.*
6. No penetration of the body or head by sand fleas. No crab predation.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body, but can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*
 - *No damage to the fish from crabs, if any, in the pot.*

(cont'd)

Table 4. (cont'd) Definition of Pacific halibut discard condition codes for pot gear in 2002.

Dead/Fleas: No sign of life or, if alive, likely to die from injuries or predation.

1. External and internal injuries.
 - *Body cavity may be ripped open.*
 - *Internal organs may be exposed and damaged.*
 - *Body tissue may be torn or ripped in a rough, ragged manner.*
 - *Hemorrhaging in skin on 25% or more of white side.*
2. Operculum pressure.
 - *Fish does not close operculum.*
3. Muscle tone and physical activity.
 - *No sign of muscle tone (limp) or fish is in rigor (stiff)*
 - *Physical activity absent or limited to fin ripples or twitches.*
 - *Little, if any, response to stimuli.*
 - *Jaw may be open and slack.*
4. Bleeding.
 - *Blood is flowing profusely from fin edges or body.*
5. Gills and gill color.
 - *Gills appear washed out, e.g., dull red, pink, or white in color.*
6. Sand fleas have penetrated the body via the eyes, fins, or anus. Crab predation may also occur.
 - *Membrane surrounding eye may be partially or completely eaten by sand fleas.*
 - *Dorsal and/or anal fin membranes may be eaten away, leaving fin rays exposed. Skin on the body is separated from tissue where sand fleas have eaten.*
 - *Crabs in the pot may also have attacked and eaten the "dead" fish.*

Table 5. Information on observer coverage, sampling, and size composition of the halibut bycatch in 2002.

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>BSAI Longline</i>						
Pacific cod	40	817	15,265	69.8	0.398	0.808
Other sp.	6	23	20	81.3	0.050	0.600
Turbot	9	246	240	93.0	0.017	0.258
<i>BSAI Pot</i>						
Pacific cod	47	135	558	66.8	0.387	0.953
<i>BSAI Trawl</i>						
Atka mackerel	13	365	150	79.1	0.427	0.647
Bottom pollock	89	441	2,809	52.0	0.787	0.927
Pacific cod	80	565	7,361	50.6	0.844	0.961
Other flatfish	24	491	818	72.6	0.435	0.647
Rockfish	11	177	60	81.3	0.300	0.583
Flathead sole	15	472	685	67.0	0.458	0.819
Other sp.	5	18	57	63.0	0.561	0.912
Pelagic pollock	99	1,292	8,049	65.7	0.470	0.778
Rock sole	22	516	4,622	47.8	0.855	0.931
Turbot	7	105	92	91.8	0.022	0.174
Yellowfin sole	24	984	2,154	69.2	0.441	0.725
<i>GOA Longline</i>						
Pacific cod	13	291	1,017	71.7	0.331	0.784
<i>GOA Pot</i>						
Pacific cod	24	111	430	72.4	0.240	0.770
<i>GOA Trawl</i>						
Bottom pollock	37	68	91	61.7	0.604	0.835
Pacific cod	50	136	2,550	51.5	0.834	0.936
Dp wtr flatfish	3	14	75	57.7	0.680	0.800
Shall wtr flatfish	29	131	2,377	48.8	0.803	0.939
Rockfish	42	310	641	85.6	0.154	0.438
Flathead sole	8	40	206	56.6	0.655	0.927
Other sp.	4	21	108	66.0	0.481	0.880
Pelagic pollock	42	114	34	50.1	0.824	0.912
Sablefish	1	4	21	69.8	0.476	0.810
Arrowtooth flndr	9	289	832	70.2	0.407	0.775
Rex sole	7	294	799	69.7	0.389	0.820

Table 6. Distribution of halibut viability data by condition factor and target fishery during 2002.

Target	Raw Data				Extrapolated Data					
	Exc	Poor	Dead	DMR	Exc	Poor	Dead	DMR	SE	
<i>BSAI Trawl</i>										
Atka mackerel	8	7	149	0.851	286	251	5,401	0.852	0.0624	
Bottom pollock	475	391	3,085	0.781	15,168	14,140	103,902	0.783	0.0531	
Pacific cod	1,402	2,122	4,415	0.683	35,635	45,355	109,632	0.686	0.0342	
Other flatfish	163	185	459	0.678	2,186	2,421	13,469	0.768	0.0845	
Rockfish	12	7	37	0.706	678	213	2,369	0.731	0.1244	
Flathead sole	144	171	264	0.623	4,305	3,172	6,295	0.601	0.1183	
Other sp.	16	19	25	0.603	389	666	803	0.628	0.2407	
Pelagic pollock	20	42	9,641	0.897	34	69	19,368	0.898	0.0034	
Rock sole	270	283	3,562	0.830	14,683	18,410	212,847	0.832	0.0251	
Turbot	15	21	40	0.665	210	481	1,345	0.745	0.1338	
Yellowfin sole	212	278	1,437	0.772	7,418	3,833	38,553	0.769	0.0403	
<i>BSAI Pot</i>										
Pacific cod	609	20	16	0.056	1,876	66	40	0.053	0.0661	
Sablefish	140	16	12	0.167	264	24	15	0.129	0.4166	
<i>GOA Trawl</i>										
Bottom pollock	8	8	76	0.809	131	58	130	0.549	0.1809	
Pacific cod	870	801	976	0.564	17,358	20,097	23,794	0.587	0.0600	
Deepwater flatfish	50	27	16	0.422	549	387	289	0.476	0.0907	
Shallow water flatfish	646	814	1,273	0.630	13,424	22,740	37,117	0.663	0.0584	
Rockfish	148	113	263	0.627	4,354	1,542	7,815	0.638	0.1013	
Flathead sole	57	42	105	0.632	775	573	3,228	0.738	0.2083	
Other sp.	10	18	63	0.754	85	296	3,186	0.854	0.1338	
Pelagic pollock	-	-	104	0.900	-	-	105	0.900	0.0000	
Sablefish	-	19	3	0.598	-	237	55	0.616	.	
Arrowtooth flounder	91	182	365	0.700	1,524	3,282	10,905	0.759	0.1113	
Rex sole	192	190	308	0.609	3,909	3,206	4,398	0.565	0.1179	
<i>GOA Pot</i>										
Pacific cod	356	58	35	0.207	693	87	74	0.188	0.1023	

Target	Raw Data					Extrapolated Data					
	Minor	Mod	Severe	Dead	DMR	Minor	Mod	Severe	Dead	DMR	SE
<i>BSAI Longline</i>											
Pacific cod	13,596	1,762	416	339	0.107	260,402	30,141	5,996	4,644	0.095	0.0113
Rockfish	7	-	-	-	0.035	16	-	-	-	0.035	.
Other sp.	18	4	3	3	0.252	596	74	150	79	0.252	0.1111
Turbot	293	35	14	22	0.149	4,103	523	182	809	0.225	0.0949
<i>GOA Longline</i>											
Pacific cod	1,001	135	24	38	0.115	52,745	7,250	1,504	1,469	0.110	0.0195
Other sp.	13,596	1,762	416	339	0.107	260,402	30,141	5,996	4,644	0.095	0.0113

Table 7. Observer coverage and halibut viability/injury data collected from the 2002 Bering Sea/Aleutian CDQ fishery.

Target	# Vessels	# of Hauls	Raw Data					Ext. data					
			Exc./ Minor	Poor/ Mod.	Dead/ Sev.	Dead	DMR	Exc./ Minor	Poor/ Mod.	Dead/ Sev.	Dead	DMR	SE
<i>CDQ Longline</i>													
P cod	20	710	2,456	250	29	46	0.087	29,606	3,125	402	464	0.086	0.0122
O sp.	2	5	19	6	0	0	0.114	40	14	0	0	0.118	0.0000
Sable	1	66	13	7	2	1	0.231	81	43	16	4	0.228	0.0000
<i>CDQ Pot</i>													
Sable	4	196	205	25	64	--	0.303	300	27	74	--	0.253	0.2159
<i>CDQ Trawl</i>													
Atka m.	3	103	0	4	129	--	0.889	0	2	917	--	0.899	0.0007
B poll	5	51	1	11	37	--	0.807	71	420	331	--	0.661	0.1711
P poll	14	756	10	47	1,397	--	0.884	17	97	4,047	--	0.889	0.0073
Yfin sol	3	106	23	75	185	--	0.750	265	911	4,354	--	0.809	0.0623

Table 8. Summary of halibut discard mortality rates (DMRs) in the Bering Sea/Aleutian Islands (BSAI) groundfish fisheries during 1990-2002.

Gear/Target	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	1990-1999	1993-2002
														Mean	Mean
<i>BSAI Trawl</i>															
Atka mackerel	66	77	71	69	73	73	83	85	77	81	77	73	85	76	78
Bottom pollock	68	74	78	78	80	73	79	72	80	74	67	74	78	76	76
Pacific cod	68	64	69	67	64	71	70	67	66	69	69	69	69	68	68
Other Flatfish	80	75	76	69	61	68	67	71	78	63	76	81	77	71	71
Rockfish	65	67	69	69	75	68	72	71	56	81	89	85	73	69	74
Flathead sole	-	-	-	-	67	62	66	57	70	79	74	69	60	67	67
Pelagic pollock	85	82	85	85	80	79	83	87	86	87	88	89	90	84	85
Rock sole	64	79	78	76	76	73	74	77	79	81	75	77	83	76	77
Sablefish	46	66	-	26	20	-	-	-	-	90	60	-	-	50	49
Turbot	69	55	-	-	58	75	70	75	86	70	74	68	75	70	72
Yellowfin sole	83	88	83	80	81	77	76	80	82	78	77	74	77	81	78
<i>BSAI Pot</i>															
Pacific cod	12	4	12	4	10	10	7	4	13	9	13	6	5	9	8
<i>BSAI Longline</i>															
Pacific cod	19	23	21	17	15	14	12	11	11	12	12	12	10	12	11
Rockfish	17	55	-	6	23	-	20	4	52	-	12	10	4	25	16
Sablefish	14	32	14	13	38	-	-	-	-	-	-	-	-	22	-
Turbot	15	30	11	10	14	9	15	22	18	17	14	6	23	16	15
<i>CDQ Trawl</i>															
Atka mackerel	-	-	-	-	-	-	-	-	-	82	89	80	90	-	85
Bottom pollock	-	-	-	-	-	-	-	-	90	88	90	90	66	-	85
Flathead sole	-	-	-	-	-	-	-	-	-	-	83	90	-	-	87
Pelagic pollock	-	-	-	-	-	-	-	-	90	90	88	89	89	-	89
Rockfish	-	-	-	-	-	-	-	-	-	88	-	90	-	-	89
Yellowfin sole	-	-	-	-	-	-	-	-	-	83	-	-	81	-	82
<i>CDQ Longline</i>															
Pacific cod	-	-	-	-	-	-	-	-	10	10	13	11	9	-	11
Turbot	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4
<i>CDQ Pot</i>															
Pacific cod	-	-	-	-	-	-	-	-	-	-	7	2	-	-	5
Sablefish	-	-	-	-	-	-	-	-	-	-	38	46	25	-	36

Table 10. Recommended Pacific halibut discard mortality rates (DMRs) for calculating bycatch mortality in the 2004-2006 groundfish fisheries off Alaska.

Bering Sea/Aleutians			Gulf of Alaska		
Gear/Target	Used In 2001-2003	Recommendation for 2004-2006	Gear/Target	Used In 2001-2003	Recommendation for 2004-2006
<i>Trawl</i>			<i>Trawl</i>		
Atka mackerel	76	78	Atka mackerel	70	60
Bottom pollock	76	76	Bottom pollock	61	59
Pacific cod	68	68	Pacific cod	61	61
Other Flatfish	71	71	Deep wtr flats	60	57
Rockfish	69	74	Shallow wtr flats	69	68
Flathead sole	67	67	Rockfish	69	67
Pelagic pollock	84	85	Flathead sole	58	62
Rock sole	76	77	Pelagic pollock	72	75
Sablefish	50	49	Sablefish	66	62
Turbot	70	72	Arrowtooth fldr	62	69
Yellowfin sole	81	78	Rex sole	62	62
<i>Pot</i>			<i>Pot</i>		
Pacific cod	9	8	Pacific cod	14	17
<i>Longline</i>			<i>Longline</i>		
Pacific cod	12	11	Pacific cod	14	13
Rockfish	25	16	Rockfish	8	8
Turbot	16	15			
	Used in 2002	Recommendation for 2004			
<i>CDQ Trawl</i>					
Atka mackerel	80	85			
Bottom pollock	90	85			
Flathead sole	90	90			
Pelagic pollock	89	89			
Rockfish	90	90			
Yellowfin sole	81	82			
<i>CDQ Longline</i>					
Pacific cod	11	11			
Turbot	-	4			
<i>CDQ Pot</i>					
Pacific cod	2	2			
Sablefish	46	36			