Optimizing the Georges Bank Scallop Fishery by Maximizing Meat Yield and Minimizing Bycatch

Prepared by

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2017 Sea Scallop Research Set-Aside - NA17NMF4540030

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1.0 EXECUTIVE SUMMARY

Project Title: **Optimizing the Georges Bank Scallop Fishery by Maximizing Meat Yield and Minimizing Bycatch**
Year Awarded: **2017-2018**
RSA Priorities Addressed By This Research: **Sea Scallop RSA High Priorities #2 bycatch research** and **#3 processes that affect scallop product quality.**
Industry Partners: **Fisheries Survival Fund**

This report presents data and analysis from funding year 2017-2018 for the long-term CFF seasonal bycatch survey on Georges Bank (GB). This bycatch survey has been conducted since October 2010 and has been modified and adapted to address management concerns. The current sampled area is located in the eastern part of GB. During each survey trip, scallop and bycatch species catch was quantified with focus on important bycatch species. Samples were collected to assess scallop meat quality and disease presence in scallops and yellowtail flounder.

This year the project objectives were: 1) Quantify groundfish bycatch rates in comparison to scallop meat yield with the goal of optimizing scallop harvest while minimizing impacts to other stocks, 2) Compare modified commercial dredges with an extended link bag configuration, designed to reduce flatfish bycatch and improve scallop size selectivity, with the standard CFF dredge, 3) Collect biological samples to examine conditions affecting scallop meat quality, 4) Collect biological samples to identify seasonal changes in reproductive cycles and spawning aggregations of scallops and key fish species, and 5) Conduct biological sampling of American lobster caught in the dredge.

During the 2017-2018 project year, scallop meat weight peaked in October and February. The bycatch rates for yellowtail, winter and windowpane flounder, monkfish, and lobster were low (< 1.5 lbs. of fish/lb. of scallops). For the gear comparison, a turtle deflector dredge (TDD) with a 7-row apron was compared with extended link aprons on commercial dredges supplied by participating vessels. Analysis of the paired catch data suggested that the extended link apron may be an effective gear modification for reducing flatfish bycatch, but with a reduction in scallop catch as well.

Roger Williams University (RWU) continued to study scallop meat quality and health using samples collected during bycatch survey trips. Previous work suggested that gray meats are caused by an apicomplexan parasite yet results from RWU showed the parasite was found in white and gray meat scallops, indicating that parasite presence alone was not the cause of discolored meats and suggesting the cause of gray meat may be more complicated than originally determined.

Significant work was also done to continue CFF's long-term analysis of spatiotemporal patterns in catch data and temporal patterns in fish and scallop reproductive stages. We observed high numbers of windowpane flounder across the entire sampling area, with catches peaking in January. Monkfish had the highest catch in September, while catches of yellowtail flounder and winter flounder were low overall. The CFF seasonal bycatch survey continues to provide a wealth of data that can be used to address a wide range of issues that impact the ecosystem on GB.

2.0 PRELIMINARY RESULTS AND DISCUSSION

- **Objective 1:** Quantify groundfish bycatch rates in comparison to scallop meat yield with the goal of optimizing scallop harvest while minimizing impacts to other stocks

The seasonal catch rates of important bycatch species were calculated in relation to the scallop catch as lbs. of fish/lbs. of scallops (**Figure 1**). There were two peaks in scallop meat weights in February and October (**Figure 2**). These peaks were unexpected, and we are investigating the cause.

a) **b)**

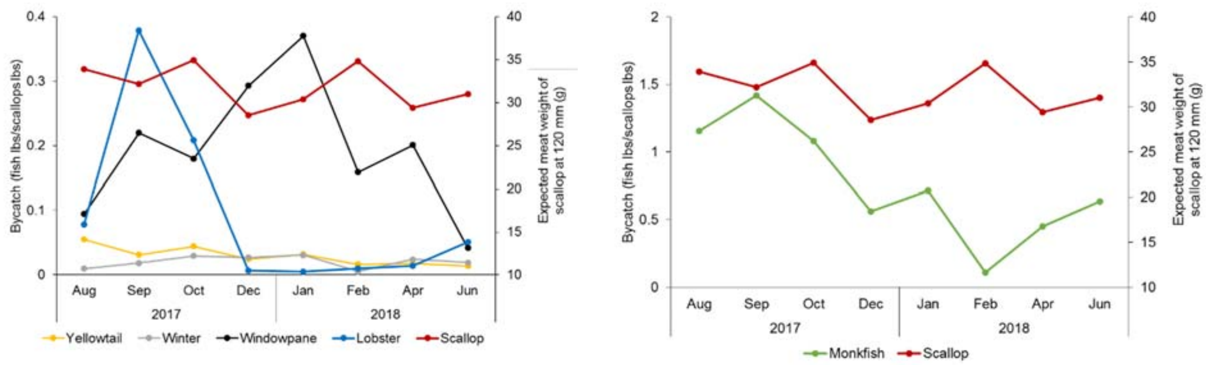


Figure 1. Bycatch rates for commercially important species, including **a)** flatfish, lobster and **b)** monkfish, in relation to scallop catch during this survey. The seasonal change in meat weight for a 120-mm scallop is expressed as expected weight in grams (g) using the results from the SHMW model (red solid line with secondary axis).

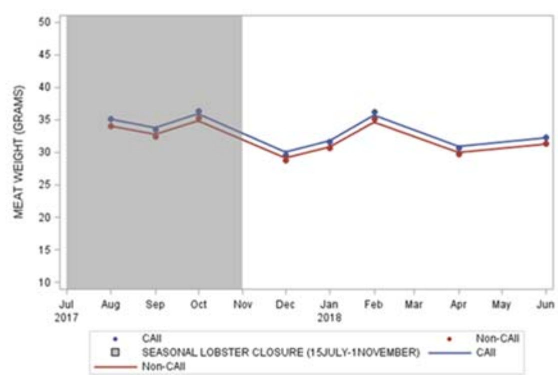
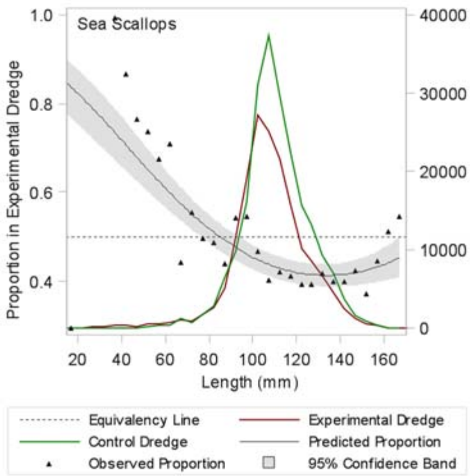


Figure 2. Temporal trends for the predicted meat weight of a white-meat 120-mm shell height scallop from the two areas on the northern edge of Georges Bank. Estimated meat weights were calculated from parameter estimates from the lowest AIC value model (red and blue circles). A smoothed curve is used to show the seasonal trend in meat weight (red and blue lines).

- **Objective 2:** Compare the standard CFF dredge with an industry dredge fitted with an extended link apron

For the length-based model, sea scallop and fourspot flounder length were significant or marginally significant predictors of relative efficiency. There was a general trend for the experimental dredge to become less efficient as length increased, suggesting that the control dredge captured a greater number of larger animals (**Figure 3**).

a)



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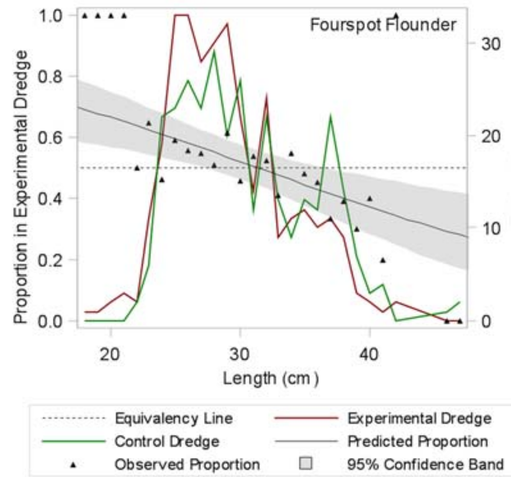

Figure 3. Relative **a)** sea scallop and **b)** fourspot flounder catch by the two dredge configurations. The triangles represent the observed proportion at length (Catchexp/(Catchexp + Catchcont), with a proportion >0.5 representing more animals at length captured by the experimental apron dredge. The grey area represents the 95% confidence band for the modeled proportion (solid black line). The model that provided the best fit to the data included a factor that accounted for individual intercepts at the station level.

Animal length was not a significant predictor of relative dredge efficiency for most of the species. Therefore, total catch was examined and there were significant reductions in scallop, windowpane flounder, and unclassified skates catch with the experimental dredge (**Table 1**).

Table 1. The observed and model estimated total changes in catch using tow-by-tow data.

Species	Experimental Dredge	Control Dredge	Percent Difference	Model Estimate	Significance
Uncl. Skates	**12,237**	**14,918**	**-17.97**	**-18.80**	**YES**
Barndoor Skate	485	512	-5.27	-4.10	NO
American Plaice	44	56	-21.43	-19.80	NO
Summer Flounder	97	91	6.59	10.71	NO
Fourspot Flounder	325	311	4.50	6.61	NO
Yellowtail Flounder	186	232	-19.83	-18.19	NO
Winter Flounder	69	88	-21.59	-19.88	NO
Windowpane Flounder	**2,256**	**3,021**	**-25.32**	**-26.02**	**YES**
Monkfish	1158	1175	-1.45	1.33	NO
Sea Scallops	**169,577**	**212,245**	**-20.10**	**-24.06**	**YES**

- **Objective 3:** Collect biological samples to examine conditions affecting scallop meat quality.

A total of six orange nodules and twelve gray meats were observed with and apparently no hot spots (**Table 2**).

Table 2. Number of scallops by color and with orange nodules

Year	Month	Orange Nodules	White Meat	Brown Meat	Gray Meat
2017	**August**	1	866	5	2
	September	0	778	3	1
	October	2	762	13	2
	December	1	743	7	4
2018	**January**	0	746	8	1
	February	2	836	4	1
	April	0	729	15	1
	June	0	857	7	0
Total		**6**	**6,317**	**62**	**12**

All meat samples collected were sent to the RWU ADL to confirm apicomplexan infection using histological methods and PCR. Histological evaluation of presumed infected and uninfected meats showed a range of results, including normal adductor muscle in gray and white meats, as well as moderate to severe changes in discolored meats (**Figure 5**). Through PCR, positive apicomplexan signals were detected in samples of white and discolored meats. See Section 3 for additional discussion of this topic.

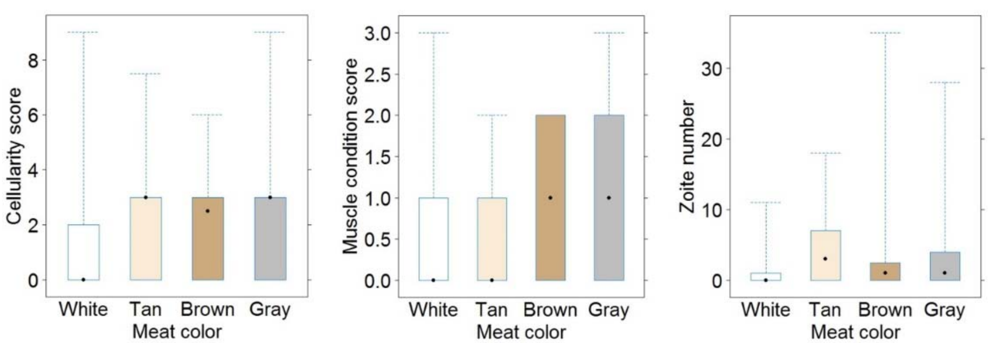

Figure 5. Box and whisker plots of meat color against a) cellularity scores, b) muscle thinning scores and c) protozoan sporozoites for samples collected during the 2015-2018 seasonal bycatch surveys. Boxes end at the first and third quartiles of the distribution of values for each variable, with the whiskers extending to the minimum and maximum values.

- **Objective 4:** Investigate the general biology of scallops and main bycatch species, specifically maturity, growth, and diseases.

The reproductive stages of the sea scallop and three flounder species were plotted to examine seasonal changes and estimate spawning periods for each species (**Figure 7**).

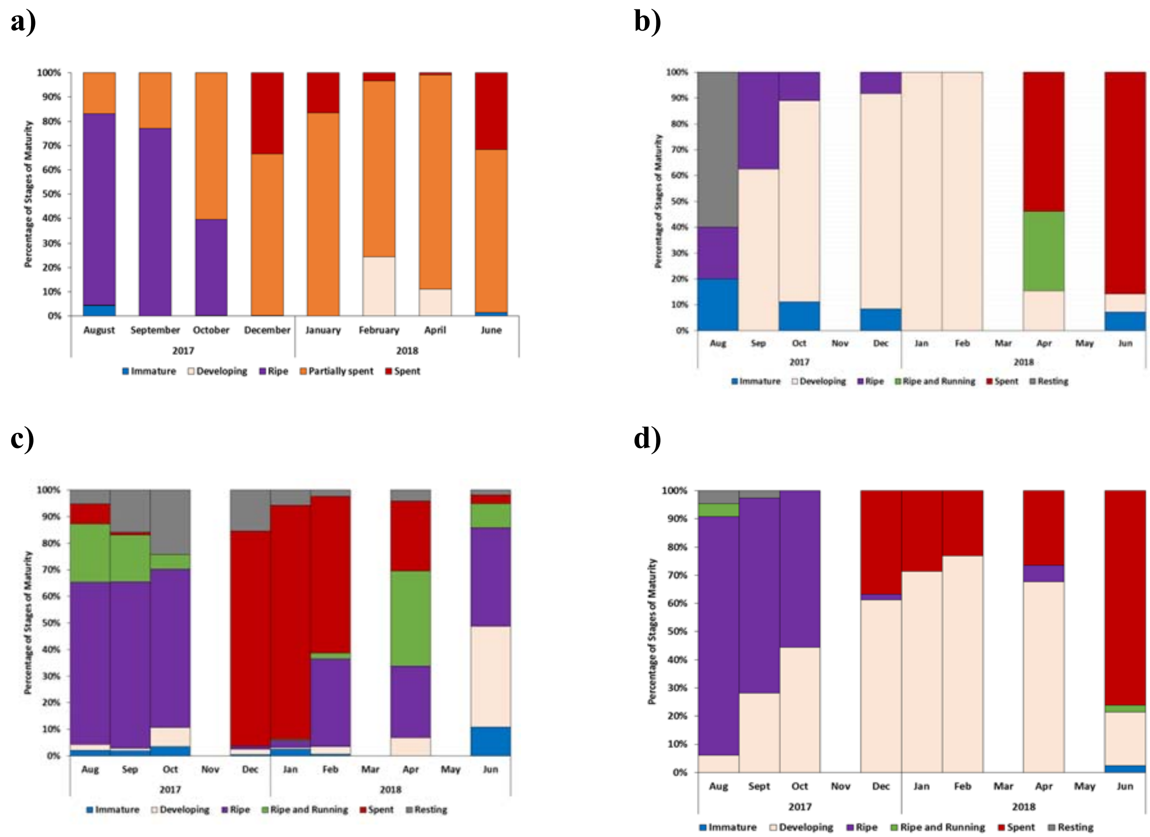

Figure 7. Seasonal maturity results for female **a)** scallops, **b)** winter, **c)** windowpane, and **d)** yellowtail flounder for each month during the 2017 seasonal bycatch survey on the eastern portion of GB determined through macroscopic observations.

- **Objective 5:** Conduct biological sampling of American lobster caught in the dredge.

Lobsters were caught across the entire survey area, with a peak of abundance in September (**Figure 8**)

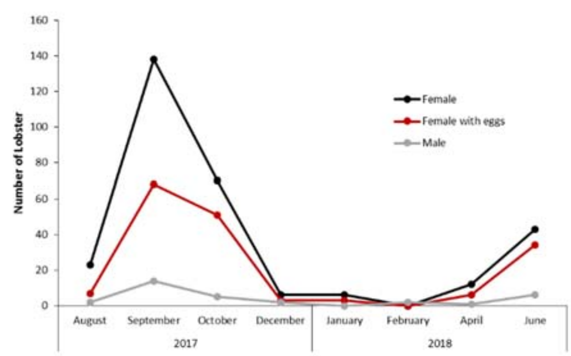

Figure 8. Catch of lobsters by trip separated by sex during the 2017 seasonal bycatch survey on the eastern portion of Georges Bank.

Distributional maps for the main species, additional tables and figures may be found in the 2017 seasonal bycatch final report.

The CFF seasonal bycatch survey program has provided a wealth of data that can be used to address a wide range of issues that impact the ecosystem on Georges Bank since 2011. The long-term seasonal data set is unique and as such has been used to evaluate populations of multiple commercial fish species, supplying fisheries managers with critical information required to adhere to ACLs and devise AMs to optimize the harvest of scallops while minimizing bycatch. The program has provided information on spatiotemporal patterns in bycatch rates in the scallop fishery and has been used to identify mechanisms to mitigate bycatch. As new issues arise, the bycatch survey has adapted.

This project has continued to highlight the value of collecting fisheries data throughout the year. The primary survey used for groundfish stock assessments is the Northeast Fisheries Science Center (NEFSC) bottom trawl survey, conducted twice a year in the spring (March-May) and fall (September-November). The CFF surveys has shown that the relative abundances of important commercial species, including windowpane flounder and monkfish, peak during winter and summer months, respectively, on GB (Winton *et al*. 2017, Siemann *et al*. 2018). This seasonal variation in fish distributions had not been captured by the NEFSC survey. By conducting surveys in winter, CFF was able to generate a biomass estimate for northern windowpane flounder by expanding swept area estimates from the 2015 and 2016 projects (Garcia *et al*. 2018a)

Other examples of important changes the seasonal bycatch survey data have captured for closed and open areas of GB over the past seven years are the relative abundance and reproductive patterns of commercial species. Reductions in the catch of yellowtail and windowpane flounder have been documented in the 2017 final report, with yellowtail flounder catch numbers decreasing by over 90% on eastern GB in areas where they were once abundant (Huntsberger *et al*. 2015, Smolowitz *et al*. 2016, **Figure 9**). In addition, the results of the reproductive staging may provide a clue to explain recent poor recruitment of yellowtail flounder on GB. Spawning had been consistently documented to occur in the late spring to early summer, but beginning in 2016 CFF scientists documented ripe yellowtail flounder in September-November (Garcia *et al*. 2018b) on northern Georges Bank. During this year's project, almost all ripe flounder were observed in August-October. Delayed spawning has been cited as a possible cause for poor recruitment in Atlantic cod because egg and larval stages may not experience the environmental conditions needed for survival (Wieland *et al*. 2000), and delayed spawning could have a similar impact on GB yellowtail flounder.

To date, CFF has completed over three years (October 2010 – March 2014) of bycatch surveys on GB in the scallop access areas in CAI and CAII, two years (August 2015 – June 2017) of surveys on the northern portion of Georges Bank, and one year (August 2017 – June 2018) of surveys on the eastern portion of Georges Bank. The shift to include all of CAII was done to better understand the seasonal patterns of habitat used by the choke flatfish bycatch species, yellowtail and windowpane flounder, which are mainly distributed within this area.

Because fishery access and habitat protection in this area may be adjusted, continued collection of scallop, fish, and lobster data from this region is critical.

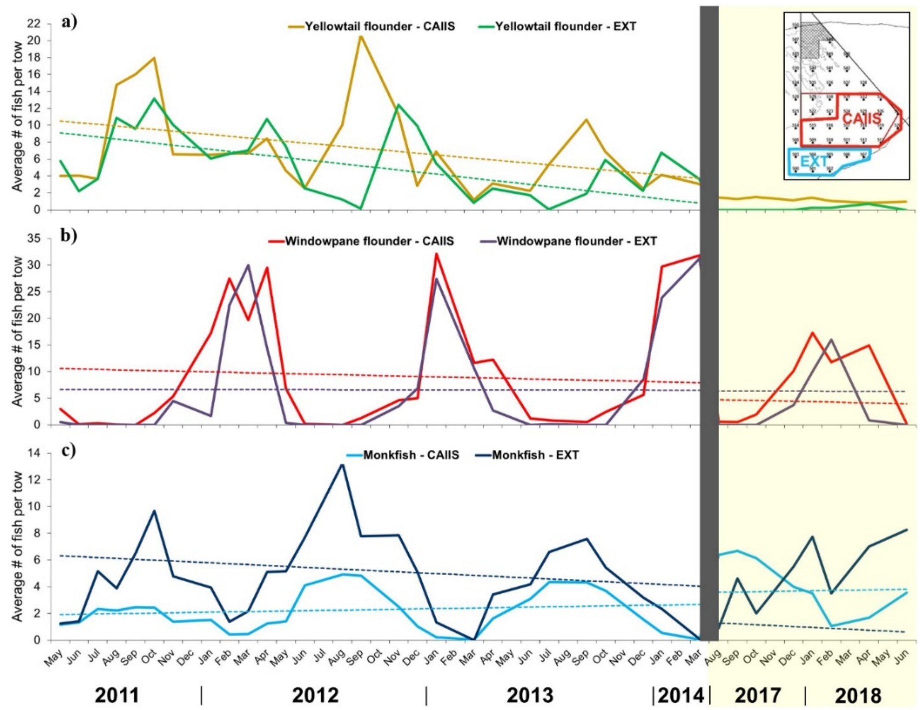

Figure 9. Average catch per tow (ACPT) at stations in CAII S and EXT during the 2011-2014 vs 2017-2018 seasonal bycatch surveys for **a)** yellowtail flounder, **b)** windowpane flounder, and **c)** monkfish. Trend lines for each time series of catch data are shown with same-colored dashed lines. The trend lines from 2011-2014 were extended into 2017-2018, and the shift in values across the time gap between March 2014 and August 2017 can be seen for windowpane flounder and monkfish. The trend lines for yellowtail flounder are not visible for 2017-2018 because the lines crossed zero before 2017.

3.0 SPECIAL COMMENTS

During previous bycatch studies, the control and experimental gear was provided by CFF, minimizing the differences between the dredge frames. During the 2017-2018 project, this experimental design was altered, and the experimental dredge was supplied by the industry vessel. While this project and the dedicated gear research both showed reduced scallop catch in the extended link dredge, the reduction was higher in this project. This may be due to the projects taking place in areas with different scallop densities or because of the different experimental designs. The design of this project was intended to offer a full examination of the impact of the variability at the fleet level and an assessment of whether management objectives will be met in light of the resulting variability. However, we believe that by adding more variables that are difficult to control (e.g. dredge width, sweep), this design precludes the ability to assess trip by trip differences and the underlying process for those differences, making it difficult to interpret the results and compare them to previous gear studies. As such, differences in the results of the dedicated gear research and the gear comparisons conducted during this bycatch trip are not surprising, and they highlight the difficulties inherent in taking empirical results from controlled gear studies and drawing inferences at the fleet level.

The results from our ongoing gray meat research suggest another mechanism, besides the accumulation of apicomplexan parasite in the muscle, may cause degradation of the scallop muscle tissue. Positive signals for the presence of the apicomplexan parasite were detected in samples of both white and discolored meats. In some gray to brown meats, the parasite foci were not associated with significant muscle damage. These findings indicate that other mechanisms, such as a generalized toxin produced by the parasite or infections at other sites in the body causing poor nutrition, may be contributing factors to muscle degeneration and gray meats. This hypothesis is further supported by ongoing modelling efforts that show gray meat prevalence is correlated with scallop reproductive stage and age (Siemann *et al*. paper in review). In order to better understand the correlation of infection by the parasite and degeneration of muscle tissue, further work should be completed, including: 1) in-situ hybridization to identify parasite life stages in the degenerating tissues; 2) correlation of PCR identification of the parasite in meats with histological evaluation, and 3) development of a quantitative PCR method that can quantify the abundance of parasites in the meats. A quantitative PCR test method would directly quantify the number of parasites in the tissue without the use of histology, offering a fast and accurate monitoring tool.

The scallop industry has become increasingly concerned about the observed distribution and magnitude of poor-quality scallops, and there has been increasing interest in using the bycatch survey data as a time series. Therefore, we hope to begin incorporating a set of fixed stations that would remain constant each year, with these stations placed across important scallop fishing grounds. Our focus on disease research would continue, incorporating improved methods for disease detection and quantifying disease impacts.

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