Halibut discard mortality rates for the Alaska groundfish fisheries

Discussion draft, April 2016[1]

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1 Introduction

Since the mid-1990s, the North Pacific Fishery Management Council (Council) has provided recommendations on discard mortality rates (DMRs) to be used by the National Marine Fisheries Service (NMFS) for in-season management of trawl and fixed-gear groundfish fisheries that incidentally catch Pacific halibut in waters off Alaska. All halibut incidentally caught by these fisheries are categorized as prohibited species catch (PSC) and are required to be discarded. DMRs represent the proportion of those discarded halibut that are not expected to survive and are specified for each groundfish fishery in the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA). Application of DMRs by in-season managers to estimated halibut discarded weight provides estimates of total mortality by each fishery and when total mortality reaches the annually-specified PSC limit, the affected fisheries are closed.

Under current practices, specified DMRs are calculated from the average of annual DMR estimates within each fishery from the most recent ten-year reference period. Annual fishery-specific DMR estimates come from onboard fishery observer sampling of halibut bycatch which includes characterizing the injury condition or viability of halibut before they are returned to the water. Halibut sampled for viability are assessed and then categorized into a set number of viability rankings using standardized protocols, each of which corresponds to a mortality probability. The expansion of the mortality probabilities from sampled halibut to total bycatch determines the total discard mortality rate for each fishery. Once specified, DMRs are generally held constant for 3 year periods, a policy supported by observed low inter-annual variability in DMR estimates coupled with the advantage that stability in specified DMRs provides for industry planning.

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In December 2015, the Council adopted DMRs for only two years, the 2016 and 2017 fishing seasons, with the expectation that ongoing work to identify alternative methods for calculating DMRs by the interagency Halibut DMR Working Group (WG) could result in re-specification of those DMRs by the beginning of 2017. The need for alternative DMR calculation methods has its basis in the transfer of responsibility for calculating DMRs from International Pacific Halibut Commission (IPHC) staff to Council support staff, and also the need to improve on existing methods given current data availability and other considerations.

With the Council's recent initiation of a Halibut Management Framework that is intended to inform, support, and reflect Council decision-making on halibut issues, further transparency in analytical methods that affect halibut management is desired. The Framework directly addresses DMRs by identifying a need to 1) improve analytical methods for calculating rates, and 2) update the empirical basis for rates, pointing out that the current rates for the viabilities are defined based on studies that were, in some cases, conducted 45+ years ago. It is likely that fishery operations that affect halibut mortality have changed since then. As noted in the Framework, implications for adjusting DMRs have direct correspondence to our perception of the magnitude of total halibut mortality by the groundfish fisheries and therefore to the availability of halibut to the directed halibut fishery.

At its February 2016 meeting the Council's SSC reviewed the draft Framework and provided the following comments with regard to DMRs:

> *"The SSC notes that an interagency staff working group, in coordination with the groundfish Plan Teams, is developing a discussion paper/preliminary analysis for Council review in April 2016, with the potential for revisions to the existing DMRs for 2017. The SSC requests that the Council task the working group to determine the origins of the DMRs, the temporal changes, and justification of these changes.*
>
> *The SSC also recommends that the priority be expanded to include:*
>
> - *Efforts to assess discard mortality rates in situ, including evaluation of sample sizes, data collection and the use of advanced technology,*
> - *Work to evaluate methods to reduce discard mortality (e.g. excluders, deck-sorting),*
> - *Efforts to improve information about what is actually being discarded in all fisheries (size, sex, age, maturity, release mortality rates (e.g. sport fishery), etc)."*

During its preparation of this discussion paper, the WG was apprised of the SSC's concerns and has confirmed, through internal discussion, its intent to address each of them, to the extent possible, both here and in cooperative dialogue with the SSC in the future. Additionally, the WG notes that it is charged with a combination of both short and long term concerns and that the most pressing is for revision of DMRs in 2017, unless otherwise directed by the Council. Therefore, the primary focus of this discussion paper is on providing:

- A description of the current estimation methods and existing available data that can contribute to estimates of halibut DMRs for immediate use (Section 2)
- Shortcomings of the current process (Section 3)
- Analytical options given the available data (Section 4)
- Strengths and weaknesses of those options, including management concerns (Section 4)
- Suggestions for moving forward in the short term (Section 4 and Section 5)
- Discussion of longer term issues and the potential development of deliverables to address these issues (Section 6)

This paper overlaps with the SSC's concerns about data collection and amount of halibut data contributing to DMR calculations as well as responsiveness to discard mortality reduction efforts. In

Section 6, this paper touches briefly on potential directions future work might take with respect to other SSC bullets.

2 Current DMR estimation methods, data collection, and in-season application

2.1 Existing DMR Estimation Methods

The annual IPHC Reports of Assessment and Research Activities (RARAs) provide a description of DMR estimation methods, which have not changed significantly since the approach was established by Williams (1996). Central to this approach, each halibut sampled for viability is assigned a survival probability based on gear type and the observer's assessment of condition factor upon release (Table 1). The fleet-wide expansion of haul-level mortalities takes into account that the BSAI and GOA groundfish fisheries are comprised of a number of smaller target (single or mixed-species) fisheries conducted with different gear types, for which DMRs vary. The assignment of vessels to target fisheries is outcome-based, using the proportions of various species in a given vessel's sampled catch. In other words, catches at or above a threshold percentage for a given species, place that haul or trip into a given target fishery. CDQ and non-CDQ fishing is assessed separately. For CDQ vessels, target fishery is assigned on a haul by haul basis. For non-CDQ vessels, target fishery is based on sampled hauls that are summed over the reporting week on CPs and summed over the fishing trip on CVs. Vessel-specific DMRs for a given target fishery are determined based on the ratio of a vessel's total halibut mortalities to total vessel halibut catch. Hauls are not combined across vessels; rather individual vessels are treated as the sampling unit – vessel DMRs are what is expanded to the target fishery level (Williams 1997).

Table 1 Assumed gear/condition-specific mortality probabilities for halibut in calculating DMRs.

<table>
<tr><th rowspan="2">Gear</th><th colspan="4">Condition</th></tr>
<tr><th colspan="2">Excellent</th><th>Poor</th><th>Dead</th></tr>
<tr><td>Trawl[a]</td><td colspan="2">0.20</td><td>0.55</td><td>0.90</td></tr>
<tr><td>Pot[b]</td><td colspan="2">0.00</td><td>1.00</td><td>1.00</td></tr>
<tr><th></th><th>Minor</th><th>Moderate</th><th>Serious</th><th>Dead</th></tr>
<tr><td>Longline[c]</td><td>0.035</td><td>0.363</td><td>0.662</td><td>1.000</td></tr>
</table>

From [a] Clark et al. (1992), [b] Williams (1996), and [c] Kaimmer and Trumble (1998)

Overall target fishery DMRs and standard errors are calculated as the mean of vessel-specific DMRs within those target fisheries, weighted in the averaging by each vessel's proportional contribution to total halibut catch. This process can be summarized as consisting of four steps:

1. Calculate halibut mortalities and total halibut catch for each qualifying observed haul for individual vessels.
2. Assign a target fishery, split out by gear type, FMP region, and CDQ/non-CDQ.
   a. For CDQ, a target is assigned to each haul.
   b. For non-CDQ, all hauls within a reporting week (CPs) or fishing trip (CVs) are aggregated to produce a weekly trip target for an individual vessel
3. Calculate a vessel-specific DMR for each target fishery by aggregating halibut mortalities and catches (within each vessel, post-stratified by target fishery)
4. Calculate an overall target fishery DMR by averaging vessel DMRs (weighted by their contribution to total halibut catch)

Table 2 and Table 3 identify the DMRs currently in regulation for the BSAI and GOA groundfish fisheries in 2016 and 2017.

Table 2 2016 and 2017 Pacific Halibut Discard Mortality Rates for the BSAI, as established in the annual harvest specifications

Non-CDQ				CDQ		
Gear	**Fishery**	**DMR (%)**		**Gear**	**Fishery**	**DMR (%)**
Trawl	Alaska plaice	66		Trawl		
	Arrowtooth flounder	84				
	Atka mackerel	82			Atka mackerel	82
	Flathead sole	72			Flathead sole	79
	Greenland turbot	82			Greenland turbot	89
	Non-pelagic pollock	84			Non-pelagic pollock	86
	Pelagic pollock	81			Pelagic pollock	90
	Other flatfish	88				
	Other species	63				
	Pacific cod	66			Pacific cod	87
	Rockfish	66			Rockfish	70
	Rock sole	86			Rock sole	86
	Sablefish	66				
	Yellowfin sole	84			Yellowfin sole	85
Hook and line	Greenland turbot	11		Hook and line	Greenland turbot	10
	Other species	9				
	Pacific cod	9			Pacific cod	10
	Rockfish	9				
Pot	Other species	9		Pot		
	Pacific cod	9			Pacific cod	1
					Sablefish	41

Table 3 2016 and 2017 Pacific Halibut Discard Mortality Rates for the GOA, as established in the annual harvest specifications

Gear	Fishery	DMR (%)		Gear	Fishery	DMR (%)
Trawl	Arrowtooth flounder	76		Hook and line	Other fisheries[1]	10
	Deepwater flatfish	62			Pacific cod	10
	Flathead sole	67			Rockfish	10
	Non-pelagic pollock	58				
	Other fisheries[1]	62		Pot	Other fisheries[1]	15
	Pacific cod	62			Pacific cod	15
	Pelagic pollock	65				
	Rex sole	72				
	Rockfish	65				
	Sablefish	59				
	Shallow-water flatfish	66				

[1]"Other fisheries" includes all gear types for skates, sculpins, squids, octopuses, and hook-and-line sablefish.

2.2 Observer Sampling Protocol

The methods used to collect halibut viability data and assess halibut injury conditions have not been altered since they were first implemented at the request of the IPHC. Observers deployed on trawl and pot gear vessels determine the viability of discarded halibut using gear-specific dichotomous keys developed by IPHC to distinguish the discard condition of halibut. Similarly, observers deployed on longline vessels determine injury assessments only from discarded halibut using the dichotomous key developed by the IPHC to categorize severity of hooking injuries. All halibut viability and injury assessments are conducted on randomly selected fish that were handled by the crew in a fashion intended to reflect typical crew handling processes. In this manner, injuries and viability of halibut assessed should thus reflect the condition of released halibut in the fishery.

At-Sea Observer Sample Methods

Observers select hauls to be sampled for species composition using a constrained randomization scheme that allows for periods for non-work activities (e.g. sleep) and non-sampling activities (e.g. paperwork, data entry) while supporting a random selection of hauls to be sampled. On selected hauls, the number and weight of fish (by species) are collected from one or more randomly selected sample units of the catch for that haul. From these data, the total weight of each species, including halibut, is estimated for the haul.

A systematic random selection of these hauls is made for the collection of biological data (e.g., length data, otoliths, etc.) according to a prioritized list (Figures 13-17 through 13-19 of the 2015 Observer Sampling Manual). Biological data are randomly collected from these selected hauls, for non-halibut species this collection is generally from within species composition samples or subsamples.

Prior to January of 2016, observers were required to assess approximately 20 halibut per day for condition: viability of the halibut caught on trawl and pot vessels and severity of hooking injuries incurred by halibut caught on longline gear. On some of the hauls randomly selected to be sampled for species composition halibut were randomly chosen by the observer to be assessed. Additional sampled hauls were selected as necessary to achieve the target of 20 assessed halibut per day. These protocols allowed observers to opportunistically select on which sampled hauls their halibut condition data (viability or injury assessment and fork length) collections would take place.

To integrate the halibut condition data collections into the hierarchical sampling design used by the observer program, halibut condition sampling recommendations are now included in the prioritized list of biological data collections (Figures 13-17 through 13-19 of the 2016 Observer Sampling Manual). This randomizes the hauls selected for halibut condition sampling in a fashion consistent with other species.

In 2016, observers plan their sampling and define their sample units such that approximately 10 halibut from every nth haul are assessed, where n is specified in the species prioritized list, and given that sufficient halibut are encountered by the observer in the nth haul. The frequency of selected hauls will be set so that we can expect condition data from approximately 20 halibut per day.

This change in 2016 is now consistent with other biological data collections such as length measurements and otolith collections. Preliminary rates are specified; however as necessary these rates will be adjusted as needed to meet the data collection goal of approximately 20 halibut condition assessments per day, in the event that 20 halibut are available for assessment by the observer. Consistent with previous years and at the IPHC request, lengths are obtained for all halibut that are assessed (viability of injury). Halibut lengths are also collected when assessments cannot be made, however, assessments without length measurements cannot be used by the IPHC.

On vessels using trawl or pot gear, observers can obtain halibut (randomly) from the species composition samples, if enough halibut are available and handling of those halibut is representative of crew handling and condition assessments can be obtained. Alternatively, if the observer expects that the species composition samples will not contain enough halibut or if crew handling is such that halibut in species composition samples are not representative of normal handling activities, a separate secondary sampling design is used to select halibut for viability assessments. Note that halibut condition data may be collected from one or more samples collected at the haul level.

Methods for selecting halibut to be assessed on vessels fishing longline gear are similar to those used in trawl or pot vessels; sample frames are established and units are randomly selected. Halibut for injury assessments will be obtained from those randomly selected samples (analogous to samples used to collect fish weights).

Shoreside Observer Sample Methods

Prior to enactment of the Amendment 91 regulations in 2011, observers would monitor the offload of catcher vessel deliveries for prohibited species (king and Tanner crab, salmon, and halibut), recording the number and weight of each species in the delivery. In addition, length data were collected for the dominant species and any prohibited species and halibut condition was assessed. These activities were discontinued at BSAI plants to allow for complete enumeration of salmon in the BSAI pollock trawl fishery (AFA deliveries). As a result, halibut condition assessments are no longer collected for the portion of the halibut catch that is landed at the processing plant and later discarded at sea. These halibut were generally classified as dead; however, any halibut sorted from the catch and discarded at-sea may have been classified as not-dead (either excellent or poor condition) depending on crew handling activities.

Changes impacting Observer Sampling Methods

There have been several changes to the sampling methods used by observers; however, the sampling goals have remained consistent for these data collections.

In 2008, the observer database was redesigned to allow for multiple samples to be recorded individually. Before this redesign, observers often collected multiple samples of catch, however, they were recorded in the data as a single sample (total of all samples taken). With the redesign of the database, emphasis was also placed on randomizing sample selection and collecting multiple samples. These changes should not have impacted the number of halibut conditions collected. Differences in the number of halibut available to the observer, due to either changes in catch levels or changes in vessel operations, may have impacted the observer's ability to obtain 20 halibut per day to be assessed.

In 2011, Amendment 91 regulations were implemented and plant observer's duties were redirected to focus more on salmon bycatch in BS pollock fisheries (AFA). At this time, plant observers no longer monitored deliveries for halibut and all halibut-related data collections occurred at sea. This would have decreased the total number of halibut length and viability assessments collected for that fishery, eliminating collections from the landed catch (halibut not discarded at sea).

In 2013, the Observer Program was restructured into several sampling strata resulting in changes to at-sea coverage rates; decreased coverage rates on non-catch share catcher vessels, particularly those over 125ft, and adding coverage in halibut IFQ fisheries. This would have decreased the number of days that observers are deployed to collect data on partial coverage catcher vessels.

Impediments to Obtaining Data

The ability of observers to collect halibut length and condition data is affected by numerous factors including; presence of halibut and vessel operations which potentially limit or prevent data collections. All halibut injury and viability assessments are conducted on randomly selected fish that were handled by the crew in a fashion that reflects typical crew handling processes. In this manner, injuries and viability of halibut assessed will reflect the condition of released halibut in the fishery.

Difficult data collection situations are most prevalent on catcher processors and motherships where the point of discard is far removed from the observer's sampling station. The assessed condition of the halibut before it reaches the point of discard may not accurately reflect the condition of the halibut as it leaves the vessel processing plant, so condition data might not be acceptable during the debriefing process.

On longline vessels fishing in either IFQ or non-IFQ fisheries, observers ask the crew to release randomly selected halibut, that would have been discarded, inboard (as opposed to shaking PSC bycatch) so that they observer can assess the injury to the halibut. Halibut that are released using typical crew handling procedures are assessed for injuries; if the halibut is released using atypical methods the data are not collected for that haul. Some release methods are difficult to replicate inboard and observers cannot always collect accurate injury data. On longline vessels, an inescapable feature of obtaining samples of fish which would otherwise be discarded is that the crew handling the fish are aware of which fish will be sampled. This provides the potential for biased observations.

2.3 In-season Application of DMRs in Managing the Groundfish Fisheries

Catch Accounting System

The observer data and landings/production data are transmitted electronically many times a day to the Alaska Region. The Catch Accounting System (CAS) runs every night using all the available data.

Estimation of halibut mortality

Estimation of halibut mortality is based on two data sources: estimates of total discarded halibut catch from the CAS (no DMRs applied) and the published DMRs. A lookup table in CAS maps the DMRs to the estimated discarded catch (see next section) based on an applicable combination of year, FMP area, target fishery code, gear, and management program code. The DMR rates are applied to the estimated halibut discarded catch corresponding to the previously described attributes to obtain an estimate of halibut mortality. Since CAS processes data on a transaction basis (e.g., each landing or observer record has an estimated amount of PSC), PSC mortality estimates (i.e., estimated dead halibut) are assigned to the appropriate in-season management account in CAS, which allows managers to monitor mortality throughout the season. For example, the GOA Halibut Mortality report that is posted on the Alaska Region website is an output of this process; in this report, halibut mortality is specified by fishery, season, and gear[2].

Estimation of total halibut discards

Estimates of total discarded halibut catch (no DMR applied) for fisheries with PSC limits are estimated using a combination of industry data and at-sea observer data. The fisheries are defined largely by area, gear, vessel type (CV or CP), and the predominant species retained during the trip (i.e., trip target). For vessels in the partial and no selection stratum, an observer-based halibut discard rate is applied to the total groundfish catch (the sum of landing reports of total groundfish catch and the estimated at-sea groundfish discard calculated). The post-stratification process used in CAS always provides in-season estimates specific to FMP area, gear, vessel type, and trip target. In addition, estimates are made for varying levels of time (using moving averages) and spatial aggregations depending on available observer information, but these levels always include a FMP area, gear, vessel type, trip target, and follow the sampling strata specified in the Annual Deployment Plans. For vessels in the full coverage stratum (or vessels volunteering for full coverage), discard estimates of halibut are calculated using that vessel's observer data (but not viability data) and are specific to a reporting area and within the week that fishing occurred (for CPs only). The details of this process are extensive; Cahalan et al. (2014) provides detail on these processes.

An import component of estimation is determining a trip target in CAS. These targets are calculated in CAS using retained catch and involve a three-step process:

1) If 95% or more of the retained catch is pollock, then a pelagic pollock target is assigned;
2) If the sum of all flatfish is greater than the amount of any other species, then a flatfish species is assigned as the trip target. If the catch occurred in the BSAI, a subroutine determines the trip target within all flatfish species. A yellowfin sole target is assigned when yellowfin sole

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[2] https://alaskafisheries.noaa.gov/sites/default/files/reports/car150_goa_halibut_mortality2016.pdf

comprises at least 70% of the retained flatfish amount. If this is not the case, then the trip target is assigned to one of three target categories based on the predominance of retained catch among rock sole, flathead sole, and other flatfish species (primarily starry flounder, rex sole, longhead dab, Dover sole, and butter sole).

3) If neither pollock nor flatfish is the trip target, then the groundfish species with the highest proportion of the retained catch is assigned as the target (inclusive of bottom pollock target).

Table 4 shows the targets used to define fisheries. Targets are calculated for each landing made by a CV (including deliveries to a mothership), and by each week for CPs (based on observer information). Targets are also specific to a management area such that CVs delivering to a mothership and all CPs have targets specific to NMFS reporting areas or special management area; CVs delivering to shoreside processors (including tenders) have targets specific to an FMP area.

Table 4 Trip target definitions used in the Catch Accounting System to estimate halibut discard mortality.

Trip Target	FMP	Trip Target	FMP
Atka mackerel	GOA/BSAI	Halibut	GOA/BSAI
Pollock (bottom)	GOA/BSAI	Rockfish	GOA/BSAI
Pollock (pelagic)	GOA/BSAI	Flathead sole	GOA/BSAI
Pacific cod	GOA/BSAI	Kamchatka flounder	BSAI
Deep water flatfish	GOA	Rock sole	BSAI
Alaska plaice	BSAI	Sablefish	GOA/BSAI
Other flatfish	BSAI	Greenland turbot	BSAI
Shallow water flatfish	GOA	Arrowtooth flounder	GOA/BSAI
Rex sole	GOA	Other Species	GOA/BSAI
Yellowfin sole	BSAI		

Note that target groups (FMP + Trip Targets) follow the species groupings used in Table 1 of the Annual Harvest Specification (NMFS 2015).

BSAI Halibut PSC Limits

The regulations set forth the BSAI halibut PSC limits and the apportionment of the limits is published in the annual harvest specifications.

Regulations (Section 679.21) authorize NMFS, after consulting with the Council, to establish seasonal apportionments of PSC amounts for the non-trawl, BSAI trawl limited access, and Amendment 80 limited access sectors in order to maximize the ability of the fleet to harvest the available groundfish TAC and to minimize bycatch. The factors to be considered are:

(1) seasonal distribution of prohibited species;
(2) seasonal distribution of target groundfish species;
(3) PSC bycatch needs on a seasonal basis relevant to prohibited species biomass;
(4) expected variations in bycatch rates throughout the year;
(5) expected start of fishing effort; and
(6) economic effects of seasonal PSC apportionments on industry sectors.

The Council recommends and NMFS approves the seasonal PSC apportionments to maximize harvest among gear types, fisheries, and seasons while minimizing bycatch of PSC based on the above criteria. The regulations specify that any underages or overages of a seasonal apportionment of a PSC limit will be deducted from or added to the next respective seasonal apportionment within the fishing year.

Apportionments of PSC limits to fishery categories

Hook-and-line gear - The regulations authorize apportioning the non-trawl halibut PSC limit into PSC bycatch allowances among six fishery categories. Three categories are not apportioned halibut PSC limits: C, D, and E below.

(A) Pacific cod hook-and-line catcher vessel fishery.
(B) Pacific cod hook-and-line catcher/processor fishery.
(C) Sablefish hook-and-line fishery.
(D) Groundfish jig gear fishery.
(E) Groundfish pot gear fishery.
(F) Other non-trawl fisheries

BSAI trawl limited access and Amendment 80 limited access - The regulations require NMFS to apportion each trawl PSC limit not assigned to Amendment 80 cooperatives into PSC bycatch allowances for seven specified fishery categories.

(A) Midwater pollock fishery.
(B) Flatfish fishery.
    (1) Yellowfin sole fishery. (2) Rock sole/flathead sole/“other flatfish” fishery.
(C) Greenland turbot/arrowtooth flounder/Kamchatka flounder/sablefish fishery.
(D) Rockfish fishery.
(E) Pacific cod fishery.
(F) Pollock/Atka mackerel/“other species.”

Amendment 80 cooperative - PSC cooperative quota assigned to Amendment 80 cooperatives is not allocated to specific fishery categories. Since 2010, there are no vessels in the Amendment 80 limited access sector. The next years PSC allocations between Amendment 80 cooperatives and the Amendment 80 limited access sector will not be known until eligible participants apply for participation in the program by November 1 each year.

Reallocation from BSAI trawl limited access sector to Amendment 80 cooperatives.

The only BSAI in-season reallocation allowed by regulation, without consultation with the Council, is from the BSAI trawl limited access sector to the Amendment 80 cooperatives.
If, during a fishing year, the Regional Administrator determines that a reallocation of a portion of the halibut PSC assigned to the BSAI trawl limited access sector to Amendment 80 cooperatives is appropriate, the Regional Administrator will issue a revised CQ permit to reallocate that amount of halibut PSC to each Amendment 80 cooperative according to the following procedure: Multiply the amount of the halibut PSC limit to be reallocated by 95 percent (0.95). This yields the maximum amount of halibut PSC limit available for allocation to Amendment 80 cooperatives.

GOA Halibut PSC Limits

Regulations establish the annual halibut PSC limit apportionments to trawl and hook-and-line gear, and authorize the establishment of apportionments for pot gear. The apportionment of the limits are published in the annual harvest specifications

The regulations authorize NMFS to seasonally apportion the halibut PSC limits after consultation with the Council. The FMP and regulations require the Council and NMFS to consider the following information in seasonally apportioning halibut PSC limits:

(1) Seasonal distribution of halibut;
(2) seasonal distribution of target groundfish species relative to halibut distribution;

(3) expected halibut bycatch needs on a seasonal basis relative to changes in halibut biomass and expected catch of target groundfish species;
(4) expected bycatch rates on a seasonal basis;
(5) expected changes in directed groundfish fishing seasons;
(6) expected actual start of fishing effort; and
(7) economic effects of establishing seasonal halibut allocations on segments of the target groundfish industry.

The Council considers information from the Stock Assessment and Fisheries Evaluation report, NMFS catch data, State of Alaska catch data, IPHC stock assessment and mortality data, and public testimony when apportioning the halibut PSC limits. The regulations specify that any underages or overages of a seasonal apportionment of a PSC limit will be deducted from or added to the next respective seasonal apportionment within the fishing year. Each halibut PSC limit specified under the regulations also may be apportioned among the GOA regulatory areas and districts.

Apportionments of PSC limits to trawl fishery categories

Trawl gear - The regulations authorizes further apportionment of the trawl halibut PSC limit to trawl fishery categories. The annual apportionments are based on each category's proportional share of the anticipated halibut bycatch mortality during the fishing year and optimization of the total amount of groundfish harvest under the halibut PSC limit. The fishery categories for the trawl halibut PSC limits are

(1) a deep-water species fishery, composed of sablefish, rockfish, deep-water flatfish, rex sole, and arrowtooth flounder; and
(2) a shallow-water species fishery, composed of pollock, Pacific cod, shallow-water flatfish, flathead sole, Atka mackerel, skates, and ''other species'' (sculpins, sharks, squids, and octopuses.

Table 28d to 50 CFR part 679 specifies the amount of the trawl halibut PSC limit that is assigned to the CV and C/ P sectors that are participating in the Central GOA Rockfish Program. This includes 117 mt of halibut PSC limit to the CV sector and 74 mt of halibut PSC limit to the C/P sector. These amounts are allocated from the trawl deep-water species fishery's halibut PSC third seasonal apportionment.

Reapportionment of GOA trawl PSC limits.

The regulations limit the amount of the halibut PSC limit allocated to Rockfish Program participants that could be reapportioned to the general GOA trawl fisheries. An amount not greater than 55 percent of the halibut PSC that had been allocated as Cooperative Quota and that has not been used by a rockfish cooperative will be added to the last seasonal apportionment for trawl gear during the current fishing year: (1) After November 15; or (2) After the effective date of a termination of fishing declaration according to the provisions set out in § 679.4(n)(2), whichever occurs first. The remainder of the unused Rockfish Program halibut PSC limit is unavailable for use by vessels directed fishing with trawl gear for the remainder of the fishing year.

Combined management of trawl halibut PSC limits from May 15 through June 30.

NMFS will combine management of available trawl halibut PSC limits in the second season deep-water and shallow-water species fishery categories for use in either fishery from May 15 through June 30 during the current fishery year. Halibut PSC sideboard limits for the Amendment 80 and AFA sectors will continue to be defined as deep-water and shallow-water species fisheries from May 15 through June 30. NMFS will reapportion the halibut PSC limit between the deep-water and shallow-water species fisheries after June 30 to account for actual halibut PSC use by each fishery category during May 15 through June

30. The Regional Administrator will issue a Federal Register notice to reapportion the amounts of trawl halibut PSC to each species fishery category.

Apportionments of PSC limits to hook-and-line fishery categories

Hook-and-line gear – The regulations authorize further apportionment of the hook-and-line halibut PSC limit to fishery categories. The demersal shelf rockfish in Southeast Outside District is apportioned 9 mt.

The regulations require that the "other hook-and-line fishery" halibut PSC limit apportionment to vessels using hook-and-line gear must be apportioned between CVs and C/Ps in accordance with regulations and in conjunction with the harvest specifications. A comprehensive description and example of the calculations necessary to apportion the "other hook-and-line fishery" halibut PSC limit between the hook-and-line CV and C/P sectors were included in the proposed rule to implement Amendment 83 (76 FR 44700, July 26, 2011) and are not repeated here. The hook-and-line halibut PSC limit is apportioned between the CV and C/P sectors in proportion to the total Western and Central GOA Pacific cod allocations, which vary annually based on the proportion of the Pacific cod biomass. Pacific cod is apportioned among these two management areas based on the percentage of overall biomass per area, as calculated in the Pacific cod stock assessment report. Updated information in the final stock assessment report describes this distributional change, which is based on allocating ABC among regulatory areas on the basis of the three most recent stock surveys. Therefore, the calculations made in accordance with the regulations incorporate the most recent change in GOA Pacific cod distribution with respect to establishing the annual halibut PSC limits for the CV and C/P hook-and-line sectors. Currently, the annual halibut PSC limits are divided into three seasonal apportionments, using seasonal percentages of 86 percent, 2 percent, and 12 percent.

Reapportionment of GOA hook-and-line PSC limits

No later than November 1 of each year, NMFS will calculate the projected unused amount of halibut PSC limit by either of the hook-and-line sectors for the remainder of the year. The projected unused amount of halibut PSC limit is made available to the other hook-and-line sector for the remainder of that fishing year if NMFS determines that an additional amount of halibut PSC is necessary for that sector to continue its directed fishing operations.

3 Shortcomings of the Current Process

This discussion paper was initiated in order to respond to some specific issues with the current DMR calculation methodology which were identified while preparing for the most recent harvest specifications process:

- *Replication:* Although methods are fairly clearly described in IPHC reports and above, it is important that the methodology used to calculate DMRs is transparent and replicable. Expansion to target fishery DMR is a multi-step process with need for clear descriptions of assumptions at each step.
- *Definition of Target Fishery:* There is a currently a mismatch between how a target fishery is identified in order to calculate DMRs (based on haul-by-haul observer data), and how a target fishery is identified in order to apply the resulting DMR (based on the "trip target" identified in the catch accounting system, assigned collectively to all catch associated with a given landing (catcher vessels) or all catch in a particular reporting area during a fishing week (catcher processors)).
- *Weighting:* There is no clear method for determining a minimum acceptable number of halibut conditions on which to base the DMR estimate. In some cases, it may not be appropriate to

weight the estimated DMR by the extrapolated number of halibut in a haul or target if the DMR is based on only a few observations of halibut discard condition.

In evaluating how to revise and improve the DMR calculation methodology, the Working Group has identified various additional shortcomings to be addressed. These are summarized in the following list, and then described in more detail below.

1. *Reduced number of halibut condition assessments:* There has been a substantial reduction in the number of halibut viability and injury assessments collected by observers for trawl-caught halibut (Table 5). Starting in about 2012, the number of qualifying hauls and vessels that form the basis for the expansion exercise under current methods is substantially reduced, and a more general grouping of fleet components may be more appropriate.
2. *DMR aggregation methods:*
    a. *Target fisheries:* The current approach of using species composition aggregated across a trip target to apply DMRs may be problematic if it does not reflect behavior of individual target fisheries and the halibut mortality incurred by those fisheries.
    b. *CP and CV Vessels:* Although differences in halibut DMRs between CP and CV vessels are likely, these vessel types are not differentiated under current methods. Vessel operations, and specifically handling of PSC catch varies greatly between these two vessel types and hence, the condition of discarded halibut can be expected to be different. Samples sizes appear to be inadequate to allow separation at present.
    c. *CDQ/non-CDQ vessels:* The DMR calculation methods are different for these two sectors, and the question is whether the different DMRs are based on differences in vessels operations, or simply a byproduct of the different calculation methods.
3. *Length of reference timeframe:* Improvement in halibut viability for some fleet components appears to have occurred and is likely tied to changes in management structure, such as fishery catch share programs. The continued use of ten-year averaging, which would have used DMRs for the basis years 2005-2014 to establish the 2016-2018 DMRs[3], may not be appropriate under those conditions.

1) <u>Reduced number of halibut condition assessments</u>

Table 5, Table 8, and Table 9 illustrate an overall decline in halibut PSC and associated number of halibut viabilities and injuries recorded by observers. Factors which could result in a decreased number of halibut conditions being collected include changes in deployment rates for portions of the fleet, changes to factory configurations that limit access to the point of discard, and increased recognition of factory issues that impact whether the assessed halibut are representative of those being discarded.

The tables show the total amount of halibut PSC and the number of halibut in the BSAI and GOA for which a condition assessment was recorded by the observer. A different table is provided for each gear type. The observer only collects halibut condition assessments on a subset of the total halibut encountered in a day (20 halibut per day through 2015, as described in Section 2.2), and the tables identify the number of viability assessments (total Alaska) as a proportion of all halibut for which a length was collected. The next columns identify the number of viabilities as a proportion of the total estimated number of halibut on observed hauls, in this case split out by management area. Finally, for perspective, the last two columns

[3] In December 2015, the Council chose to set DMRs for a single specifications cycle only, in order to allow time for a more thorough assessment of the DMR calculation methodology.

identify the total halibut PSC estimate from the Catch Accounting System for the BSAI and GOA groundfish fisheries, where PSC is reported in total tons without application of a mortality rate.

Table 5 shows that the number of viabilities being taken for halibut in the trawl fisheries has gone down significantly since 2005. The decrease in the number of sampled halibut since 2005 (approximately a 42% reduction) tracks the decrease in the total extrapolated estimate of halibut PSC intercepted in the groundfish fisheries (a 50% PSC reduction in the BSAI and a 44% reduction in the GOA). The number of viabilities collected, however, has decreased considerably more – an 86% reduction in the BSAI, and a 91% reduction in the GOA. Section 2.2 above identifies some potential causes for these reductions: the implementation of BSAI Amendment 91 in 2011 resulted in fewer halibut assessments at shoreside plants for BSAI catcher vessels; the implementation of the restructured observer program in 2013 removed a source of bias associated with monitoring, but also reduced absolute levels of observer coverage especially for large catcher vessels operating in the GOA. In addition, vessel operations and factory configurations have changed since 2005, potentially impacting access to halibut being discarded.

Table 5 Number of halibut viabilities taken on BSAI and GOA *trawl* vessels, as a proportion of all halibut for which a length was collected, and of all estimated halibut on the sampled haul; and total halibut PSC in the BSAI and GOA (without application of a mortality rate)

Year	Number of viabilities			Viabilities as a proportion of all halibut for which a length was collected (total Alaska)	Viabilities as a proportion of total estimated number of halibut on sampled hauls		Extrapolated estimate of total halibut PSC in fishery (total mt, not mortality)	
	BSAI	GOA	Total		BSAI	GOA	BSAI	GOA
2005	38,058	5,021	43,079	83.4%	2.54%	2.27%	4,908	3,223
2006	34,727	3,414	38,142	86.5%	2.47%	1.86%	4,789	3,004
2007	51,587	5,871	57,625	85.8%	2.53%	2.34%	4,644	2,916
2008	37,800	4,290	42,090	66.6%	1.46%	1.39%	3,646	2,937
2009	31,476	3,342	34,818	58.0%	1.29%	1.09%	3,700	2,722
2010	21,390	3,474	24,864	50.0%	1.23%	1.29%	3,565	2,415
2011	17,218	2,767	19,985	45.8%	1.13%	0.93%	3,287	2,773
2012	13,689	3,852	17,541	44.4%	0.81%	1.25%	3,962	2,548
2013	12,254	1,162	13,416	38.4%	0.90%	0.51%	3,836	1,845
2014	9,769	772	10,541	32.0%	0.68%	0.33%	3,741	2,021
2015	5,242	470	5,712	19.2%	0.45%	0.20%	2,471	2,118

Source: NMFS AFSC Observer Program, data compiled by AKFIN

Table 6 provides a different look at halibut viabilities in the trawl fisheries by reporting similar information with respect to the number of hauls, rather than simply the number of viabilities. The table provides a different look at halibut viabilities in the trawl fisheries by reporting similar information with respect to the number of hauls, rather than simply the number of viabilities. The table provides the number of hauls from which a halibut viability was collected, the number of hauls from which a halibut length was collected, and the total number of observed hauls. Observer coverage in the BSAI increased in 2008, with the implementation of Amendment 80, as can be seen in the increase in total number of hauls sampled. The number of hauls from which a halibut length was collected has been fairly consistent, but the number of hauls with recorded viabilities has declined, both in absolute terms and as a proportion of total observed hauls.

Table 6 **Number of hauls with halibut viabilities taken on BSAI and GOA *trawl* vessels; the number of hauls for which a halibut length was collected; and the total number of observed hauls.**

YEAR	BSAI				GOA			
	Number of hauls with recorded halibut viabilities	Number of hauls with from which a halibut length was collected	Total number of hauls sampled	Halibut viabilities as a proportion of total hauls sampled	Number of hauls with recorded halibut viabilities	Number of hauls with from which a halibut length was collected	Total number of hauls sampled	Halibut viabilities as a proportion of total hauls sampled
2005	6,565	7,582	24,701	26.58%	777	888	1,906	40.77%
2006	6,965	7,814	24,377	28.57%	626	718	1,925	32.52%
2007	8,376	9,426	25,079	33.40%	829	1,175	2,736	30.30%
2008	6,610	9,822	27,360	24.16%	750	1,275	2,862	26.21%
2009	4,542	8,725	22,464	20.22%	594	1,029	2,753	21.58%
2010	3,821	8,463	22,747	16.80%	646	1,256	2,800	23.07%
2011	3,680	9,049	30,526	12.06%	482	1,117	2,812	17.14%
2012	2,367	7,799	28,795	8.22%	584	1,293	3,611	16.17%
2013	2,991	8,798	29,798	10.04%	330	1,235	2,975	11.09%
2014	2,550	9,343	30,154	8.46%	195	1,227	3,526	5.53%
2015	1,693	8,082	29,373	5.76%	97	1,112	3,828	2.53%

Another potential concern is that the halibut condition assessments that are being taken are not evenly distributed among fishery participants. This may be a function of the location of observer's sampling station relative to the point of halibut discard on some vessels; if the halibut condition cannot be assessed at the point of discard, it may not accurately reflect the condition of the halibut as it leaves the vessel, as described in Section 2.2. Table 7 identifies viabilities from BSAI trawl catcher processors during the last three years. The first 17 vessels are Amendment 80 vessels, which prosecute the most varied array of target fisheries in the BSAI. In 2013 and 2014, there were three to four vessels in each year on which no halibut were assessed for viability, although many halibut lengths were collected. In fact, halibut viabilities were concentrated primarily on four to six vessels during those years, largely dictating the DMR for many of the BSAI target fisheries.

Note that in 2015, there appears to be highly truncated viability assessment across Amendment 80 vessels (Table 7). One reason for this may be that all halibut sampling records from vessels participating in the halibut deck sorting EFP were not transferred to NMFS and the NORPAC observer database.

Table 7 **Number of halibut viability assessments and number of halibut measured from individual BSAI trawl catcher processor vessels in 2015, in non-pollock targets (CDQ and non-CDQ combined)**

Vessel	Sector	2013		2014		2015	
		Number of Viabilities	Number of Measurements	Number of Viabilities	Number of Measurements	Number of Viabilities	Number of Measurements
1	AM80	832	994	154	1,214		1,387
2	AM80	14	929	915	1,682		838
3	AM80	151	633	466	803		1,179
4	AM80	525	892	6	864	1	406
5	AM80	5	1,351	1	944	269	1,051
6	AM80	231	757		889		788
7	AM80	1	396	124	602		582
8	AM80	119	795	2	254		610
9	AM80	104	776	8	841	1	1,046
10	AM80	2	1,081	21	1,569		1,898
11	AM80	2	541	6	873		793
12	AM80	1	349	6	820		374
13	AM80	2	582		732	2	437
14	AM80		444	2	753	2	457
15	AM80		1,270		823	3	828
16	AM80		1,375	2	1,101		959
17	AM80	2	834		1,030		1,076
18	AFA	383	558	308	991		412
19	AFA	506	526	2	479		196
20	AFA	40	40	33	35	91	91
21	AFA	1	13	52	53	27	27
22	AFA	14	14	37	37		44
23	AFA		16		20	48	48
24	AFA		757	1	680	37	650
25	AFA	12	14	1	56		
26	AFA				35		
27	AFA				24		
28	AFA		15		43		28
TOTAL		2,947	15,952	2,147	18,247	481	16,205

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

For fixed gear vessels, Table 8 and Table 9 illustrate more consistency overall in the number of halibut condition assessments collected, although there is inter-annual variability; also, a much higher proportion of sampled fish are being assessed for injury or release condition. For longline vessels, there is more variability in GOA viability assessment than in the BSAI.

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Table 8 **Number of halibut injury assessments taken on BSAI and GOA *longline* vessels, as a proportion of all halibut for which a length was collected, and of all estimated halibut on the sampled haul; and total halibut PSC in the BSAI and GOA (without application of a mortality rate)**

Year	Number of injury assessments			Assessments as a proportion of all halibut for which a length was collected (total Alaska)	Assessments as a proportion of total estimated number of halibut on sampled hauls		Estimate of total halibut PSC in fishery (total mt, not mortality)	
	BSAI	GOA	Total		BSAI	GOA	BSAI	GOA
2005	13,574	651	14,225	84.7%	1.78%	0.54%	5,908	3,802
2006	12,871	2,351	15,222	98.0%	2.47%	1.02%	4,475	4,306
2007	11,234	1,677	12,911	94.1%	2.34%	1.06%	4,812	5,594
2008	10,256	1,130	11,386	94.4%	1.60%	1.12%	6,141	4,737
2009	11,394	1,457	12,851	96.0%	1.61%	0.87%	6,100	3,795
2010	9,790	2,101	11,891	90.3%	1.27%	1.32%	5,969	2,019
2011	12,666	2,344	15,010	91.5%	1.63%	1.26%	5,616	2,166
2012	14,303	514	14,817	90.9%	1.57%	0.68%	6,206	1,868
2013	17,491	2,761	20,252	83.2%	1.59%	1.17%	5,786	1,615
2014	12,201	5,888	18,089	74.7%	1.38%	1.72%	4,897	1,906
2015	10,763	4,451	15,214	77.6%	1.92%	1.41%	3,496	1,992

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

Table 9 **Number of halibut viabilities taken on BSAI and GOA *pot* vessels, as a proportion of all halibut for which a length was collected, and of all estimated halibut on the sampled haul; and total halibut PSC in the BSAI and GOA (without application of a mortality rate)**

Year	Number of viabilities			Viabilities as a proportion of all halibut for which a length was collected (total Alaska)	Viabilities as a proportion of total estimated number of halibut on sampled hauls		Estimate of total halibut PSC in fishery (total mt, not mortality)	
	BSAI	GOA	Total		BSAI	GOA	BSAI	GOA
2005	1,285	1,090	2,375	99.8%	30.45%	26.40%	37	194
2006	953	483	1,436	85.0%	22.90%	33.13%	43	109
2007	405	344	749	94.5%	31.20%	27.12%	23	121
2008	787	522	1,309	80.9%	18.05%	21.47%	70	194
2009	236	78	314	100.0%	27.38%	22.94%	18	43
2010	639	222	861	96.6%	25.69%	20.11%	49	169
2011	1,410	1,234	2,644	94.9%	29.55%	25.38%	80	262
2012	1,568	1,156	2,724	97.8%	32.33%	26.34%	69	248
2013	509	372	881	92.7%	24.66%	32.12%	44	88
2014	505	186	691	97.5%	24.96%	17.90%	45	62
2015	733	969	1,702	98.8%	27.26%	25.69%	43	131

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

In 2016, the Observer Program altered how observers collect halibut condition data so that those sampling methods are consistent with data collections for other species. In addition to increasing the rigor of the underlying sample design, this adjustment will increase the utility and representation of the data available for estimation of DMRs.

2a) Target fishery aggregation methods

Additional tables in the Appendix break out the summary tables above into more detail, and provide a description of the number of halibut condition assessments available by target fishery. In the Appendix, target fisheries are pulled from the Catch Accounting System (CAS), where they are assigned using the algorithms described in Section 2.3, and the dataset is then joined with the observer sample data. This is a difference from the methodology used up to now by the IPHC, which has assigned a target fishery to observed hauls in order to calculate DMRs. Using the NMFS CAS trip targets, however, matches with how observer data is extrapolated to target fisheries to estimate PSC, as described in Section 2.3. The tables reveal the fact that in recent years, there are many trawl target fisheries for which there are very few viabilities supporting the calculation of DMR for a specific target fishery, and highlight a key problem with the current DMR estimation methodology. It will be important to establish an appropriate threshold for identifying when too few halibut conditions are available, and how the available condition data should be aggregated. In the 2015 application of the IPHC DMR methodology, Williams (2015) considered DMR values based on less than 50 halibut viability observations within a target fishery to be unreliable. The Working Group has discussed, however, that a threshold number of viabilities may not be the best metric, given the observer sampling protocol, and is investigating alternatives, such as number of hauls with recorded halibut viability within a target fishery, or other options.

2b) CP and CV vessels

The additional tables in the Appendix also provide more detail about halibut condition assessments broken out by operational type (catcher processor/ catcher vessel) to assess whether the DMR is based primarily on viabilities associated with a single sector. For example, in the BSAI non-CDQ trawl fishery, there are fisheries that are largely prosecuted by catcher processors, but also have some catcher vessel activity (Atka mackerel, rockfish, yellowfin sole). The DMR for these target fisheries is determined exclusively based on viabilities taken on catcher processors. Conversely, in the Pacific cod fishery, the DMR is determined primarily on viabilities from catcher vessels. In another instance, for the non-pelagic pollock target fishery (as defined by CAS), the DMR for vessels using non-pelagic trawl gear (Amendment 80 catcher processors) is based primarily on viabilities from vessels using pelagic trawl gear (AFA catcher processors). Further study is needed to evaluate whether the fishing patterns of these various operational types would necessarily lead to a different viability profile of intercepted halibut in all target fisheries. In the longline sector prior to 2013, the tables show that almost all injury code assessments came from the catcher processor sector, but the number of injuries from catcher vessels increased substantially beginning in 2013 with observer restructuring and the collection of data from additional vessels. A disaggregation by operational type (or trawl gear configuration – pelagic or non-pelagic) may not make sense in all target fisheries, if there is only a small amount of fishing in that trip target by the other operational type.

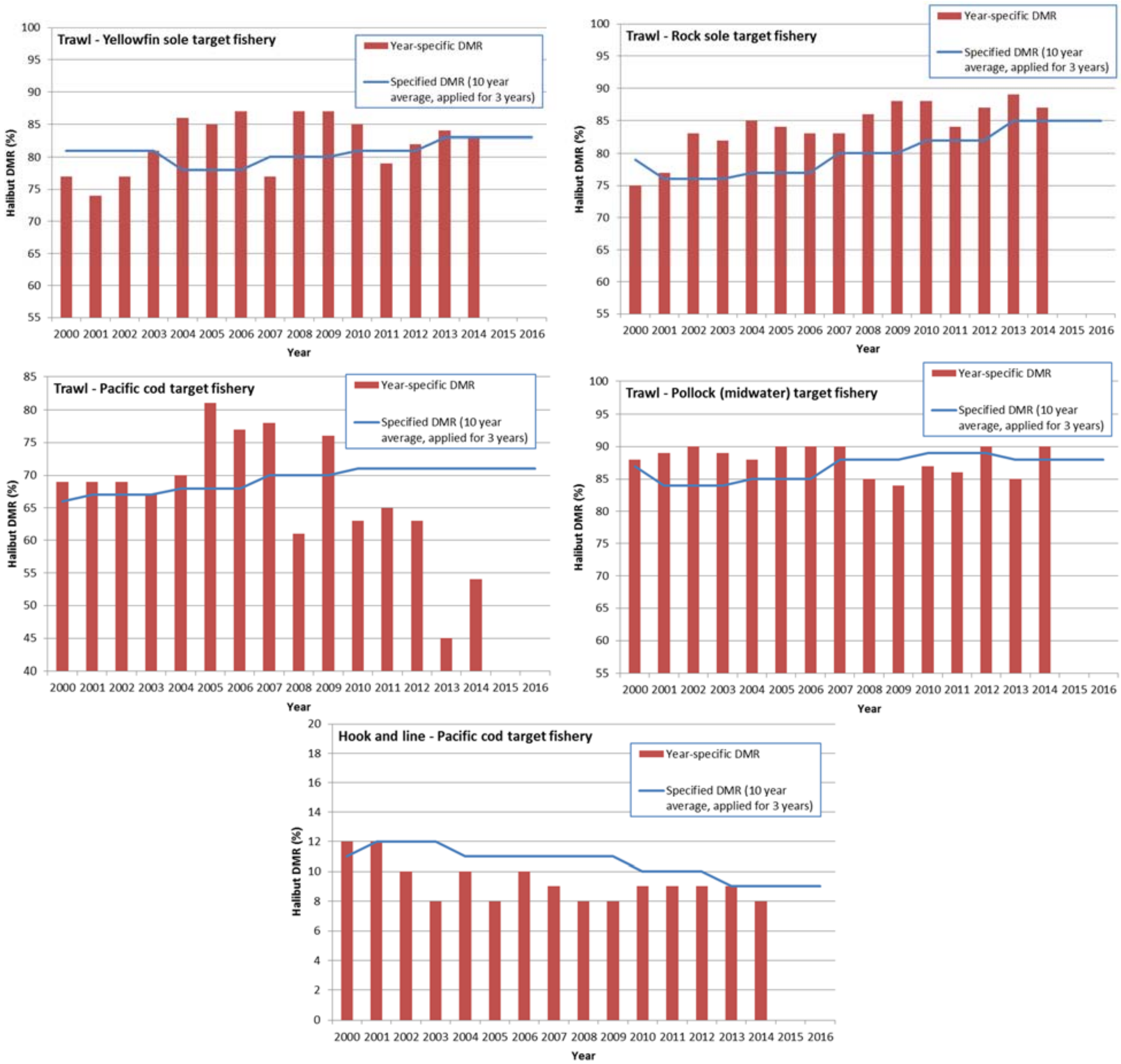
2c) CDQ/non-CDQ

DMRs are currently specified independently for CDQ and non-CDQ fisheries, and Table 2 illustrates that DMRs in the CDQ fisheries are generally higher than for the same target fishery in the non-CDQ fisheries. The additional tables in the Appendix present the number of viabilities in each target fishery separately for CDQ fisheries, by gear type. There are several reasons why the calculation of DMRs for CDQ fisheries may be higher than for non-CDQ. First, as described in Section 2.1, a slightly different methodology has been used by the IPHC to determine the target fishery for the CDQ fishery. The target is assigned on a haul by haul basis; for non-CDQ vessels, target fishery is based on sampled hauls that are summed over the reporting week or fishing trip. Given the reduction in the number of viabilities described above, it may be worth considering whether it is appropriate to aggregate CDQ and non-CDQ fisheries in order to have more a more robust basis for assigning DMRs to target fisheries. A second operational difference in the CDQ versus the non-CDQ fishery may also be to do with relative mortality rates on catcher processors versus catcher vessels. CDQ quota is largely leased to catcher processors, which have generally had a higher estimated DMR as compared to catcher vessels, and if the assessment of CDQ DMRs is not diluted by lower DMRs from catcher vessels, then the resulting DMR may end up to be higher. Further evaluation of the CDQ DMR calculations is needed to elucidate this issue.

3) Length of reference timeframe

Figure 1 provides a graph of the year-specific estimates of DMRs calculated for each fishery using that year's observer data, compared to the DMR that is specified for each fishery during the harvest specifications process based on the previous ten-year average. In some cases, such as with the hook and line Pacific cod target fishery, the year-specific DMRs are consistently below the 10-year average DMR that is specified. In other instances (e.g., trawl yellowfin sole target fishery), the ten-year average smooths out interannual variation above or below the assumed DMR, and in still other instances (e.g., the trawl rock sole target fishery), the year-specific DMRs are consistently above the specified DMR in recent years.

Figure 1 Specified (10-year average) vs year-specific discard mortality rates (DMRs) in target fisheries for trawl flatfish, cod, and pelagic pollock, and longline Pacific cod, 2000 to 2016. Note, actual DMRs have not yet been calculated for target fisheries after 2014.



4 Alternative Methods

As part of the WG consideration of short and long term DMR estimation issues, and within the context of a need for SSC and Council review in April, an effort was made to deconstruct DMR analytical components so that the short and long term aspects of each could be considered. The following elements comprise the basic four-part structure of DMR analysis:

- Unit of estimation - *The level of resolution to which the DMR estimates will be applied.*
    - Currently DMRs are provided for target fisheries as defined by by region/gear/species with CDQ and non-CDQ fishing activity separated.
- Estimation method - *How the DMR estimates will be derived within the unit of estimation.*
    - Currently based on the mean DMR among sampled vessels, weighted by the catch of halibut. Vessels are assigned to target fishery by week (or haul) for non-CDQ (CDQ).
- Temporal smoothing - *How previous years' data will contribute to the DMR estimate.*
    - Currently, average of each DMR over the most recent 10-year period (each year is equally weighted, regardless of number of condition assessments used, even very sparse years are included). No additional years are added to compensate for years where DMR estimates were not available.
- Duration of application - *How long the DMR estimate will be applied before it is reanalyzed.*
    - Currently, DMRs are applied for three years.

Table 10 summarizes each of these four elements for a range of alternative estimation methodologies and the status quo approach. Considering the present situation (status quo) and looking forward, the information provided in Table 9, is broken into modifications that can be done with existing data ("feasible improvement" and possibly "near future alternative") compared to improvements that would likely

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Table 10 Status quo and alternative methodologies for establishing discard mortality rates

	Unit of estimation	Estimation method	Temporal smoothing	Duration of application
Definition	The level of resolution to which the DMR estimates will be applied.	How the DMR estimates will be derived within the unit of estimation.	How previous years data will contribute to the DMR estimate.	How long the DMR estimate will be applied before it is reanalyzed.
status quo	Post-stratified target fisheries by region/gear/species with CDQ and non-CDQ fishing activity separated.	Mean DMR among sampled vessels, with catch of halibut as the weighting within vessel. Vessels assigned to target fishery by week (or haul) for non-CDQ (CDQ).	Each DMR over the most recent 10-year period is combined via a raw average (each year is equally weighted, regardless of sample size, even very sparse years are included). No additional years are added to compensate for missing years.	DMRs are applied for three years.
Potential development of alternatives and considerations for 2017+				
1) *Status quo*	Provides historical consistency. Sample sizes **inadequate** for some fishery/year combinations, particularly in recent years. Delineation between CDQ and non-CDQ may no longer be meaningful. Does not allow for pooling of similar fisheries based on similar rates. Pooling creates weak incentives to individual vessels.	Assumes unobserved vessels are likely to produce DMRs most similar to observed vessels catching the largest number of halibut. Does not have a logical link to the sampling design nor provide for a meaningful variance calculation. *Concerns over representativeness of observed releases on factory longliners and in the directed halibut fishery.*	Provides a very stable, slow to change DMR value. This may be appropriate for highly variable estimates without clear trends over time. Produces a **biased estimate** when there are trends in recent years. Requires an *ad hoc* choice of the number of years over which to average, rather than reflecting the inherent trend and variability in the data. Stability creates weak incentives for reduced fishery DMRs.	Provides for stability in future planning, a reduction in workload in revising the estimates, but still provides for moderate updating as DMRs or sampling programs change over time. Stability creates weak incentives for reduced fishery DMRs.
2) 'Feasible improvement'	Divide or combine existing target fisheries based on current sample sizes and understanding of operational differences between some vessel types (CV, CP). I.e. provide DMRs for a mix of target fishery and vessel type combinations; perhaps drop the CDQ/non-CDQ delineation. Reflects a compromise between the feasibility of extensive analysis in 2016 and issues with existing stratification.	Expanded DMR estimates within unit of estimation, weighting by haul within trip and vessel, and among vessels based on catch. Document pragmatic rules for pooling/borrowing DMRs among fleets where sample size is low. Begin analysis of fully design-based estimators as well as model-based estimators. *Video monitoring of release methods on longline vessels?*	Recent (3-5) year's estimates, terminal year and/or Kalman-filter approach (where possible). Provides stronger incentive for DMR reduction. Kalman-filter includes sparse (or missing) sample sizes naturally, without *ad hoc* duration selection choices via weighted average of recent values based on estimated variance and inter annual variability.	Update DMRs on a 1-2 year basis as additional analysis becomes available, and/or estimated rates change. Still requires substantial manual recalculation. May reduce stability for planning due to changing fishing conditions and behavior.

	Unit of estimation	Estimation method	Temporal smoothing	Duration of application
3) 'Near-future alternative'	Delineate all meaningful target fisheries and vessel types possible.	A mix of design-based (expanding from subsample to haul, to trip; post-stratifying to vessel and to fishery…) and pooled estimators pending further refinement of the changes to viability sampling instituted in 2016. This improves the variance estimates and relative weighting of observations based on statistical design.	Recent (3-5) year's estimates, terminal year and/or Kalman-filter approach (where possible). Provides stronger incentive for DMR reduction.	Update DMRs on a 1-2 year basis as additional analysis becomes available, and/or estimated rates change. Still requires substantial manual recalculation. May reduce stability for planning due to changing fishing conditions and behavior.
4) 'Ongoing progress'	Based on further refinement of sampling protocols, extend estimates to the level of individual coops (where possible). Strengthens incentives for DMR reduction.	A mix of model-based (using auxiliary information such as time out of water, haul size, release method etc.) and coop specific DMR estimates built directly from the sampling design, and optimized through refinement of data collection targets. Allows for reduced observer duties (viability sampling).	Previous year's estimates and/or Kalman-filter approach (where possible) used for each fishing season. Provides very strong incentive for DMR reduction.	Update DMRs on a 1-2 year basis as additional analysis becomes available, and/or estimated rates change. Requires at least partially automated recalculation. May reduce stability for planning due to changing fishing conditions and behavior.
5) 'Gold Standard' (Perhaps not fully achievable, even over the medium to long term).	DMRs for individual vessels. Requires full observer coverage, and may still result in greater variability and susceptibility to 'observer effects' for unobserved fishing. Requires significant technical overhead for calculation and accounting. Provides the strongest incentives for lower DMRs via individual accountability.	A mix of model-based (using auxiliary information such as time out of water, haul size, release method etc.) and vessel specific DMR estimates built directly from the sampling design, and optimized through refinement of data collection targets. Allows for reduced observer duties (viability sampling).	Previous year's estimates and/or Kalman-filter approach (where necessary) used for each fishing season. Provides very strong incentive for DMR reduction.	One-year. Requires automated calculation. Provides very strong incentive for DMR reduction. May reduce stability for planning due to changing fishing conditions and behavior.

The discussion below relates directly to the analytical components identified and described in the previous section. The short and long term plans for each component are described in light of the improvements they provide compared to current practices. While the elements in Table 9 and the discussion outline a plan for moving forward, it is expected that modifications to observer sampling initiated in 2016 may play a big part in how the plan unfolds. In other words, the expansion of halibut sampling may necessitate an adaptive response to the sampling results should they consist of discard mortality patterns that depart in a meaningful way from previously observed patterns. Additionally, the new data collection protocol may essentially initiate a new time series such that some of the plans may be best left until an accumulation of annual DMR estimates is available. Ideally, the plan for alternative calculation methods will be both prescriptive and responsive, adapting to the new data, while also guiding any operational changes necessary for generating statistically sound DMR estimates.

4.1 Unit of Estimation

As described above, this item in the analysis defines the "target fishery", or component of the groundfish fleet to which DMRs are applied by CAS and is arrived at in the estimation procedure through statistical expansion from observer sampling within the defined unit. Currently, DMRs are estimated for target fisheries that are defined by region/gear/species and then further categorized as being CDQ or non-CDQ. Functionally, the separation of the groundfish fleet into separate estimation units is done so that the resultant grouping reflect differences in fishing operations that are meaningfully linked to differences in DMRs.

Because DMRs are specified separately for the BSAI and GOA, the groundfish fleet is first separated by region. In addition to the administrative differences in managing the two regions, the BSAI fleet tends to consist of larger vessels that deploy more gear on longer sets/tows. Water temperature and depth differences that can affect DMR also differentiate the two areas.

The next level of separation is gear. Field and lab investigations into halibut DMRs (e.g., Peltonen 1969, Hoag 1975, Clark et al. 1992, Pikitch et al. 1998, among others) have tended to focus on mortality associated with specific gear types. Generally, trauma, compression, and difficulty ventilating gills makes halibut survival in trawl gear much lower than what is expected for hook and line (HAL) or pot gear. Further investigations into this fundamental aspect of halibut discard mortality are being explored by the IPHC and are likely to be a research priority for years to come.

Within gear types, differences in fishing operations would be expected on a by-species basis, assuming similar handling operations among vessels for a given species target.

Under the current approach, target fisheries are further broken out into CDQ and non-CDQ operations. Discussion by the WG suggested that a more natural break-out would be to split CV and CP vessels given the expectation that attributes such as tow duration, size of catch, and handling of the catch on the vessel can differ significantly between these fishing sectors. In contrast, splitting out CDQ and non-CDQ can be misleading when a given vessel is used under both categories, and this can even occur within a given trip. DMRs that are associated with CDQ fishing appear to be a reflection of the predominance of CP vessels that are used for CDQ.

<u>Recommendations</u>
Short term departures from the status quo reflect a compromise between the extensive analyses which will be necessary over the long run and the immediate need to improve upon the existing stratification of target fisheries. Alternatives to the current splitting and pooling of fisheries should be accompanied by consideration of available data, especially discard condition sampling, relative to individual target fisheries. An exploration of alternative methods would attempt to balance the decrease in uncertainty associated with pooling fisheries (i.e., increasing sample size) and any loss in ability to detect differences between fisheries. The WG discussed specification of minimum data requirements as a likely tool in the near term. While other measures of uncertainty, e.g., a maximum coefficient of variation (CV), may be appealing from a statistical perspective, it remains unclear at present how to calculate variance for the "statistics" of interest. Further work to identify appropriate variance calculation methods would include a rigorous exploration of the assumptions associated with each step in the DMR calculation process from halibut discard condition sampling up through expansion to the unit of estimation.

Beyond the near term, it is likely that we could explore methods that further refine alternative pooling and splitting of fisheries. As stratification becomes more refined, these approaches would offer the benefit of incentivizing reductions in DMRs. Formal analysis of grouping alternatives could consider optimizing on the potential for responsive changes in operations in order to better incentivize reductions in DMRs. While reliance on current sampling methods would not support a transition to vessel-specific DMRs, the concept is at least hypothetically appealing as a potential long term goal since this is likely the most responsive and accountable fleet unit for which DMRs could be assigned.

4.2 Estimation Method

Estimating DMRs for target fisheries involves a hierarchy of calculations that begins, under status quo methods, with discard condition sampling of halibut for selected vessel hauls. Those rates, then are carried up to generate estimates of halibut DMR at the trip level, then further to vessel DMRs, and finally, to DMRs for the target fishery as a whole. As part of this process, alternative weighting options can be considered. Existing methods consider the vessel to be the sampling unit and so DMRs are generated with vessel-specific DMRs being weighted by individual vessel's total halibut catch.

Discussion by the WG focused on the option of whether target fishery DMRs should be expanded from trips or individual hauls. It was pointed out that within the partial coverage fleet observers are randomly assigned to trips, as opposed to, vessels, for example. As described above, within trips, hauls are randomly selected for species composition sampling and viability samples usually consist of a fixed target number, e.g., 20/day. It was generally agreed that for the near term, the expansion should continue to proceed from haul to trip to fishery.

Nevertheless because individual hauls can be associated with differing duration, catch weight, fishing depth and other factors within a trip, the incidence of halibut capture and the associated mortality could vary importantly among hauls within individual trips. CPs may participate in several fisheries within a trip with targets assigned to hauls within a week, and again halibut mortality may vary within the trip. If DMRs were to be expanded directly from hauls to the fishery level, changes may have to be made to the observer sampling protocol and the CAS. These factors, combined with a need for consistency between in-season monitoring and post-season estimation for specification purposes, constrains the immediate transition to haul-based methods.

<u>Recommendations</u>

Important changes in sampling protocol implemented for 2016 forward (discussed in Section 2.2) will help define options for hierarchical (design-based) DMR estimation in the coming years. For the purpose of specifying DMRs for 2017, it will be important to consider the 2015 and earlier sampling frame, the constraints of available data, and the sampling hierarchy in developing the estimation process. This may entail a step-wise process, particularly in modifications to CAS operations. Additionally, a key goal in the development of improved calculation methods is transparency. A step-wise walk through a series of potential alternative calculations is illustrated in Figure 2, and status quo elements and steps are included for comparison. The diagram scopes out the decision points and programming that would occur to develop a new DMR procedure. Tables 1 and 2 represent the sources that would be utilized. At the join of these two tables the only filter that would be applied is based on year. This filter would be used either for an individual year or a group of years. The step containing mortality rates from IPHC to the injury/viability codes is based on gear type. Once the rates are applied the next step would then be to apply average haul DMR to extrapolated halibut at the desired level if weighting is chosen. At the weighting level it may be necessary to prune samples that are extrapolated outside what would be considered statistically significant. Finally the extrapolated halibut would be averaged by groups chosen, or if weighting is not chosen the samples would be averaged by the groups. The final DMRs are then applied to the PSC estimates in the Catch Accounting System, this would be done outside the scope of the procedure. The translation of these steps into a stored data query and analysis script would achieve the transferability goal for this analytical element.

Progress in estimation methods will be measured by the extent to which variance estimates are improved and estimates are built from the sampling design. To that extent, there are not really incentives within this element, but improvement in statistical robustness feeds back to the other analytical components.

As the 2016 modifications to sampling design accumulate over the next few years, we may be able to explore a mix of design-based and pooled estimators. Further on, model-based estimates that incorporate biological attributes of incidentally captured halibut, characteristics of hauls, and handling procedures may be used. One of the main factors influencing halibut mortality on trawl vessels is the time the halibut spends out of the water before being discarded. This can be measured directly by observers and used in conjunction with other measured covariate data to model the mortality of halibut discarded. This approach has the benefit of potentially reducing the reliance on assessments of halibut discard condition and allowing the observer to collect other fisheries data.

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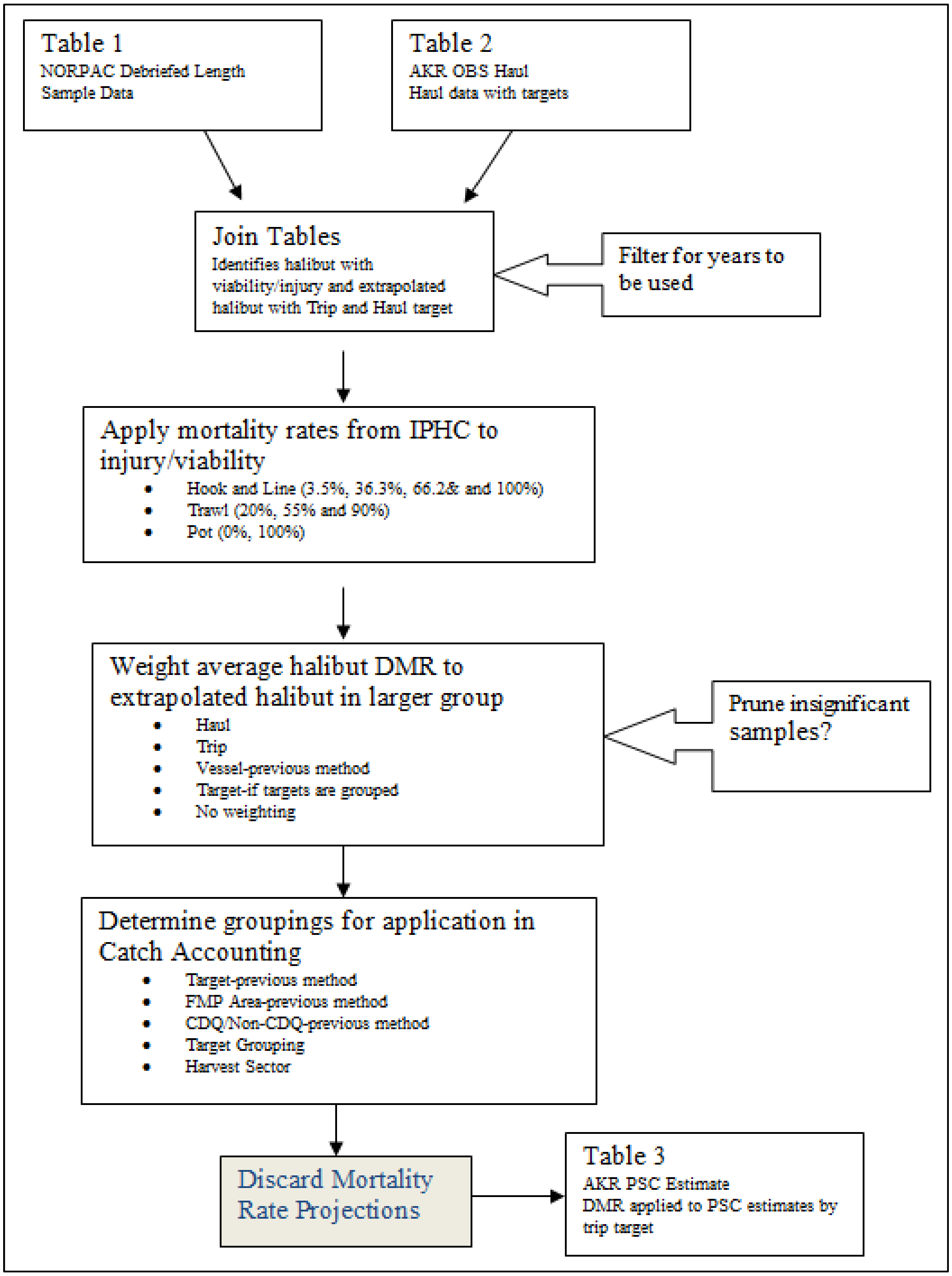

Figure 2 Halibut DMR estimation steps including both status quo and alternative components at each step.

4.3 Temporal Smoothing

The existing reference timeframe consists of the most recent ten-year period for which annual DMRs have been calculated. Currently, this approach does not take into account the changes in sampling intensity that have occurred. Furthermore, it renders the prescribed DMRs somewhat insensitive to operational changes that may have occurred in recent years, which tends to de-incentivize changes in fishing practices that may actually reduce halibut mortality.

The smoothing approach itself, under status quo, is a simple average that does not take into account sample intensity, and so years with very few halibut assessed for viability have equal influence as years with high sampling rates.

<u>Recommendations</u>
A potential alternative to simple averaging would be the use of an alternative smoothing approach such as a Kalman filter which weights each year's estimated DMR by the inverse of its variance. Hence, years where the variance of the DMR was high would generally contribute less to the smoothed estimate than low variance DMR years. For this reason, the times series would not necessarily need to be truncated to recent years, an approach that may otherwise be appealing as an approach to limit the influence of very old data when fishery operations may have been quite different. The random effects model, a variant of the Kalman filter, is the standard Groundfish Plan Team approach for smoothing time series of data such as survey catches for assessment model inputs. Fine tuning to account for contributors to variance outside of sample size may also be necessary.

As the length of the reference period is shortened, recent fishery performance plays an increasingly important part in determining the specified DMRs. This should have the effect of providing increasing incentives to the fisheries for DMR reduction. Other potential alternative methods include evaluating different time periods over which to average, use of other time-series models, or alternative estimation methods (non-time series models).

4.4 Duration of Application

The status quo approach, which has already been deviated from in the latest specifications, is to assign and maintain DMRs for three year periods. In December 2015 the Council specified DMRs for only two years with the expectation that alternative methods would be developed to re-specify DMRs for 2017 and possibly beyond. The benefits to industry of operating under a constant DMR are linked to predictability.

<u>Recommendations</u>
In previous RARAs, it has been noted that DMRs for the various target fisheries are fairly stable across years. Nevertheless, reduction in discard mortality is a stated goal of the Halibut Management Framework and as such, changes in fishing operations that reduce mortality have been implemented on many vessels. By applying a specified DMR over a shorter time period, these changes in mortality will be incorporated into quota management more rapidly and hence provide greater incentive to participating vessels to continue their efforts to decrease halibut discard mortality. Reduced duration of application, however, also reduces stability for planning purposes.

4.5 Other Considerations

Deck Sorting

The subset of the Amendment 80 fleet is participating in an EFP that allows halibut to be sorted from the catch and discarded on the trawl deck. A random sample of these halibut will be assessed for viability before being discarded. In addition, observers will sample the catch in the vessel's factory using standard sample methods. In the past, these viability and catch composition data were stored separately from the standard observer database and hence were not incorporated into standard observer sample protocols or the CAS. In 2016, these data will be collected by NPGOP observers, captured in the NORPAC database, and used to monitor the halibut PSC for those vessels participating in the EFP. The focus of the WG will be on improving calculation and application of halibut DMRs for the component of the fleet that is subject to full or partial observer coverage outside of this EFP.

5 Key Points

- Near term calculation of DMRs. Based on SSC/Council feedback, we will evaluate how to formulate a DMR calculation and the associated implications of the final candidate methods.
  - Alternative methods will be evaluated for re-specification of 2017 DMRs. Modifications to methods will likely include:
    - Modified estimation units that reflect target fisheries to which they will be applied. These estimation units may be consolidations of current units in order to ensure sufficient data are available and to reflect both fishing operations (i.e. CP/CV or gear designations) and fishery (i.e. target species).
    - Refinement of the estimation method including weighting alternatives with descriptions of key assumptions developed for each step
    - An abbreviated reference timeframe for smoothing. Since the challenges associated with variance estimation will be a constraining factor, variance based smoothing methods cannot be developed in the near term.
    - One year specification period (2017 only). Since this is an ongoing evaluation of potential estimation methods, a single year specification period will allow for incremental changes to the estimation methods. In addition, observer program data collection methods were updated in 2016, hence data collected under these new methods will not contribute to the evaluation until 2017. Continued work on estimation methods may result in alternative DMRs for 2018 being presented in late 2017, and additional recommendations for improvements to DMR estimation being applied to later years.
  - Alternative methods would be presented to the Groundfish Plan Teams for feedback in September 2016.
- Extension of alternative methods to previous years. In order to fully understand the effect of using a revised protocol, we would include a retrospective evaluation of what halibut PSC would have been had we applied DMRs using an alternative calculation, and the difference between that and our existing understanding of PSC mortality
- DMR Reporting
  - Currently, we are not envisioning any alternative DMR methodologies that do not include the requirement to specify a DMR pre-season, which will be used in-season for management of PSC limits in CAS. At the end of the year, the estimate of halibut mortality based on the specified DMR is reported to the Council and the public. The actual estimate of halibut mortality for a given year is not calculated until after the year has ended, based on that year's observer data. In our Council process, this actual annual estimate is then used to appropriately set future years' DMRs, but not formally reported. In the IPHC process, the actual annual estimate is updated in the stock assessment as the best available information on halibut mortality in prior years.

- One consideration for the Council process is whether reporting the updated actual annual estimate to the Council independent of the setting of DMRs is appropriate. Currently, the CAS output is used as the source for all Council analyses on halibut mortality, regardless of the fact that those values are based on a DMR set pre-season rather than actual DMR observed that year in the fishery. Hence, there may be a need to create a new official report of historic halibut mortality that can be used to adjust halibut mortality values in Council reporting. This may be of relevance in the Council's upcoming BSAI halibut abundance-based PSC limit discussion, should an analysis be tasked.
- Similarly, once a revised DMR calculation method has been decided, it will presumably be used beginning in 2017. This may impact our understanding of halibut mortality in previous years and thus the Council's (and the IPHC's) may choose to use the revised estimates as the best available halibut mortality estimate for prior years. If so, and if the new calculation is applied retrospectively, the time frame (how far back) to which the new methods are applied should be evaluated.

6 Directions for future work

As discussed in the introduction, at its February 2016 meeting the Council's SSC requested that the DMR working group expand its scope to include a discussion of the following elements in addition to the material that has been discussed in this paper:

- Evaluate methods to reduce discard mortality (e.g. excluders, deck-sorting),
- Identify the origins of the DMRs, the temporal changes, and justification of these changes
- Efforts to improve information about what is actually being discarded in all fisheries that target or intercept halibut (size, sex, age, maturity, release mortality rates (e.g. sport fishery), etc).

With respect to the first bullet, the Council is actively supporting industry efforts to reduce discard mortality in the BSAI groundfish fisheries, especially through use of halibut excluders and at-sea deck sorting and discard of halibut. The Council receives an annual report from the Amendment 80 cooperatives about their efforts to reduce halibut bycatch, including discard mortality. The trawl groundfish sectors are currently developing protocols for deck-sorting through an exempted fishing permit (EFP), however once that process is complete, the Council will likely review an analysis to implement regulatory change to allow deck-sorting. The analysis will include a thorough examination of methods to reduce discard mortality, and the effectiveness of deck-sorting. The current EFP extends through the remainder of 2016, and once the findings have been reported, it may be possible to begin the regulatory analysis for review in 2017.

A number of actions are being undertaken by the IPHC that will address the second and third bullets cited above, and which are briefly identified below:

Management Strategy Evaluation - The IPHC has begun an exploration of alternative metrics that could modify the currency underlying its halibut management recommendations, i.e., moving away from yield-based methods. A new IPHC staff member has been hired to coordinate formal Management Strategy Evaluation (MSE) that may identify areas of supporting halibut analyses with the greatest management risk. This exercise is likely to intersect with halibut DMR efforts in the sense that it could explore the potential costs associated with different DMR assumptions, under current methods, and the sensitivity of those assumptions for both the non-target fisheries as well as the directed fishery.

Research on mortality rates associated with halibut condition categories -. The survivability of halibut in each condition category is estimated on the basis of studies conducted by the IPHC in the 1970s. A review of the historical experiments contributing to these viabilities is being prepared for the annual IPHC research reporting. Having evaluated the historical basis for these associations, the IPHC has determined that it is an appropriate time to revisit this estimation. New tools, particularly tagging technology, offer a new ability to directly estimate survival, which may improve estimates of DMRs for some sizes of halibut. These survivability studies are a high priority in the IPHC research program, and began in 2015. A significant hurdle in this pending research is estimating survival for the smaller size categories of fish (less than 50 cm / 19 inches), which are not amenable to even the newer (i.e., lighter weight) electronic tagging technology.

Research on the DMR in the commercial halibut fishery - the IPHC applies a 16 percent mortality rate to halibut discarded in the commercial halibut IFQ fishery. Research is currently underway to re-evaluate the actual DMR in the commercial halibut fishery, given changes in fishery behavior and size-at-age since the DMR was established in 1995. Categorization of release methods through electronic monitoring and relating the methods to a database of injuries related to each method is one promising avenue for research.

7 References

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Appendix

Halibut viability samples detailed by target fishery

This section provides further detail with respect to the summary tables of halibut viability sampling, Table 5, Table 8, and Table 9. The following tables for trawl, longline and pot gear break out the number of viabilities by target fishery, CDQ/non-CDQ, operational type, and for trawl vessels, gear configuration.

Target fisheries are pulled from the Catch Accounting System (CAS), where they are assigned using the algorithms described in Section 2.3, and the dataset is then joined with the observer sample data. This is a difference from the methodology used up to now by the IPHC, which has assigned a target fishery to observed hauls in order to calculate DMRs. Using the NMFS CAS trip targets allows a match with extrapolated estimates of PSC in each target fishery from the CAS. In all the tables, only years with a sample are shown; there are years where no halibut sample was taken but a PSC amount was still applied. The tables also identify some trip targets that are used in catch accounting, but for which a DMR is not assigned using the IPHC methodology (for example, Kamchatka flounder in Table 11, illustrating the BSAI non-CDQ trawl fisheries). These instances are indicated by the words “not used” in parenthesis following the name of the trip target.

In the tables describing the trawl fisheries (Table 11 through Table 13), the number of viabilities has also been broken out by operational type (catcher processor/ catcher vessel) and gear configuration (non-pelagic trawl/ pelagic trawl) to assess whether the DMR is based primarily on viabilities associated with one sector, while other sectors may have different fishing interactions. This appears most acute in the BSAI trawl fisheries. For example, in the BSAI non-CDQ trawl fishery, the Pacific cod and pollock fisheries are prosecuted by both catcher processors and catcher vessels; other target fisheries (as defined by CAS) are prosecuted primarily by catcher processors with a small amount of catcher vessel activity (Atka mackerel, rock sole, rockfish, yellowfin sole); and the remainder are almost exclusively prosecuted by catcher processors. For the fisheries that while largely CP fisheries still have some CV activity, Table 11 demonstrates that the DMR for these target fisheries is determined exclusively based on viabilities taken on catcher processors. Conversely, in the Pacific cod fishery, the DMR is determined primarily based on viabilities from catcher vessels, while in the non-pelagic pollock target fishery (as defined by CAS), the DMR of vessels using non-pelagic trawl gear (Amendment 80 catcher processors) is based primarily on viabilities from vessels using pelagic trawl gear (AFA catcher processors).

The catcher processor/catcher vessel breakout was also applied to hook and line gear type. Table 14 shows almost all injury code assessments in the BSAI non-CDQ fishery coming from the catcher processor sector prior to the implementation of observer restructuring in 2013. In the GOA also (Table 16), the number of viabilities from catcher vessels increased substantially beginning in 2013.

Trawl tables

Table 11 Number of halibut viabilities taken on *BSAI non-CDQ trawl* vessels by target, operational type and gear configuration, and total as a proportion of the number of halibut measured, and of the number of halibut estimated on sampled hauls; and total halibut PSC in the BSAI (without application of a mortality rate)

Trip target	Year	Number of viability assessments: Catcher processors, non-pelagic trawl	Catcher processors, pelagic trawl	Catcher vessels, non-pelagic trawl	Catcher vessels, pelagic trawl	Viabilities as a proportion of all halibut for which a length was collected (total BSAI)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality): for CPs	for CVs
Alaska Plaice	2007	54				100.00%	10.80%	2.81	
	2008	99				96.12%	7.47%	1.98	
	2009	10				71.43%	4.41%	0.41	
	2010					0.00%	0.00%	1.09	
	2011	32				43.24%	0.79%	9.85	
	2012					0.00%	0.00%	6.15	0.01
	2013	54				48.21%	0.55%	33.57	0.13
	2014					0.00%	0.00%	0.55	
	2015					0.00%	0.00%	2.67	
Arrowtooth Flounder	2005	967				74.73%	1.32%	280.87	
	2006	298				88.96%	0.98%	175.09	
	2007	65				73.86%	0.69%	22.14	
	2008	634				44.52%	1.40%	169.49	
	2009	65				8.70%	0.10%	297.03	
	2010	25				4.31%	0.08%	234.86	
	2011	31				2.81%	0.06%	222.18	
	2012	6				0.24%	0.00%	535.25	
	2013	33				3.14%	0.05%	309.55	0.03
	2014	1				0.09%	0.00%	238.98	
	2015					0.00%	0.00%	82.17	
Atka Mackerel	2005	388				76.08%	1.34%	97.41	
	2006	187			1	79.66%	0.80%	101.87	
	2007	230		3		42.60%	0.36%	240.69	2.56
	2008	120				25.05%	0.74%	78.98	4.37
	2009	29				10.21%	0.28%	83.37	0.54
	2010	20				12.99%	0.27%	69.65	0.98
	2011	48				10.81%	0.21%	137.50	3.92
	2012	44				5.12%	0.10%	180.97	29.86
	2013	32				12.60%	0.20%	80.75	5.44
	2014	23				10.18%	0.12%	93.19	2.62
	2015	1				0.47%	0.01%	111.59	5.54
Flathead Sole	2005	540				80.00%	1.41%	359.34	
	2006	861				67.58%	1.09%	491.22	
	2007	465				60.47%	0.41%	429.52	
	2008	1,252				37.88%	1.03%	331.95	
	2009	416				20.71%	0.43%	239.17	
	2010	168				8.67%	0.21%	228.62	
	2011	98				10.93%	0.34%	92.57	
	2012	1				0.15%	0.00%	111.96	0.02
	2013	59				5.44%	0.12%	172.35	
	2014	7				0.95%	0.02%	162.86	0.38
	2015	12				3.85%	0.07%	63.91	
Greenland Turbot	2009					0.00%	0.00%	8.17	
	2010					0.00%	0.00%	2.75	
	2011	1				11.11%	0.50%	1.47	
	2013					0.00%	0.00%	0.57	

Trip target	Year	Number of viability assessments				Viabilities as a proportion of all halibut for which a length was collected (total BSAI)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)	
		Catcher processors		Catcher vessels					
		non-pelagic trawl	pelagic trawl	non-pelagic trawl	pelagic trawl			for CPs	for CVs
Kamchatka (not used)	2011	28				8.81%	0.18%	117.26	
	2012	7				2.95%	0.05%	127.34	
	2013					0.00%	0.00%	51.89	
	2014					0.00%	0.00%	18.92	
	2015					0.00%	0.00%	57.89	
Other Flatfish	2005	275				94.50%	2.66%	95.99	
	2006	70				69.31%	2.73%	20.69	
	2007	24				42.11%	0.90%	100.93	
	2008	109				81.95%	1.57%	15.64	
	2009	47				52.22%	0.79%	15.99	
	2010					0.00%	0.00%	3.63	
	2011	26				100.00%	4.30%	0.85	
	2012					0.00%	0.00%	8.59	
	2013					0.00%	0.00%	2.94	
	2014					0.00%	0.00%	0.07	
Other Species	2005	53				100.00%	19.70%	1.21	
	2006	31				100.00%	1.39%	8.34	
	2007					0.00%	0.00%	5.46	0.01
	2009					0.00%	0.00%	0.19	
	2010					0.00%	0.00%	0.31	
Pacific Cod	2005	5,429		3,620		76.49%	1.48%	1,233.80	877.13
	2006	3,658		2,841		70.60%	1.14%	1,223.94	861.89
	2007	2,365		3,679	4	62.64%	1.01%	905.23	610.43
	2008	252		2,664	88	68.77%	1.93%	63.37	415.21
	2009	745		856	65	57.95%	1.52%	109.72	258.86
	2010	190		2,433	28	61.78%	1.75%	51.68	358.78
	2011	17		3,312	3	67.61%	2.36%	28.87	334.54
	2012	7		2,417	1	48.21%	0.68%	55.90	603.60
	2013	107		2,241		54.48%	1.16%	67.01	434.51
	2014	34		3,004		59.94%	1.64%	58.45	395.69
	2015			2,060	10	55.87%	1.61%	56.79	333.28
Pollock - bottom	2005		101		3,100	100.00%	72.40%	1.20	18.17
	2006		123		2,611	100.00%	72.95%	4.73	8.25
	2007		397	47	3,968	97.74%	34.91%	18.21	21.54
	2008	308	761		250	86.21%	1.93%	74.75	46.96
	2009	95	4,625		2,659	88.21%	4.20%	174.08	113.29
	2010	81	1,222	1	1,994	76.73%	3.36%	122.99	73.61
	2011	156	2,186	4	109	77.94%	1.86%	169.89	22.96
	2012	42	1,483		50	74.86%	1.66%	95.53	51.81
	2013	102	1,694		37	58.81%	2.09%	187.35	9.87
	2014	52	600		3	61.10%	1.36%	80.49	18.24
	2015		56			13.15%	0.33%	29.83	3.71
Pollock - midwater (trips with at least 95% retained pollock)	2005		4,232	1	11,574	99.70%	51.71%	37.89	62.69
	2006		5,076		11,896	99.96%	45.71%	62.13	57.29
	2007		9,249	133	21,189	99.93%	43.32%	120.39	154.44
	2008		10,267	3	2,738	99.24%	11.72%	157.63	95.70
	2009		9,201		2,101	98.94%	8.27%	171.69	82.50
	2010		4,569		2,345	90.17%	16.51%	90.36	38.29
	2011	2	5,496		1,283	82.82%	6.68%	109.23	111.27
	2012		6,306		940	90.32%	4.50%	155.83	143.80
	2013		4,078		300	89.20%	9.02%	88.31	29.70
	2014		2,808		220	83.10%	6.95%	62.67	49.41
	2015		2,155		130	53.90%	7.27%	77.96	31.39

Trip target	Year	Number of viability assessments				Viabilities as a proportion of all halibut for which a length was collected (total BSAI)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)	
		Catcher processors		Catcher vessels					
		non-pelagic trawl	pelagic trawl	non-pelagic trawl	pelagic trawl			for CPs	for CVs
Rock Sole	2005	4,615		38		76.66%	0.94%	994.42	1.34
	2006	3,416				73.62%	0.80%	1,034.21	
	2007	4,350		33		73.84%	0.53%	1,120.26	9.07
	2008	8,981				52.87%	0.74%	784.98	
	2009	5,329	1			35.89%	0.58%	771.57	1.65
	2010	5,055				34.62%	0.62%	1,079.52	
	2011	701	1			8.54%	0.13%	573.95	0.01
	2012	604				12.34%	0.16%	436.82	15.09
	2013	1,171	1			19.33%	0.29%	673.52	0.06
	2014	1,280				16.47%	0.25%	753.19	3.99
	2015	195				2.41%	0.04%	559.30	8.38
Rockfish	2005	25				80.65%	1.94%	17.74	
	2006	22				95.65%	0.63%	39.01	
	2007	20		1		100.00%	1.00%	21.98	0.43
	2008	224		4		91.94%	6.60%	42.46	2.64
	2009	79		9		80.73%	1.86%	38.82	2.69
	2010	4				1.69%	0.04%	67.78	0.54
	2011	65		1		19.64%	0.28%	112.31	4.33
	2012	18				4.02%	0.09%	82.76	0.59
	2013	7				1.40%	0.02%	134.10	4.28
	2014	7				2.04%	0.03%	79.68	2.81
	2015	2				1.06%	0.01%	75.48	1.25
Sablefish	2008					0.00%	0.00%	1.02	
	2009					0.00%	0.00%	0.11	
	2013					0.00%	0.00%	1.00	
	2014					0.00%	0.00%	0.80	
Yellowfin Sole	2005	1,404		4		84.46%	0.85%	727.29	0.72
	2006	1,829		1		85.51%	1.11%	556.56	0.11
	2007	2,220				88.84%	0.83%	628.86	0.00
	2008	6,173				56.93%	0.84%	1,150.18	50.78
	2009	3,893				34.18%	0.46%	1,224.03	5.25
	2010	2,611				36.23%	0.59%	1,038.24	
	2011	941	2			16.82%	0.25%	1,020.49	11.42
	2012	507				11.01%	0.16%	1,004.72	62.25
	2013	1,358			1	25.76%	0.40%	1,230.13	77.96
	2014	664				10.65%	0.16%	1,443.66	35.44
	2015	246				4.29%	0.06%	762.03	83.61

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

Table 12 Number of halibut viabilities taken on *BSAI CDQ trawl* vessels by target, operational type and gear configuration, and total as a proportion of the number of halibut measured, and of the number of halibut estimated on sampled hauls; and total halibut PSC in the BSAI (without application of a mortality rate)

Trip target	Year	Number of viability assessments				Viabilities as a proportion of all halibut for which a length was collected (total BSAI)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)	
		Catcher processors		Catcher vessels					
		non-pelagic trawl	pelagic trawl	non-pelagic trawl	pelagic trawl			for CPs	for CVs
Alaska Plaice (not used)	2011					0.00%	0.00%	1.47	
	2012					0.00%	0.00%	0.04	
	2013					0.00%	0.00%	0.47	
Arrowtooth Flounder (not used)	2005	18				45.00%	7.66%	0.53	
	2006	354				89.62%	3.66%	34.05	
	2007	43				46.24%	1.82%	10.66	
	2008	25				100.00%	4.39%	1.55	
	2009	35				58.33%	2.67%	18.34	
	2010					0.00%	0.00%	15.18	
	2011					0.00%	0.00%	16.53	
	2012					0.00%	0.00%	23.63	
	2013					0.00%	0.00%	16.25	
	2014					0.00%	0.00%	12.28	
	2015	7				87.50%	2.36%	3.30	
Atka Mackerel	2005	110				35.95%	4.02%	15.35	
	2006	68				82.93%	3.59%	14.44	
	2007	57		1		54.72%	1.37%	18.33	0.25
	2008	16				53.33%	2.41%	5.48	
	2009					0.00%	0.00%	9.59	
	2010					0.00%	0.00%	2.02	
	2011	3				3.70%	0.13%	8.17	0.75
	2012	53				65.43%	1.37%	19.05	1.74
	2013	3				4.55%	0.12%	13.04	
	2014	1				2.63%	0.06%	11.52	
	2015	10				35.71%	0.63%	8.24	0.32
Flathead Sole	2005	5				62.50%	2.84%	2.26	
	2006					0.00%	0.00%	2.62	
	2007	69				67.65%	3.12%	10.49	
	2009	15				9.09%	0.18%	15.83	
	2010					0.00%	0.00%	15.84	
	2011					0.00%	0.00%	0.67	
	2012	34				97.14%	2.68%	3.34	
	2013					0.00%	0.00%	6.25	
	2014					0.00%	0.00%	0.59	
Greenland Turbot	2008	1				100.00%	0.55%	2.81	
	2013					0.00%	0.00%	0.49	
Kamchatka Flounder (not used)	2011					0.00%	0.00%	0.21	2.39
	2012					0.00%	0.00%	0.52	
Other Species	2011					0.00%	0.00%	2.17	

Trip target	Year	Number of viability assessments				Viabilities as a proportion of all halibut for which a length was collected (total BSAI)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)	
		Catcher processors		Catcher vessels					
		non-pelagic trawl	pelagic trawl	non-pelagic trawl	pelagic trawl			for CPs	for CVs
Pacific Cod	2005					0.00%	0.00%	0.04	
	2007	27		1		93.33%	6.26%	0.88	0.16
	2008					0.00%	0.00%	5.14	
	2009					0.00%	0.00%	0.95	
	2010					0.00%	0.00%	0.12	
	2011	26				96.30%	1.72%	3.22	
	2012					0.00%	0.00%	12.52	3.28
	2013	21				25.61%	0.73%	9.69	
	2014	26				29.21%	0.71%	6.41	3.61
	2015					0.00%	0.00%	11.94	
Pollock - bottom	2005		3		14	100.00%	3.54%	0.02	0.69
	2006		68			100.00%	32.85%	0.77	
	2008	30	28			98.31%	5.30%	2.72	0.02
	2009	13	60		54	100.00%	2.70%	4.92	1.99
	2010		154			83.70%	8.44%	4.60	
	2011	18	328			88.72%	7.66%	8.49	
	2012	4	15			38.78%	1.04%	2.17	
	2013	15	102			76.97%	3.89%	6.96	
	2014		15			28.30%	0.75%	4.06	1.50
	2015		2			8.70%	0.46%	0.83	
Pollock – midwater (trips with at least 95% retained pollock)	2005		888		109	99.30%	17.04%	9.68	2.47
	2006		743		46	100.00%	25.29%	10.59	0.47
	2007		1,419		278	100.00%	29.67%	18.53	3.51
	2008		1,303		7	98.87%	19.63%	23.63	0.52
	2009		1,025		49	100.00%	19.16%	15.95	0.94
	2010		483			77.40%	19.57%	6.87	
	2011		2,009			75.38%	14.22%	37.03	
	2012		897			97.50%	12.62%	13.73	
	2013		737			81.08%	16.99%	11.48	
	2014		920			83.18%	15.22%	22.74	
	2015		320			57.76%	12.72%	8.35	
Rock Sole	2005	124				5.33%	1.00%	20.06	
	2006	247				61.29%	1.24%	30.89	1.83
	2007	632		28		50.77%	1.51%	93.08	11.96
	2008	926				98.09%	1.50%	36.12	1.61
	2009					0.00%	0.00%	11.21	
	2010	4				0.52%	0.01%	32.36	
	2011	115				27.32%	0.52%	39.39	0.05
	2012	27				4.10%	0.06%	47.27	0.72
	2013	58				11.81%	0.21%	43.90	0.75
	2014					0.00%	0.00%	37.43	0.79
	2015	7				1.67%	0.03%	26.95	0.79
Rockfish	2006	3				100.00%	30.00%	0.34	
	2007	6				100.00%	5.83%	0.60	
	2008	37				82.22%	4.56%	11.18	
	2009					0.00%	0.00%	4.33	
	2010					0.00%	0.00%	2.14	
	2011					0.00%	0.00%	1.41	0.37
	2012					0.00%	0.00%	10.18	0.48
	2013					0.00%	0.00%	1.44	0.18
	2014					0.00%	0.00%	2.43	2.95
	2015					0.00%	0.00%	0.09	0.11
Sablefish (not used)	2007	2				100.00%	4.44%	0.17	
	2008	19				100.00%	1.40%	2.23	

Trip target	Year	Number of viability assessments				Viabilities as a proportion of all halibut for which a length was collected (total BSAI)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)	
		Catcher processors		Catcher vessels					
		non-pelagic trawl	pelagic trawl	non-pelagic trawl	pelagic trawl			for CPs	for CVs
Yellowfin Sole	2005	282				47.64%	1.63%	46.56	
	2006	226				60.27%	1.08%	46.85	0.01
	2007	416				55.69%	1.58%	59.29	
	2008	408				64.45%	1.31%	64.88	0.12
	2009					0.00%	0.00%	17.10	
	2010					0.00%	0.00%	22.02	
	2011	175				34.72%	0.57%	78.03	1.43
	2012	119				12.86%	0.29%	111.72	2.37
	2013	43				6.56%	0.12%	110.53	19.34
	2014	104				16.40%	0.29%	120.19	12.73
	2015	1				0.31%	0.00%	48.30	14.62

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

Table 13 Number of halibut viabilities taken on *GOA trawl* vessels by target, operational type and gear configuration, and total as a proportion of the number of halibut measured, and of the number of halibut estimated on sampled hauls; and total halibut PSC in the GOA (without application of a mortality rate)

Trip target	Year	Number of viability assessments				Viabilities as a proportion of all halibut for which a length was collected (total GOA)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)	
		Catcher processors		Catcher vessels					
		non-pelagic trawl	pelagic trawl	non-pelagic trawl	pelagic trawl			for CPs	for CVs
Arrowtooth Flounder	2005	1,004		488		96.32%	2.07%	325.61	399.79
	2006	207		326		52.36%	0.76%	357.54	530.59
	2007	2,460		163		94.28%	3.21%	301.15	339.14
	2008	652		415		51.03%	1.55%	304.20	448.37
	2009	252		129		74.12%	1.14%	79.63	341.36
	2010	234		228		69.27%	1.20%	105.71	465.66
	2011	299		281		39.11%	0.67%	384.38	721.65
	2012	350		515		49.54%	0.97%	291.65	528.83
	2013	122		154		28.34%	0.49%	153.50	325.68
	2014	79		29		5.23%	0.09%	516.85	565.36
	2015	1		52		2.31%	0.06%	308.89	487.58
Atka Mackerel (not used)	2010	22				100.00%	8.40%	1.63	
	2011					0.00%	0.00%	0.72	
	2013	21				87.50%	6.05%	1.97	
Deep Water Flatfish	2007			2		100.00%	2.41%		0.49
	2015					0.00%	0.00%		0.00
Flathead Sole	2005	192				98.97%	6.19%	69.19	0.39
	2006	20		45		100.00%	1.85%	24.37	12.16
	2007	16		7		95.83%	0.38%	26.55	0.48
	2008	199		34		70.39%	1.69%	65.66	29.49
	2009	73				33.18%	0.52%	91.30	8.21
	2010	2		92		22.76%	0.69%	182.79	66.86
	2011	274		2		83.89%	2.20%	77.92	13.98
	2012	8		118		57.53%	1.11%	28.88	160.71
	2013	71				16.14%	0.40%	43.36	0.06
	2014					0.00%	0.00%	0.40	3.20
	2015					0.00%	0.00%	3.53	
Other Species	2007					0.00%	0.00%		0.28
	2009			43		100.00%	50.00%		1.93

Trip target	Year	Number of viability assessments				Viabilities as a proportion of all halibut for which a length was collected (total GOA)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)	
		Catcher processors		Catcher vessels					
		non-pelagic trawl	pelagic trawl	non-pelagic trawl	pelagic trawl			for CPs	for CVs
Pacific Cod	2005	55		1,346	29	83.04%	1.66%	54.66	1,034.05
	2006			827	1	89.13%	2.18%	32.99	534.12
	2007			1,001		66.47%	1.92%	15.33	733.42
	2008	3		871	14	56.10%	1.30%	8.84	927.49
	2009	346		456		58.97%	1.14%	41.01	416.84
	2010			1,313	216	68.05%	2.09%	3.97	393.25
	2011			1,111		39.75%	0.84%	14.59	719.49
	2012	2		1,551		59.66%	1.36%	21.36	829.13
	2013			253		55.12%	1.26%	0.10	475.08
	2014			233		50.87%	0.65%		347.61
	2015			223		34.36%	0.43%	0.93	775.36
Pollock - bottom	2005				133	99.25%	107.26%		3.14
	2006			68	402	87.52%	10.66%		117.00
	2007			106	192	99.67%	9.65%		134.25
	2008	16		55	2	29.67%	0.83%		115.75
	2009	22		43		57.52%	0.83%	0.02	61.73
	2010			57	2	98.33%	2.32%		29.88
	2011			147		75.77%	1.59%	1.39	174.36
	2012			163		61.28%	1.21%	5.05	77.33
	2013	28		78		69.74%	1.30%	7.00	220.70
	2014			68		97.14%	2.05%	0.06	137.39
	2015			67		44.97%	0.40%	0.39	166.47
Pollock - midwater	2005				40	100.00%	90.91%		0.70
	2006				23	95.83%	85.19%		0.54
	2007				84	100.00%	158.49%		2.54
	2008				9	100.00%	7.20%		2.49
	2009				1	100.00%	0.25%		1.56
	2010			31	3	87.18%	18.09%		18.10
	2011				1	33.33%	2.63%		15.41
	2012					0.00%	0.00%		4.73
	2013			4	1	15.15%	0.43%		28.80
	2015					0.00%	0.00%		11.88
Rex Sole	2005	223				64.08%	3.66%	138.05	
	2006	290				99.32%	3.71%	208.40	
	2007	33				7.27%	0.19%	209.91	
	2008	162				46.55%	1.13%	169.38	2.54
	2009	474				47.98%	0.85%	404.53	29.92
	2010	295		3		18.79%	0.46%	373.95	13.56
	2011	241				51.61%	1.06%	161.49	10.08
	2012	263		40		64.06%	1.13%	105.56	16.12
	2013	122				6.97%	0.19%	196.75	24.60
	2014	15		40		13.41%	0.34%	67.64	12.50
	2015					0.00%	0.00%	34.82	7.86

Trip target	Year	Number of viability assessments				Viabilities as a proportion of all halibut for which a length was collected (total GOA)	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)	
		Catcher processors		Catcher vessels					
		non-pelagic trawl	pelagic trawl	non-pelagic trawl	pelagic trawl			for CPs	for CVs
Rockfish	2005	64		470	1	79.03%	2.93%	160.72	207.17
	2006	35		148		100.00%	0.82%	141.16	112.42
	2007	214		183	71	42.47%	2.29%	105.65	31.23
	2008	324	3	135	3	71.76%	1.81%	141.62	17.17
	2009	96	1	180	3	56.68%	1.30%	91.84	16.82
	2010	45		119	19	29.23%	0.63%	113.04	25.82
	2011	111		114		43.86%	1.09%	68.78	39.05
	2012	12		160		39.27%	0.76%	90.96	18.26
	2013	50		141		36.73%	0.73%	88.28	24.68
	2014	71		74		23.27%	0.48%	94.99	28.57
	2015			98		14.00%	0.25%	122.72	33.74
Sablefish	2007			80	18	82.35%	6.27%		6.34
	2008			43	8	69.86%	2.32%		6.90
	2009			52		86.67%	8.74%	0.00	3.34
	2010			18		66.67%	1.43%	0.00	4.46
	2011			37		59.68%	3.57%		6.19
	2012			10		27.78%	0.73%		4.66
	2013			46	3	46.67%	1.07%		11.86
	2014			5		19.23%	0.65%	0.00	1.57
	2015			14		45.16%	1.72%	0.04	3.01
Shallow-water Flatfish (not used)	2005	34		942		92.95%	2.58%	102.71	726.54
	2006	237		785		92.24%	2.74%	78.53	854.14
	2007			1,220		74.53%	1.79%	3.28	1,006.11
	2008	8		1,334		66.40%	1.35%		696.65
	2009	33		1,120		59.99%	1.14%	27.80	1,104.28
	2010			775		74.02%	1.68%	4.14	611.94
	2011	18		130		61.41%	1.36%	31.99	331.38
	2012			658		70.53%	2.21%	21.19	342.94
	2013	31		37		5.87%	0.24%	55.66	187.24
	2014			144		36.73%	0.50%	22.94	222.06
	2015			15		22.73%	0.07%	61.82	98.73

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

Fixed gear tables

Table 14 Number of halibut injury assessments taken on *BSAI non-CDQ hook-and-line* vessels by target and operational type, and total as a proportion of all halibut measured, and of number of halibut estimated on sampled hauls; and total estimated halibut PSC in the BSAI (without application of a mortality rate)

Trip target	Year	Number of viability assessments		Viabilities as a proportion of all halibut for which a length was collected	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (total mt, not mortality)	
		Catcher processors	Catcher vessels			Catcher processors	Catcher vessels
Arrowtooth (not used)	2007	11		100.00%	1.15%	10	
	2009	2		100.00%	1.34%	1	
Turbot	2005	51		92.73%	1.22%	160	
	2006	84		82.35%	2.79%	77	0
	2007	38		100.00%	1.89%	44	
	2008	10		26.32%	0.48%	10	
	2009	5		100.00%	0.13%	47	
	2010	15		100.00%	0.25%	90	
	2011	27		100.00%	0.61%	41	
	2012	12		100.00%	0.24%	50	
	2013	3		100.00%	0.47%	10	
	2014	1		100.00%	0.13%	10	
	2015	6		100.00%	0.39%	24	
Other Species	2005	21		100.00%	0.46%	1	
	2007	1		100.00%	1.69%	2	
	2008	11		100.00%	8.33%	0	
	2009	7		100.00%	1.23%	2	
	2015	7		100.00%	3.45%	2	
Pacific Cod	2005	10,821		95.02%	1.76%	5,009	32
	2006	10,415		98.20%	2.56%	3,636	22
	2007	8,583		93.84%	2.32%	4,034	50
	2008	7,348		97.18%	1.56%	5,130	41
	2009	9,303		98.74%	1.73%	5,051	26
	2010	7,800		89.01%	1.30%	4,894	17
	2011	10,597		91.13%	1.66%	4,767	11
	2012	12,467		91.37%	1.56%	5,491	18
	2013	15,351		89.44%	1.65%	5,089	37
	2014	10,250	30	94.30%	1.35%	4,386	65
	2015	9,262	36	93.44%	1.89%	3,207	17
Rockfish	2007	4		100.00%	4.76%	1	
	2013	4		11.11%	0.51%	1	
	2014		5	83.33%	4.03%	1	
Sablefish (not used)	2005	35		100.00%	1.20%	47	14
	2006	43	2	100.00%	1.76%	131	43
	2007	14		100.00%	0.43%	81	23
	2009	9		64.29%	0.07%	231	53
	2010	1		100.00%	0.01%	168	45
	2011			0.00%	0.00%	78	14
	2013	43	6	100.00%	1.14%	56	3
	2014	8	2	43.48%	0.29%	19	7
	2015	15		100.00%	0.92%	21	3

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

Table 15 Number of halibut injury assessments taken on *BSAI CDQ hook-and-line* vessels by target and operational type, and total as a proportion of the number of halibut measured, and of number of halibut estimated on sampled hauls; and total halibut PSC in the BSAI (without application of a mortality rate)

Trip target	Year	Number of viability assessments		Viabilities as a proportion of all halibut for which a length was collected	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total, not mortality)
		Catcher processors	Catcher vessels			
Turbot	2005			0.00%	0.00%	48
	2006	22		100.00%	3.50%	10
	2008	43		75.44%	3.23%	1
Pacific Cod	2005	1,777	181	86.33%	1.70%	160
	2006	2,027		99.90%	2.32%	78
	2007	2,505		93.68%	2.53%	44
	2008	2,719		94.77%	1.73%	10
	2009	1,995		83.40%	1.29%	47
	2010	1,966		86.00%	1.36%	90
	2011	1,830		87.35%	1.49%	41
	2012	1,824		90.52%	1.80%	50
	2013	1,822		91.01%	1.37%	10
	2014	876		65.18%	1.17%	10
	2015	848		87.51%	2.42%	24
Sablefish	2005	5		100.00%	0.62%	2
	2009			0.00%	0.00%	81
	2013			0.00%	0.00%	2
	2014	14		56.00%	1.01%	0

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

Table 16 **Number of halibut injury assessments taken on *GOA hook-and-line vessels* by target and operational type, and total as a proportion of the number of halibut measured, and of the number of halibut estimated on sampled hauls; and total halibut PSC in the BSAI (without application of a mortality rate)**

Trip target	**Year**	**Number of viability assessments**		**Viabilities as a proportion of all halibut for which a length was collected**	**Viabilities as a proportion of total number of halibut estimated on sampled hauls**	**Estimate of total halibut PSC in fishery** (total mt, not mortality)	
		Catcher processors	Catcher vessels			Catcher processors	Catcher vessels
Arrowtooth	2006	70		100.00%	2.41%	35	
Other Species	2006	81		100.00%	6.55%	10	32
Pacific Cod	2005	163	89	83.44%	1.06%	300	1,260
	2006	1,957	24	99.75%	1.16%	1,149	1,346
	2007	1,511	83	100.00%	1.43%	848	1,228
	2008	966	155	90.70%	1.69%	725	2,818
	2009	1,305	90	100.00%	1.36%	771	1,846
	2010	1,920	180	100.00%	1.76%	1,047	832
	2011	2,326	18	96.70%	1.57%	1,083	857
	2012	348	127	85.74%	1.12%	441	1,135
	2013	637	739	98.36%	1.61%	309	1,032
	2014	1,345	772	90.90%	1.79%	701	952
	2015	1,560	518	95.15%	1.60%	619	1,080
Rockfish	2014		9	64.29%	9.68%		3
	2015		7	63.64%	3.65%		0
Sablefish	2005	153	184	47.80%	0.88%	425	1,780
	2006	82	7	53.29%	0.29%	236	1,497
	2007	76	4	89.89%	0.26%	197	3,321
	2008	9		100.00%	0.03%	218	976
	2009	62		100.00%	0.20%	175	1,003
	2010	1		100.00%	0.00%	78	61
	2011			0.00%	0.00%	96	115
	2012	19		100.00%	0.06%	171	121
	2013	103	184	56.72%	0.56%	72	202
	2014	201	508	68.90%	1.10%	104	146
	2015	225	352	66.47%	1.06%	165	128

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

Table 17 Number of halibut viabilities taken on *non-CDQ pot* vessels by target in the *BSAI and GOA,* and total as a proportion of the number of halibut measured, and of the number of halibut estimated on sampled hauls; and total halibut PSC in the combined BSAI and GOA (without application of a mortality rate)

Trip target	Year	Number of viability assessments			Viabilities as a proportion of all halibut for which a length was collected (total Alaska)	Viabilities (total Alaska) as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (mt) (total Alaska, not mortality)
		BSAI	GOA	Total			
Pacific Cod	2005	758	1,090	1,848	99.9%	26.78%	216
	2006	571	483	1,054	80.6%	23.91%	132
	2007	116	344	460	99.6%	29.64%	126
	2008	705	508	1,213	94.7%	22.64%	247
	2009	57	78	135	100.0%	26.16%	48
	2010	442	212	654	97.9%	26.21%	196
	2011	1,094	1,233	2,327	94.2%	27.05%	329
	2012	1,304	1,138	2,442	98.7%	29.25%	307
	2013	369	372	741	91.5%	26.77%	115
	2014	364	180	544	97.3%	20.31%	102
	2015	580	965	1,545	98.7%	24.63%	173
Sablefish (not used)	2005	216		216	99.5%	40.99%	15
	2006	132		132	100.0%	26.24%	21
	2007	147		147	79.5%	29.46%	19
	2008	71		71	22.9%	5.77%	18
	2009	135		135	100.0%	24.95%	12
	2010	149		149	92.0%	26.80%	23
	2011	213		213	100.0%	28.51%	13
	2012	217		217	100.0%	33.08%	10
	2013	82		82	100.0%	30.83%	17
	2014	2		2	100.0%	5.88%	5
	2015	5		5	100.0%	20.83%	1

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

Table 18 Number of halibut viabilities taken on *BSAI CDQ pot* vessels by target, and total as a proportion of the number of halibut measured, and of the number l halibut estimated on sampled hauls; and total halibut PSC in the BSAI (without application of a mortality rate)

Trip target	Year	Number of viability assessments (BSAI)	Viabilities as a proportion of all halibut for which a length was collected	Viabilities as a proportion of total number of halibut estimated on sampled hauls	Estimate of total halibut PSC in fishery (total Alaska mt, not mortality)
Pacific Cod	2005	0	0.0%	0.00%	0
	2006	0	0.0%	0.00%	0
	2007	0	0.0%	0.00%	0
	2008	0	0.0%	0.00%	0
	2009	0	0.0%	0.00%	0
	2010	0	0.0%	0.00%	0
	2011	0	0.0%	0.00%	0
	2012	43	98.7%	37.39%	1
	2013	9	91.5%	29.03%	0
	2014	105	97.3%	28.61%	2
	2015	140	98.7%	28.99%	2
Sablefish	2005	311	99.5%	33.59%	8
	2006	218	100.0%	27.56%	9
	2007	142	79.5%	27.52%	5
	2008	6	22.9%	3.17%	2
	2009	44	100.0%	31.43%	1
	2010	45	92.0%	8.35%	4
	2011	82	100.0%	33.74%	1
	2012	3	100.0%	2.48%	1
	2013	49	100.0%	31.21%	1
	2014	0	100.0%	0.00%	0
	2015	7	100.0%	233.33%*	0

Source: NMFS AFSC Observer Program, NMFS Regional Office, data compiled by AKFIN

*Reflects historical separation of observer sampling between catch estimation and viabilities

Historic halibut mortalities used by in-season management

Table 17 provides the total annual halibut mortalities that are calculated for each fishery by the CAS as the product of halibut PSC and halibut DMR. As touched upon briefly in Section 6, these numbers, once calculated, are not revised after improved estimates of annual DMRs are generated. If the history of halibut catches by these fisheries were to be used for allocating PSC or other purposes where an accurate measure of halibut mortality by fishery was desired, the Council may wish to develop a reporting mechanism for incorporating updates into the catch record.

Table 19 Annual Halibut Mortality in metric tons by Area, Gear, and Target

Area	Gear	Target	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
BSAI	HAL	Pacific cod	402	449	569	558	491	478	551	461	401	290	465
BSAI	HAL	Greenland turbot	12	5	1	6	10	5	5	1	1	3	5
BSAI CDQ	HAL	Pacific cod	44	56	79	66	73	68	58	58	37	22	56
GOA	HAL	Pacific cod	325	297	505	377	233	243	200	163	196	217	276

Area	Gear	Target	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
BSAI	Trawl	Atka mackerel	79	185	63	64	54	107	160	66	74	90	94
BSAI	Trawl	Bottom pollock	10	29	90	213	144	141	108	152	76	26	99
BSAI	Trawl	Pacific cod	1,418	1,061	335	258	291	258	468	356	322	277	505
BSAI	Trawl	Alaska plaice	c	2	c	0	1	7	4	24	c	2	6
BSAI	Trawl	Other flatfish	15	75	12	12	c	c	6	c	0	c	20
BSAI	Trawl	Rockfish	29	17	34	32	55	94	68	109	65	61	56
BSAI	Trawl	Flathead sole	329	301	232	167	169	69	83	126	119	47	164
BSAI	Trawl	Kamchatka flounder						89	97	39	14	44	57
BSAI	Trawl	Other species	c	4		c	c						4
BSAI	Trawl	Pelagic pollock	102	242	223	224	114	196	267	104	99	96	167
BSAI	Trawl	Rock sole	796	903	628	619	885	471	371	573	644	483	637
BSAI	Trawl	Sablefish			c	c				c	c		-
BSAI	Trawl	Greenland turbot				6	2	1		c	c	c	3
BSAI	Trawl	Arrowtooth flounder	124	17	127	223	178	169	407	235	182	62	172
BSAI	Trawl	Yellowfin sole	434	503	961	983	841	836	864	1,086	1,228	702	844
Total BSAI	Trawl		3,337	3,338	2,705	2,800	2,735	2,438	2,902	2,870	2,823	1,889	2,784

Table 17 (continued) Annual Halibut Mortality in metric tons by Area, Gear, and Target

Area	Gear	Target	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
BSAI CDQ	Trawl	Atka mackerel	12	16	c	8	c	8	18	11	10	7	11
BSAI CDQ	Trawl	Bottom pollock	c	c	2	6	4	7	2	6	5	1	4
BSAI CDQ	Trawl	Pacific cod		1	c	c	c	3	14	9	7	c	7
BSAI CDQ	Trawl	Alaska plaice						c	c	c			-
BSAI CDQ	Trawl	Rockfish	c	c	9	c	c	1	9	1	4	0	4
BSAI CDQ	Trawl	Flathead sole	c	c		c	13	c	c	c	c	c	13
BSAI CDQ	Trawl	Kamchatka flounder						2	c	-			1
BSAI CDQ	Trawl	Other species						c					-
BSAI CDQ	Trawl	Pelagic pollock	10	20	22	15	6	33	12	10	20	8	16
BSAI CDQ	Trawl	Rock sole	25	84	32	c	28	34	42	39	34	24	38
BSAI CDQ	Trawl	Sablefish		c	c								-
BSAI CDQ	Trawl	Greenland turbot			c					c	-		-
BSAI CDQ	Trawl	Arrowtooth flounder	c	8	c	c	12	c	18	c	9	c	12
BSAI CDQ	Trawl	Yellowfin sole	40	51	56	15	19	68	97	112	116	54	63
Total CDQ BSAI	Trawl		87	180	122	44	82	157	212	189	205	94	137

Area	Gear	Target	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
GOA	Trawl	Atka mackerel		-			c	-		c			-
GOA	Trawl	Bottom pollock	69	79	68	36	18	104	49	137	82	100	74
GOA	Trawl	Pacific cod	346	472	590	288	246	455	527	295	216	481	392
GOA	Trawl	Deepwater flatfish		0			-				-	-	-
GOA	Trawl	Shallow water flatfish	634	717	495	804	437	258	259	163	164	108	404
GOA	Trawl	Rockfish	170	92	106	73	93	72	73	75	82	103	94
GOA	Trawl	Flathead sole	23	16	58	61	162	60	123	28	2	c	59
GOA	Trawl	Other species		-	-	1			-				0
GOA	Trawl	Pelagic pollock	0	2	2	1	14	12	4	20	-	9	6
GOA	Trawl	Sablefish	0	4	4	2	3	4	3	8	1	2	3
GOA	Trawl	Arrowtooth flounder	613	442	519	290	411	796	591	350	791	581	538
GOA	Trawl	Rex sole	129	132	108	274	248	110	78	153	55	29	132
Total GOA	Trawl		1,984	1,956	1,951	1,831	1,633	1,871	1,706	1,228	1,392	1,414	1,697

Table 17 (continued) Annual Halibut Mortality in metric tons by Area, Gear, and Target

	Gear	Target	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Total	HAL		783	807	1,154	1,007	807	794	815	684	635	533	802
Total	Trawl		5,408	5,474	4,778	4,675	4,450	4,465	4,820	4,287	4,420	3,397	4,618
Grand Total			6,191	6,281	5,932	5,682	5,257	5,260	5,635	4,971	5,055	3,930	5,419