GROUNDFISH MANAGEMENT TEAM REPORT ON PROPOSED PACIFIC HALIBUT ELECTRONIC MONITORING DISCARD MORTALITY RATES FOR BOTTOM TRAWL VESSELS

Introduction

In September, the Council tasked the Scientific and Statistical Committee (SSC) with reviewing the Groundfish Management Team's (GMT) proposed methodology for determining Pacific halibut electronic monitoring discard mortality rates (EM DMRs) for bottom trawl gear. If endorsed by the SSC, the GMT will submit a supplemental report that addresses follow-on actions that would be within the purview of the Council and would not require additional SSC review (e.g., options for applying EM DMRs if less than 100 percent video review is adopted).

This report contains four sections pertaining to the SSC review of the GMT's proposed EM DMRs that should be consulted in the following order: (1) background summary of the EM DMR issue; (2) summary of the modeling results that were used to develop the GMT's proposed EM DMRs; (3) the GMT's proposed EM DMR methodology and results; and (4) the GMT's responses to requests from September to possibly improve the methodology.

Section 1: Background summary of EM DMR issue

For observed trawl trips, vessel accounts are debited individual bycatch quota (IBQ) for Pacific halibut north of 40°10' N. lat. based on the viability of the fish that the observer reports. The rates are as follows: excellent = 20 percent mortality; poor = 55 percent mortality; and dead = 90 percent mortality.[1] These rates are also used in estimating mortality coastwide in the West Coast Groundfish Observer Program (WCGOP) Annual Pacific Halibut Bycatch in U.S. West Coast Fisheries reports.[2] The GMT does not propose changing these viability DMRs since they are already established for use in management and are endorsed by the International Pacific Halibut Commission (IPHC); but rather we used the viability data from observed trips to inform our proposed EM DMRs (described in section 3).

In contrast to the viability approach used with observers, halibut caught on EM trips are assigned 90 percent mortality (corresponding with the dead viability category) because video reviewers cannot determine the condition of the halibut using the IPHC key, as it requires hands-on assessment. Given that the current EM DMR of 90 percent is conservative compared to the observer viability approach, and because halibut bycatch can be constraining, the Council requested development of alternative EM DMRs that better reflect the estimated mortality of the halibut discarded on EM trips and more closely align with the rates used on observed trips.

[1] For the dichotomous key on how halibut viabilities are assessed, please see page 27 of the Appendix of the 2017 WCGOP Training Manual.
[2] The latest reports can be found on the Northwest Fisheries Science Center Management Report website.

Section 2: Summary of Pacific halibut viability modeling using observer data

As described above, halibut viability cannot be directly assessed in EM video review, but alternative predictors of halibut condition can be recorded. Previous research on bottom trawl vessels in British Columbia found that halibut viability can be predicted by factors such as the length of the halibut, the time-on-deck, and the tow size and duration (Richards et al. 1994).

As such, the Pacific States Marine Fisheries Commission (PSMFC) examined relationships between halibut viability and these (and other) potential predictors, which were based on data from the west coast bottom trawl fishery during an expanded observer survey that occurred in 2015-2016 (Agenda Item E.6, Attachment 1, September 2017). Observers routinely record halibut viability, fork length, haul depth, haul duration, weight of haul, composition of haul, location, date, and time. For the purposes of this investigation, observers also recorded the time-on-deck for each halibut discarded, since that was a main factor affecting DMRs in previous research studies.

Halibut viability and related predictors were recorded for 12,729 individual halibut from all observed bottom trawl trips from 2015-2016. These halibut were collected from 3,566 hauls on 55 vessels. Three types of trawl gear were used: large footrope (49 percent of hauls); small footrope (13 percent of hauls); and selective flatfish trawl (SFFT; 38 percent of hauls), which are low-rise, small footrope trawls with a cutback headrope.

Relationships between halibut viability and predictor variables were modeled using generalized ordered logistic regression models (GLM models designed for ordinal categorical data with non-proportional odds). An initial analysis using the 2015 data looked only at single variable regression models and showed time-on-deck to be, by far, the strongest single predictor (Table 1). This can be seen in the Akaike information criterion (AIC) model scores (lower is better), which are a metric to determine the relative quality of a set of models to accomplish the best level of fit with as few predictor variables as possible. In short, it balances the benefits of improved fit versus the cost of added complexity. In addition, it is also evident from the plots of raw data that time-on-deck is the main attributor to DMRs (Appendix): amongst the comparisons of the viability distributions for each variable, only time-on-deck exhibited a notable dissimilar pattern that would indicate possible causation.

Based on these results, a small set of multivariable models that included time-on-deck were selected and tested with independent data from 2016. Although there were improvements to AIC scores associated with more complex models (e.g., adding haul duration), the GMT notes that improvements were relatively modest (Table 2) given the added complexity that multiple variable models would present for catch accounting. Further, the results from classification tree to model predictors of halibut viability using 2015-2016 data also showed time-on-deck to be the primary predictor; and while haul duration was included at the final split, it only improved the error rate by one percent.

Fitted single variable regression model values were used to create probability distributions for each individual predictor using the complete data set (both 2015 and 2016 data). The time-on-deck probability distributions were the basis for the GMT's proposed EM DMR approach (discussed in section 4).

In conclusion, time-on-deck was by far the strongest single predictor of halibut DMRs from observed trips, and moving to more complicated models resulted in marginal gains to explanatory power at the cost of added complexity. Therefore, the GMT's proposed EM DMR methodology is based entirely on the fitted time-on-deck model results. Section 3 provides further rationale as to why more complex methods were not used.

Table 1. Single variable model results used to evaluate the relationships of factors affecting halibut DMRs on observed trips. Note that time-on-deck was by far the strongest predictor.

Model	Odds E|PD	Odds EP|D	AIC	logLikelihood	deltaAIC
VIABILITY ~ log(TIME_ON_DECK)	0.333 *	0.364 *	10275.51	-5133.756	0.000
VIABILITY ~ log(HAUL_DURATION)	0.287 *	0.275 *	11965.67	-5978.836	1690.162
VIABILITY ~ AVG_DEPTH	0.996 *	0.996 *	12411.04	-6201.52	2135.530
VIABILITY ~ log(CATCH_WEIGHT)	0.817 *	0.779 *	12524.32	-6258.162	2248.813
VIABILITY ~ LENGTH_CM	1.006 *	1.005 *	12633.88	-6312.938	2358.365
VIABILITY ~ log(ROCKFISH_PERCENT)	0.982	0.966	12642.32	-6317.161	2366.812

Table 2. Multiple variable model results used to evaluate the relationships of factors affecting halibut DMRs on observed trip.

Model	AIC	logLikelihood	deltaAIC
VIABILITY ~ log(TIME_ON_DECK) + log(HAUL_DURATION) + LENGTH_CM + log(CATCH_WEIGHT)	10198.99	-5089.496	0.000
VIABILITY ~ log(TIME_ON_DECK) + log(HAUL_DURATION) + LENGTH_CM	10199.13	-5091.563	0.134
VIABILITY ~ log(TIME_ON_DECK) + log(HAUL_DURATION) + log(CATCH_WEIGHT)	10209.26	-5096.63	10.268
VIABILITY ~ log(TIME_ON_DECK) + log(HAUL_DURATION)	10210.76	-5099.378	11.765
VIABILITY ~ log(TIME_ON_DECK)	10486.97	-5239.486	287.980

Section 3: The GMT's proposed EM DMR methodology

This section summarizes the GMT's proposed EM DMR methodology from September (Agenda Item E.6.a, Supplemental GMT Report 1, September 2017) that was forwarded by the Council for further review (Agenda Item E.6, Draft Council Motion, September 2017). The GMT's proposed EM DMR methodology is based on the modeling of halibut viability using observer data (Section 2) that showed viability was predominantly affected by time-on-deck compared to the other factors that were evaluated (fish length, tow duration, tow depth, fish weight of tow, ratio of spiny finned fish in tow).

While more complicated models than time-on-deck were more parsimonious (Table 2), the GMT did not believe that the benefits of more complicated models than time-on-deck alone (i.e., slightly greater ability to predict DMRs of individual discards) outweighed the costs of added complexity for catch accounting (discussed more below).

The GMT's proposed EM DMR methodology is based on the fitted probabilities from the time-on-deck model (Figure 1). For any given time-on-deck, there is a probability that a halibut could be of excellent, poor, or dead viability, and these likelihoods all sum to one. Since each viability condition has a different DMR, and the probability of each viability occurrence changes with time-on-deck, the GMT's proposed EM DMR method weights the probability of each viability by its respective DMR (Figure 1).

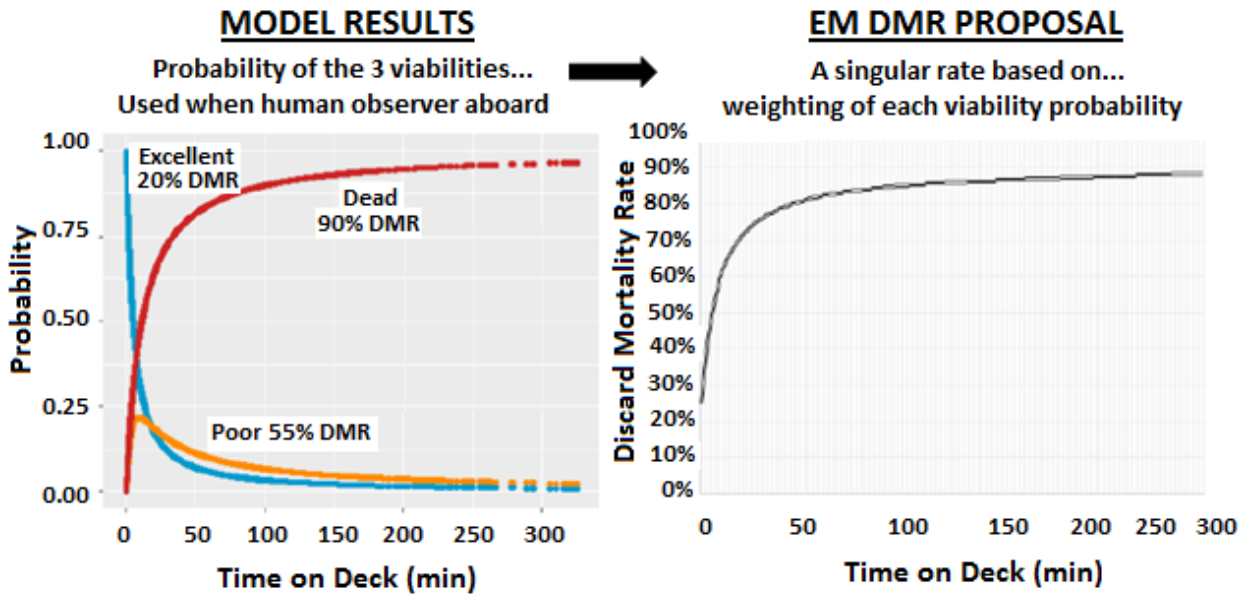


Figure 1. Basis for the time-on-deck GMT's EM DMR proposal.

The GMT's proposed EM DMR formula based on time-on-deck is as follows:
DMR = ProbabilityExcellent.20 + ProbabilityPoor*.55 + ProbabilityDead*.90*

An example of the proposed EM DMR at 5 minutes is as follows:
49.6% = (47.7% *ProbabilityExcellent* * 20% ExcellentDMR) + (20.2% ProbabilityPoor * 55% PoorDMR) + (32.1% ProbabilityDead * 90% DeadDMR) = 49.6%

The GMT believes that our proposed EM DMR approach should accurately represent fleetwide mortality since it is based on the assumption that EM trips should be similar to observed trips (per basis of modeling) under the same time-on-deck conditions. This was verified after validation testing of our proposed EM DMR methodology (described in Section 4).

However, the GMT does note that since time-on-deck is not a perfect predictor, there will be discrepancies at the individual fish level between the EM DMR proposal and the current viability approach used with observers (i.e., sometimes EM will give a higher rate than observers would have and vice versa). In other words, there are factors other than time-on-deck that are influencing DMRs, especially during earlier times-on-deck (e.g., 0-25 minutes), as this is when halibut have a fairly good chances of being excellent, poor, or dead.

Although the predictability of DMRs at the individual fish level could possibly be improved by moving to a multiple variable EM DMR method (per model results that had multiple variable models being more parsimonious), the discrepancies at the individual fish levels with just time-on-deck would be expected to "average-out" with higher sample sizes, which should provide accurate estimates of DMRs at broader levels (i.e., fleet-wide basis and for long-term vessel-specific) that are the main catch accounting objectives. As such, moving toward a more complicated method that could better pinpoint the DMRs of individual discards is not expected to result in much additional benefit to the broader level catch accounting primary goals (i.e., fleet-wide or long-term vessel-specific). These are the main reasons why the GMT does not believe the benefits of moving toward a more complex approach outweigh the costs of added complexity for catch accounting.

In conclusion, the GMT believes that our proposed EM DMR methodology would meet four primary goals: (1) accurately represent fleetwide mortality, which is a main objective to ensure that removals stay within the quotas used to sustainably manage the halibut stock; (2) accurately represent long-term vessel-specific DMRs, which is important for individual fishing quota; (3) would create incentive for fishermen to release halibut as quickly as possible to reduce discard mortality; and (4) the resulting "savings" could be utilized by fishermen to increase attainments of healthy target stocks.

Section 4: GMT responses to requests from September

In September, the Groundfish Electronic Monitoring Policy Advisory Committee (GEMPAC) and GMT noted additional requests or items for further research (Agenda Item E.6.a, Supplemental GEMPAC Report, September 2017; Agenda Item E.6.a, Supplemental GMT Report 1, September 2017).

The GMT responses to these requests are addressed below. Note that only requests 1 through 3 pertain to the GMT's proposed EM DMR methodology that the SSC is being tasked with reviewing. Other requests that pertain to follow-on actions by the Council are labeled as "follow-on" since they are not critical to the SSC review, but could be of interest to those reviewing the EM DMR proposal.

Request 1 (SSC): Validate the GMT's proposed EM DMR results to the viability approach currently used with observers

As previously discussed, the GMT believes that our proposed EM DMRs based on time-on-deck should accurately represent the overall mortality rate from observed trips as a whole. While there may be discrepancies at individual fish level, the overall mortality should "average out" across the fleet, and also to individual vessels in the long run.

To test if this was true, the GMT compared the results from our proposed EM DMR methodology to the results of the viability approach using the same fish. In 2016, the WCGOP placed observers on a subsample of EM bottom trawl vessels to assess viabilities of discarded halibut. Based on those viabilities, WCGOP calculated an overall DMR of 68 percent for 12 trips, consisting of 27 hauls and 80 discarded halibut (Appendix E of Agenda Item E.1.b, NMFS NWFSC Report 3, September 2017). The GMT applied the proposed GMT EM DMR method to

these same fish (i.e. plugged time-on-deck for the same fish observed on EM trips into our formula), which resulted in a 62 percent overall DMR.

These results were promisingly similar, as some difference would be expected given the difference in methods and the low sample size of boats with both EM and observer. Note that these validation trips were not included in the model results used to develop the GMT's proposed EM DMR methods as to not introduce bias and create a truly independent test.

Request 2 (SSC): Investigation to whether different types of bottom trawl affect DMRs
The GEMPAC hypothesized that the type of bottom trawl gear (large vs. small roller vs. SFFT) could affect DMRs and requested evaluation of viability by gear type; however, this does not appear to be the case (not different by gear) as the distributions by gear are similar (Figure 2). Although large footrope appears to have a slightly higher relative proportion of dead viability fish during early times-on-deck (e.g.,0-15 minutes), the GMT believes that the difference was not large enough to warrant a change to EM DMR methodology.

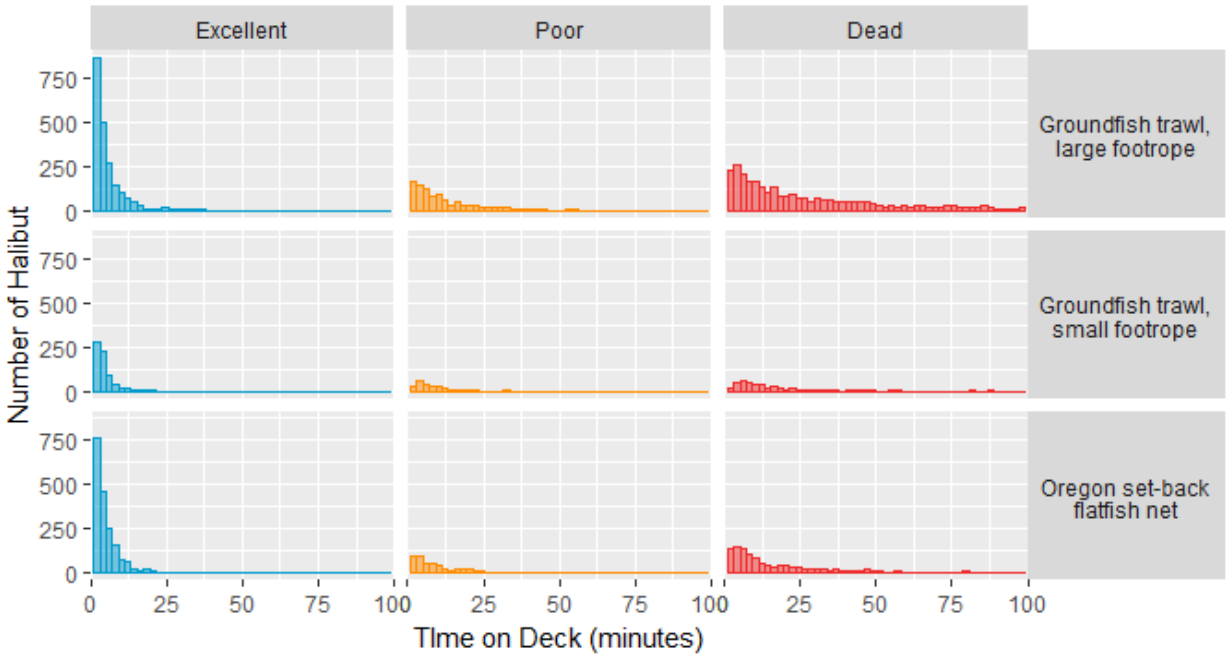


Figure 2. Comparison of the time-on-deck distributions by bottom trawl type. The overall shapes of the distributions are important to compare, not the counts.

Request 3 (SSC): Exploration of the geographic location of the data used in the analysis. Based on discussions in September, the GMT wanted to assess if the data used in the modeling that formed the basis of the GMT's proposed EM DMRs was spatially representative. Since the data used in developing the rate included all observed bottom trawl halibut discards, the modeling and proposed EM DMRs are spatially representative of the most recent fishing years (Figure 3), which presumably would be most similar to future years. However, as the overall spatial distribution of the IFQ trawl fishery has been changing, future periodic checks to ensure that the data used in the modeling remains spatially representative would be beneficial.

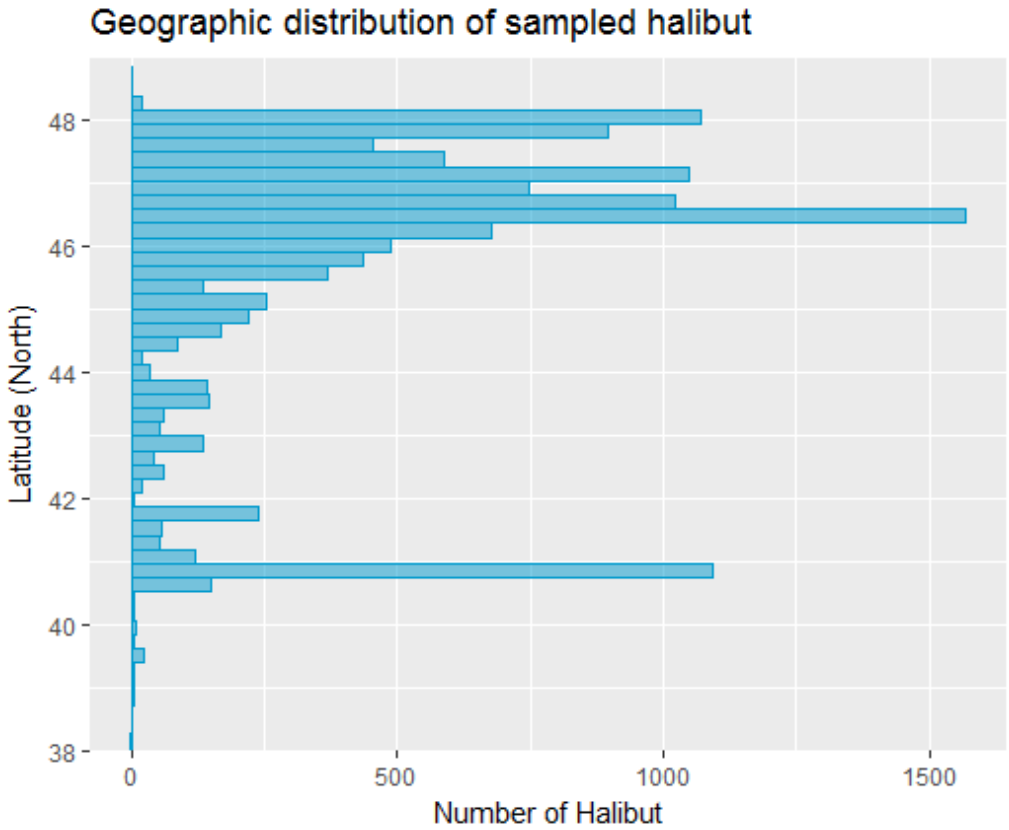


Figure 3. Latitudinal distribution of halibut included in viability modeling (2015-2016 observer data).

Request 4 (follow-on): Approach for applying EM DMRs if less than a 100 percent EM review rate were adopted

Currently, 100 percent of the video collected during EM hauls is reviewed to generate discard estimates, including those for Pacific halibut. The GMT's EM DMR proposal is based on that practice continuing as time-on-deck recorded by video reviewers is the main contributor to mortality rates. However, when developing EM regulations, the Council directed the National Marine Fisheries Service (NMFS) and Council staff to work with the GMT, GEMPAC, Groundfish Electronic Monitoring Technical Advisory Committee (GEMTAC), and other advisory bodies to develop a process for reducing the level of video review to a minimum level necessary to audit logbooks (April 2017 Decision Summary).

While it is the GMT's understanding that there is still ongoing work on this process, it did raise the question of how to account for not having time-on-deck data for every halibut if there is a shift to less than 100 percent review. The GMT will discuss possible solutions in Agenda Item F.11.a, Supplemental GMT Report 2, November 2017. For example, if a halibut is recorded on the discard logbook, that would prompt an automatic review so that time-on-deck could be recorded.

Request 5 (follow-on): Investigation into available non-whiting midwater trawl halibut mortality data and applicability of proposed EM DMR

In September, the GEMPAC recommended and the Council approved that only proposed EM DMRs for bottom trawls be forwarded for further review (Agenda Item E.6.a, Supplemental GEMPAC Report, September 2017; Agenda Item E.6, Draft Council Motion, September 2017). However, the GEMPAC requested in April 2017 development of EM DMRs for both bottom and non-whiting midwater trawls (Agenda Item F.2.a, Supplemental GEMPAC Report, April 2017).

The GMT does not recommend that our proposed EM DMRs for bottom trawls be used for non-whiting mid-water trawls at the current time. Since time-on-deck data does not exist for mid-water trawls in relation to viability (i.e., expanded 2015-2016 observer survey was for bottom trawls only), the GMT does not recommend modeling be conducted for mid-water trawls at this time. In other words, while time-on-deck can be recorded for EM mid-water trawls during video review, it is unknown how time-on-deck relates to halibut viability since there are no observer comparisons available.

Request 6 (follow-on): Explore whether or not this approach would be applicable coastwide

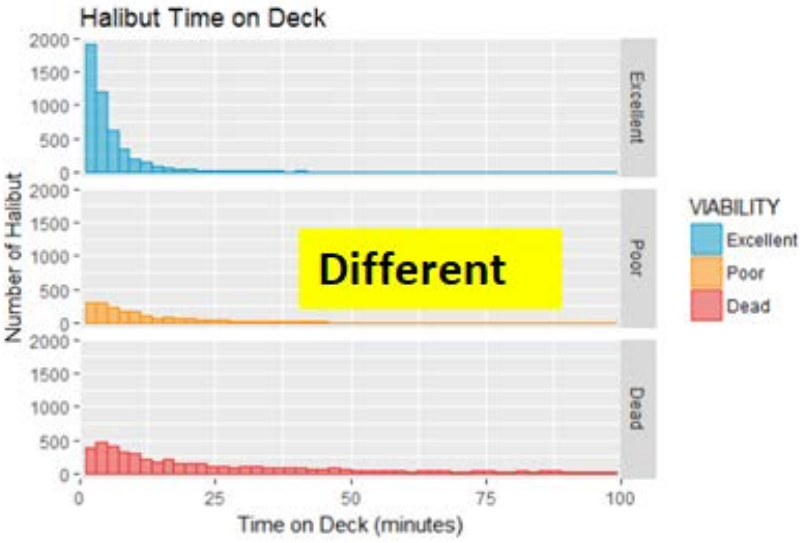
Initially, the proposal to determine a lower DMR for EM bottom trawl vessels was in part to help make bottom trawl trips using EM more viable, as the current 90 percent DMR was too limiting. However, there is only IBQ for north of 40° 10' N. latitude, as the area to the south is managed with a set-aside. The GMT does not see a reason why the same EM DMRs would not be applicable for both areas since that modeling used to inform the EM DMRs included all observed coastwide bottom trawl trips from 2015-2016. While the majority of the halibut in the study that informed the EM DMR approach were caught north of 40° 10' N. lat. (> 99 percent), the small sample from south of 40° 10' N. showed similar patterns of time-on-deck in relation to viability.

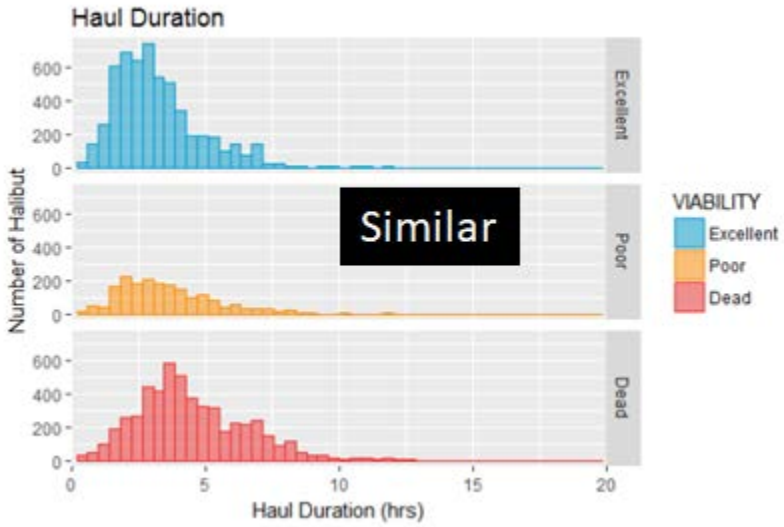
In Agenda Item F.11.a, Supplemental GMT Report 2, the GMT will further discuss why we believe that the proposed EM DMR proposal should be used coastwide, as it may provide incentive for fishermen to release halibut as quickly as possible (as opposed to the current 90 percent assumption, regardless of actual viability). Further, having consistent methodologies is preferable when possible.

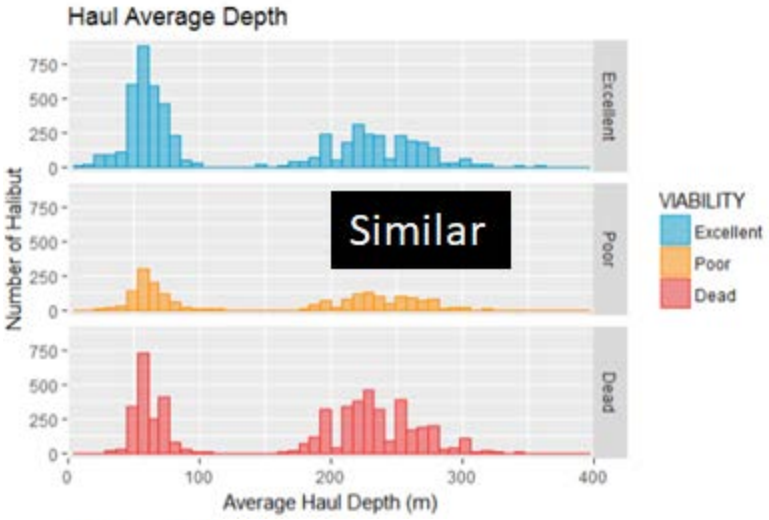
Works Cited:

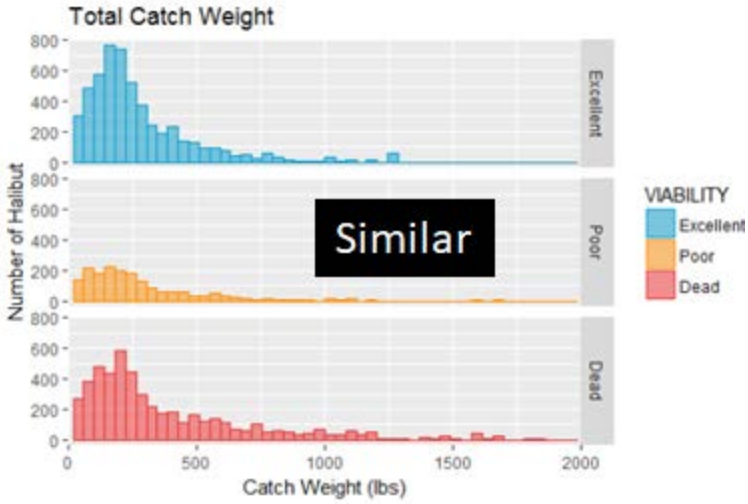
Richards LJ, Schnute JT, and J Fargo. 1994. Application of a generalized logit model to condition data for trawl-caught Pacific Halibut, Hippoglossus stenolepsis. Canadian Journal of Fisheries and Aquatic Sciences 51: 357-364

APPENDIX:
Raw distributions of halibut viability by the factors investigated to possibly affect halibut DMRs on observed trips






Haul Average Depth
Number of Halibut
Excellent
Poor
Dead
Similar
VIABILITY
Excellent
Poor
Dead
0
250
500
750
0
100
200
300
400
Average Haul Depth (m)


Total Catch Weight
Number of Halibut
Excellent
Poor
Dead
Similar
VIABILITY
Excellent
Poor
Dead
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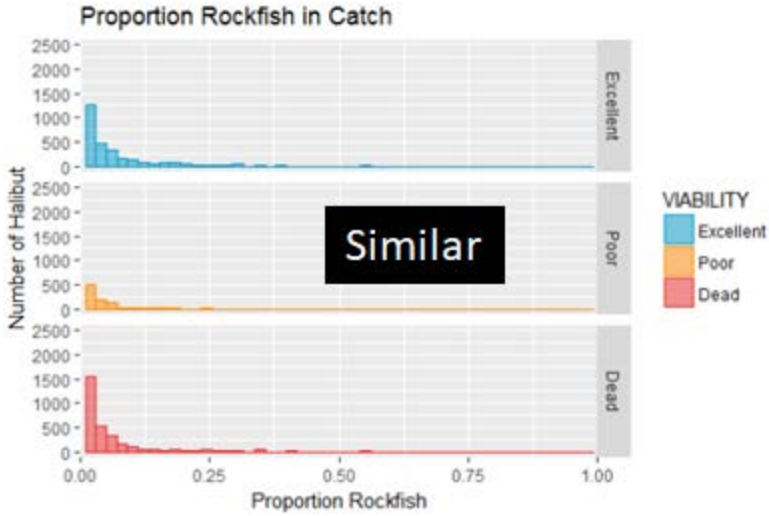
400
600
800
0
500
1000
1500
2000
Catch Weight (lbs)


Proportion Rockfish in Catch
Number of Halibut
Excellent
Poor
Dead
Similar
VIABILITY
Excellent
Poor
Dead
0
500
1000
1500
2000
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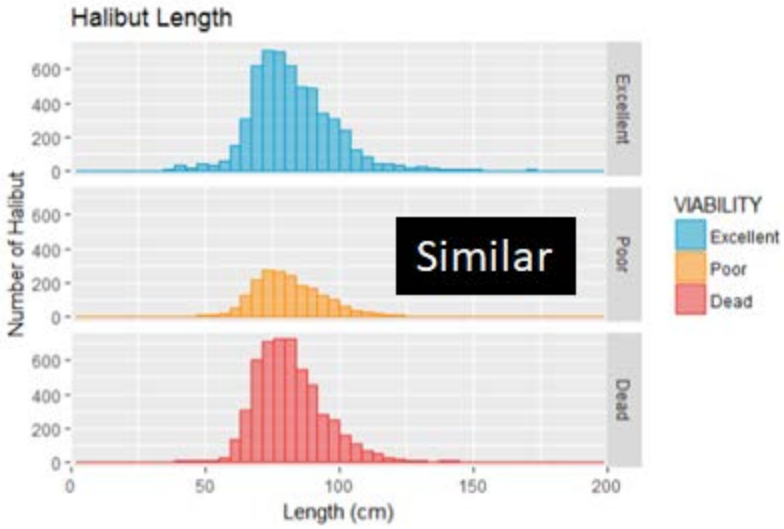
0.25
0.50
0.75
1.00
Proportion Rockfish


Halibut Length
Number of Halibut
600
400
200
0
Excellent
Poor
Dead
Similar
0
50
100
150
200
Length (cm)
VIABILITY
Excellent
Poor
Dead

PFMC
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