Final Report on EFP 12-01: Halibut deck sorting experiment to reduce halibut mortality on Amendment 80 Catcher Processors

John Gauvin
Fishery Science Projects Director
Alaska Seafood Cooperative

December 1, 2013

<u>DRAFT Final Report on EFP 12-01: Halibut deck sorting experiment to reduce halibut mortality on Amendment 80 Catcher Processors</u>

<u>Executive Summary</u>:

Exempted fishing permit (EFP) 12-01 expanded upon EFP 09-02's initial effort to explore ways to reduce halibut bycatch mortality rates on Amendment 80 (A80) trawl catcher processors through on-deck sorting of halibut. An objective of the 2012 EFP was to conduct testing on a wider subset of Amendment 80 fisheries, vessel sizes, and weather conditions over a longer time span to gain further insight into the feasibility and practicality considerations of incorporating these modified halibut catch handling protocols into A80 fishery operations. Another focus was to improve upon the procedures used in the 2009 study to estimate halibut mortality rates in a manner that avoids potential bias through the study methods themselves. To do this, one out of five deck-sorted halibut were randomly selected for length and viability assessment instead of the census approach used in 2009. The switch to sampling was done to avoid holding halibut out of water for a prolonged period prior to viability assessment which we suspect upwardly biased mortality rates on some tows in the 2009 EFP. Finally, to evaluate the precision and accuracy of the sample-derived halibut weight estimates, all halibut were collected post sampling on 20% of the EFP tows to compare census versus sample-derived weight estimates of deck-sorted halibut.

To evaluate the changes in fishing operations and catch handling methods employed to reduce halibut mortality associated with the project, we worked with EFP participants this time to ensure the testing included high catch rate (of target species) fisheries (e.g. rock sole, yellowfin sole). Similarly, the 2012 study also involved a larger subset of A80 vessels including those in both the largest and smallest length classes. These steps were taken to help evaluate the degree to which the relatively high efficiency of halibut sorting on deck and significant reduction on halibut mortality rates observed in the 2009 EFP were attributable to the target fisheries and vessels evaluated in the 2009 EFP. Also new for this 2012 EFP, time stamps were recorded for all sampled halibut to evaluate the effects of time out of water on halibut condition.

As in 2009, halibut mortality estimated from the EFP viability assessments were compared to the mortality estimates calculated using the "official" IPHC trawl discard mortality rates. Any "savings" (difference between the EFP derived estimates and the "official" estimates) would, in theory, be available to participants to extend fishing operations and thereby increase groundfish harvests and revenues to EFP participants to help cover the costs of participation in the study.

The 2012 EFP field work was conducted intermittently between May 27 and September 19, 2012 on four Amendment 80/Alaska Seafood Cooperative (AKSC) vessels: F/T *Arica*, F/T *Constellation*, F/T *Vaerda*l, and the F/T *US Intrepid*. Primary target fisheries included yellowfin sole (in "fall" fishing mode), arrowtooth flounder, flathead sole and rock sole and to a lesser extent P. cod, bottom pollock and rex sole. All the EFP vessels used their own groundfish and halibut PSC allocations issued through their Alaska Seafood Cooperative membership for the fishing done during the EFP.

<u>Summary of Results:</u> Across all vessels and target fisheries (98 hauls), 81% of the halibut by number and 87% by weight were sorted out of the catch on deck. The average halibut mortality rate for the deck-sorted halibut was approximately 57%. On average 6.1 halibut returned to the water per minute compared to 2.2 halibut during the 2009 EFP. The halibut sampling methodology prevented sorting delays on most hauls, but backlogs of halibut awaiting measurement and assessment did still occur on a few hauls with very high halibut catch rates.

In total, the participating vessels caught 1,890 mt of groundfish, 74.44 mt of which was halibut (3.9%). The total halibut mortality during the EFP was 47.59 mt (~87% of the halibut mortality that AKSC dedicated to the EFP from its 2012 A80 allocation). Total mortality accounted for on deck was 39.09 mt (57.1% avg. mortality rate on "standard" hauls) while the total mortality accounted for in the factory was 8.50 mt (89.4% average mortality rate). The halibut mortality based on official DMR's applied to the target fisheries of the EFP would have been 58.36 mt. Therefore, the modified catch handling procedures resulted in an estimated "savings" of 10.77 mt of halibut mortality. By savings is meant halibut mortality that would have occurred had the halibut been handled under the procedures normally required in the A80 fisheries. Accordingly, with the lower mortality rates, additional fishing opportunity would have been available to the EFP participants under the construct of the exempted fishing permit. With participants not utilizing their entire A80 halibut caps again in 2012, however, no actual additional fishing opportunity occurred as a result of the EFP.

Disregarding "non-standard" hauls where halibut were temporarily collected in lieu of being released immediately to evaluate the sampling methods, the overall EFP mortality rate was 61.0% compared to the 78.3% official DMR which would have been in place outside of the EFP based upon the fisheries which were targeted. Finally, an important result of the study was that halibut mortality was shown to increase with time out of water, with 20-30 minutes out of water being the critical time window for effective mortality reduction.

Garnered from post-EFP interviews, the general consensus from skippers and vessel personnel was that halibut deck sorting to reduce mortality would be more practical in fisheries with relatively smaller haul sizes (≤ 30 mt) and where larger, hence easier to sort halibut are encountered. The larger halibut make it easier for the catch to be sorted on deck in a timely fashion (within the 20-30 minute critical time window) so as not to negatively affect the efficiency of their fishing and processing operations while also sufficiently reducing halibut mortality. At the same time, <u>sorting of halibut on deck under the same catch accounting procedures of the EFP was not thought to be adaptable to **all** Amendment 80 fisheries</u>. The major issue for EFP participants was that deck sorting in high volume fisheries with high halibut bycatch (e.g. rock sole) would only be feasible and likely beneficial with modifications to the EFP protocols. Additionally, deck sorting in high catch fisheries with low bycatch (e.g. yellowfin sole, even in the fall when halibut catch rates are "relatively high") would offer considerably less benefit given the time and effort necessary for minimal mortality reduction or "savings". Also noted was how harsh weather conditions could restrict the on-deck duties of sea samplers or observers to quantify and/or assess deck-sorted halibut. This would negatively affect fishing operations.

The EFP results and feedback from the skippers on feasibility will be useful in considering potential future applications of some or all of the changes in fishing and catch handling methods employed in the EFP to the regular Amendment 80 fishery. Several potential future pathways for reducing halibut mortality and addressing the concerns of the EFP skippers could be approached including: (1) Focus the effort on sorting halibut on deck to the lower catch rate fisheries (e.g. flathead sole, bottom pollock, cod, arrowtooth, rex sole); (2) deck sort in the higher catch rate target fisheries also (e.g. rock sole and possibly yellowfin which require more time and effort to deck sort halibut) <u>but</u> remove the EFP's prohibition of running fish over the factory flow scale until sorting on deck was completed and a sea sampler was present in the factory (this was a significant factor affecting operational efficiency and time lost to processing); (3) consider ways to allow deck sorting during the critical time window of 20-30 minutes for any and all A80 fisheries where halibut catch is an important driver. For the 20-30 minute time window approach, a "sorted on deck" halibut mortality rate could be applied to halibut sorted on deck and a default IPHC rate to those found in the factory; (4) in the long run, vessel rebuild designs could allow for better catch accounting and reduced handling of deck-sorted halibut and provide more sheltered areas and safer deck conditions for observers; (5) Electronic monitoring (EM) technology to quantify halibut deck sorted within the 20-30 critical time window (this would alleviate the need for an extended on-deck sea sampler/observer presence as occurred in the EFP, allowing for normal factory operations to occur without time delays); EM could also be utilized in the factory to ensure no discarding of halibut while the observer/sea sampler was performing on-deck duties, also allowing for normal factory operations.

EFP 12-01 Draft Final Report: Halibut Deck Sorting on Amendment 80 Vessels to Reduce Halibut Mortality

Exempted fishing permit (EFP) 12-01 built upon EFP 09-02 to evaluate halibut mortality rates for halibut sorted on deck and continued to explore the practicality and feasibility of sorting and assessing halibut viabilities on deck as a means to reduce halibut bycatch mortality rates on Amendment 80 (A80) trawl catcher processor vessels fishing in the Bering Sea.

Project Objectives

A main objective of EFP 12-01 was to expand upon the 2009 EFP and further evaluate the degree to which changes in fishing and catch handling procedures are feasible and effective in reducing halibut mortality rates on A80 vessels. EFP catch handling procedures allowed sorting of halibut from the catch on deck. Halibut removed in the trawl alley were slid onto specially constructed sampling stations where sea samplers measured lengths and assessed viabilities on a sample of the halibut before returning them to the sea via an overboard chute. The participating vessels made improvements from 2009 by elevating the measuring tables (or chutes) to a more comfortable working position for the sea samplers, making it more feasible for sea samplers to assess viabilities and return the halibut to the water as quickly as possible.

In an effort to expand upon what was learned in 2009, the goal of this EFP was to test the improved procedures over a wider range of A80 fisheries with varying amounts of halibut bycatch in various weather conditions at different times of the year (within the time window allowed by the EFP), and on vessels of different sizes. These factors along with species composition, halibut size, catch volume, haul duration, deck space, and vessel configuration would be useful for evaluating the effectiveness, practicality, and feasibility of sorting halibut from the catch on deck to reduce halibut mortality.

One of the key variables affecting halibut viabilities is thought to be the amount of time the fish spend out of water prior to being assessed by the on-board sea samplers, or observers in the case of normal A80 fishing. Under the 2009 EFP, the sea samplers were required to collect lengths and assess viabilities on all halibut sorted from the catch on deck. Collecting halibut data from every halibut (census) proved to be time consuming for the earlier EFP, and on some hauls there were backlogs of halibut awaiting length and viability assessments by the sea samplers which likely affected the mortality estimated. To avoid this problem, the 2012 fieldwork employed a sampling design to expedite data collection, keep pace with the crew's sorting, and move the halibut overboard as quickly as possible. Instead of a census, one out of five deck-sorted halibut were randomly selected for length and viability assessment. The 20% sampling fraction selected for the EFP was derived from a power analysis conducted on the 2009 data. The sampling approach was detailed in the application for the 2012 EFP wherein it was shown that 20% of the halibut sampled randomly throughout the flow of fish from a haul was expected to provide reasonable accuracy for estimating catch and viabilities. A sample size of 20% was also expected to be workable in terms of the time needed to collect data from the halibut. The sampling design for 2012 allowed sufficient time for sea samplers to record time of assessment for each fish from which data were collected. This allowed us to collect data to gain a better understanding of the effects of time out of water on halibut condition, something that was not possible to do in the 2009 EFP due to the census approach used.

Finally, for the 2012 project, all halibut were collected post sampling on 20% of the tows (referred to as non-standard tows in the EFP) so the census versus sample weight of deck-sorted halibut could be compared.

To gain insights regarding the practicality and feasibility of sorting halibut on deck, EFP captains and mates and other key crew members (e.g. factory managers) were interviewed following the fieldwork on each EFP vessel. These informal interviews enquired how the EFP activities and requirements affected the pace of fishing and fish processing operations on the vessel. Specific areas that were addressed in the interviews included how the tow size (quantity of fish per tow) in combination with sorting halibut on deck affected labor shifts on the vessel for deck and factory workers, how time needed to deck sort halibut affected vessel operations, and how the requirement that no fish could be moved out of the tank until the deck sorting was completed affected the flow of fish and economics of fishing. The interviews also asked participants how methods could be improved if additional work is done to evaluate ways to reduce halibut mortality on A80 vessels in the future. In this regard, captains and mates/other key crew members were also requested to provide suggestions regarding how future changes in vessel design might affect the practicality of deck sorting halibut.

Methods

EFP Catch Handling and Data Collection Procedures

The specific catch handling protocol and procedures for halibut sorting, viability assessment and accounting for the EFP were as follows:

1. Once EFP fishing commenced on a vessel, all hauls by the vessel followed the catch handling and accounting procedures of the EFP until the vessel's EFP activities concluded. Vessels were not allowed to switch back and forth between EFP and normal A80 fishing once EFP fishing began.
2. For each EFP tow, the codend was brought on deck and pulled forward of the live tank hatches to create sufficient space to sort halibut from the catch as the codend was dumped into the live tank.
3. Sea samplers were always present on deck whenever any EFP-authorized halibut sorting was occurring, from the moment the codend zipper was opened until the last fish were dumped into the live tank and the halibut sorting and sampling was completed.
4. The codend zipper was opened in a manner that achieved a reasonable rate of flow out of the codend to allow halibut to be sorted out of the catch by the deck crew and slid from the trawl alley to the specially constructed holding bin adjacent to the halibut measurement and assessment station. Only halibut were removed from the catch on deck and they were slid instead of lifted whenever possible so as to minimize injury/mortality.
5. Crew members ensured that the halibut were moved into the sampling area at an appropriate pace so as not to overwhelm the sea sampler with halibut. One crew member was always stationed at the holding bin in order to slide halibut to the measuring table/chute under the direction of the sea sampler. This was done in a manner which provided the sea sampler with adequate time to collect and record length, viability, and time data on halibut selected for sampling.
6. Sea samplers used specially designed, randomized EFP deck sheets to record all data and to determine which halibut would be sampled on "standard" hauls.
7. For "standard" hauls the sea samplers counted all halibut and recorded length, viability, and time data for one in five halibut selected randomly using the special EFP deck sheets.
8. Sea samplers randomly selected one in five hauls to be "non-standard" hauls. For these "non-standard" hauls (length census), the sea samplers counted and recorded lengths of all halibut using the special EFP deck sheets. No viability or time data was recorded on "non-standard" hauls.

9. Following the completion of halibut sorting and data collection on deck, the sea sampler moved to the processing area below deck to account for and assess viabilities for halibut missed during deck sorting. Once the sea sampler was present at the sorting belt in the factory, the processing crew could begin running fish out of the live tank. A sea sampler was always present while sorting occurred in the factory or on deck. Only one sea sampler was on duty at any given time, therefore sorting never occurred simultaneously on deck and in the factory.
10. Crew members assisted sea samplers in removing halibut from the sorting belt in the factory. Just prior to the point of discard, the sea samplers collected length and viability data on all halibut missed during sorting operations on deck.
11. In addition to halibut length, viability, and time data, the sea sampler recorded the time at which the net was brought on deck and the amount of time which elapsed during sorting and accounting for halibut both on deck and in the factory. On deck, the “sorting time” started when the codend zipper was opened and ended when the entire catch was dumped into the live tank and all halibut sampling was completed. In the factory, the “sorting time” started when the first fish from the haul flowed out of the live tank and ended when the last fish from the haul passed over the flow scale and all halibut sampling was completed.
12. Upon completion of each haul, the sea sampler provided all raw data (halibut counts, lengths, viabilities, and time data) to the project manager for entry into the EFP spreadsheet. Once the raw data was entered, the EFP spreadsheet automatically calculated halibut weights and mortalities both on deck and in the factory for each haul. The weight and mortality figures were calculated using the standard IPHC length/weight conversion table and standard formula for calculating DMR for halibut caught by trawl gear.
13. The project manager provided the total factory halibut weight for each haul to the vessel observers for subtraction from the flow scale weight used for ATLAS reporting to NMFS. The observers did not collect or report any halibut data for EFP hauls.

Prior to leaving the dock to begin EFP fishing trips on each of the four participating vessels, the field project manager, Mr. Joe Colling, a former fishery observer and currently working as a project manager for the PI on various field research projects, facilitated a pre-cruise briefing attended by North Pacific Groundfish Observer Program (NPGOP) staff, EFP vessel captains, key crew members, sea samplers, and observers. The purpose of the briefings was to ensure that everyone involved fully understood the catch handling and accounting procedures and the roles and responsibilities of crew members, sea samplers, and observers during EFP fishing. Copies of the Exempted Fishing Permit and the briefing summary sheet outlining roles, responsibilities, and catch handling procedures were distributed to all those attending the briefings. Following the briefing, time was made available for questions and concerns. In several of the briefings, captains raised the issue of what to do in case killer whales or other fish-eating marine mammals were observed attempting to feed on released halibut. While not a formal procedure of the EFP, Mr. Colling advised in the briefings that the captain consider moving the vessel to another location to avoid whale predation on released halibut.

In addition to the briefing by the EFP field project manager, the NPGOP staff specifically briefed the observers independently with regard to differences in observer data collection and reporting during EFP fishing.

Halibut sampling stations and off-board chutes

Prior to the start of EFP fishing, each participating vessel company was responsible for the design and construction of a deck sampling station that included a halibut holding bin, measurement surface, and off-board chute. Based on feedback from the 2009 EFP, the measurement tables/chutes were elevated to some degree in order to provide a more comfortable sampling position for the sea samplers. The photos in Figure **1** show the different designs and orientations of the sampling stations on each of the four EFP vessels.

Figure 1. Vessel sampling stations. *Vaerdal* (top left), Arica (top right), *Constellation* (bottom left), and *US Intrepid* (bottom right)

EFP Data Accounting and Calculations

Data recorded for each haul included haul number, date, total halibut count, halibut lengths, halibut viabilities, halibut time stamps (time of assessment), time the net came on board, sorting start time, and sorting end time. The sea samplers recorded all deck and factory data on specially designed waterproof EFP deck sheets. Boxes on the sheets indicated which fish should be selected based on the one in five or 20% sampling. The boxes for fish selected for sampling were designed to have sufficient room to record the data collected from each fish and boxes with the outline in bold indicated that data should be collected for that fish. Five different versions of these deck sheets with different sampling selections were printed and then the sheets were pooled and shuffled to randomize them so that the fish selected for sampling were randomized in order to prevent crew selection bias for fish that would be sampled throughout the EFP. Data for each haul were entered into the project spreadsheet.

The project manager provided the total factory halibut weight for each haul to the observers on board for subtraction from the flow scale weight used for ATLAS reporting to NMFS. In addition, the project manager summarized the data, tracked halibut mortality, and provided haul by haul or daily data updates to the permit holder, vessel captain, and the data management personnel of the vessel owner.

For "standard" hauls, halibut catch and mortality were calculated in the following manner:

1. Estimated weight of halibut sorted on deck: This was calculated by converting the length of each sampled halibut to a weight using the IPHC standard length/weight conversion and then dividing the sum of the weights by the number of halibut sampled. The average weight of deck halibut in the tow was then multiplied by the total number of halibut sorted on deck.
2. Estimated mortality of halibut sorted on deck: As per IPHC standards, the weight of each sampled halibut assessed as "excellent" was multiplied by 0.20, "poor" by 0.55, and "dead" by 0.90. The resultant sum of mortality of the sampled halibut was then multiplied by the estimated total weight of halibut sorted on deck (#1 above).
3. Weight of halibut collected in the factory (missed during deck sorting): The length of each halibut collected in the factory was measured and converted to a weight using the IPHC standard length/weight conversion. These weights were summed to calculate the total factory halibut weight.
4. Mortality of halibut collected in the factory (missed during deck sorting): The viability of each halibut collected in the factory was assessed and the mortality rate of each fish (using the mortality scores of "excellent" = 0.20, "poor" = 0.55, and "dead" = 0.90 determined by the sea samplers) was multiplied by its weight (#3 above). The resultant mortality weights were summed to calculate the total factory mortality.
5. Total mortality of halibut for EFP haul: Sum of #2 and #4 above.

For "non-standard" hauls where all halibut were measured for the purpose of evaluating the precision of sampling procedures, halibut catch and mortality were calculated in the following manner:

1. Weight of halibut sorted on deck: All halibut were measured and lengths were converted to weights using the IPHC standard length/weight conversion. These weights were summed to calculate the total deck halibut weight.
2. Mortality of halibut sorted on deck: Total halibut weight (#1 above) was multiplied by the published mortality rate (Table 2) for the fishery target assigned to the haul as was determined by the predominant species in the observer sample.
3. Weight of halibut collected in the factory (missed during deck sorting): Same procedure as for "standard" hauls, the length of each halibut collected in the factory was measured and converted to a weight using the IPHC standard length/weight conversion. These weights were summed to calculate the total factory halibut weight.
4. Mortality of halibut collected in the factory (missed during deck sorting): (same procedure as for "standard" hauls). The viability of each halibut collected in the factory was assessed and the mortality rate of each fish (where "excellent" = 0.20, "poor" = 0.55, and "dead" = 0.90) was multiplied by its weight (#3 above). The resultant mortality weights were summed to calculate the total factory mortality.
5. Total mortality of halibut for EFP haul: Sum of #2 and #4 above.

A census of halibut lengths was collected for the "non-standard" hauls in order to evaluate sampling precision in estimating the weight of halibut sorted on deck. By calculating the deck halibut weight using both methods for the same haul, the EFP was able to see how accurate the sampling methodology was in estimating total halibut weight sorted on deck for the "non-standard" hauls (one out of five hauls, randomly selected). Finally, halibut mortality estimated from the EFP viability assessments were compared to the mortality estimates calculated from using the "official" IPHC trawl discard mortality rates with the goal that any mortality net difference ("savings") could ostensibly be used to extend fishing operations, groundfish harvests and revenue.

Results

Operations

The EFP field work was conducted between May 27th and September 19th, 2012 on four A80 vessels that are members of the Alaska Seafood Cooperative (AKSC) vessels: F/T *Arica*, F/T *Constellation*, F/T *Vaerda*l, and the F/T *US Intrepid* (see Table 1 for a summary of EFP fishing). The participating vessels used their own A80 groundfish quotas along with halibut PSC allowances which were set aside by the AKSC and designated for use specifically under the EFP. It is important to understand that the EFP was intended to test the modified catch handling procedures in a variety of fisheries where halibut bycatch mortality could potentially be reduced and to examine the effectiveness and practicality/feasibility of doing so.

Because the EFP was focused on evaluating the modifications to halibut handling procedures in the context of the normal mode of operation of A80 fisheries, no exemptions were requested or authorized as part of the EFP in terms of areas where EFP fishing could take place and regulations governing groundfish or PSC retention during the EFP. It is also noteworthy to point out that with 2012 being a rather extreme southern extent of ice year, most vessels had already used a majority of their rock sole quota for the year before the start of the EFP and therefore were constrained by their normal A80 groundfish allocations to conducting EFP fishing in areas with little or no rock sole in the catch.

Table 1. Vessels, target fisheries, EFP fishing dates, number of EFP hauls per vessel, and sea samplers aboard each vessel.

EFP Vessel:	**Arica**	**Constellation**	**Vaerdal**	**US Intrepid**
Target Fisheries:	Rock sole Arrowtooth P. Cod Yellowfin	Flathead Btm Pollock Rock sole P. Cod	Arrowtooth Other flatfish (rex) Atka mackerel	Yellowfin
EFP Fishing Dates:	May 27-30 September 17-19	June 11-14	August 5-9	September 5-12
Total no. EFP Hauls:	26	19	21	32
Sea Samplers:	A. Theriault & G. Mayhew P. Moore & J. Memoly	J. Mulkey & J. Wright	T. Muldrew & R. Mahler	P. Moore & J. Memoly

The *Arica* had planned to target arrowtooth flounder in May, but they were unable to do so because the sea ice made it impossible to reach those fishing grounds. With their late arrival into the fishery due to a longer-than-anticipated shipyard stay, however, the *Arica* did have the quota flexibility to target rock sole for a majority of their May EFP trip. Unfortunately, halibut bycatch rates were high in the rock sole target and EFP fishing was suspended after four days in order to save a portion of their designated halibut PSC so they could revisit the EFP in September during the fall yellowfin sole fishery.

The *Constellation* made their June EFP trip targeting flathead sole, but due to the high halibut catch rates EFP fishing was suspended after five days as the vessel had used the entirety of halibut PSC amount allotted to them for the EFP. Due to mechanical issues, the *Vaerdal's* August EFP trip was cut short when the vessel had to return to Dutch Harbor after five days targeting arrowtooth flounder and rex sole. Finally, the *US Intrepid's* EFP participation adhered to the planned time window and duration with EFP operations taking place during the first two weeks of September with no major mechanical or logistical problems. Despite all of the challenges presented by quota limitations, high halibut catch rates, sea ice, and mechanical issues, the EFP fishing effort was valuable on all four of the participating vessels.

All of the deck sampling stations were effective in terms of allowing the crew members and sea samplers to accomplish the deck sorting and halibut sampling tasks of the EFP. Elevating the halibut measurement and viability assessment tables/chutes allowed the sea samplers to position themselves more comfortably than was possible when the sampling surfaces were at deck level in 2009. Unfortunately, use of the horizontal slide and incline belt extending from the trawl alley to the sea sampler work station on the *US Intrepid* had to be abandoned. This was because the slide impeded the crew's ability to shovel target species of fish into the live tanks and the belt was sloped too steeply to be useful. It was also evident at the onset of deck sorting that the belt itself could have an impact on halibut condition as halibut put on the belt at the start of the EFP tended to slide back down the belt instead of being carried to the sea sampler work station. Instead of using the slide and incline belt, the crew carefully cradled the halibut and placed them in the elevated holding bin adjacent to the sampling table. While this set up was not ideal, the crew did an impressive job of adjusting and the deck sorting and sampling on the *US Intrepid* was equally as effective as it was on the other EFP vessels.

<u>Halibut sorting performance on deck and in the factory</u>

Vessel crew members put forth a very good effort to sort halibut from the catch – there were often as many as 8 to 10 crew members on deck sorting halibut, shoveling target catch into the live tank, and assisting the sea samplers by moving halibut to their stations and sliding halibut to them when instructed to do so. For halibut missed during deck sorting operations, sea samplers were able to do a majority of the halibut collections in the factory, and the processing crew assisted them in adjusting the speed of the sorting belt speed when necessary.

Deck sorting was effective overall with crew members able to sort out approximately 81% of the total number of halibut caught during the EFP and over 87% of the total by weight (Table 2). The four EFP vessels caught a total of 20,643 halibut of which 16,646 were sorted on deck, and 3,997 were sorted in the factory. Three of the participating vessels sorted exceptionally well on deck, sorting over 94% of the total number of halibut and over 95% of the total halibut by weight. On the other vessel, the *Arica*, crew members sorted 67% of the halibut by number and 78% of the halibut by weight. Much of the difference on the Arica is attributable to a few tows with high halibut catch rates that made sorting a high fraction of halibut on deck particularly problematic.

Over the course of 98 EFP hauls (including standard and non-standard combined), vessel-specific factors including size, deck space, and configuration did not appear to have much impact on the effectiveness of deck sorting. From a mechanical standpoint, all vessels were able to provide the necessary crew, deck space, and sampling area to execute the EFP activities effectively. On average, halibut sorting and sampling on deck took approximately 28 minutes per haul, and completion of sorting and sampling in the factory averaged approximately 292 minutes. Because of the change in sampling design for the 2012 EFP, an average of 6.1 halibut were returned to the water per minute of sorting compared to 2.2

halibut in 2009. The halibut sampling methodology prevented sorting delays on most hauls, but backlogs of halibut awaiting measurement and assessment were inevitable on a small number of tows with halibut bycatch rates. Halibut catch rates were particularly high during EFP fishing in May and June, and overall the average halibut catch rate of 3.9% was twice the average halibut catch rate of 1.9% experienced during the 2009 EFP.

Table 4 shows that deck sorting was very effective in all fisheries targeted with the exception of rock sole. High catch volumes and small halibut size reportedly created challenges which resulted in less effective sorting performance in the rock sole fishery.

Table 2. EFP data summarized by vessel (deck mortality rates do not include data from "non-standard" hauls)

			EFP Halibut Catch								
			Sorted on Deck		Total			% Deck-Sorted		Avg. Sorting Time (min.)	
Vessel	**No. of EFP Hauls**	**Total EFP Catch (mt)**	**No.**	**Wt. (kg)**	**No.**	**Wt. (kg)**	**Halibut Catch Rate**	**By No.**	**By Wt.**	**Deck**	**Factory**
Arica	26	788.24	7009	28418.7	10468	36420.3	4.60%	67.00%	78.00%	37.8	372.5
Constellation	19	239.8	5048	16272	5302	16758.8	7.00%	95.20%	97.10%	27.1	204.2
Vaerdal	21	202.78	1716	6830.3	1826	7147.9	3.50%	94.00%	95.60%	20	104.6
US Intrepid	32	658.74	2873	13419.1	3047	14113.4	2.10%	94.30%	95.10%	26.6	487
Totals	**98**	**1889.56**	**16646**	**64940**	**20643**	**74440**	**3.90%**	**80.60%**	**87.20%**	**27.9**	**292.1**

	EFP Mortality Rate			EFP Mortality (mt)				
Vessel	**Deck**	**Factory**	**Overall**	**Deck**	**Factory**	**Total**	**IPHC DMR Mortality (mt)**	**Mortality Savings (mt)**
Arica	56.60%	89.70%	63.40%	17.01	7.18	24.19	29.06	4.88
Constellation	60.50%	87.80%	61.30%	10.19	0.43	10.62	12.44	1.82
Vaerdal	38.00%	82.80%	39.80%	3.17	0.26	3.43	5.43	2
US Intrepid	62.70%	90.00%	63.90%	8.72	0.63	9.35	11.43	2.09
Totals	**57.10%**	**89.40%**	**61.80%**	**39.09**	**8.5**	**47.59**	**58.36**	**10.77**

Table 3. EFP data summarized by target fishery ("non-standard" hauls not included)

Target Fishery	No. of Hauls	Total Catch (mt)	Avg. Haul Size (mt)	Halibut Catch (mt)	Halibut Mortality (mt)	EFP Mortality Rate	IPHC DMR	Prescribed DMR Mortality (mt)	Halibut Mortality Savings (mt)
Arrowtooth	17	167.56	9.86	14.924	8.579	57.5%	76%	11.342	2.763
Yellowfin Sole	40	911.05	22.78	22.354	13.597	60.8%	81%	18.107	4.510
Flathead Sole	13	159.54	12.27	12.272	7.647	62.3%	74%	9.081	1.434
Rock Sole	8	252.45	31.56	11.160	7.292	65.3%	82%	9.151	1.859
Other Flatfish (Rex Sole)	2	5.67	2.84	0.081	0.025	30.9%	72%	0.058	0.033
Cod	2	18.97	9.49	1.152	0.644	55.9%	71%	0.818	0.174
Bottom Pollock	2	42.94	21.47	0.673	0.318	47.3%	73%	0.491	0.173
Atka Mackerel	1	27.48	27.48	0.432	0.332	76.9%	76%	0.328	-0.004
All Targets:	**85**	**1,585.6 6**	**18.65**	**63.048**	**38.434**	**61.0%**	**78.%**	**49.377**	**10.943**

Table 4. Effectiveness of Deck Sorting Halibut: rock sole target vs. other targets

Target Fishery	Avg. Haul Size (mt)	No. Deck Halibut	Deck Halibut Wt. (kg)	No. Total Halibut	Total Halibut Wt. (kg)	Avg. Halibut Wt. (kg)	Avg. Halibut Length (cm)	% Deck Sorted (by no.)	% Deck Sorted (by wt.)
Rock Sole	34.67	2,636	7,933.8	5,332	13,360.9	2.51	61 cm	49.4%	59.4%
All Other Species	17.73	14,010	5,7006.3	15,311	6,1079.5	3.99	70 cm	91.5%	93.3%
Overall	19.28	16,646	6,4940.1	20,643	7,4440.4	3.61	68 cm	80.6%	87.2%

Halibut Viability Assessment and Measurements

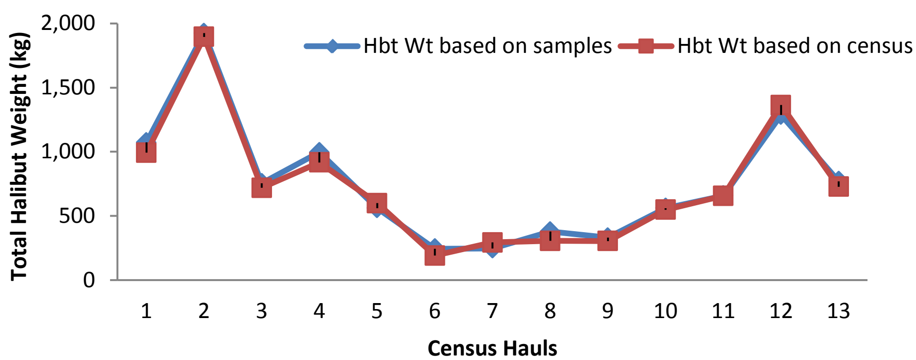
Based on the field project manager's conversations with the sea samplers throughout the EFP, the sea samplers felt that the halibut viability assessments and measurements went smoothly in terms of the sampling methodology. Several of the sea samplers commented regarding the deterioration of halibut condition as the amount of time the fish spent out of the water increased, particularly on hauls where high halibut catch rate resulted in sampling backlogs and long sorting times. The length census sampling hauls did not seem to extend the sorting time significantly. Sea samplers were able to return halibut to the water at nearly the same pace on "non-standard" hauls, collecting and recording length data for all halibut, as they were on standard hauls, collecting and recording length, viability, and time data on 20% of the halibut. All of the sea samplers involved in the EFP worked very hard to ensure the collection of quality data, the biggest challenge for them was the long hours spent in the factory with very few breaks.

Although observers/sea samplers are trained to use the official NPGOP "Key to Pacific Halibut Condition Codes for Trawl Vessels" to assess halibut viability, some subjectivity may still exist. This may explain some potential anomalies in the results such as F/T *Arica* having the highest average sorting time while not having the highest EFP halibut mortality rate. Even if they receive the same training as part of their certification as observers, it seems some differences in interpretation of halibut viability indicators is inevitable. Alternatively, this outcome could be attributable to other factors that cannot be examined in our data such as water temperature at fishing depth compared to temperature on deck or specifics of the codends on different vessels that affect halibut viability. In any case, evaluating the variability of observer viability assessments was beyond the scope of this EFP.

Halibut Weight Estimation: Census vs. Sample

Census data from the "non-standard" hauls showed that the sampling methodology was remarkably accurate in estimating total halibut weight (Figure 2). Overall, sampling slightly overestimated the actual total halibut weight on "non-standard" census hauls by 2.84%.

Figure 2. Comparison of total halibut weight determined by sample and census data for "non standard" hauls.



Halibut Catch and Mortality

Table 2 summarizes the EFP data by vessel (deck mortality rates do not include data from “non-standard” hauls due to extended time added to census collections) and Table 3 summarizes the mortality data by target fishery (“standard” hauls only). In total, the participating vessels caught 1889.56 mt of groundfish, 74.44 mt of which was halibut. The total halibut mortality during the EFP was 47.59 mt: total mortality accounted for on deck was 39.09 mt (57.1% avg. mortality rate on “standard” hauls) while the total mortality accounted for in the factory was 8.50 mt (89.4% average mortality rate). The halibut mortality based on official DMR would have been 58.36 mt; therefore the modified catch handling procedures of the EFP resulted in an estimated “savings” of 10.77 mt of halibut mortality. Disregarding “non-standard” hauls, the overall EFP mortality rate was 61.0% compared to the 78.3% official DMR which would have been in place outside of the EFP based upon the fisheries which were targeted.

Noting that the average mortality rate for halibut sorted on deck was 57%, which is not as low as the 45% rate that occurred in 2009, it is important to recognize that this is still well below the discard mortality rates (DMR) assigned to the A80 fisheries targeted during the EFP (DMR for the BSAI fisheries targeted during the EFP average 78%, see Table 3).

There are several possible explanations why mortality rates were higher in 2012 even though the sampling protocol was designed to reduce the time needed for collecting data from halibut. One reason to explain the increased mortality rates for the 2012 EFP is that the wider range of target fisheries in 2012 included some targets where larger hauls are more common and halibut mortality rates are perhaps higher (e.g. rock sole). Another is that a lingering question from the 2009 EFP was whether the low halibut mortality rates resulted from the selection of target fisheries where catch per tow quantities were relatively low. For the 2012 EFP, a specific objective was to include target fisheries with more normal fishing procedures and more representative catch amounts per tow. To this end, average catch amount per tow in 2009 was 12.8 metric tons compared to 18.7 mt in 2012. The longer tows and more representative catch amounts per tow may explain the increase. Other plausible explanations exist as well (e.g. differences in water temperature versus temperature on deck between the two studies) but due to the nature of the study design, there is no way of knowing what is responsible for the difference in mortality rates among the multiple possible factors.

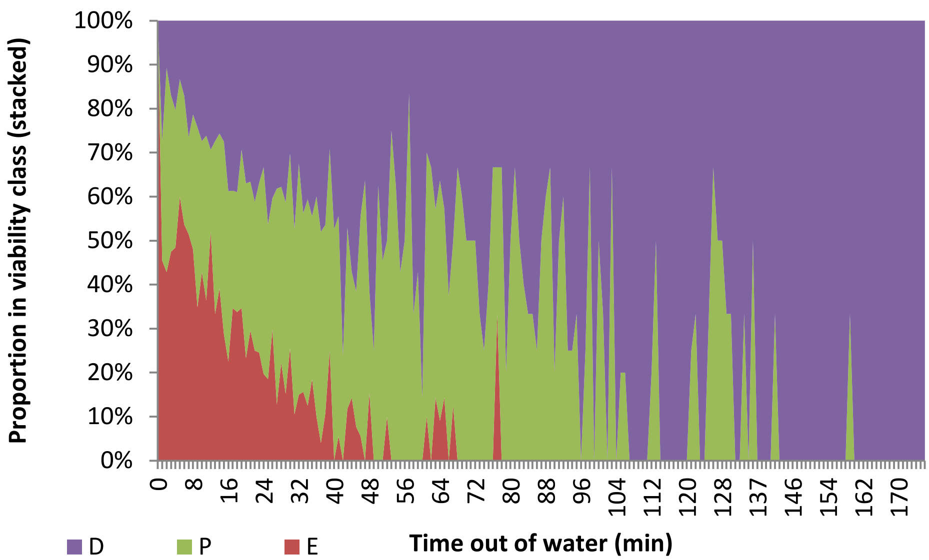
Time Out of Water

Halibut mortality clearly increased as the amount of time the fish spent out of water increased (Figure 3) during the sorting operations and data collections for each haul. This data is of particular interest on hauls where high halibut bycatch rates resulted in backlogs of halibut awaiting assessment. Even with the relatively fast pace of data collections relative to 2009 due to the use of sampling instead of a census, some backlogs were inevitable, and the resultant delays in viability assessment likely impacted halibut condition on these hauls.

With the collection of time stamps in 2012, we were able to evaluate within-haul effects of time on halibut condition, a critical aspect of a thorough assessment of ways to reduce halibut mortality that could not be examined in the 2009 EFP. The data showing the relationship between time out of water and assessed viability ratings is found in Figure 3. This shows that the first 30 minutes out of the water appear to be critical to halibut viability. While there can be little doubt that time out of water affects halibut condition, what is striking in Figure 3 is the very high fraction of halibut falling into the excellent viability category during the first 20-30 minutes after the net was brought on board. Further evaluation of this showed that this high fraction of excellent condition halibut occurred for hauls in all target fisheries of the EFP and this may be the most important area of focus for reducing halibut mortality rates in the future.

The mortality rate for halibut which were missed during deck sorting and therefore recovered on the sorting belt in the factory averaged 89%. The EFP mortality rate for halibut which were assessed in the factory is considerably higher than the average DMR (78%) for the fisheries targeted during the EFP. This may be due to the delay in the start of processing due to the EFP deck sorting activities that had to be completed prior to starting to sort fish in the processing area. With the average deck sorting time being 28 minutes, the halibut in the EFP vessels' live tanks (missed during sorting operations) had been out of the water about 30 minutes on average prior to the start of sorting. The delayed start of factory sorting due to the EFP catch handling procedures on deck may well have prevented the opportunity for factory sorted halibut to be assessed during that critical first 30 minutes of time out of the water. The average time to process hauls and sort halibut from the catch in the factory during the EFP was 292 minutes (nearly five hours per haul).

Figure 3. Relationship between time out of water and halibut viability rating (D=Dead, P=Poor, E=Excellent). N= 2,836 (number of halibut from standard hauls with both a viability assessment and a time out of water value). 12 outliers were removed (t > 176 minutes).

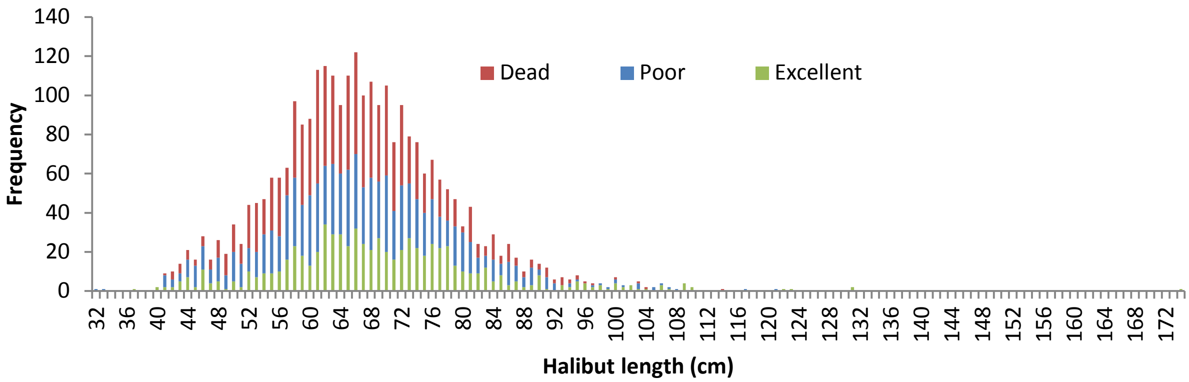


Catch volume also appears to explain halibut mortality, particularly when the total catch exceeded the capacity of the holding tanks. During these instances, the sorting time (and resulting "time out of water") was increased and in a few cases interrupted as a portion of the catch went unsorted until hours had passed and space became available in the tanks (A80 catch handling rules do not allow for mixing of catch from different hauls hence the long delays on a few tows). Haul size and number of halibut per haul directly influenced the sorting time. The larger the haul and the more halibut to sort through and sample, the higher the sorting time, which resulted in an increased time out of water and increased mortality. With the available data, these two possible factors affecting mortality rates for halibut cannot be separated. While it was evident that time out of water has a direct influence on halibut condition, the impact of other factors including species composition, haul duration, and halibut size were less obvious for our data.

Figure 4 displays the graphical relationship between halibut size and viability rating - a close look at the graph seems to indicate that halibut larger than 75 cm tended to have slightly lower mortality. This may be due to larger halibut being more resilient to effects of being in the net or because they were easier to remove from the catch during sorting operations. In the case of the latter, this would mean that halibut size did affect sorting efficiency and sorting time and therefore halibut size appears to be related to viability in that context.

Overall, mortality rates across the four primary species which were targeted during the EFP (arrowtooth flounder, yellowfin sole, flathead sole, and rock sole) were very similar, ranging from 57.5% to 65.3% (see Table 3). However, with the exception of one haul on the *Arica* which had a very high halibut catch rate, the mortality rate in the arrowtooth fishery was 36.8%, much lower than that of the other fisheries and likely due to the relatively small haul size and short sorting time.

Figure 4. Frequency of viability ratings by halibut length



Information on Feasibility from Post-EFP Interviews with Captains and Key Crew

Following each vessel's participation in the fieldwork, the field project manager and principal investigator conducted separate interviews (in-person and on the telephone in some cases) with all the vessel captains and mates who had participated in the EFP.

As was set out in the EFP application, the interviews were designed to be qualitative. The questions used were intended to elicit feedback on what factors captains/mates/crew felt were most important in determining the mortality rates the vessel achieved during the EFP as well as the considerations that were most important in determining the practicality and feasibility of incorporating the EFP's modified catch handling procedures into their operations to reduce halibut mortality rates.

Any other feedback resulting from or following the answers to the questions was allowed to be in free-flowing format. As was discussed in the EFP application, the interviews and discussions were intentionally informal so as to ensure that captains would be candid in their responses. Accordingly, we did not attempt to formally tabulate the information collected in each post-EFP discussion/interview and we have not attributed it to specific vessels. Notes were kept during the discussions and the common themes and ideas are summarized below.

In the interviews, captains/mates/ and key crew were asked to first summarize how the EFP went from their perspective and whether they felt the EFP's procedures for catch handling in conjunction with the differences in the way fishing/processing were feasible for some or all of the target fisheries in which the vessel regularly participates. In nearly all interviews, respondents wanted first to know which of the

EFP's catch handling procedures and requirements specifically would need to be in place if the EFP somehow led to changes in the regular fisheries to reduce halibut mortality. Almost universally, it was felt this was important to know as they provided input on feasibility. At the same time, this is obviously an unknown at this point so we were not able to answer this question concretely. To get around this, interviewees were asked to comment on which of the EFP fishing and catch handling procedures were workable and which ones they felt were less so or not feasible at all.

In considering the separate fishing and catch handling procedures of the EFP, captains and mates were unanimous in identifying the prohibition on running any fish from a tow over the vessel's flow scale until all the deck sorting was completed for that tow. This was true for all vessels participating in the EFP, both large and small. This prohibition would apparently be problematic for any real-world application of deck sorting for halibut in the subset of A80 flatfish fisheries that are "high volume" fisheries (e.g. yellowfin sole and rock sole). Without exception, this was considered to be the most constraining aspect of the EFP for A80 target fisheries like rock sole and yellowfin sole but not for flathead sole, Arrowtooth flounder, Pacific cod, where this was apparently not an issue.

The problem for the high volume fisheries was that under high catch rates, the EFP's prohibition to move fish from the tank to the sorting bins until deck sorting was completed and the sea sampler was present in the factory apparently impeded or stopped the flow of the factory. Under the EFP the crew could process fish that had already been across the flow scale and sorted into bins by the crew but this apparently didn't adequately accommodate the processing rates of the factory and left processors waiting for new fish which would not flow until the sea sampler was back in the factory following the completion of deck sorting. The factory processing rate and fishing/sorting operations are scaled to the vessel so that any pinch point in the flow, such as not being able to run fish over the scale without the sea sampler present, becomes problematic at peak fishing/processing rates that occur in the higher catch rate fisheries.

Several interviewees stated that in retrospect, they should have requested that the AKSC furnish more than the two sea samplers than it provided for the EFP. This would have allowed them to have one sea sampler in the factory overseeing collection and sampling from halibut missed during sorting on deck and a sea sampler on deck overseeing deck sorting and data collections there. The third sea sampler would presumably have only been needed during peak fishing and only when EFP vessels were targeting high catch volume fisheries (e.g. yellowfin sole or rock sole) according to those who commented on the possibility of additional sea samplers. This would have increased the costs of participation in the EFP but participants on all but the smallest vessel in the EFP felt that the cost of the slowdown in production rate was much greater than the cost of adding another sea sampler (including the need to reduce the crew with dedicating one more bunk to a sea sampler). For the smaller vessel in the EFP, the bunk space was critical and adding another sea sampler for following the EFP protocols in high volume fisheries like rocksole was not workable.

Another major point gleaned from the interviews addressed crew labor needed to sort halibut on deck. Across the board it was felt that that having the crew out on deck sorting halibut was not problematic in terms of the labor and the time it took. The common view of participants was, however, in a high catch rate fishery like yellowfin sole where halibut bycatch rates are generally quite low, it was perhaps debatable whether all the work to sort the halibut from large quantities of yellowfin on deck was actually worth the crew's efforts. The point was that the 20 minutes or so of work needed to sort halibut from yellowfin was perhaps not merited if only a few halibut would be returned to the water from the deck because there just isn't that much halibut in the catch. This result tracks the 2009 findings even though the 2012 testing occurred in fall yellowfin sole where we had expected the quantity of halibut per tow to be higher than spring yellowfin (2009) and therefore more viable in terms of justifying the sorting effort on deck.

A related issue was that deck sorting halibut in the rock sole fishery was generally thought to be somewhat more difficult because halibut were small and sometimes not much bigger than the rock sole. But the feeling from the interviews was that although the sorting in the rock sole fishery required more labor and was less effective, it was potentially still worthwhile because there was usually enough halibut to justify the work and the resultant reduction in mortality. Of note here was that according to our data, the fraction of halibut sorted on deck for rock sole target tows was approximately 60% by weight. For the other EFP target fisheries, the percentage of halibut sorted on deck was over 90% on average so it does look like sorting halibut in the rock sole fishery is more difficult and less effective.

Weather conditions also figured into interviewees' assessments of feasibility, but not in the manner we had expected. Participants felt that crew members could sort on deck in most or nearly all weather conditions they experienced in the EFP and perhaps in excess of 70%-80% of the fishing days they encounter each year. On the other hand, they felt that sea samplers could probably not be expected to be on deck for extended periods of time in poor weather conditions doing the measurements and viabilities on halibut in the manner required by the EFP. For this reason, captains were naturally concerned by the potential of a "real world" application of deck sorting where, like for the EFP, deck sorting and halibut sampling was required on each tow with no option to opt out for weather conditions (or other issues). They felt that if sea samplers had to be on deck doing the same duties they performed in the EFP for all hauls, this might greatly restrict vessel operations because harsh weather conditions could prohibit sea samplers/observers from going out on deck to perform their duties. This, they felt, would have potentially huge impacts because there are not that many days in the winter months that are likely to be suitable for sea samplers to be doing what they did in the EFP. The time period from January through March and November through December were seen as the most likely to be problematic in this regard.

When asked whether they encountered weather conditions that were unsuitable for sea samplers to be on deck during the EFP, the response was that weather was not a factor in the EFP for the most part. It should also be noted that most boats participated in June through August. In one instance, however, a boat participating in September encountered poor weather. To accommodate the situation, the vessel captain opted to wait to start the EFP. This transpired in the following manner. The weather apparently came up unexpectedly as the vessel was traveling to the grounds to start the EFP with the sea samplers and project manager already on board. In consideration of the sea conditions when they arrived at the fishing grounds, the captain decided it was unsafe for the EFP to start. The sea samplers and project manager were thus essentially off duty for a few days at the start of that fishing trip. During that time, regular A80 fishing and catch handling were in effect for the vessel's two regular observers and the vessel crew. When the weather improved some, the EFP was started and the vessel was able to complete their leg of the EFP. Interestingly, the EFP went fairly smoothly on that vessel when it did commence even if the seas and deck conditions were still relatively challenging compared to the rest of the weather for the EFP.

Seeing how this poor weather condition situation was handled from a broader perspective, perhaps some would argue that trying to do the EFP for the entire trip and hence in quite bad weather might have been informative. But exposing the data collection personnel who would have had to be on deck for extended periods to potential injury under harsh conditions is never wise. The vessel captain appeared to have a good sense of the limits for weather conditions suitable for the EFP. To address the situation, he came up with a workable plan for how to get the EFP done without needing to risk having to suspend EFP work and the inefficiency of having to return to port and offload in order to finish the EFP. Overall, it is illustrative of the inherent constraint that deck sorting could become if procedures in a real world application required the same EFP catch handling protocols to be in place in all fisheries throughout the year and in all weather conditions.

A final issue that came up in nearly all the interviews was potential ways to make deck sorting feasible in the future either in the context of additional research or for implementation into the regular A80 fisheries at some point. One approach was to modify the procedures used in the EFP for catch handling. Another approach involved changes to vessels as part of vessel rebuilds. The latter issue included how vessels in the future could be designed to allow for good catch accounting and improved handling of halibut and perhaps other PSC species. This received a lot of attention in the interviews.

On the subject of changes to vessels in the future, ideas ranged from small-scale improvements like adding shelter decks and slides to get halibut and possibly other PSC species back into the water in a controlled manner with good accountability. This idea revolved around a well-placed shelter deck assuming that the EFP's catch handling procedures would still be in place in a real world application. The shelter deck would be a raised with a covered area where sorted halibut or possibly other PSC would be delivered via a conveyor belt and catch accounting would occur in this more protected area. This was discussed as a way of making the sea sampler duties easier, safer, and more practical and effective under adverse weather conditions.

A more forward looking idea for changes to vessels in the future was redesigning the way fish are brought on board. Fish could be pumped out of the net or come on board in smaller batches via a hopper of some sort or much smaller tow amounts and factories designed to process fish differently than occurs today. These changes would be intended to reduce or eliminate effects on PSC of a relatively large amount of fish being pulled up the stern ramp which would then increase halibut viability and quality of products from target species. A system like this might even also allow the "deck sorting" to occur below deck in a protected area as fish first come on board so that fish are not out of water for any extended time. Other vessel modifications would clearly be involved to allow sorting to occur in the factory with low mortality rates under this concept.

Another approach would be to have an oxygenated water tank on deck for holding halibut or other prohibited species for samplers where accounting could take place after deck sorting. Under this approach, sea samplers would be on deck for a shorter period of time and not be in harm's way during times when cables and equipment are under strain.

A final idea that received a lot of attention in the interviews is to utilize the data from the EFP showing that survival of halibut is relatively high for 20-30 minutes following haulback. The view was expressed in several different ways but the basic idea is that crews could get the halibut back in the water in less than 20 minutes in many A80 fisheries where there is enough halibut bycatch to make the effort worthwhile. The concept would be that the number of halibut sorted during that time would be accounted for via electronic monitoring (EM). Such a system would consist of a set of cameras that collect images or video of halibut to rapidly document the number and possibly even the length of each fish to derive a weight estimate. This technology would be designed to replace the need to have sea samplers on deck.

Under this alternative approach to deck sorting, electronic monitoring would ensure handling of halibut followed procedures and nothing other than halibut was sorted on deck. A default mortality rate generated from EFP data or some future viability sampling work would be applied to those halibut sorted in the 20 minutes. The amount of mortality for the remaining halibut, those missed during the 20 minutes of sorting or when the sorting could not get through all the fish in 20 minutes, would be accounted for by collecting the halibut in totes in the factory similar to the way it was done in the EFP. Some captains thought that because halibut survival is low after 20-30 minutes, as was seen in the EFP, it might be a good idea to allow/require retention of those fish and there were varying perspectives on how that would work and whether they could be processed and sold or would have to be donated to a food bank. While we did not stifle discussion of this idea, we did point out to the fishermen being interviewed that the retention of halibut remains a controversial issue. To this, several replied that it should be re-evaluated because throwing back a dead fish that many people would like to eat would probably be equally controversial.

Finally, deck sorting only during the first 20-30 minutes made a great deal of sense because it would then address the problem of the occasional haul with lots of halibut where it is infeasible to complete sorting in 20-30 minutes. Under this scenario, sorting would occur for the 20-30 minute window and the remainder of halibut catch would be accounted for in the factory and a higher mortality rate applied to that portion occurring after the deck sorting time window. This would allow for good accounting and at the same time avoid a long period of deck sorting where, as our data suggest, the benefits in terms of lower mortality rates are not realized.

Discussion

This project expanded upon what was learned during the 2009 EFP and reinforced the conclusion that halibut mortality rates on Amendment 80 trawlers can be reduced by sorting halibut from the catch on deck and returning them to the sea as quickly as possible. By conducting EFP activities on four different vessels over the course of five months we were able to consider the feasibility and practicality of the modified catch handling procedures on different sized vessels fishing in a variety of fisheries at different times of the year. Using a sampling methodology for viability assessments instead of a census of viabilities as was the case in 2009, enabled the return of halibut to the water at nearly three times the pace. In addition, recording time stamps along with halibut viabilities allowed us to learn more about the extent to which the time spent out of the water impacts halibut mortality.

The amount of time a halibut spends out of the water is clearly a key variable impacting halibut mortality rates. Figure 3 shows how halibut viabilities deteriorate over time: the longer a halibut spends out of the water prior to assessment, the less likely the fish receives a viability rating of “excellent” and the more likely the fish receives a viability rating of “dead”. After ten minutes out of the water, approximately 40% of the halibut were determined to be in “excellent” condition, 40% in “poor” condition, and 20% in “dead” condition. By the twenty minute mark, 25% were still in the “excellent” rating, with 40% receiving “poor” ratings and 35% receiving “dead” ratings. After thirty minutes on deck, viability assessment proportions were 15% “excellent”, 45% “poor”, and 40% “dead”. Beyond forty minutes time spent out of the water halibut mortality continually increased as very few halibut were assessed as “excellent”.

While the EFP sampling methodology did enable the crew and sea samplers to return halibut to the sea at a pace of 6.1 halibut per minute compared to 2.2 halibut per minute during the 2009 EFP, high halibut bycatch rates in this EFP also created backlogs with halibut sitting in holding troughs awaiting viability assessments on nearly 10% of the hauls. The deck sorting and sampling time on 85% of the hauls was 35 minutes or less. Backlogs of halibut occurred on nine hauls and generally delayed the end of sorting and viability assessment by approximately fifteen to twenty minutes, while on two hauls the sorting time exceeded two hours due to extremely high halibut bycatch rates. These inevitable delays extended the time the halibut spent out of the water and directly increased mortality. Statistical analysis revealed that the outlier hauls with overwhelming amounts of halibut did not strongly impact the mean deck mortality (57.1%). The mean deck mortality on standard hauls excluding two outliers which were greater than two standard deviations from the mean was 55.1%, which is only 2.0% lower than the overall mean deck mortality.

It was also observed that each sea sampler assessed viabilities at a different pace and this may have contributed to the backlogs in some instances. From a conceptual standpoint, the delays were not a result of the process of sorting halibut and returning them to the sea, but rather a byproduct of the viability assessment sampling protocols and sea sampler limitations in spite of the use of a sampling protocol for the 2012 EFP. With two sea samplers each working 12 hour shifts on board the EFP vessels, only one was on duty at any given time to account for halibut lengths and conditions.

In addition, the limitation of having only one sea sampler available at any time presented the challenge of maintaining normal levels of factory production while complying with the EFP's catch handling requirements. As per the protocols of the EFP, vessels were not allowed to run any fish out of the live tanks unless a sea sampler was present in the factory to monitor the sorting belt and sample any halibut which were missed during deck sorting. Whenever fish were brought on board the vessel, sorting in the factory was halted so that the sea samplers could attend to their sampling duties on deck. While the stoppage of sorting in the factory did not completely halt production, vessels did need to alter their fishing strategies and factory activities to minimize the extent to which production was slowed. Upon completion of the on deck sampling, the sea samplers returned to the factory and the vessel could continue sorting the catch from the live tanks.

Deck sorting itself was efficient and practical in the flathead sole, arrowtooth flounder, rex sole, Pacific cod, and bottom Pollock fisheries. However, deck sorting halibut in the rock sole and fall yellowfin sole proved to be less effective (rock sole with many mostly small halibut) and less worthwhile (yellowfin tows with little or no halibut catch). Two issues which may have hindered the effectiveness and practicality of deck sorting while targeting yellowfin sole and rock sole were large haul size, small halibut size, and low catch rates of halibut (for yellowfin sole). Catch volumes exceeding 30 mt appear to have made it difficult to sort the entire catch efficiently using the EFP catch handling procedures. As a result, the time the halibut spend out of the water is extended and the mortality would be expected to be higher. Additionally, the halibut caught as bycatch in the rock sole fishery were much smaller and therefore difficult to detect and sort from the catch compared to halibut caught in the other fisheries. The average halibut weight was 2.51 kg in the rock sole fishery compared to an average halibut weight of 3.99 kg in all other fisheries combined during the EFP. It should be noted that regardless of the target fishery, deck sorting halibut is only practical and feasible when the total catch is kept to a reasonable limit to ensure that the catch can be sorted in a timely fashion. Likewise, when halibut catch rates are low, as was seen in the vast majority of tows in spring yellowfin sole in 2009 and was the case for at least the majority of tows for fall yellowfin sole in 2012, the physical labor and slowdowns in fishing and processing are not necessarily justified by the rather small savings in mortality.

Participating captains and mates provided valuable information regarding feasibility. Summarizing what they related, it was felt that for lower catch rate fisheries such as flathead sole, rex sole, and arrowtooth flounder, deck sorting was feasible using the catch handling procedures of the EFP. For higher catch rate fisheries, the biggest obstacle to feasibility was the EFP catch handling requirement that fish from a given haul not be moved over the flow scale until deck sorting is completed and the sea sampler is present in the factory. This EFP procedure was clearly an important component of the EFP from the perspective of the NMFS Observer Program (AFSC, FMA) and NMFS Alaska Regional Office personnel who worked with the permit applicant to design the EFP. It also needs to be recognized that the EFP was aimed at learning about halibut mortality rates in response to changes in fishing and fish handling practices. Any future extension of the work or application to the regular fishery would not necessarily have to be done using the same EFP fish handling and sampling protocol. For instance, cameras might be used in the factory to ensure that halibut missed during deck sorting were handled according to the protocol. Currently, cameras are used for this type of monitoring of fish bins on A80 vessels. Additionally, participants also noted that an additional sea sampler might remedy the slowdown in factory flow mentioned by all EFP participants.

A major issue seen in the EFP data but rarely mentioned in the interviews was deck sorting of large catch tows (over 30 mt) at a pace that did not exceed the 20-30 minute windows that our data demonstrate is the “low halibut mortality time window”. Our data show that large tows with lots of halibut were particularly problematic from a halibut mortality reduction perspective because mortality rates were relatively high on these tows and long hours were needed to complete sorting. There were, however, very few of these (2 out of 93 hauls) so perhaps this is not a big concern in the overall consideration of deck sorting feasibility and effectiveness.

Deck sorting in the rock sole fishery was also mentioned as more difficult, but still worth the time and effort, because halibut caught in that target fishery are small and sometimes not much bigger than the target species. Desk sorting in fall yellowfin sole fishing was generally considered to be doable but a less productive use of all the effort given the low halibut catch rates in the fishery and expected negligible amount of mortality savings. And finally, deck sorting in poor weather conditions was considered doable for crew over the course of the EFP and up to 80% of the weather that is experienced during the year but much more constricting for sea samplers/observers who they believe are unable to work on deck in rough weather. The expectation was that restrictions would be placed on fishing in rough seas to prevent risk to sea samplers on deck and this would impede fishing operations. If there were no way to opt out of deck sorting (as was pretty much the case for the EFP), the number of fishing days available to the fleet would be reduced due to rough weather - particularly in the January to March and November to December timeframes.

The EFP data and information from crew on feasibility are useful for consideration of potential future applications of some or all of the changes in fishing and catch handling employed in the EFP to the regular A80 fishery. From the perspective of the permit holder, the information provided in the EFP suggests several potential future pathways for reducing halibut mortality on the sector’s vessels. One would be to explore how to implement the EFP procedures in the sector’s lower catch rate fisheries (e.g. flathead sole, bottom pollock, cod, arrowtooth) with perhaps some adjustments to the EFP catch handling and accounting procedures. Another would be to explore ways to include the higher catch rate target fisheries (e.g. rock sole and possibly yellowfin sole) by addressing the problem of being prohibited from running fish over the flow scale until sorting on deck was completed and a sea sampler was present in the factory.

A third approach which comes out of the suggestions from the interviews with captains would be to conduct deck sorting only during the critical time window of 20-30 minutes from the time a net comes on board. Accounting for the number and/or weight of halibut sorted on deck could be accomplished via alternative methods (e.g. EM, hopper or flow scale) that would be need to be developed and verified to evaluate its utility to provide the desired data. Under this new approach, viability might be attributed to halibut sorted on deck via a default rate based on future studies or periodic viability sampling at some level sufficient to make it reasonably representative of the handling procedures.

While this new direction likely requires additional steps to develop and field test, it might address the issues identified in this report such as having sea samplers working on deck under adverse weather conditions and the potential problems created by trying to implement the deck sorting protocols for some target fisheries but not others. The 20-30 minute sorting window approach seems to be workable in all of the Amendment 80 flatfish fisheries and would also address the potential problem of trying to deck sort large tows (over 30 mt based on the data from the EFP) which could require sorting for a period of longer than 30 minutes when the EFP data suggest that mortality savings are probably not going to be very large. If this alternative approach is given further consideration, it is important to note that each haul would require estimation of two separate halibut amounts (amount of halibut sorted on deck and amount not sorted on deck) and possibly attribution of two separate mortality rates. A possible way around this could be to whole haul halibut recovered in the factory (as was done in the EFP) and application of a default rate or consideration of retention of those halibut as they are likely to have the highest mortality rates.