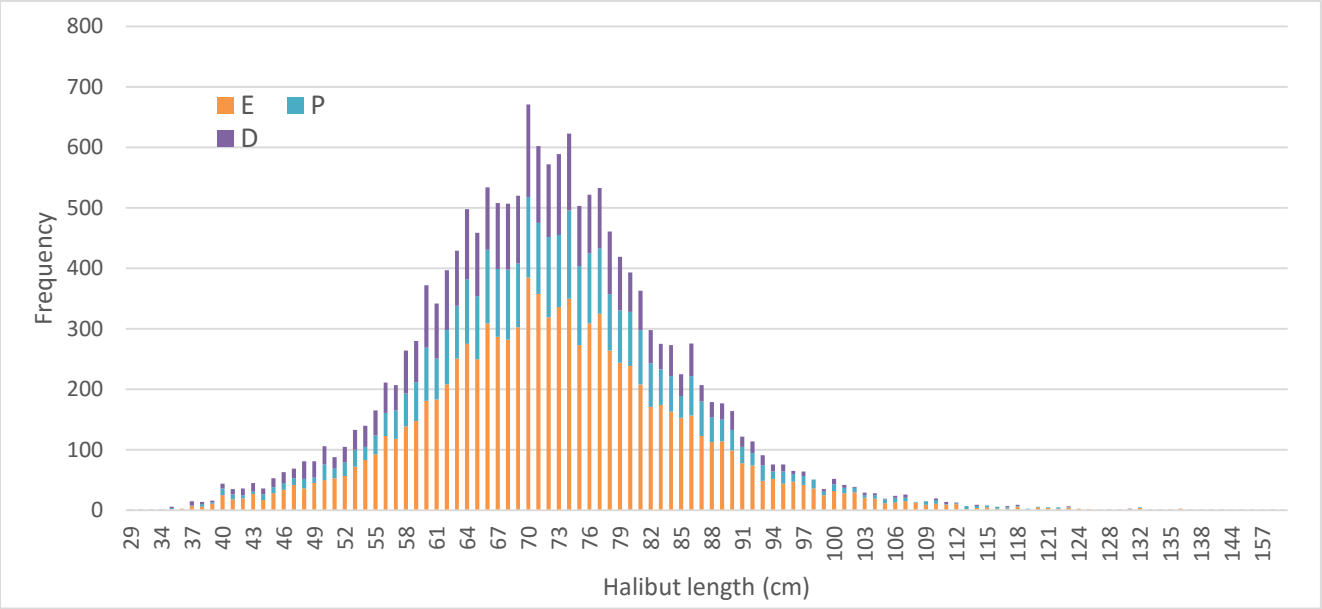
Figure 4



If fish size were an important factor for predicting viability then we might expect to see the frequency of poor and dead fish distributed more towards the smaller fish and the frequency of large fish dominating the right-hand tail of the distribution above. In reality we see some relatively small fish ranked as "excellent" and a few very big fish were rated as poor or dead. In the middle there is quite a consistent distribution between the viability categories. On balance, however, Figure 4 does show that large halibut have a higher chance of being in excellent condition than poor or dead. The time it takes to sort large fish being sorted from the deck may affect these results. Some big fish may have come out of the net last so time out of water might have affected the results in a manner that masked the ability to see an expected relationship of larger fish being able to survive being caught in a trawl better than small ones. Likewise, the crew's ability to sort out big fish faster and the strategy to sort in a manner that gets the biggest reduction in mortality in 20-25 minutes may affect our ability to see a relationship between size and viability.

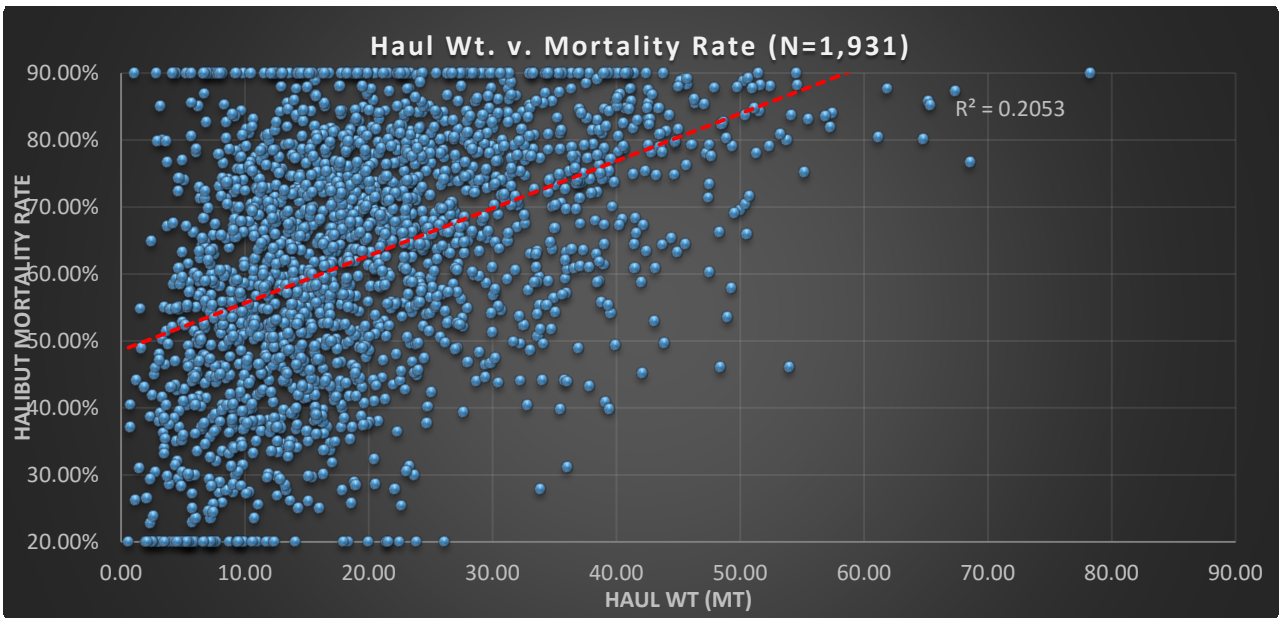
Finally, the effects on fishing variables on viability are of interest. We initially looked at these factors in 2012 but were unable to uncover any strong relationships that made intuitive sense. One concern is that most fishing variables (such as the amount of catch in the haul and tow duration) are not independent explanatory variables. These interactions present potential for multicollinearity problems with multivariate regressions and hence more complex (and unfamiliar to the PI for this EFP) modeling methods would be needed.

For the 2015 EFP, we did not log towing times, speeds, and other variables of interest for attempting to examine the relationship between fishing variables and halibut viability. One piece of information that we did collect in 2015 was the overall weight of catch per haul from the

vessel's flow scale (referred to as "OTC") per haul. Total catch might be a factor in explaining viability to some extent because it is probably related to towing time which many captains feel can affect viability as fish tire with extended towing times. Likewise, the amount of catch in the net when the net is brought up the stern ramp may affect the amount of pressure on halibut in the net.

To look at this, OTC (catch weight per haul) was plotted against viability in Figure 5 below. Overall, there does not seem to be a strong relationship between tow size and viability. If anything, it does appear that the very large hauls do have higher mortality rates but the relationship overall is week and especially noisy for the lower catch per haul end of the spectrum. Also, the "R" squared statistic for the regression is low, which is typical for analyses of applied data in "real world" experiments.

Figure 5



Conclusions:

The main objective of EFP 15-02 was to evaluate the potential scale of mortality savings for a set of catch handling practices collectively referred to as deck sorting. In that regard, the combination of procedures worked to create more than 150 MT of mortality savings and demonstrated that deck sorting has large potential for generating savings in halibut mortality. Additionally, all but one of the nine EFP vessels achieved mortality rates in the range of 41-52%, and deck sorting was generally feasible for participants in a wide variety of flatfish target fisheries including yellowfin sole. These are very encouraging results.

The evaluation of factors affecting viability of halibut above suggested that the most critical determinant of halibut viability is time out of water. The data from this EFP and the one in 2012 suggested that viability declines substantially if the fish is not returned to the water within 20-25 minutes of when the net is brought on board. EFP data collection procedures were specifically designed to allow data to be collected without increasing time out of water appreciably. A sampling structure that allows data collection to keep pace with the crews' ability to sort and return halibut to the water is needed to ensure that deck sorting achieves its potential mortality savings. The sampling protocol also proved to obtain accurate data concerning halibut bycatch quantities and mortality. A balance needs to be struck between collecting accurate and complete data and slowing return of halibut to the water. The EFP protocol obtained a reasonable balance. If sampling and catch accounting methods used by sea samplers or observers (in the future) result in fish staying out of water longer, viability savings will be squandered due to overemphasis on catch accounting precision.

Although time out of water is a primary determinant of viability, several other factors (including fishing practices) may affect viability. These factors likely are likely responsible for the variability in that complicates predicting viability based solely on time out of water. For example, some fish out of water for less than 20 minutes do not achieve "excellent" viability and conversely, a higher than expected number of fish out of water in excess of 30 minutes were in excellent condition. It is likely that fishing practices are responsible for some of this variability. The effects of fishing practices is most evident when one considers examples in the extreme, such as extremely long tow times or large haul sizes. Viability of halibut from these practices may be poor regardless of whether the fish are returned to the water quickly. The design of the accounting under EFP specifically addressed these uncertainties by using data from each haul to determine the halibut mortality from that haul.

This use of vessel and haul specific accounting was also important to establishing incentives for halibut mortality savings under the EFP. This EFP project was not designed or intended to identify which fishing and catch handling variables are most important to halibut viability. Nor was it designed to look at how incremental changes in one of more of these factors would change viability outcomes the most. But the analyses of factors affecting halibut viability serves to illustrate that one factor alone cannot ensure the achievement of a reduction in mortality rates. As a result, incentives need to be present to help ensure mortality savings are achieved. By accounting for halibut at the tow level, each vessel was incentivized to attempt to achieve actual mortality savings on each tow, notwithstanding the unpredictability of that savings. The presence of incentives was evident in variability of mortality across vessels in the EFP and the responses to those different rates. Specifically, by accounting for mortality at the vessel level, vessels that were not achieving reductions in mortality made adjustments in fishing and handling practices to

make improvements and those unable to achieve reasonable gains from deck sorting elected to drop out of the EFP, instead relying on other tools to achieve mortality reductions. Had the EFP halibut accounting protocols not recognized this difference (instead applying a uniform mortality rate to all vessels), it is likely that vessels unable to achieve substantial improvements in mortality rates under the EFP would have continued to fish under the EFP to receive the benefit of the lower mortality rate under the EFP. By allowing the viability tests on a vessel to determine the mortality of halibut sorted on that vessel, the EFP both incentivized halibut savings and provided substantially more accurate accounting of halibut mortality of vessels fishing under the EFP. Preserving this incentive is important given the uncertainty of fishing practices effects on halibut mortality and the range of mortality rates found on the different vessels in the EFP.

The insights gained in the post EFP informal interviews in 2012 and again this year reinforce the conclusion that we need to preserve the direct and vessel-specific incentive structure used in the EFPs to date. In this regard, it needs to be recognized that fishing practices that reduce halibut mortality and halibut sorting by crews are essentially added fishing and catch handling costs affecting profits for vessel operators. If incentivized through halibut mortality savings to the operator of the vessel a, then operators will be very likely to take the necessary steps to ensure those savings are achieved. Ensuring that savings are available to the fishermen willing to incur the costs and efforts to make them is really the only workable approach. Regulating fish handing, towing times, haul size, and other factors is simply not feasible, would have unknown impacts on mortality, and would not be good fishery management practice.

The success of the EFP in achieving its goal of halibut mortality reduction arose in large part from its design. Crediting each vessel with its own mortality savings ensured that vessel operators took the steps needed to achieve actual savings. Structuring data collections from halibut to keep pace with sorting ensured halibut would be returned to the water as quickly as possible, helping to prevent an outcome where time taken to do halibut data collections reduced halibut viability. These features will be important to maintain in future deck sorting initiatives.