

**A Contemporary Assessment of the Bycatch of Regulated Species and the
Nordmore Grate in the Northern Shrimp Fishery**

2009 Annual Report

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Project objectives and scientific hypotheses:

The primary goal of this project was to evaluate the bycatch of regulated groundfish species during the 2008-2009 northern shrimp season and assess the efficacy of the Nordmore grate in reducing the bycatch of regulated groundfish and non-regulated species. Specific project objectives were to:

1. Monitor and document the bycatch of regulated groundfish and non-regulated species during the 2008-2009 northern shrimp fishing season.
2. Compare regulated species bycatch during the 2008-2009 fishing season across spatial and temporal scales.
3. Determine the ability of the Nordmore grate to reduce bycatch of regulated species to 5% or less of total catch weight.
4. Identify the factors affecting the operational performance of the Nordmore grate and compare the catching performance of both upward and downward excluding grates.

Methods and work plan:

Objective 1 – Monitor and document the bycatch of regulated species during the 2008-2009 northern shrimp fishing season.

A data collection program was established using observers to monitor and document the bycatch of regulated groundfish and non-regulated species during the 2008-2009 shrimp season (for the purposes of this study regulated species are defined by the Northeast Multispecies Fishery Management Plan). Our plan was to sample ~5% of the fishing fleet by completing 64 days of observer coverage aboard four vessels over the course of four months (Table 1). Observers were to spend four consecutive days per month (weather permitting) collecting tow-by-tow catch data for shrimp, regulated and non-regulated bycatch during normal commercial fishing operations. We expected to collect catch data from 3-4 tows per day, which is typical of normal industry practice (Schick et al., 2006).

Table 1. Planned observer data collection program

Boat #	Days per month			
	Dec	Jan	Feb	Mar
1	4	4	4	4
2	4	4	4	4
3	4	4	4	4
4	4	4	4	4

All GMRI observers received project-specific training from GMRI staff experienced in at-sea research and observer training. They collected and recorded catch data following sampling protocols closely aligned with the NOAA observer program. This included length and weight data for regulated species along with shrimp weight and that of other bycatch species. Observers also recorded gear configuration data, along with fishing location, direction, and duration.

Boats were selected based upon their history of fishing throughout the entire shrimp season in the general vicinity of the majority of the fishing fleet, history of landing shrimp at ports dominating shrimp landings, and their willingness and preparedness to participate in this study. Our goal in using these criteria was to ensure that observer coverage reflected the overall distribution of fishing effort across the wider fishing fleet. Because we wanted to compare bycatch across a spatial scale, we also strove to select boats from a variety of locations along the Gulf of Maine coast.

Objective 2 – Compare the bycatch of regulated species during the 2008-2009 fishing season, across spatial and temporal scales.

To spatially compare the bycatch of regulated species we selected four vessels fishing in distinct locations from Northern Massachusetts to Port Clyde, Maine (see work completed). Temporal comparison of bycatch was facilitated by sampling over the course of four different months at approximately the same time each month. Catch data was then compared between locations and time.

Objective 3 – Determine the ability of the Nordmore grate to reduce the bycatch of regulated species to 5% or less of total catch weight

The regulated species catch was compared to that of other catch fractions, including shrimp and non-regulated bycatch. This assessment allowed the Nordmore grate's ability to meet the $\leq 5\%$ bycatch target to be evaluated on both spatial and temporal scales, and to identify potential bycatch hotspots or key species that may require further evaluation and/or grate modification.

Objective 4 – Identify the factors affecting operational performance of the grate and compare the catching performance of both upward and downward excluding grates.

Observers collected data about grate design and operational performance including bar spacing, grate angle, grate height, width, and orientation along with details associated with grate deployment, retrieval, deck handling, and maintenance. This information provided valuable insight into grate operation under typical commercial fishing operations and the range and variability of factors affecting grate performance.

The original proposal called for one boat to regularly alter grate orientation between upward and downward exclusion. Unfortunately, this practice proved to be unfeasible was tested only on one boat over three days. All boats in this study normally use an upward excluding grate.

Work completed to date:

All field sampling for this project has been completed for a total of 39 days at sea and 136 tows. A total of 5 vessels were used at sites ranging between northern Massachusetts to Port Clyde, ME (Table 2). While we had originally planned on sampling aboard four vessels for a total of 64 days over a four month period, we were unable to meet this goal because i) despite the fishery opening in December nearly all vessels did not commence fishing until January, ii) several vessels restricted their fishing operations due to oversupply and lack of market demand for shrimp, and iii) several vessels prematurely terminated shrimp fishing due to this lack of demand. In April we added the F/V Jeanne C to obtain sampling data for an additional month and add to the total number of sampling days and tows.

Table 2. Total number of sampling days sorted by location

Vessel Name	Sampling Area	Sampling Days Per Month			
		January	February	March	April
F/V Lady Dee	Northern Massachusetts	4	0	0	0
F/V Kirsten Lee	Boon Island	4	4	0	0
F/V North Star	Saco Bay	4	3	6	0
F/V Jeanne C.	Seguin Island	0	0	0	3
F/V Ella Christine	Midcoast ME	4	4	3	0

Poor weather and market conditions made it unfeasible to sample over the course of four consecutive days. Therefore, we simply made an effort to sample over four days as close together as possible during each month. The largest gap between sampling was 7 days and the largest gap between the first and last days of sampling was 15 days.

Sampling procedures were consistently employed by five observers trained by experienced GMRI staff members. At the conclusion of each tow, all bycatch was separated from the shrimp and sorted by species. Each regulated fish species was collectively weighed to the nearest tenth of a pound and individual fish were measured to the nearest cm. For species caught in large numbers, only the first 100 individuals caught per day were measured because there was only limited time between tows in which to collect data. Because of their prevalence, the lengths of silver hake, red/white hake mix, and both Atlantic and river herring were recorded to the nearest cm. Shrimp weights for each tow were estimated at 100 pounds per full tray, with partial tray weight estimated based upon the proportion filled.

Results to date:

Overall bycatch data

Table 3 provides catch data for all 39 trips completed during this study, along with average catch data per trip from individual vessels. This data shows that regulated species bycatch was generally low with mean bycatch per boat ranging from 0.22-2.01%, well below the 5% threshold. The total bycatch, including non-regulated species was also relatively low with mean values per boat ranging from 0.82-6.43%.

Table 3. Average catch & bycatch per trip

Vessels	Shrimp (lbs)	Regulated Species (lbs)	Non-Regulated Species (lbs)	Mean Bycatch Regulated Spp. (% ± SD)	Mean Bycatch All Spp. (%)
All Vessels (n=39 trips)	2670.8	30.3	74.5	1.19 ± 1.12	4.11 ± 3.83
Northern Mass. (n=4 trips)	2962.5	23.2	45.4	0.75 ± 1.01	2.34 ± 1.01
Boon Island (n=8 trips)	3777.5	64.2	126.0	2.01 ± 1.83	5.63 ± 4.74
Saco Bay (n=13 trips)	2318.8	34.6	110.5	1.55 ± 0.53	6.43 ± 3.17
Seguin Island (n=3 trips)	1220.0	21.9	45.9	1.59 ± 0.77	4.46 ± 4.93
Midcoast ME (n=11 trips)	2571.4	5.5	13.0	0.22 ± 0.24	0.82 ± 0.93

One of 39 trips had an average regulated species bycatch greater than 5%; this trip was at the Boon Island site on 1/9/2009 and had a regulated species bycatch of 5.34%. Additionally, of the 136 tows only 7 (5.1%) had regulated species bycatch of 5% or greater (Table 4). The majority of these tows occurred at the Boon Island site at the beginning of the fishing season. During this time fishermen were searching for aggregations of shrimp and oftentimes ended up catching relatively high proportions of regulated species with low catches of shrimp. As the season progressed and the fishermen found more productive fishing spots, this bycatch declined.

Table 4. Data for tows with regulated species bycatch >5%.

Location	Date	Haul	Shrimp (lbs)	Regulated (lbs)	Other (lbs)	Shrimp (%)	Regulated (%)	Other (%)
Northern Mass.	1/21/09	1	200	17.2	35.45	79.16	6.81	14.03
Boon Island	1/9/09	1	600	54.7	65.1	83.36	7.60	9.04
Boon Island	1/9/09	2	50	19.6	44	44.01	17.25	38.73
Boon Island	1/10/09	1	325	30.3	40.6	82.09	7.65	10.26
Boon Island	1/12/09	2	725	50.2	64.7	86.32	5.98	7.70
Boon Island	1/13/09	3	100	9.4	13.7	81.23	7.64	11.13
Saco Bay	3/13/09	1	80	5	2.6	91.32	5.71	2.97

Spatial and temporal comparison of bycatch

Because two vessels prematurely dropped out of the shrimp season, a spatial comparison of bycatch amongst all four original vessels was only possible in January. Figures 1 and 2 indicate that the vessel fishing near Boon Island caught the highest proportion of regulated species bycatch during the month of January with a mean of about 3.5%. The Saco Bay vessel caught the next highest proportion of regulated species with a mean just under 2%, while the Northern Massachusetts and Midcoast ME vessels both averaged less than 1%.

Figure 1 also shows fairly high proportions (8-14%) of non-regulated species bycatch caught during some of the January trips for Boon Island and Saco Bay which consisted primarily of silver hake (*Merluccius bilinearis*). Although the vessel in Northern Massachusetts ended their shrimp season in January, we were able to collect and compare data from the three other vessels for February (Figure 3). In February, the Saco Bay vessel had the highest proportion of regulated species bycatch with a mean of 1.4%, followed by Boon Island at .6% and Midcoast ME at .08% (Figure 4).

In March, only the Saco Bay and Midcoast ME vessel continued fishing. The Saco Bay vessel had regulated species bycatch averaging just under 1.5%, while the Midcoast ME vessel had extremely low regulated species bycatch with a mean of .07% (Figure 6). As in January, the non-regulated species bycatch was relatively high (7-10%) for 3 of the Saco Bay trips (Figure 5). Again, this was primarily due to catching high numbers of silver hake.

The Seguin Island vessel, which was added near the end of the project, was the only vessel in the project that continued shrimping into April. As seen in Figures 7 and 8, bycatch of both regulated and non-regulated species was relatively low with a mean bycatch of regulated species of 1.6%.

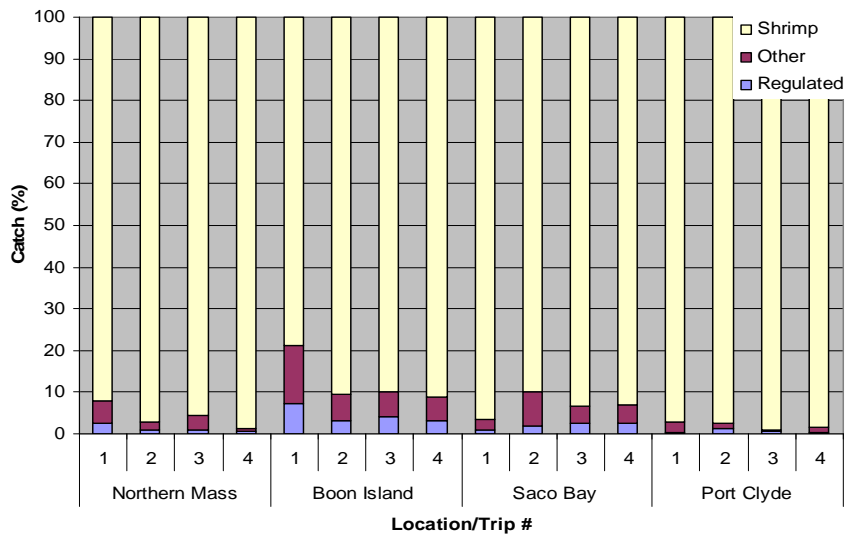


Figure 1. Bycatch per trip for January

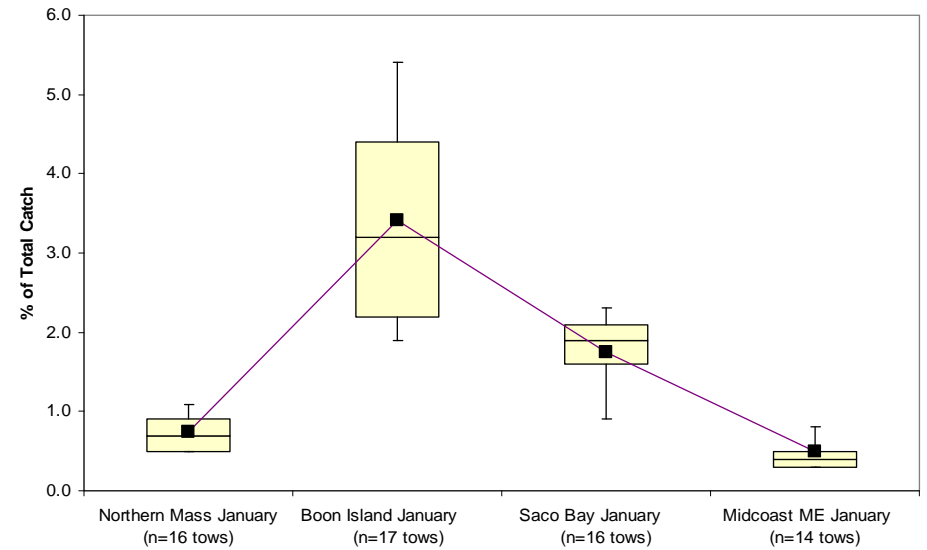


Figure 2. Mean (black square), median (horizontal line), upper and lower quartiles (areas enclosed by box), and maximum and minimum values (vertical lines) of regulated species bycatch as % of total catch in January.

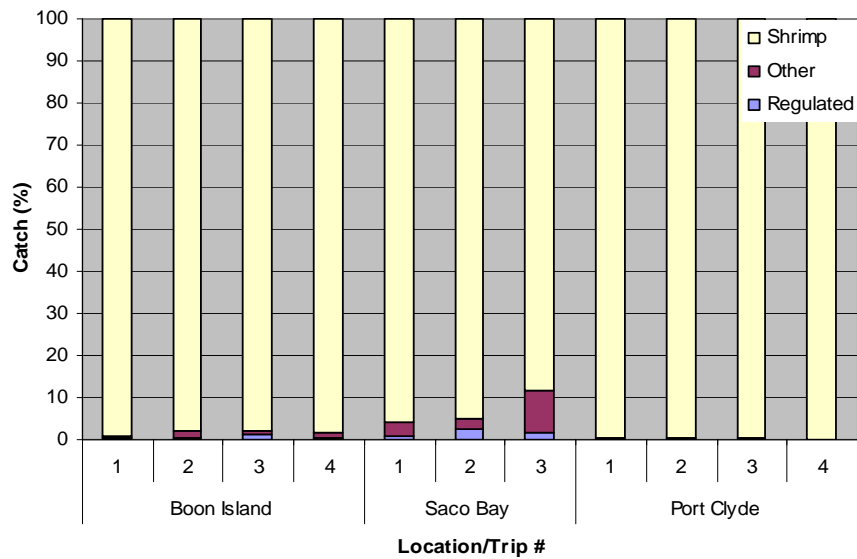


Figure 3. Bycatch per trip for all locations in February

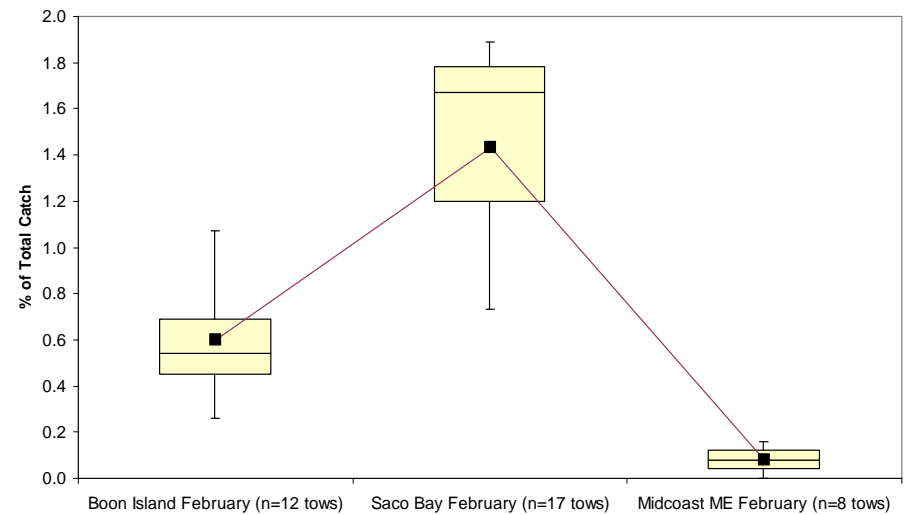


Figure 4. Mean (black square), median (horizontal line), upper and lower quartiles (areas enclosed by box), and maximum and minimum values (vertical lines) of regulated species bycatch as % of total catch in February.

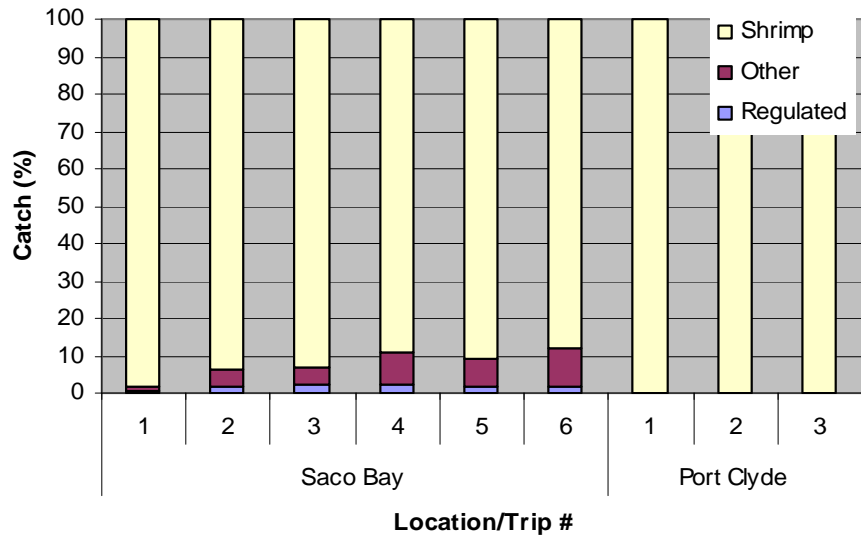


Figure 5. Bycatch per trip for March

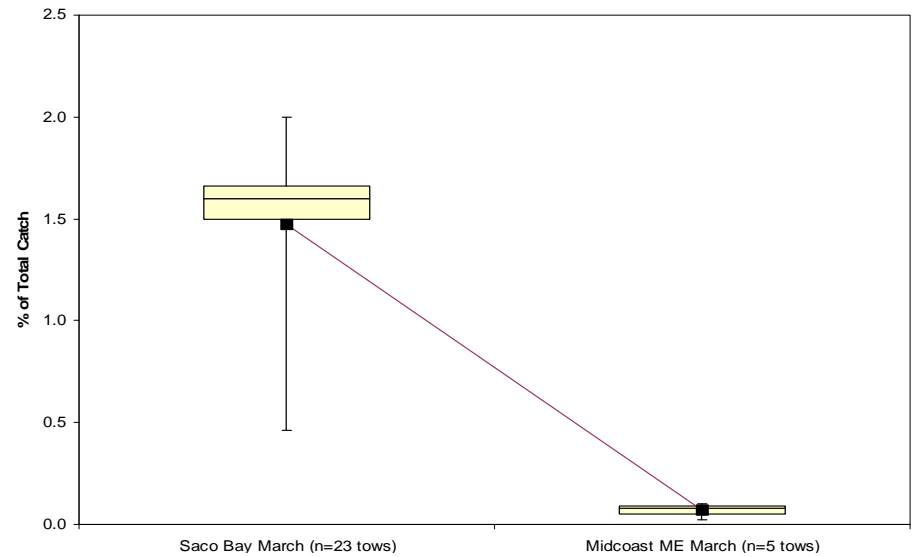


Figure 6. Mean (black square), median (horizontal line), upper and lower quartiles (areas enclosed by box), and maximum and minimum values (vertical lines) of regulated species bycatch as % of total catch in March.

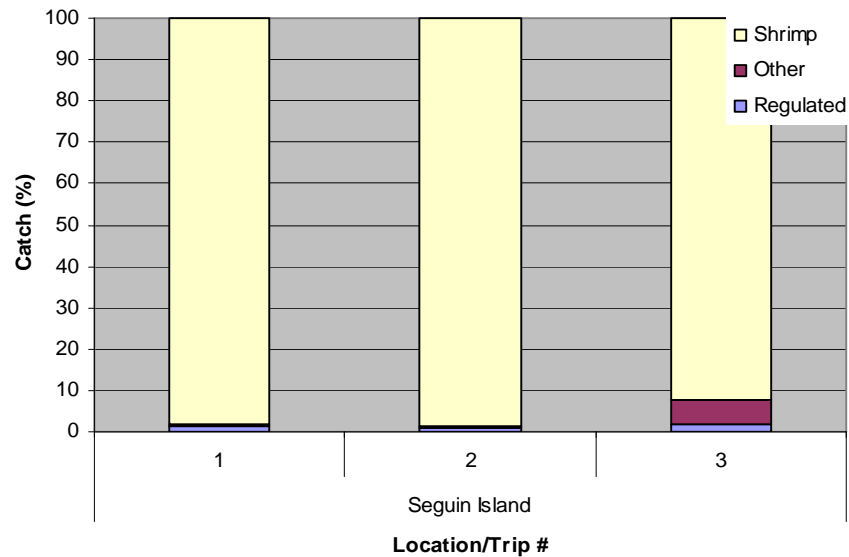


Figure 7. Bycatch per trip for April

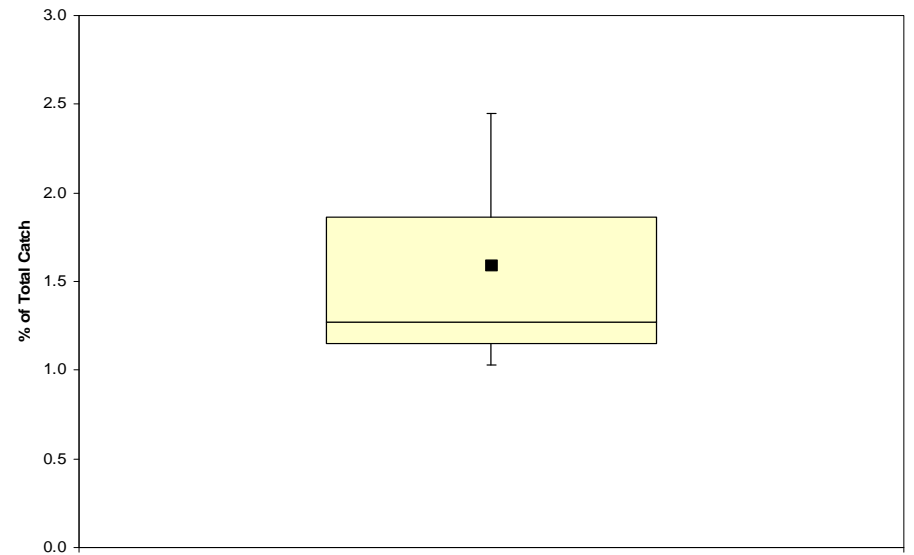


Figure 8. Mean (black square), median (horizontal line), upper and lower quartiles (areas enclosed by box), and maximum and minimum values (vertical lines) of regulated species bycatch as % of total catch in April.

Catch data was also temporally compared for each location where fishing occurred for more than one month. At the Boon Island site, bycatch of regulated species declined from a mean of 3.4% in January to a mean of 0.6% in February (Figure 9). Additionally, the data spread decreased from January to February, indicating more consistent levels of bycatch in February.

At the Saco Bay site, regulated species bycatch remained relatively constant across months with a mean of 1.8% in January, 1.4% in February, and 1.5% in March (Figure 10). Data spread was fairly equal for January and February, but was reduced in March.

Bycatch for Midcoast ME was low throughout the study period, it did decline slightly from a mean of 0.5% in January to a mean <0.1% in February and March (Figure 11). Data spread for this location also decreased throughout time.

Of note is the pattern of decline in regulated species bycatch and data spread from the first month of sampling to subsequent months for all locations. While this may indicate a temporal fluctuation in the amount of bycatch present, it may also be attributable to fishermen knowledge. As previously discussed, fishermen may catch larger amounts of bycatch relative to shrimp early in the season as they are still trying to locate more productive areas for shrimp. As the season goes on and they have identified areas with higher concentrations of shrimp, the proportion of regulated species bycatch may decline.

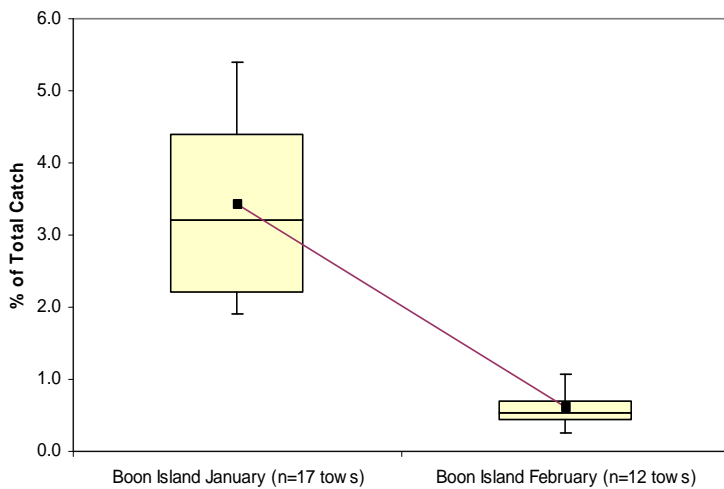


Figure 9. Mean (black square), median (horizontal line), upper and lower quartiles (areas enclosed by box), and maximum and minimum values (vertical lines) of regulated species bycatch and % of total catch for Boon Island by month.

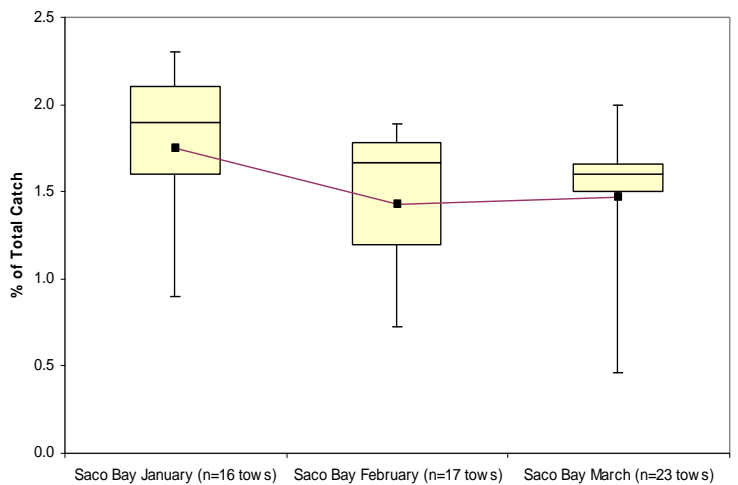


Figure 10. Mean (black square), median (horizontal line), upper and lower quartiles (areas enclosed by box), and maximum and minimum values (vertical lines) of regulated species bycatch and % of total catch for Saco Bay by month.

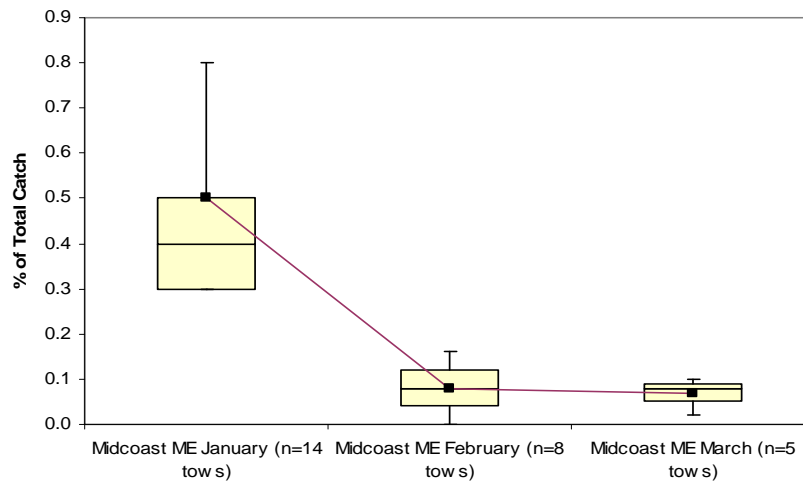


Figure 11. Mean (black square), median (horizontal line), upper and lower quartiles (areas enclosed by box), and maximum and minimum values (vertical lines) of regulated species bycatch and % of total catch for Midcoast ME by month.

Grate orientation

The effect of grate orientation on catch rates was tested only on one vessel. Initially the grate was oriented to exclude downwards but after three trips was reoriented to exclude upwards (Table 5). The grate remained in this orientation for the remainder of the project. The results suggest that a downward excluding grate retained a higher proportion of regulated bycatch. Care is required interpreting this result, which occurred soon after the fishing season commenced and during which time the fisherman was searching for commercial aggregations of shrimp.

Table 5. Shrimp and bycatch proportions by trip. The first three trips were completed with a downward excluding grate and the remainder with an upward excluding grate.

Trip date	Shrimp (%)	Regulated bycatch (%)	Other bycatch (%)
1/9/2009	86.31	5.34	8.35
1/10/2009	91.88	2.32	5.80
1/12/2009	89.73	4.04	6.23
average	89.31	3.90	6.79
1/13/2009	93.73	1.94	4.34
2/11/2009	99.38	0.26	0.37
2/12/2009	98.06	0.52	1.42
2/14/2009	97.85	1.08	1.08
2/15/2009	98.03	0.57	1.40
average	97.41	0.87	1.72

Composition of regulated species bycatch

Regulated species bycatch composition was evaluated for all trips in each location by weight and number. The Northern Massachusetts vessel's regulated species bycatch was dominated by American plaice (dabs) which accounted for more than 75% of regulated species in both weight and number (Figure 12). Dabs also dominated the regulated species bycatch of the Boon Island vessel which also caught a fair number of red/white hake, winter flounder, and yellowtail flounder (Figure 13). Regulated species bycatch at the Saco Bay site consisted of almost equal amounts of dabs and red/white hake by weight, while dabs dominated by number (Figure 14). Winter flounder also comprised a relatively large portion of the catch. In Midcoast ME red/white hake took over as the dominant bycatch species both in weight and number, followed by dabs and winter flounder (Figure 15). Dabs dominated the regulated species bycatch at the Seguin Island site, but this vessel also caught a fair amount of red/white hake and witch flounder (Figure 16).

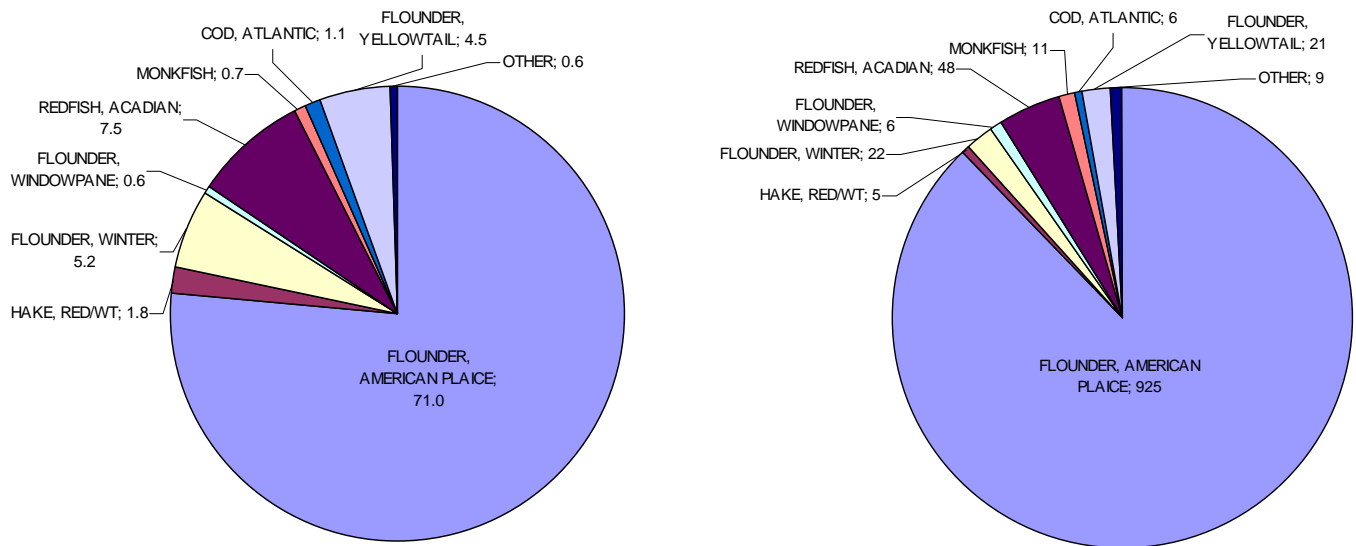


Figure 12. Regulated species bycatch for Northern Massachusetts by weight (lbs., left) and number (right).

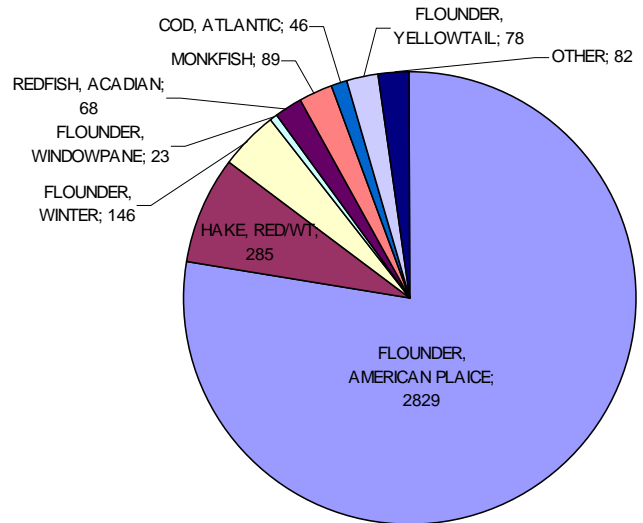
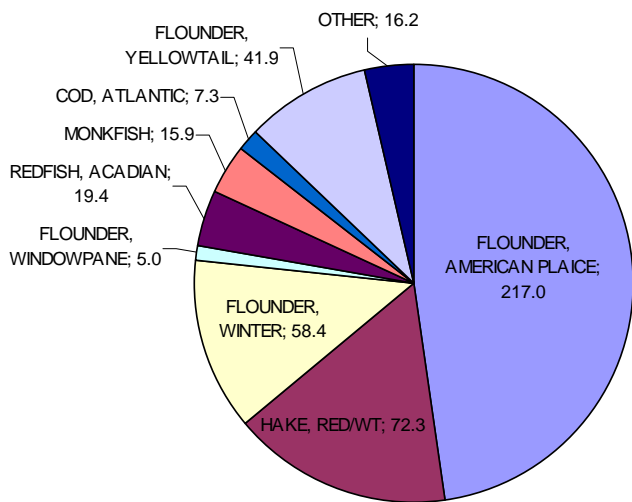


Figure 13. Regulated species bycatch for Boon Island by weight (lbs., left) and number (right).

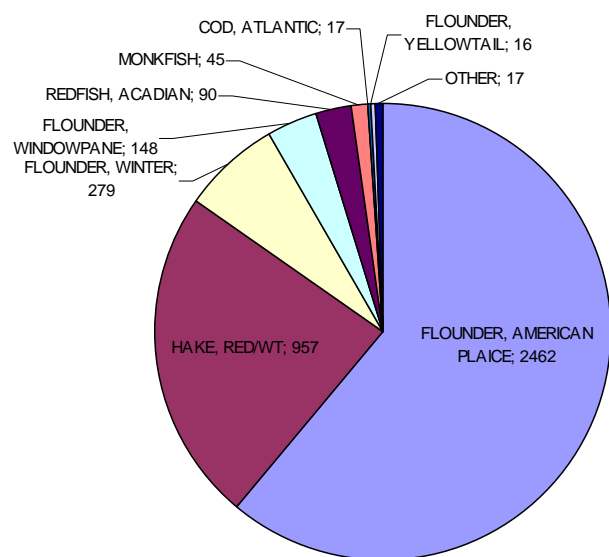
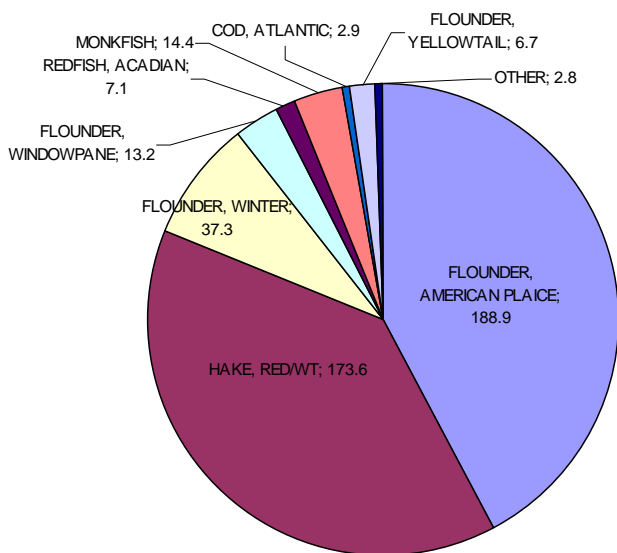


Figure 14. Regulated species bycatch for Saco Bay by weight (lbs., left) and number (right).

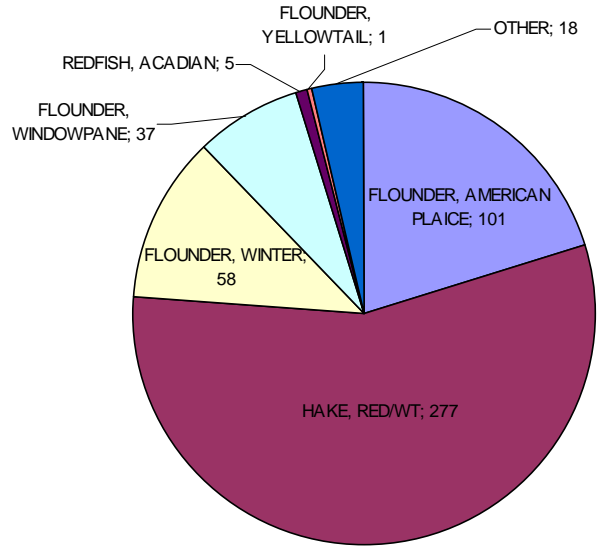
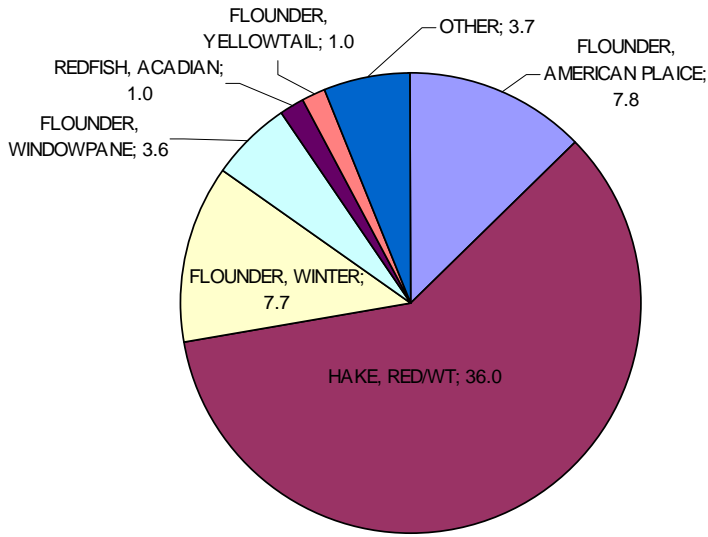


Figure 15. Regulated species bycatch for Midcoast ME by weight (lbs., left) and number (right).

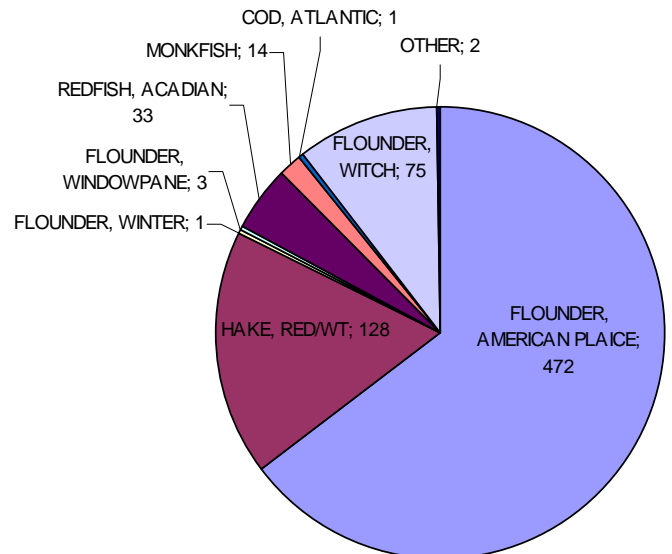
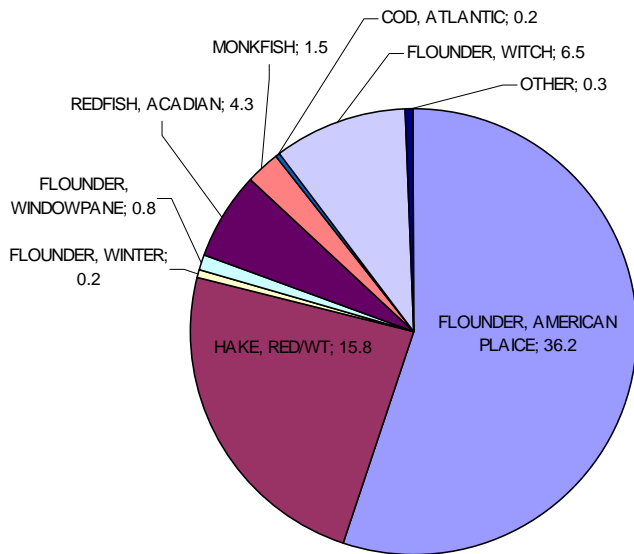


Figure 16. Regulated species bycatch for Seguin Island by weight (lbs., left) and number (right).

Because of the large quantity of dabs caught during the course of this study (6789 individuals for a total of 521 lbs.), we also performed a length frequency analysis on sub-samples of dabs in each location (Figures 17-21). For all locations 11-16 cm fish comprised the largest proportion of the dab catch, although at the Seguin Island site there was also large numbers of fish in the 20-28 cm range. The length of dabs in all other sites tended to drop off after about 16-19 cm. All measured dabs were below the legal landing size of 35.6 cm.

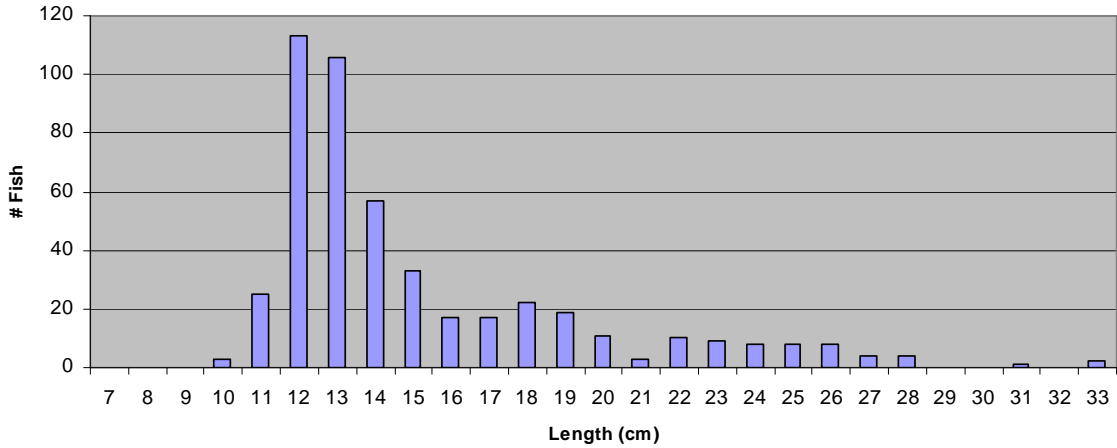


Figure 17. Length frequency distribution for dabs caught by the Northern Massachusetts vessel.

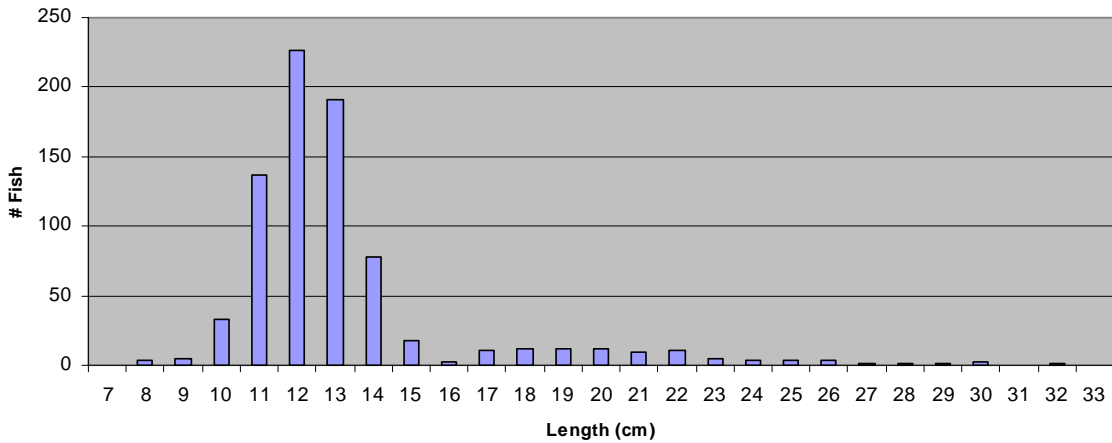


Figure 18. Length frequency distribution for dabs caught by the Boon Island vessel.

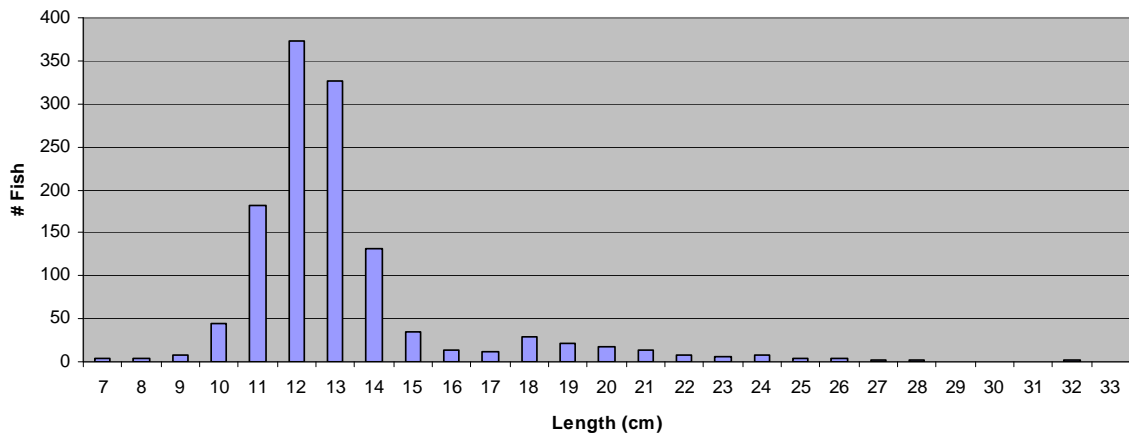


Figure 19. Length frequency distribution for dabs caught by the Saco Bay vessel.

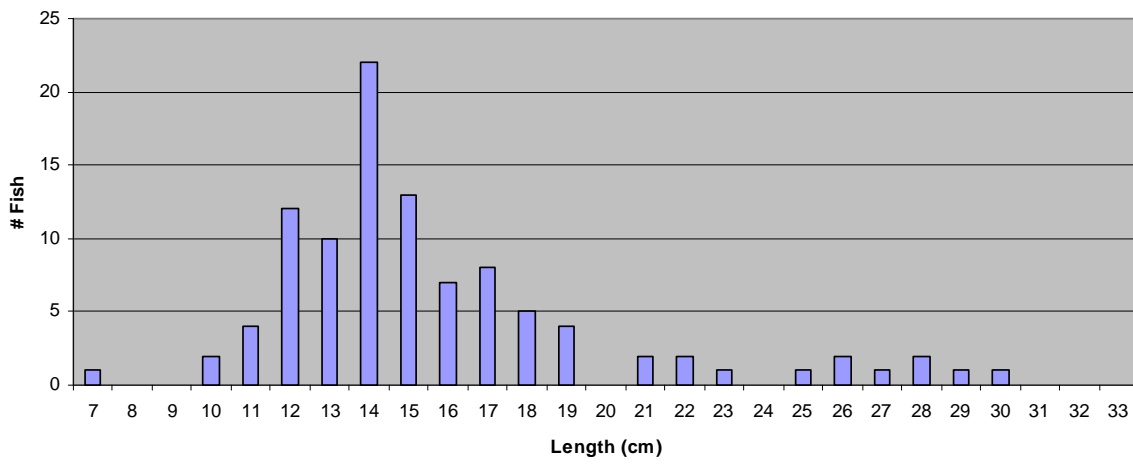


Figure 20. Length frequency distribution for dabs caught by the Midcoast ME vessel.

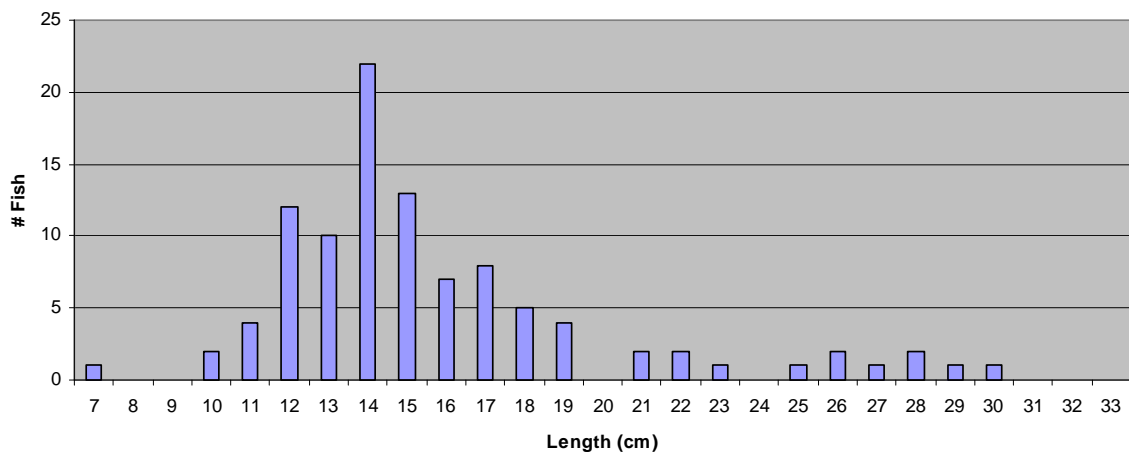


Figure 21. Length frequency distribution for dabs caught by the Seguin Island vessel.

Presentations:

The PI presented a summary of this work at the 8th Annual NEC Project Participants meeting in Portsmouth, NH on March , 25th, 2009.

Future work:

All field work for this project has been completed. The results presented here should be considered preliminary and further evaluation and analysis will be completed in coming months..

The results of these analyses will be provided in the final report.

Impacts and applications:

Based on analysis to date the Nordmore grate appears to be an extremely effect bycatch reduction device and only in rare circumstances is the 5% target of regulated bycatch exceeded. In our study only 5% of tows exceeded this target, and this typically occurred at one location and during the beginning of the fishing season when searching for large aggregations of shrimp. As the season progressed the proportion of this bycatch in the total catch reduced substantially.

The catch of hake and undersized American plaice remains problematic and further efforts are required to reduce catches of these species.

Related projects:

N/A

Partnerships:

The quality of involvement by all fishing industry participants has been excellent, despite market limitations (related to oversupply and low prices) affecting the level of involvement of some vessel captains. All vessel captains were very accommodating and helpful, even to the extent of assisting with catch sorting and the collection of bycatch data.

We were largely unsuccessful in our attempts to find vessels to replace those that dropped out of the project to operate in other fisheries. This was not a reflection of our partnership with shrimp fishermen, but reflects the aforementioned marketing problems and a concomitant level of uncertainty in the fishery. Many fishermen were unable to commit to this project as they were unsure of their level of involvement in the fishery.