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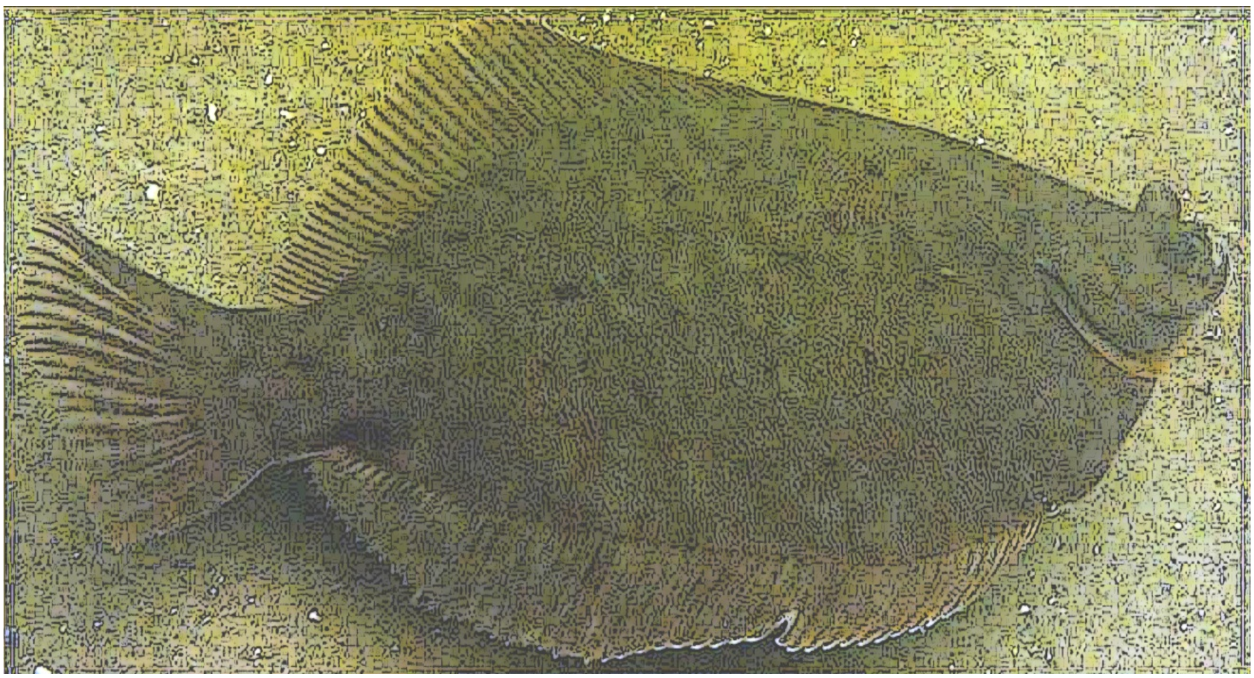
Southern New England Juvenile Fish Habitat Research Paper



US Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

Southern New England Juvenile Fish Habitat Research Paper

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Abbreviations

AIC: Akaike information criterion

BIC: Schwarz Bayesian information criterion

BOEM: Bureau of Ocean Energy Management

CFF: Coonamessett Farm Foundation, Inc.

CPUE: Catch per unit effort

NBD: New Bedford dredge

NEFSC: Northeast Fisheries Science Center

NOAA: National Oceanic and Atmospheric Administration

S-K: Saltonstall-Kennedy

SMAST: University of Massachusetts Dartmouth School for Marine Science and Technology

SNE: Southern New England

USGS: United States Geological Survey

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1. Project Overview

Coonamessett Farm Foundation, Inc. (CFF) completed a series of five winter dredge surveys in southern New England waters between December 2015 and early April 2016 for a project funded by the National Oceanic and Atmospheric Administration (NOAA) Saltonstall-Kennedy (S-K) grant program (**Table 1**). Since the dredge survey locations overlapped with Bureau of Ocean Energy Management (BOEM) lease areas (**Figure 1**), fish catch data collected during the dredge surveys could provide needed information about fish winter presence in the area. Furthermore, because each dredge station was also surveyed at least once with a towed camera sled, the CFF survey provides information about benthic habitat in this area.

Table 1. *Survey months (as referenced for the rest of the report) with trip start and end dates*

Month	Start date	End date
December	12/07/15	12/11/15
Early February	02/02/16	02/05/16
Late February	02/22/16	02/26/16
March	03/15/16	03/18/16
April	03/29/16	04/01/16

The objectives of this study were to 1) generate maps of the habitat types identified from the CFF video surveys, the distribution of catch numbers for winter flounder, windowpane flounder, yellowtail flounder, and monkfish for each survey month, and the distribution of winter flounder classified by reproductive stage for each survey trip; 2) analyze substrate (sandy, mixed, and rocky) associations for winter flounder, windowpane flounder, yellowtail flounder, and monkfish using generalized linear models; and 3) compare the CFF surveys results with the Northeast Fisheries Science Center (NEFSC) 2011-2015 spring bottom trawl survey data for winter flounder, windowpane flounder, yellowtail flounder, and monkfish, the 2010-2013 University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST) drop camera scallop surveys, and published United States Geological Survey (USGS) sediment data (soft sediments by grain size layer at http://www.northeastoceandata.org/data-explorer/?habitat).

2. Data Collection and Analysis

Scallop dredge tows were conducted at 32 stations during each trip (**Figure 1**). One additional station just south of Martha's Vineyard was surveyed during four of the trips (December, late February, March, and April), while an additional six stations were surveyed in early February. Scallop and fish catch at each station was recorded, and the fish catch included four species that will be the focus of this report: winter flounder, windowpane flounder, yellowtail flounder, and monkfish. Because the project funded by the S-K grant program focused on the identification of offshore winter flounder spawning grounds, we also collected reproductive stage data for every winter flounder taken during the surveys. We conducted video surveys at 33 of the dredge survey stations (**Figure 1**), and each site was categorized based on the bottom type (sand, gravel, or rocks) and amount of shell hash and sand dollars (high, low, or absent).

2.1 Dredge Surveys

The dredge surveys used a fixed grid design, with the stations laid out to cover waters from Block Island to south of Martha's Vineyard at depths close to 30 meters. CFF and the commercial fishermen we surveyed had previously caught winter flounder in this area, and some fishermen reported catching ripe winter flounder during February and March. Stations were separated by 9.3 km east to west and north to south. Each tow passed through the center of the pre-determined grid cell, with tow start points, and therefore tow directions, determined randomly for each station prior to the research cruises.

During each survey, two commercially rigged scallop dredges, owned by CFF, were towed from the vessel. The control dredge bag had a typical 7-row apron, while the experimental dredge had a shorter 5-row apron. The dredge bags were not lined because the study was targeting only

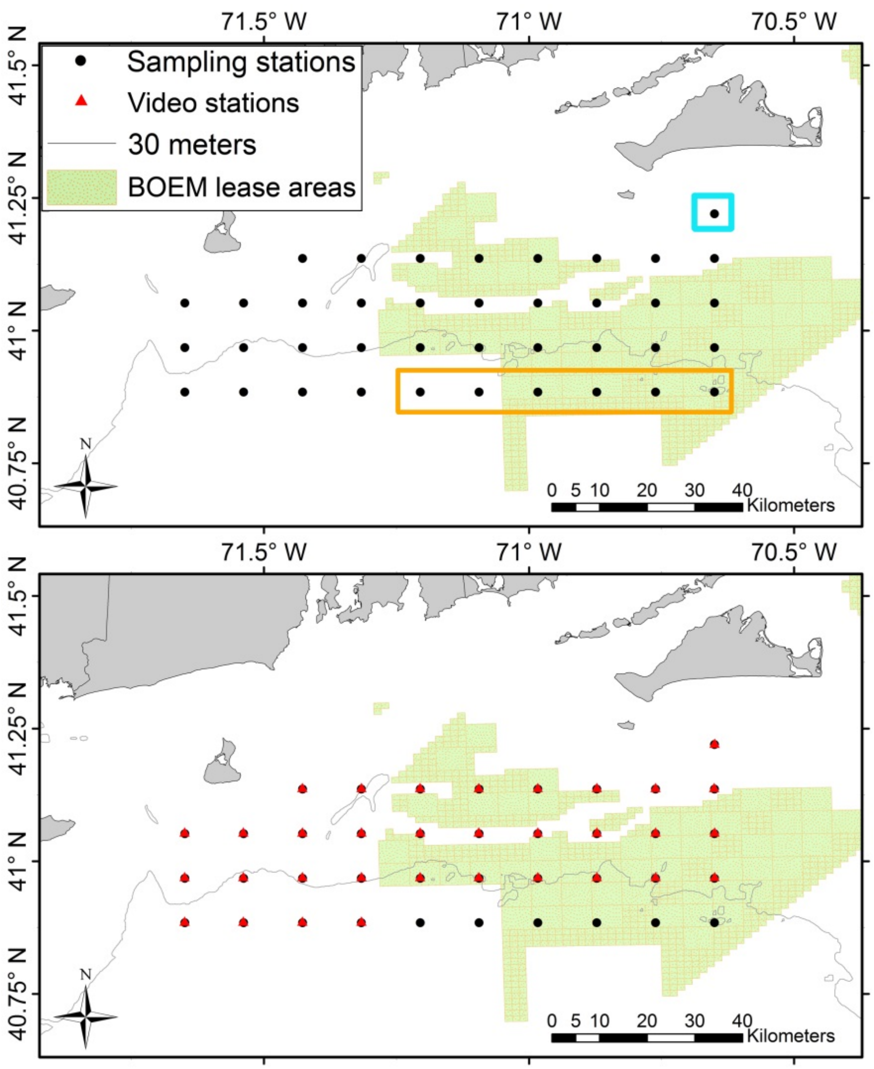

Figure 1. *Location of the dredge survey (top) and video survey (bottom) stations. The dredge station outlined in blue was surveyed during four out of five trips and the six stations outlined in orange were surveyed during one trip. All other stations were surveyed during all five trips.*

larger mature winter flounder. Tows were 15 minutes long at 4.8 knots. During the first three trips (December and early and late February), two turtle-deflector dredges were used for the surveys. However, because the dredge headbales were repeatedly damaged by rocks at some of the stations, the control headbale was switched to the stronger New Bedford dredge (NBD) for the last two trips (March and April). The dredge configuration details are shown in **Table 2**.

Start and end coordinates, depth, and temperature were recorded for each tow, with temperature and depth recorded every 30 seconds using Star-Oddi DST milli-TD temperature-depth loggers attached to the dredges. After each tow, scallops and commercially important fish species were sorted, counted, and measured. The reproductive stage of each winter flounder was determined using established sex and reproductive stage guidelines (Brown-Peterson et al. 2011) based on characteristics of the reproductive organs during gross dissections.

Table 2. *Dredge configuration details*

Specification	Control TDD	Experimental TDD	Control NBD
Width	4.57 meters	4.57 meters	4.57 meters
Ring size	4 inch	4 inch	4 inch
Apron	7-by-40 ring	5-by-40 ring	7-by-40 ring
Bag	10-by-40 ring	10-by-40 ring	10-by-40 ring
Sides	6-by-18 ring	6-by-20 ring	6-by-18 ring
Skirt	2 ring	2 ring	3 ring
Twine top mesh	10.5 inch	10.5 inch	10.5 inch
Hanging ratio	2-to-1	2-to-1	2-to-1
Turtle mat	Present	Present	Present
Ticklers	9 rows	9 rows	9 rows
Scope	3:1 + 10	3:1 + 10	3:1 + 10

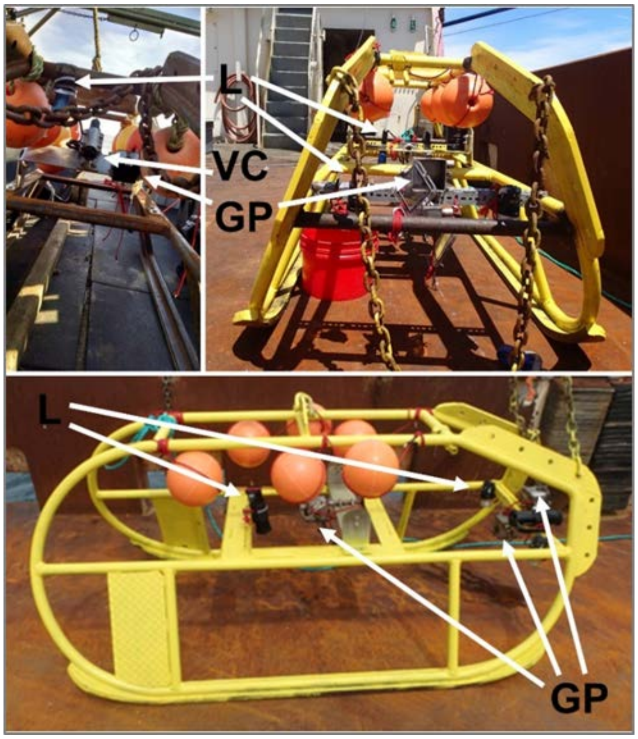

Figure 2. *On-deck photos of the benthic sled with different camera (VC – Outland Technology underwater camera, GP – waterproof GoPro housings) and light (L – different underwater LED lights) configurations.*

2.2 Video Surveys

Video surveys were conducted using the CFF benthic sled (**Figure 2**). The sled was configured with two GoPro cameras with 2.97 mm rectilinear lenses (https://www.peauproductions.com/) facing down, one GoPro camera with the stock fisheye lens facing forward at an oblique angle, and two FIX NEO underwater dive lights angled toward the bottom to illuminate the fields of view for the downward-facing cameras.At least one video transect was conducted at the main stations during the project. To obtain clear images in the videos, the sled had to be towed at speeds of less than 2 knots. Because a large scallop vessel cannot travel continuously and consistently at such a slow speed, we completed the video transects by having the vessel move at faster speeds while approaching the designated video analysis areas, coast through each area, and then pick up speed once again. It was difficult to tow the video sled in bad weather or moderately rough seas, so it was not possible to conduct video surveys at each station during each trip. As a compromise, we chose to survey each station at least once, and survey stations with winter flounder present when conditions permitted. Consequently, some stations were surveyed with the video sled two to four times over the course of the study.

2.3 Data Analysis

Video analysis: Videos from the benthic sled tows were analyzed using Behavioral Observation Research Interactive Software event-logging software. All videos were viewed in slow motion by a single trained observer. State and point events were notated according to the scheme in **Table 3**. Equivalent Wentworth scale categories are also listed in **Table 3**.

Table 3. *Coding scheme used to annotate video footage. All measurements given are approximate and based on the known size of images taken with a GoPro camera with a 2.97 mm lens mounted on the sled at the known height of the cross bars.*

Variable	Description	Wentworth scale categories
State event (notate start and stop)		
Sand	Grain diameter < 1% of image width (< 75mm)	Sand - small cobble
Gravel	Grain diameter > 1% and < 10% of image width (75 - 600mm)	Cobble
Light shell hash	<= 50% of frame has hash	
Heavy shell hash	> 50% of frame has hash	
Light sand dollars	<= 5 sand dollars per frame	
Heavy sand dollars	> 5 sand dollars per frame	
Point event (notate occurrence)		
Boulder	> 50% of frame (> 290 cm diameter)	Boulder
Cobble	<= 50% of frame	Large cobble - small boulder
Flatfish	Flatfish in frame	
Groundfish	Groundfish in frame	
Skate	Skate in frame	
Sea star	Sea star in frame	
Macroalgae	Macroalgae in frame	

Mapping in ArcGIS: The substrate types determined from the video analysis were plotted by station, and this layer was included in additional maps for reference. The abundances (number per tow) of winter flounder, windowpane flounder, yellowtail flounder, and monkfish were plotted by station and month. The numbers of winter flounder per reproductive stage were also plotted by station and month. The cumulative abundance of scallops (bushels per tow) was plotted by station.

CFF results were plotted with data from the following other surveys to qualitatively compare multiple data sets collected in the same southern New England (SNE) area.

1) The CFF dredge and Northeast Fisheries Science Center (NEFSC) 2011-2015 spring bottom trawl survey data for winter flounder, windowpane flounder, yellowtail flounder, and monkfish. Catch data for each survey was adjusted for swept area to give comparable catch per unit effort (CPUE) estimates using the average swept area for the dredge tows (based on tow start and end locations and dredge width) for the CFF surveys and the global mean swept area for the NEFSC trawl tows (from Jacobson et al.2014).
2) The CFF dredge and 2010-2013 SMAST drop camera scallop surveys.
3) The CFF video sled and published USGS sediment data (soft sediments by grain size layer at http://www.northeastoceandata.org/data-explorer/?habitat).

Statistical analysis: Fish catch by month and substrate type (sand, mixed gravel/sand, and rocky) was summarized using box plots created with the "lattice" package in R (Sarkar 2008). Changes in abundance by trip and substrate preferences were examined using generalized linear models with a negative binomial distribution in the R package "glmmADMB" (Fournier et al. 2012, R Core Team 2015, Skaug et al. 2013). Catch per tow for winter flounder, windowpane flounder, yellowtail flounder, and monkfish was modeled using trip and substrate (sand, mixed, and rocky) as categorical variables. The presence of sand dollars was not included in the models because sand dollar presence was strongly correlated with sandy substrate. The final model was determined based on the Akaike information criterion (AIC) and the Schwarz Bayesian information criterion (BIC) values (Akaike 1973, Schwarz 1978). When the models selected by the two criterion differed, final selection was made by combining the two criteria.

3. Results

3.1 Substrate Map and the Coastal and Marine Ecological Classification Standard

Substrate with shell hash was rarely observed in the videos, so that category was removed when the video data was summarized for mapping. Therefore, the substrate map shows the locations of sandy substrate, mixed gravel substrate, rocks, and areas with high sand dollar concentrations (**Figures 3&4**).

Most of the survey area had sandy substrate, including the majority of the area overlapping the BOEM lease areas (**Figure 4**). High concentrations of sand dollars were found only at the sandy stations (**Figure 4**). Six of the stations in the northwest corner of the survey area had mixed gravel substrate, and rocks (cobble and boulders) were seen in the videos from six stations in the same area (**Figure 4**). The habitat types observed in the CFF video survey were classified according to Coastal and Marine Ecological Classification Standard criteria, and the groups are listed in **Table 4** (NOAA 2012).

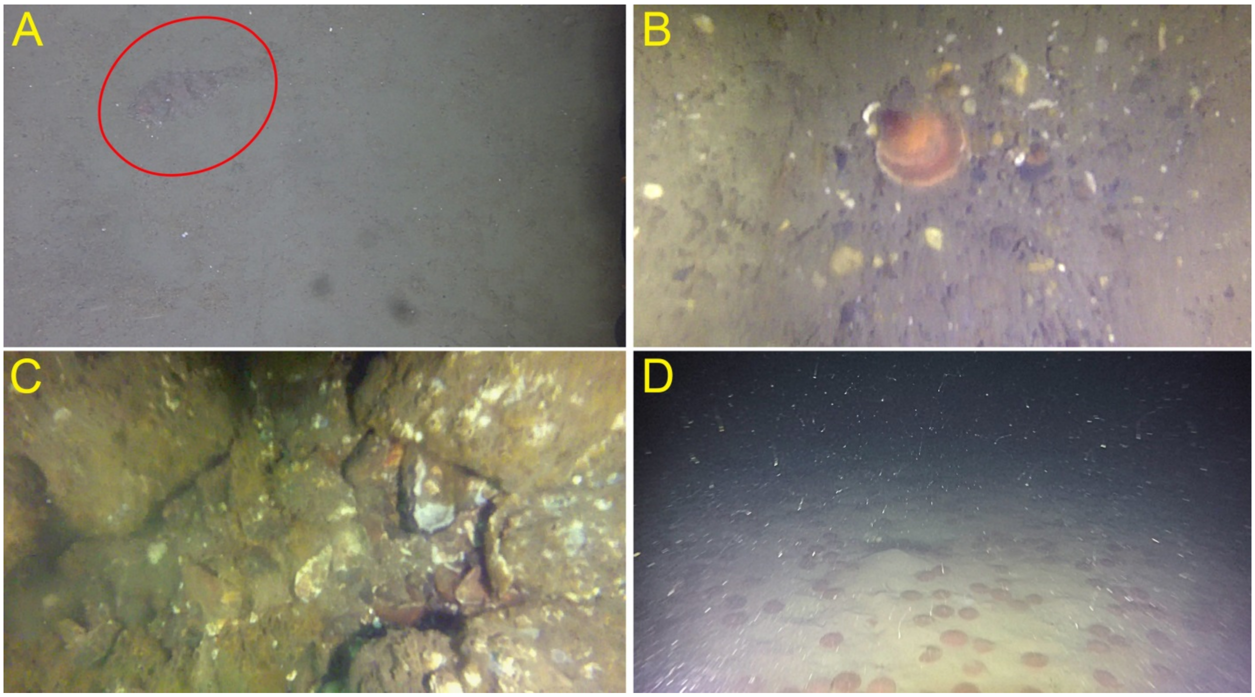

Figure 3. *Examples of substrate types seen in the video survey. A) Sandy substrate with a small ~13 cm summer flounder (circled in red). B) Mixed substrate with a ~102 mm scallop. C) Rocky substrate. D) Area with a high concentration of sand dollars. Images A-C were taken with the downward-facing GoPro camera (field of view ~ 0.23 m^2). Image D was taken with the forward-facing GoPro camera.*

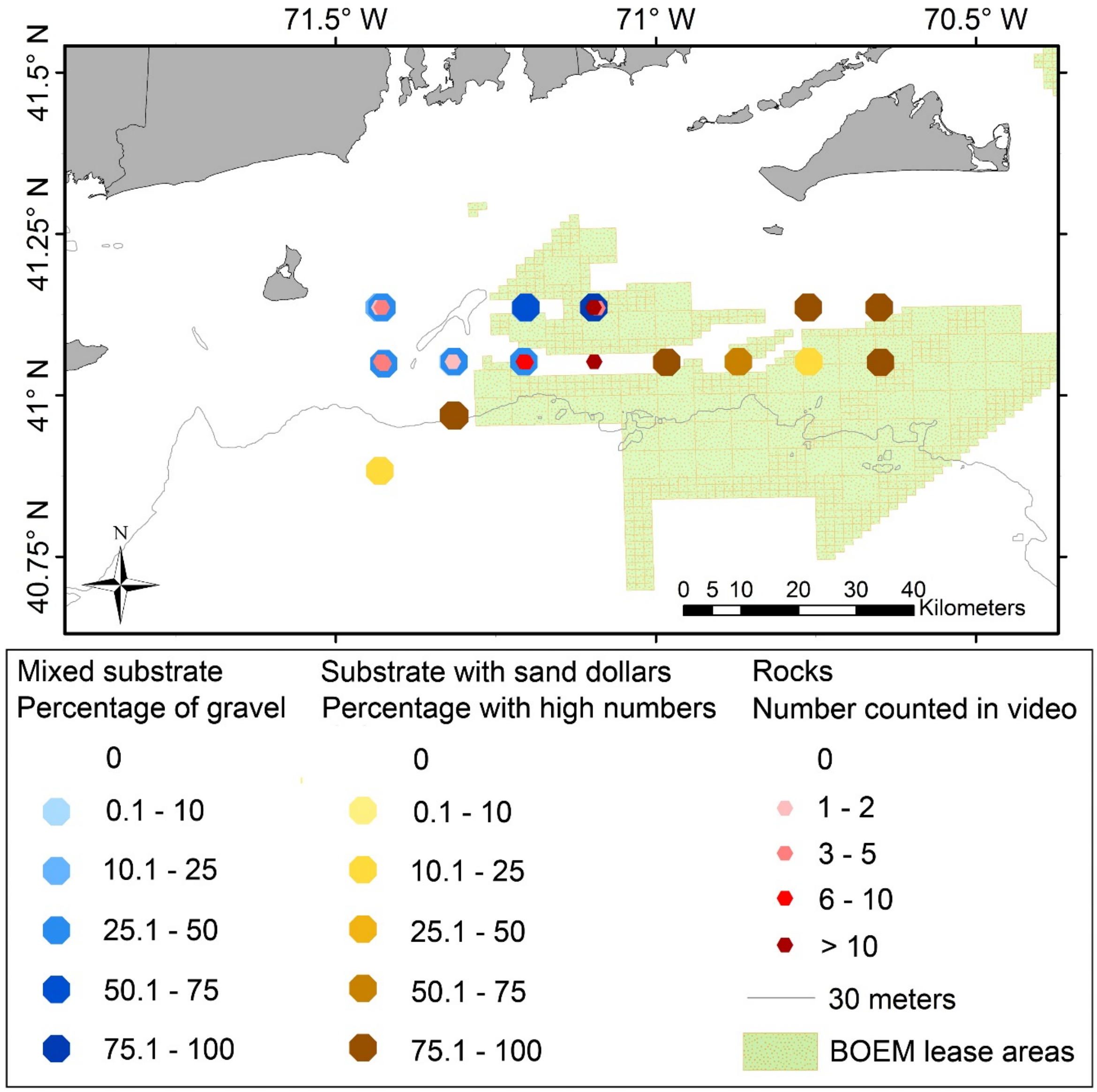

Figure 4. *Map of the habitat categories determined from the video analysis.*

Table 4. Classifications of geologic and biotic substrates from the CFF video survey in SNE waters in accordance with Coastal and Marine Ecological Classification Standards.

Component	Origin	Class	Subclass	Group	Subgroup/ Community
Substrate	Geologic substrate	Unconsolidated mineral substrate	Fine unconsolidated substrate	*	*
Substrate	Geologic substrate	Unconsolidated mineral substrate	Coarse unconsolidated substrate	Gravel	Cobble and boulder
Substrate	Biogenic substrate	Shell substrate	Shell hash	*	*
Biotic	Benthic/ attached biota	Benthic/ attached biota	Faunal bed	Soft sediment fauna	Sand dollar bed
* Identification to group and subgroup/community was not possible using benthic sled video					

At one station surveyed in December and March using the video sled, we observed very different benthic substrates (**Figure 5**). Very rocky substrate was observed in December, while sandy substrate was observed only 380 meters to the west in March. This could have been due to mobilization of substrate during the months between the surveys, with sand covering the rocky areas observed in December. Alternatively, bottom substrates could be very patchy in this region.

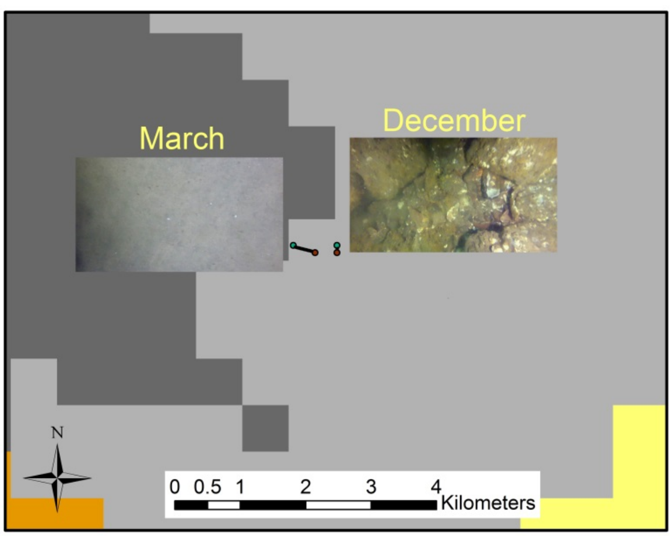

Figure 5. *Substrate types observed during two video surveys at the same station. Background colors indicate substrate types from the USGS sediment data sets with dark gray indicating gravel and light gray indicating coarse sand.*

3.2 Dredge Survey and Fish Catch

The catch per trip and average catch per station by month and by substrate type for winter flounder, windowpane flounder, yellowtail flounder, and monkfish are summarized in **Tables 5 – 7**. Box plots summarizing the catch per station by month and by substrate type are shown in **Figures 6 and 7**. Catch data at each station by month can be found in **Table A1** of Appendix A.

The catch at each station was plotted by month for each fish species. The map sets are shown in **Figures 8 – 11**. Winter flounder catches were low overall, with the largest number caught in December (**Figure 8**). They were caught along the northern edge of the survey area in December, while the catch shifted west to the mixed substrate stations in February. Windowpane flounder catch was also highest in December, and while there was no clear shift in the catch distribution by month, catch was significantly lower at the rocky stations (**Figure 7**). Like the other two flounder species, yellowtail flounder catch was highest in December, and the catch distribution shifted from the northern to more southern stations (**Figure 10**). Monkfish catch peaked in March, and catch was highest toward the southwest stations throughout the survey months (**Figure 11**). Monkfish catch was significantly lower at the mixed and rocky stations (**Figure 7**).

Table 5. *Catch per trip (month) for winter flounder, windowpane flounder, yellowtail flounder, and monkfish.*

Month	Total number caught per trip			
	Winter flounder	Windowpane flounder	Yellowtail flounder	Monkfish
December	23	475	50	220
Early February *	16	374	42	244
Late February	9	245	14	257
March	3	184	19	311
April	5	214	18	237

* The early February trip included 6 additional stations

Table 6. *Average catch per station by trip (month) for winter flounder, windowpane flounder, yellowtail flounder, and monkfish.*

Month	Average number caught per station			
	Winter flounder	Windowpane flounder	Yellowtail flounder	Monkfish
December	0.72	14.84	1.56	6.88
Early February	0.48	11.33	1.27	7.39
Late February	0.28	7.66	0.44	8.03
March	0.10	5.94	0.61	10.03
April	0.16	6.69	0.56	7.41

Table 7. Average catch per station by substrate type for winter flounder, windowpane flounder, yellowtail flounder, and monkfish.

Substrate	Average number caught per station			
	Winter flounder	Windowpane flounder	Yellowtail flounder	Monkfish
Sand	0.31	10.06	0.96	9.02
Mixed	0.89	6.44	0.78	2.33
Rocky	0.40	4.40	0.40	1.40

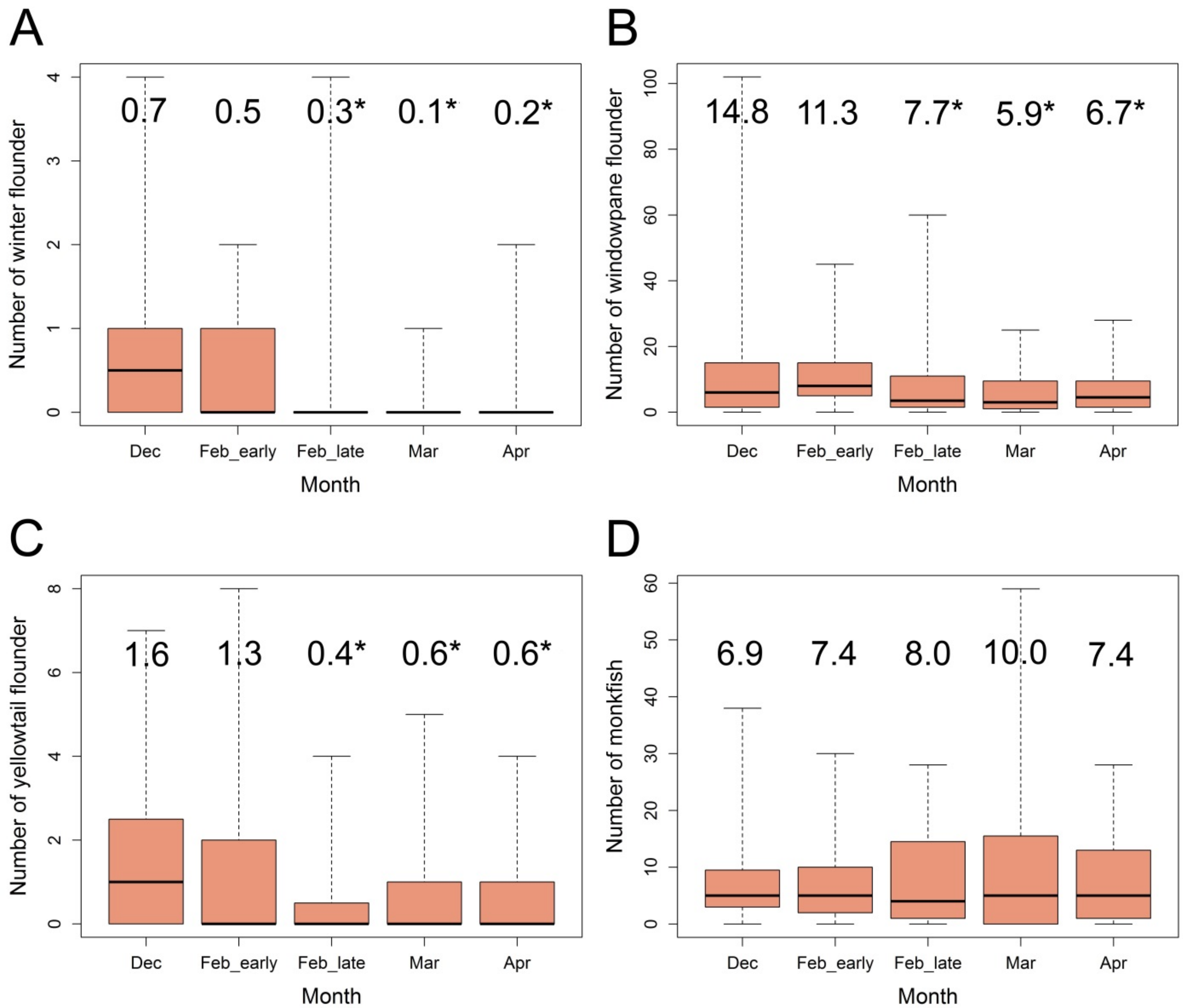

Figure 6. *Box plots showing the catch by month for A) winter flounder, B) windowpane flounder, C) yellowtail flounder, and D) monkfish. Boxes end at the first and third quartiles of the distribution of catches per station, with the whiskers extending to the minimum and maximum catch values. The lines in the boxes are the median catch per station each month. Numbers above each month are the average catch per station each month, and asterisks indicate that the catch was significantly different from the catch in December.*

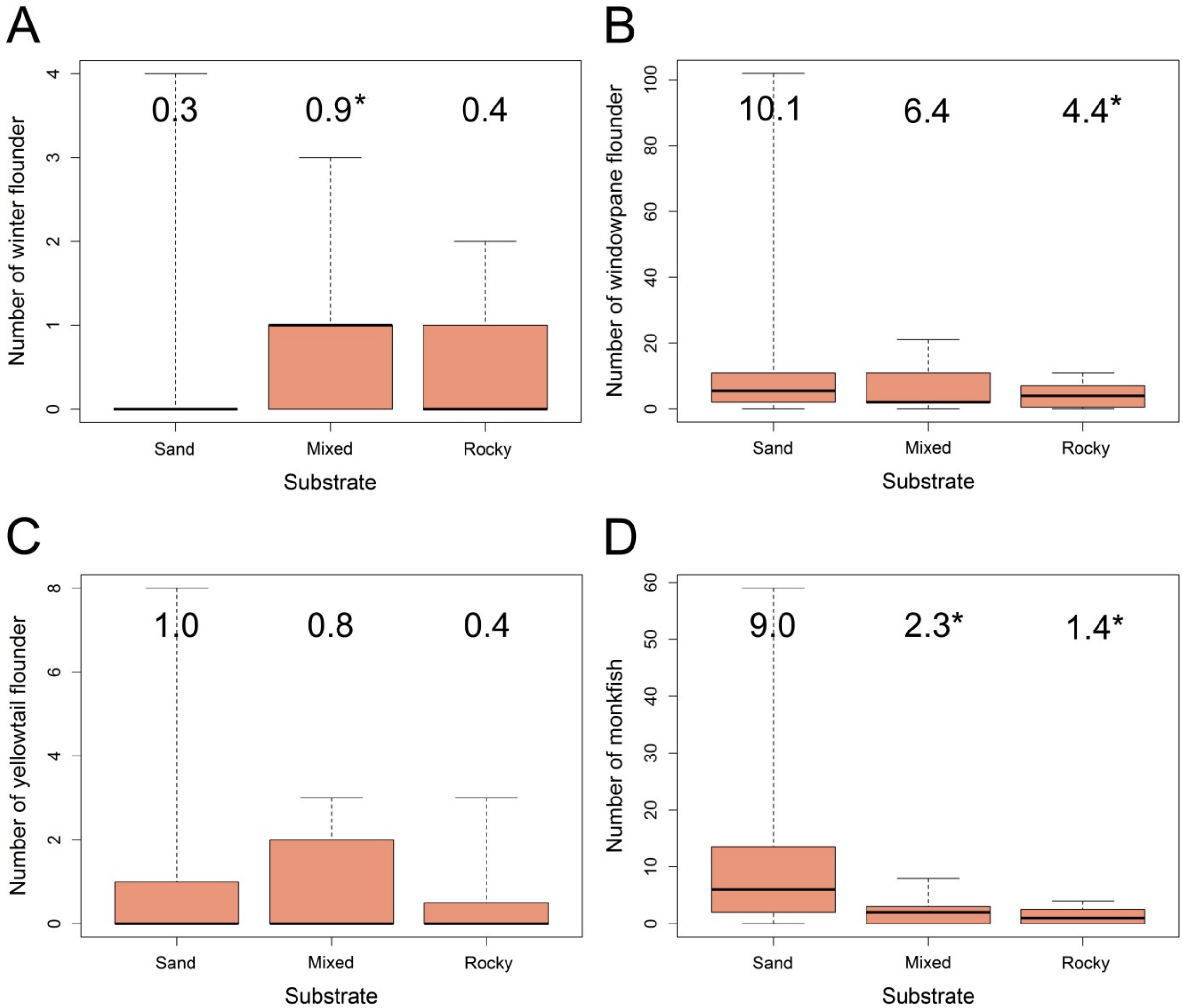

Figure 7. *Box plots showing the catch by substrate type for A) winter flounder, B) windowpane flounder, C) yellowtail flounder, and D) monkfish. Boxes end at the first and third quartiles of the distribution of catches per station, with the whiskers extending to the minimum and maximum catch values. The lines in the boxes are the median catch per station on each substrate type. Numbers above each substrate are the average catch per station, and asterisks indicate the catch was significantly different from the catch on sand.*

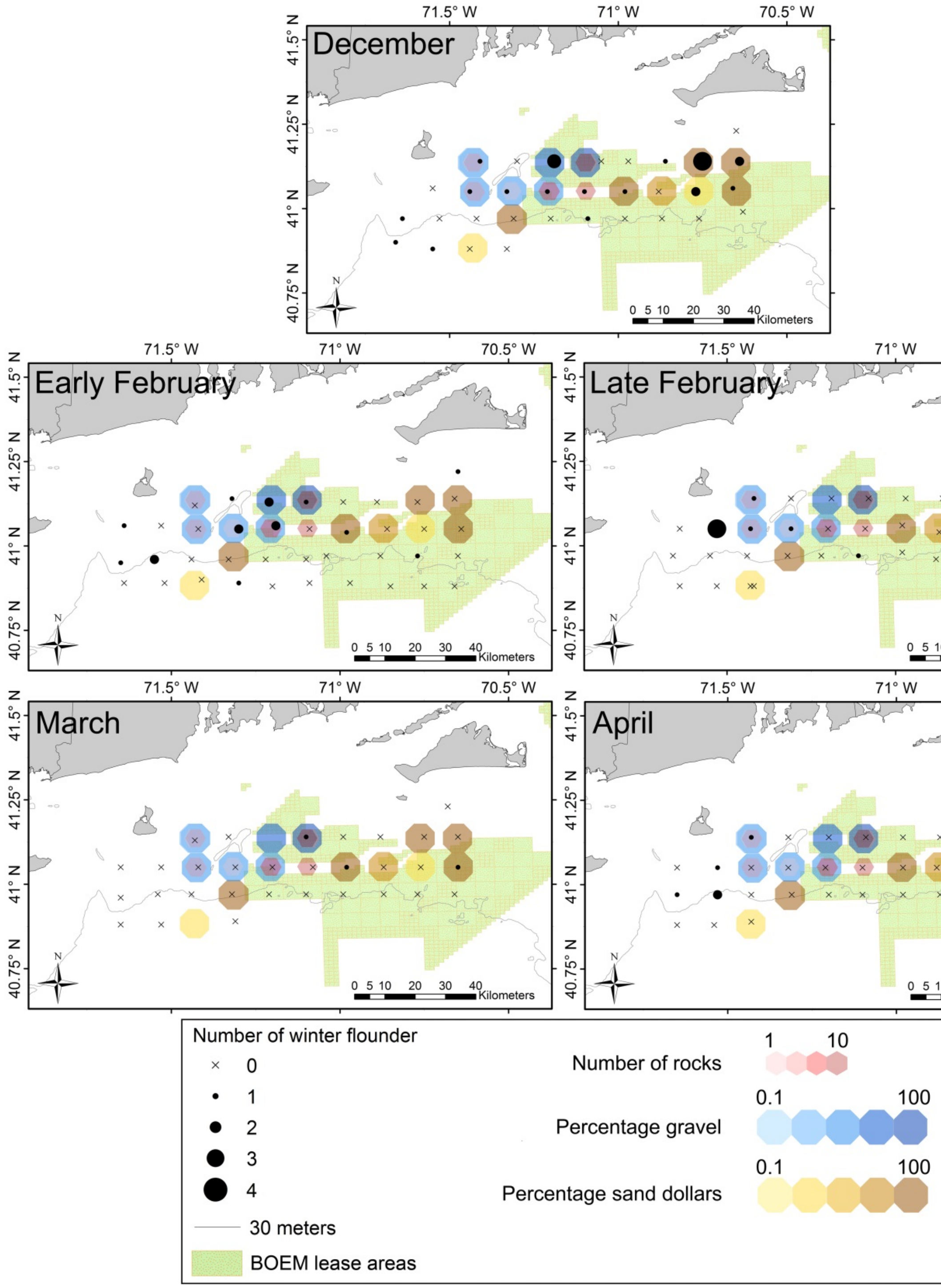

Figure 8. *Winter flounder catch by month*

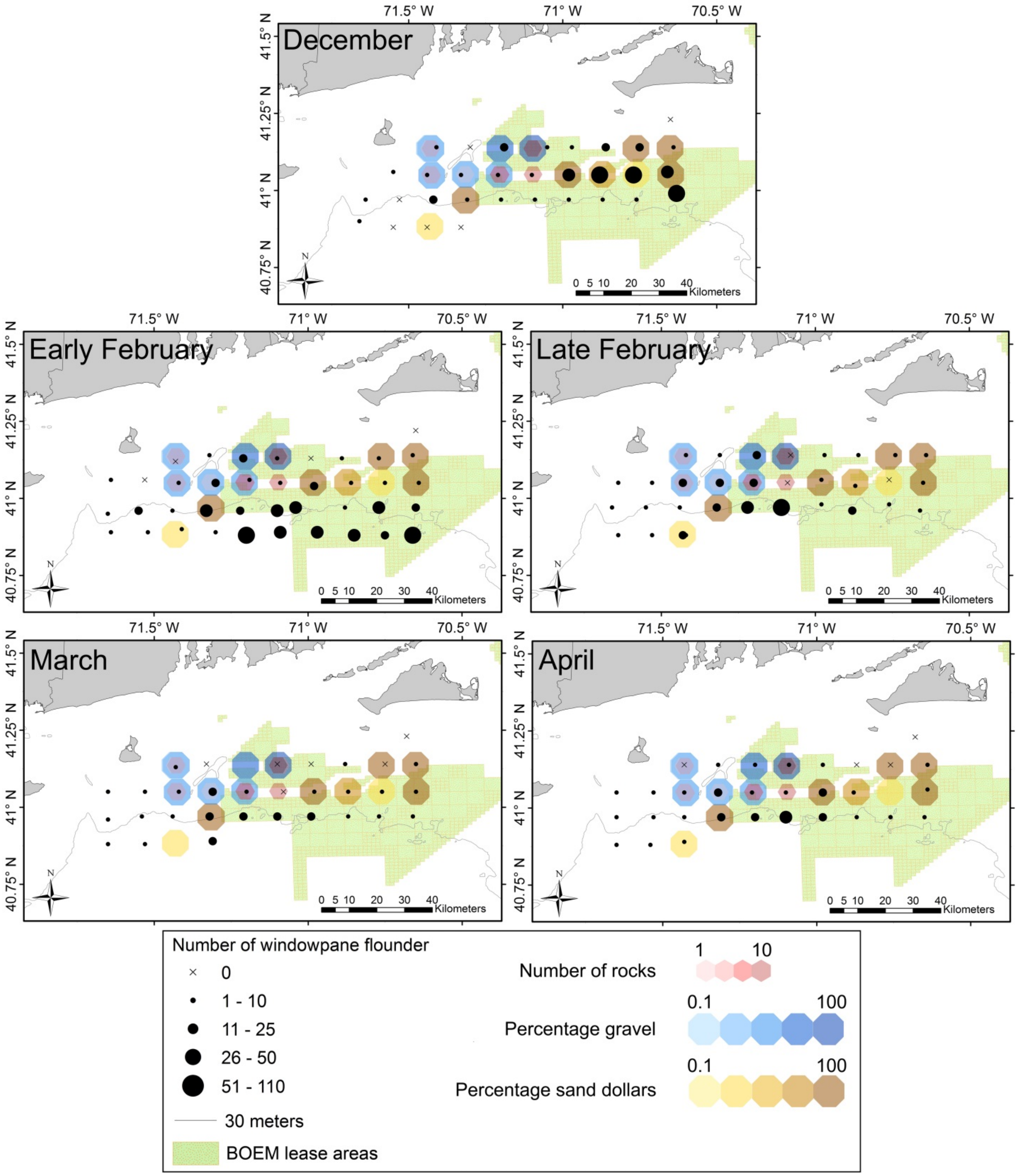

Figure 9. *Windowpane flounder by month*

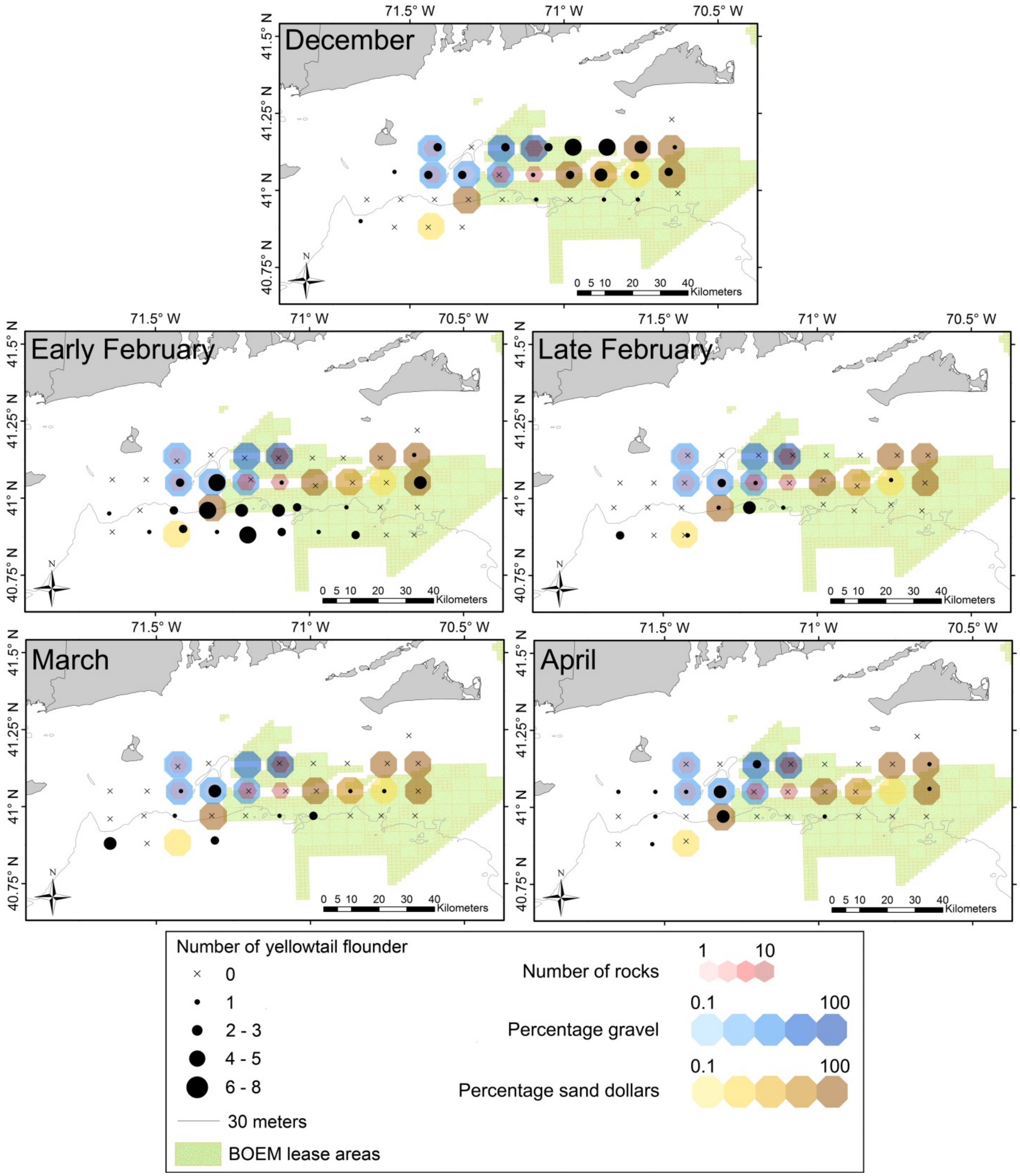

Figure 10. *Yellowtail flounder catch by month*

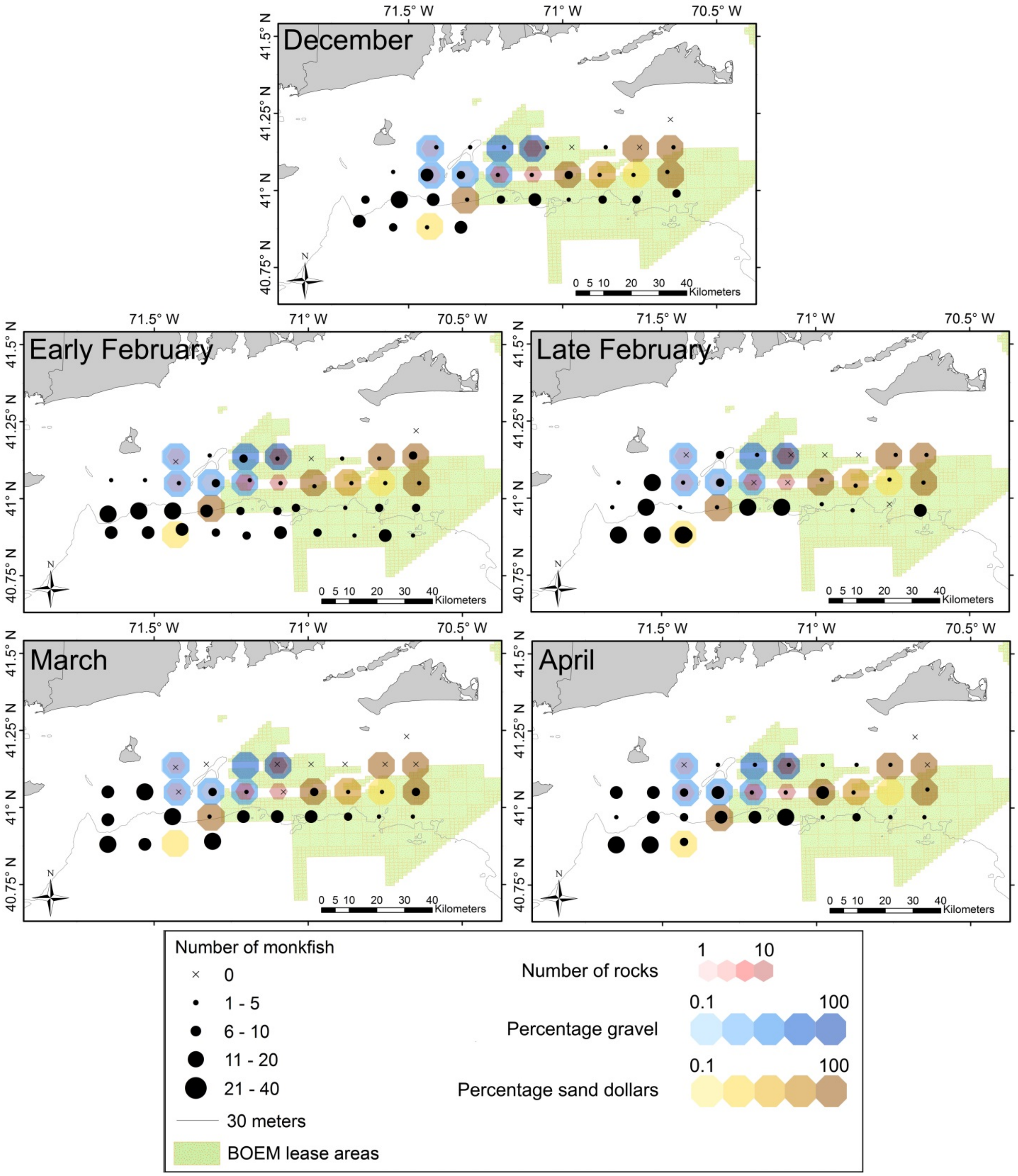

Figure 11. *Monkfish catch by month*

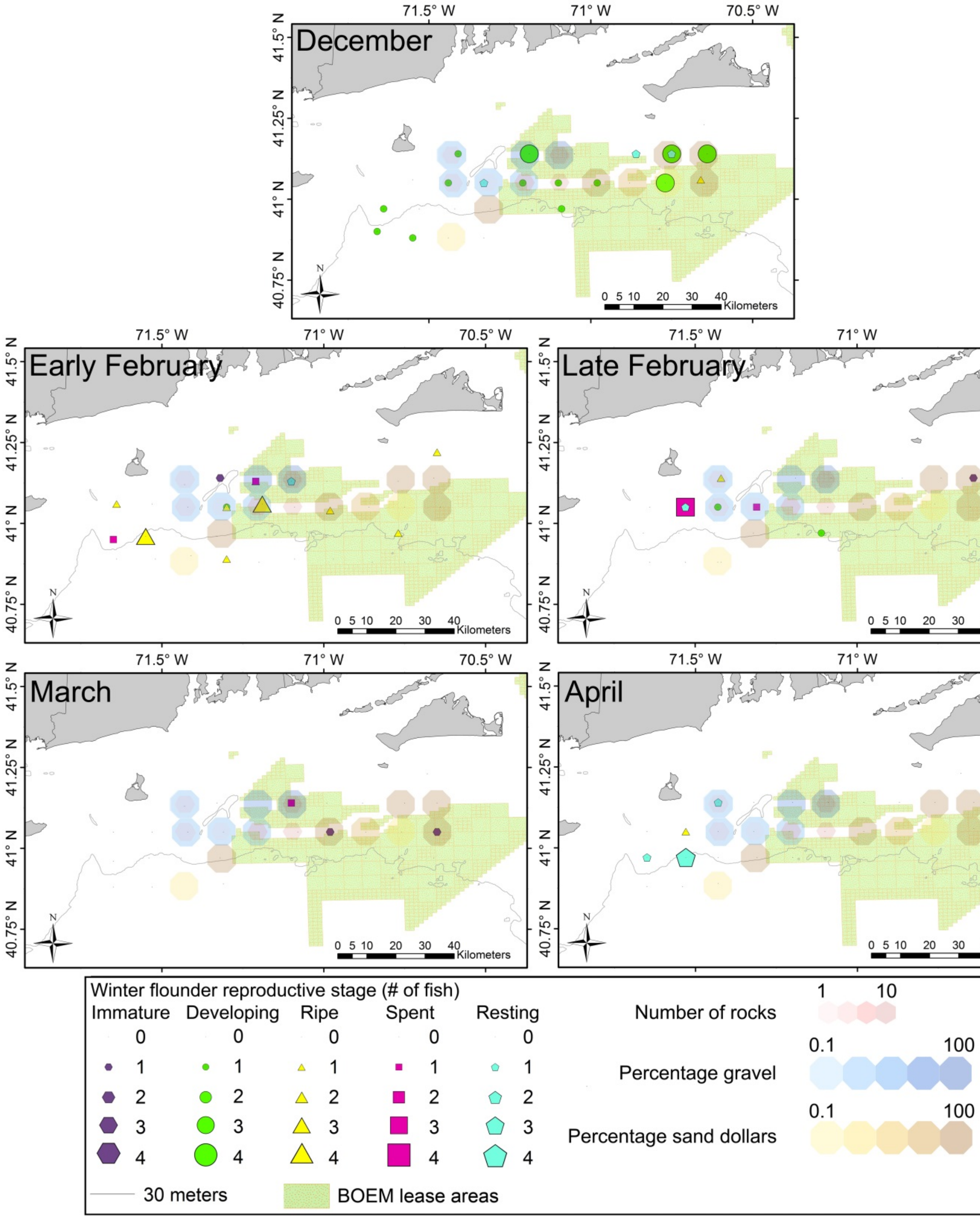

Figure 12. *Winter flounder catch and reproductive stage by month.*

Winter flounder catch was classified by reproductive stage and mapped by month (**Figure 12**). Stage data for each station by month can be found in **Table A2** of Appendix A. The majority of the flounder caught in December were developing, although a few were resting and one was ripe. By early February, most of the flounder were ripe, but a few immature, resting, or spent fish were caught. By late February, the majority of the flounder were spent, and fish in each reproductive stage were caught. In March, the few flounder that were caught were immature or spent. By April, most of the flounder were resting, although one ripe fish was also caught.

The scallop catch was mapped by station, with habitat and scallop presence in the SMAST drop camera surveys from 2010 – 2013 used as base layers (**Figure 13**). Scallops were caught across the survey area, with the lowest catch occurring in the southeast corner.

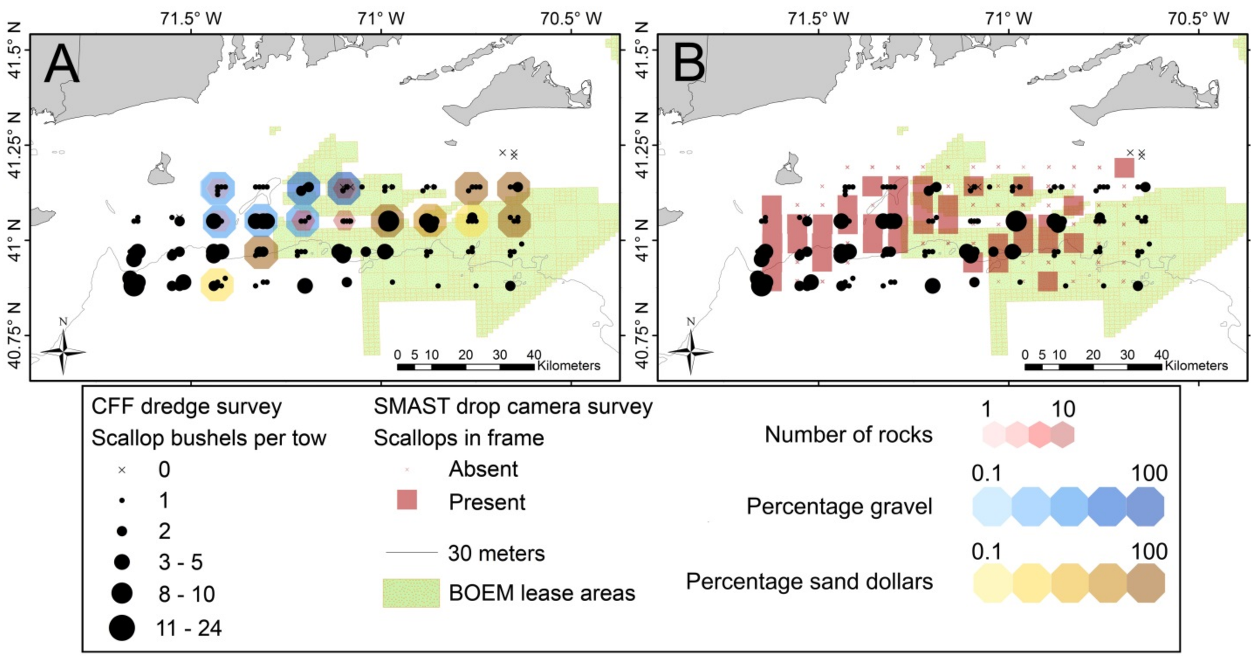

Figure 13. *Scallop catch by station, overlaid on A) habitat types and B) scallop presence in the SMAST video survey.*

3.3 Statistical Modeling

The catch numbers for winter flounder, windowpane flounder, yellowtail flounder, and monkfish were modeled with month (trip) and substrate included as fixed effects. Stations with greater than seven rocks observed during the video survey were classified as rocky when defining the modeling categories. Stations with more than 25% of the video footage (by time) classified as gravel were defined as mixed. When stations were surveyed more than once, substrate percentages and rock counts were averaged before categorizing the station. The best fitting models were selected based on the lowest AIC and BIC values combined (**Table 8**). The best fitting model for the three flounder species did not include substrate as a predictor, while only substrate was included in the best fitting model for monkfish. The model outputs, including coefficient estimates, are shown in **Table 9**.

Table 8. *AIC and BIC values for models to predict catch numbers of winter flounder, windowpane flounder, yellowtail flounder, and monkfish using month and substrate or month or substrate alone as predictors. Models with the lowest combined criteria values are highlighted with pale yellow.*

Species	**Month and substrate**		**Month**		**Substrate**	
	AIC	BIC	AIC	BIC	AIC	BIC
Winter flounder	240.7	265.3	240.6	259.0	251.1	263.4
Windowpane flounder	1037.5	1062.1	1039.9	1058.4	1043.3	1055.6
Yellowtail flounder	409.2	433.8	408.4	426.8	414.5	426.8
Monkfish	984.9	1009.5	1006.4	1024.8	977.7	990.0

Table 9. *Final models for catch numbers of winter flounder, windowpane flounder, yellowtail flounder, and monkfish as determined by AIC and BIC values.*

	Coefficient Estimate	**Standard error**	**z-value**	**p-value**
Winter flounder				
(Intercept)	-0.3300	0.2470	-1.3400	0.1806
Early February	-0.3940	0.3740	-1.0500	0.2930
Late February	-0.9380	0.4350	-2.1600	0.0310
March	-2.0050	0.6420	-3.1200	0.0018
April	-1.5260	0.5270	-2.8900	0.0038
Windowpane flounder				
(Intercept)	2.6980	0.2090	12.9000	0.0000
Early February	-0.2700	0.2950	-0.9200	0.3597
Late February	-0.6620	0.2990	-2.2100	0.0269
March	-0.9170	0.3040	-3.0200	0.0025
April	-0.7970	0.3000	-2.6600	0.0079
Yellowtail flounder				
(Intercept)	0.4460	0.2750	1.6200	0.1043
Early February	-0.2050	0.3910	-0.5200	0.6001
Late February	-1.2730	0.4500	-2.8300	0.0047
March	-0.9360	0.4310	-2.1700	0.0298
April	-1.0220	0.4320	-2.3700	0.0180
Monkfish				
(Intercept)	2.1997	0.0951	23.1300	0.0000
Mixed	-1.3524	0.4254	-3.1800	0.0015
Rocky	-1.8632	0.3623	-5.1400	0.0000

3.4 CFF Results Relative to Other Surveys in the Same Area

Previous work by CFF examined the presence of four important commercial species in CFF seasonal dredge surveys and NEFSC bottom trawl surveys that were conducted at stations that were spatially and temporally close (depth ≤ 7 meters apart, distance ≤ 6.5 km apart, sampling date ≤ 7.5 days apart) (Siemann et al. in press). For the 21 stations that met these criteria, the catch was adjusted based on swept area (average swept area for the dredge tows based on tow start and end locations and dredge width, global mean swept area using door spread for the NEFSC trawl tows from Jacobson et al.2014). The trends between adjusted catch for each species are summarized in **Table 10**. When catch from spatiotemporally close scallop-dredge and bottom-trawl tows were compared, the dredge caught more windowpane flounder and monkfish, while the bottom trawl caught more winter and yellowtail flounder. The trawl caught winter flounder at more stations and the dredge caught monkfish at more stations. Windowpane and yellowtail flounder were caught slightly more often at trawl stations.

Table 10. *Summary of previous CFF comparison of dredge survey catch and spatiotemporally close NEFSC trawl survey catch.*

Species	Gear with higher catch	Percent increase	Gear with catch at more stations	Dredge stations with catch > zero	Trawl stations with catch > zero
Winter flounder	Trawl	1.17	Trawl	1/14	8/14
Windowpane flounder	Dredge	4.58	Trawl	15/17	17/17
Yellowtail flounder	Trawl	2.18	Trawl	20/21	21/21
Monkfish	Dredge	7.04	Dredge	13/13	7/13

For the current project, we compared the CPUE (fish/km^2) for the CFF surveys in March and April 2016 with the CPUE from the NEFSC spring trawl surveys from 2011 to 2015. The resulting maps are shown in **Figure 14**. Overall, the trends match those CFF observed previously. Catch for the trawl (NEFSC) surveys was higher for winter and yellowtail flounder, while catch for the dredge (CFF) surveys was higher for windowpane flounder and monkfish (**Table 10 and Figure 14**).

We also examined the size-frequency distributions of the catch from the CFF dredge and NEFSC trawl surveys (**Figure 15**). The fish caught in the dredge tended to be larger, which is not surprising since the NEFSC survey trawl is lined to retain small fish while the CFF dredges were not. The trawl clearly caught more windowpane and yellowtail flounder in all size classes (**Figure 15A&C**), while the dredge caught more large windowpane flounder and monkfish (**Figure 15B&D**). The dredge may catch fewer small windowpane flounder and monkfish, but because the surveys took place during different years (NEFSC in 2011 – 2015, CFF in 2016), it is difficult to conclude this with any certainty.

Scallop catch data from the CFF dredge survey was compared to scallop presence/absence in the SMAST drop camera surveys (**Figure 13B**). Scallop catch was highest in the dredge survey at stations where scallops were present in the SMAST survey. However, scallops were caught in the dredge survey at stations where scallops were not detected in the drop camera images. The cause for this difference is not clear. Scallops present in 2015 - 2016 may not have been present during the earlier years of the SMAST video survey. Alternatively, there could be patchiness in the distribution of scallops on the scale of the distance between the CFF and SMAST stations.

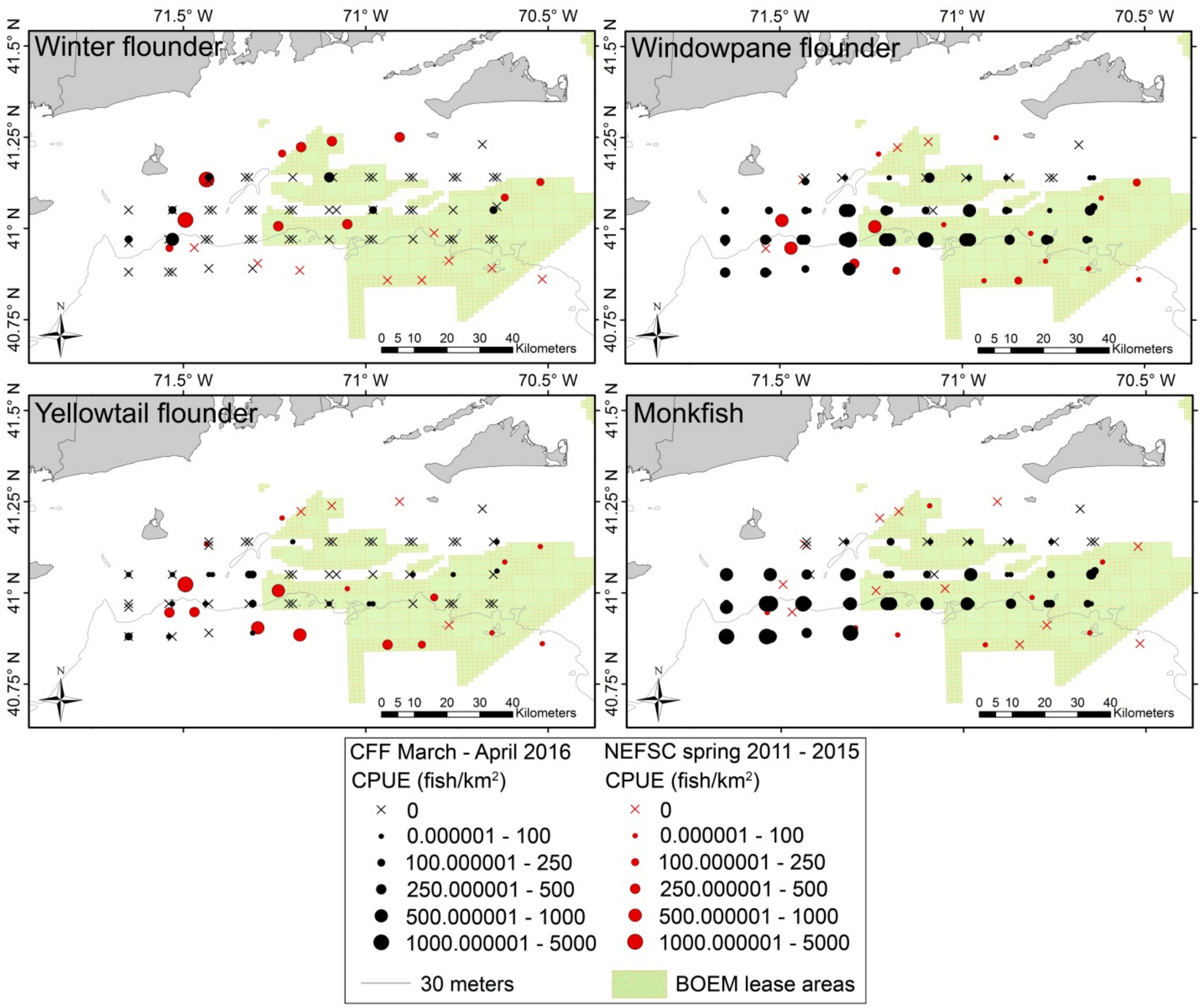

Figure 14. *CPUE of winter flounder, windowpane flounder, yellowtail flounder, and monkfish in the 2015-2016 CFF dredge survey and the 2011-2015 NEFSC spring bottom trawl surveys.*

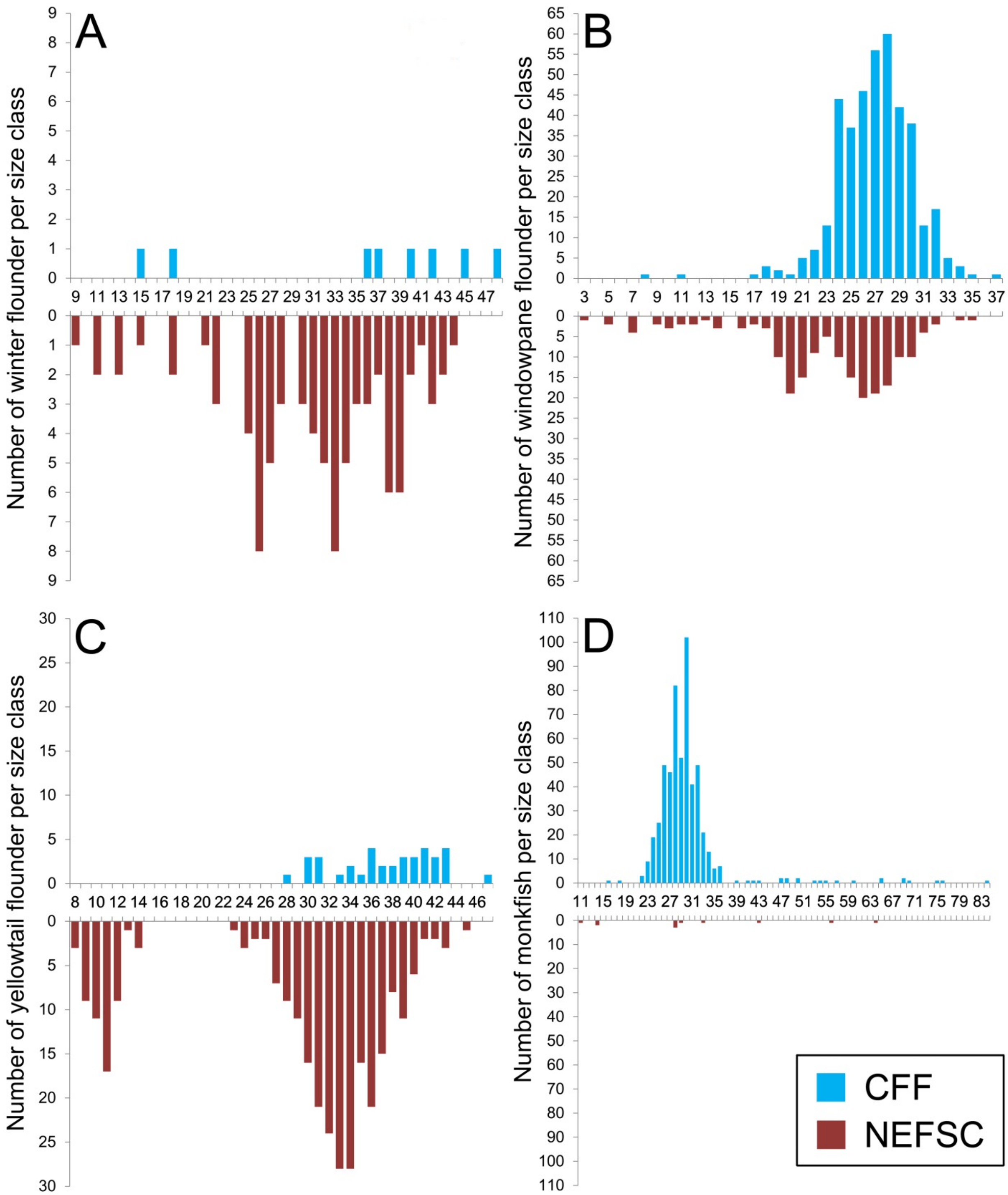

Figure 15. *Size-frequency histograms for A) winter flounder, B) windowpane flounder, C) yellowtail flounder, and D) monkfish in the 2015-2016 CFF dredge survey (blue) and the 2011-2015 NEFSC spring bottom trawl surveys (maroon).*

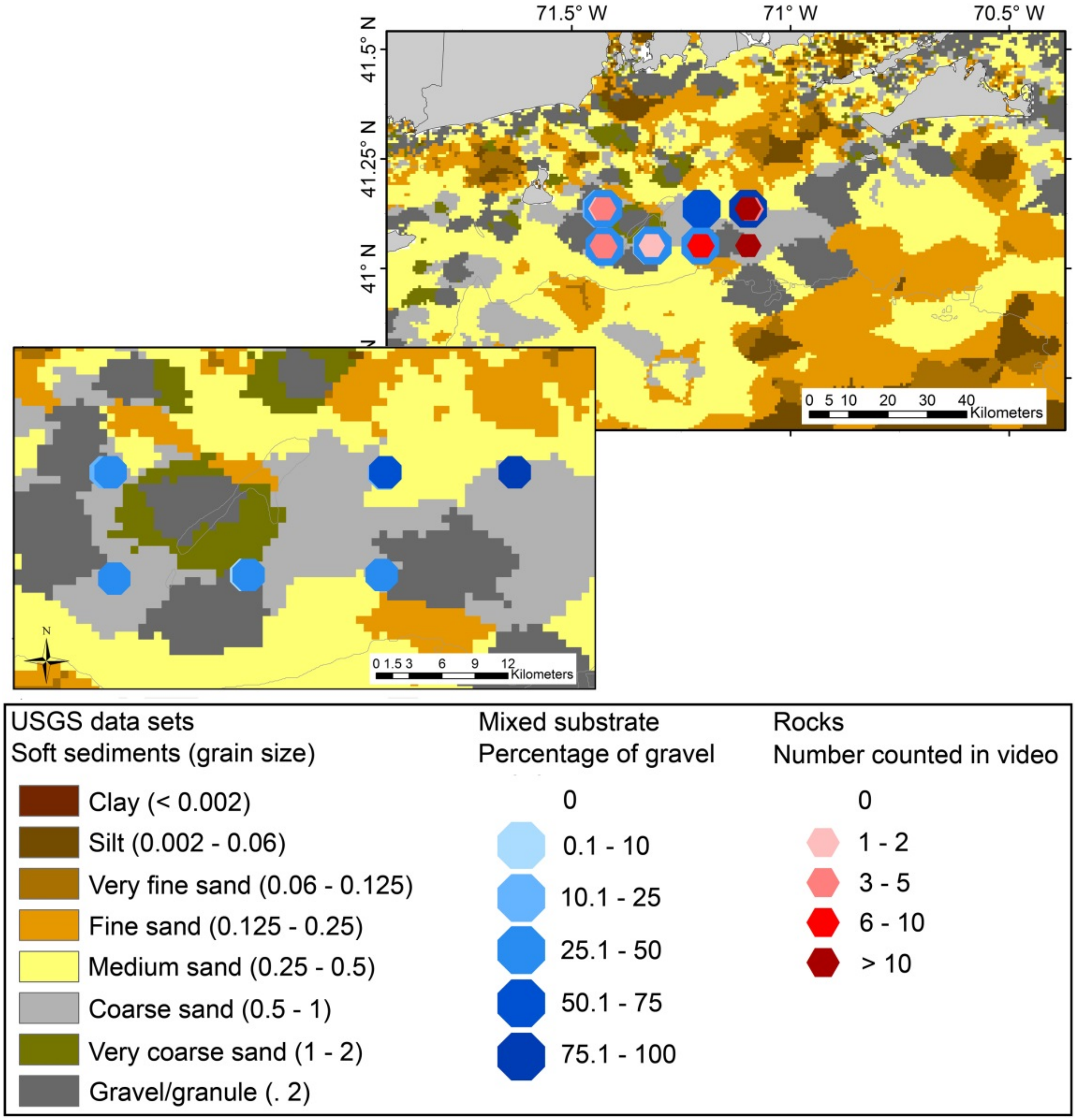

Figure 16. *Substrate types from the CFF video sled survey and sediment types from USGS data sets.*

Substrate types from the CFF video survey were mapped with sediment types from a shapefile created using USGS sediment databases (**Figure 16**). The sand category in the CFF video annotations included sediments on the Wentworth scale that ranged from sand through small cobble, and the stations with sandy substrate in the CFF survey were in areas classified as having fine sand to gravel sediments in USGS surveys. The CFF survey did identify areas with mixed substrate, comparable to areas with cobble using the Wentworth scale. The USGS sediment-type map layer includes grain categories up to gravel. Four of the CFF mixed-substrate stations were on or near the edge of areas designated as having gravel substrate during USGS surveys. The other two stations with the highest percentage of cobble were located in areas designated as having fine to coarse sand.

4. Discussion

The goal of the research funded by the S-K grant program was to identify winter flounder offshore spawning habitat in SNE waters. Previous studies had led scientists to believe the winter flounder spawning in SNE occurred exclusively in shallow, inshore waters such as Narragansett Bay. Because we identified ripe winter flounder in early February and spent flounder in late February, it is likely that winter flounder are spawning in the area we surveyed. Based on the presentation of CFF data, experts attending the recent 15th Flatfish Biology Conference on December 6th and 7th, 2016 in Westbrook, CT universally agreed that winter flounder were spawning offshore in SNE. The consensus was that ripe and spent winter flounder swim slowly and therefore could not enter, spawn in, and then leave nearby Narragansett Bay, the closest documented winter flounder spawning location, in 2 ½ weeks.

Flounder catch was strongly dependent on survey month. Although winter flounder catch was significantly higher at mixed substrate stations, month was a much more important factor for predicting winter flounder catch numbers, and the best model for predicting winter flounder catch included only month. Similarly, although windowpane flounder catch was significantly lower at rocky stations, the best model for predicting windowpane flounder catch only included month as a factor. Yellowtail flounder catch was not significantly different on any substrate type, and substrate type was not a significant factor for predicting yellowtail flounder catch numbers. All three flounders were caught at stations within the BOEM lease area, with catch numbers highest in the month of December.

This contrasted with the results for monkfish. Substrate type strongly impacted monkfish catch, with the best model for predicting catch including only substrate type but not month. Because the area of overlap between the CFF survey and the BOEM lease areas has primarily sandy substrate, monkfish were present across the BOEM lease areas for all months from December through April.

Some care has to be taken when interpreting the fish catch data from the dredge surveys because the dredge headbale type was changed midway through the project. However, fish catch with the turtle deflector dredge tends to be lower or equal to catch with the NBD (Smolowitz et al. 2012). Because flounder catch declined after the dredge headbale was switched to an NBD and monkfish catch with the NBD in April was within the range of catches with the turtle deflector dredge in December and February, we are comfortable using the catch data from the entire study.

Scallop dredges appear to be better gear for assessing windowpane flounder and monkfish than the lined survey bottom trawls used by NEFSC. Comparisons between CPUE from CFF dredge surveys and the NEFSC trawl surveys consistently indicate that commercially rigged scallop dredges catch more of these two fish, even without dredge liners in the gear. The addition of a liner or use of a bag with small (< 4-inch diameter) rings, to retain small fish, would further improve dredges as a survey tool for these important commercial fish species. However, the NEFSC bottom trawl does appear to catch winter flounder and yellowtail flounder more effectively than scallop dredges. This is not surprising since modifications made to commercial dredges in recent years were designed to minimize flatfish bycatch. However, improved gear modifications are clearly necessary if windowpane flounder and monkfish continue to be caught in high numbers.

Figure 17. *CFF drop camera stands.*

Next steps
The S-K project will include two more research trips. During these trips, drop cameras (**Figure 17**) will be used to record activity on and near the sea floor where winter flounder were caught in February 2016. CFF has previously recorded the presence of winter and summer flounder feeding at bait stations using these camera platforms (**Figure 18**). We hope to capture image sequences of winter flounder spawning behavior. However, even if we are not successful capturing this elusive event, we will certainly collect valuable data on the presence and behavior of marine species in the area.

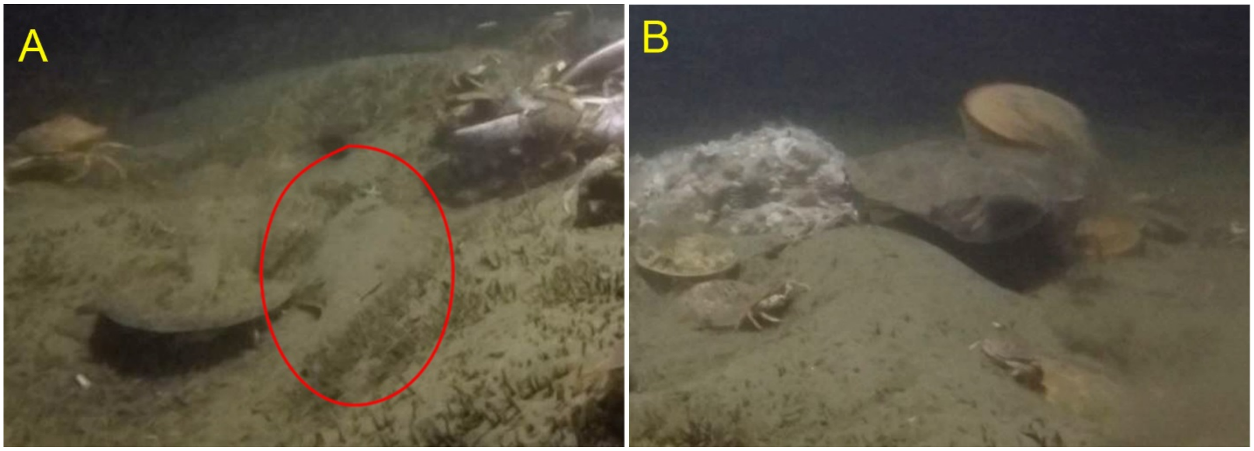

Figure 18. *Images taken with GoPro cameras mounted on the CFF drop camera stands. A) Winter flounder (circled in red). B) Summer flounder with a scallop swimming overhead.*

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Appendix A. Data Tables

Table A1. *Catch number per station for winter flounder (WinterF), windowpane flounder (WPF), yellowtail flounder (YTF), and monkfish, scallop bushels per station, and substrate details for each station.*

Month	Latitude	Longitude	WinterF	WPF	YTF	Monkfish	Scallops (bushels)	Sand	Gravel	Sand dollars	Rocks	Substrate
Dec	41.230	-70.650	0	0	0	0	0	1	0	0	0	sand
Dec	41.138	-70.643	2	9	1	3	0.02	1	0	0.97	0	sand
Dec	41.136	-70.754	4	19	4	0	0.02	1	0	1	0	sand
Dec	41.136	-70.864	1	21	7	1	0.04	1	0	0	0	sand
Dec	41.136	-70.974	0	9	7	0	0.2	1	0	0	0	sand
Dec	41.136	-71.054	0	7	3	2	0.02	0	1	0	11	rocky
Dec	41.136	-71.193	3	21	2	5	1	0.58	0.42	0	0	mixed
Dec	41.136	-71.299	0	0	0	4	0.12	1	0	0	0	sand
Dec	41.136	-71.413	1	4	3	3	0.08	0.74	0.26	0	2	mixed
Dec	41.057	-70.655	1	39	2	2	0.5	1	0	1	0	sand
Dec	41.052	-70.769	2	70	3	4	0.5	1	0	0.21	0	sand
Dec	41.052	-70.881	0	102	5	5	5	1	0	0.72	0	sand
Dec	41.052	-70.982	1	44	3	10	5.25	1	0	1	0	sand
Dec	41.052	-71.103	1	7	1	2	0.05	1	0	0	11	rocky
Dec	41.052	-71.213	1	5	0	4	0.5	0.91	0.09	0	7	rocky
Dec	41.052	-71.326	1	4	2	10	5	0.82	0.18	0	1	sand
Dec	41.052	-71.439	1	6	2	11	2.25	0.84	0.16	0	4	sand
Dec	41.056	-71.545	0	5	1	3	0.2	1	0	0	0	sand
Dec	40.987	-70.630	0	60	0	8	0.4	1	0	0	0	sand
Dec	40.968	-70.760	0	6	1	7	0.55	1	0	0	0	sand
Dec	40.968	-70.869	0	5	1	6	0.5	1	0	0	0	sand
Dec	40.968	-70.976	0	7	0	5	1.1	1	0	0	0	sand
Dec	40.968	-71.087	1	2	1	12	2	1	0	0	0	sand
Dec	40.968	-71.203	0	1	0	9	0.2	1	0	0	0	sand
Dec	40.968	-71.309	0	4	0	5	1	1	0	1	0	sand
Dec	40.968	-71.423	0	11	0	11	2.75	1	0	0	0	sand
Dec	40.968	-71.533	0	0	0	38	1.25	1	0	0	0	sand
Dec	40.968	-71.637	1	6	0	7	3.05	1	0	0	0	sand
Dec	40.884	-71.327	0	0	0	15	0.5	1	0	0	0	sand
Dec	40.884	-71.441	0	0	0	4	1.1	1	0	0.1	0	sand
Dec	40.884	-71.549	1	0	0	8	1.8	1	0	0	0	sand
Dec	40.897	-71.660	1	1	1	16	3.55	1	0	0	0	sand

Month	Latitude	Longitude	WinterF	WPF	YTF	Monkfish	Scallops (bushels)	Sand	Gravel	Sand dollars	Rocks	Substrate
Feb_early	41.218	-70.646	1	0	0	0	0	1	0	0	0	sand
Feb_early	41.137	-70.655	0	6	1	6	1	1	0	0.97	0	sand
Feb_early	41.132	-70.765	0	9	0	1	0.02	1	0	1	0	sand
Feb_early	41.129	-70.885	0	7	0	2	0.03	1	0	0	0	sand
Feb_early	41.130	-70.989	0	0	0	0	0.55	1	0	0	0	sand
Feb_early	41.132	-71.095	1	2	0	3	0.2	0.5	0.5	0	11	rocky
Feb_early	41.130	-71.214	2	16	0	8	1.75	0.58	0.42	0	0	mixed
Feb_early	41.136	-71.321	1	7	0	2	0.35	1	0	0	0	sand
Feb_early	41.124	-71.425	0	0	0	0	0.01	0.74	0.26	0	2	mixed
Feb_early	41.047	-70.640	0	5	4	2	0.8	1	0	1	0	sand
Feb_early	41.054	-70.746	0	8	0	3	0.2	1	0	0.21	0	sand
Feb_early	41.053	-70.858	0	5	0	4	1.5	1	0	0.72	0	sand
Feb_early	41.042	-70.975	1	12	0	1	2	1	0	1	0	sand
Feb_early	41.045	-71.087	0	4	1	1	0.06	1	0	0	11	rocky
Feb_early	41.055	-71.191	2	10	0	1	0.04	0.91	0.09	0	7	rocky
Feb_early	41.047	-71.304	2	21	8	6	4.5	0.82	0.18	0	1	sand
Feb_early	41.050	-71.418	0	6	3	1	0.75	0.84	0.16	0	4	sand
Feb_early	41.058	-71.530	0	0	0	2	0	1	0	0	0	sand
Feb_early	41.056	-71.640	1	8	0	5	0.2	1	0	0	0	sand
Feb_early	40.972	-70.653	0	23	0	10	0.15	1	0	0	0	sand
Feb_early	40.966	-70.772	1	26	0	7	0.5	1	0	0	0	sand
Feb_early	40.965	-70.881	0	10	1	4	0.8	1	0	0	0	sand
Feb_early	40.955	-71.104	0	43	2	7	1.8	1	0	0	0	sand
Feb_early	40.958	-71.216	0	45	4	7	2.5	1	0	0	0	sand
Feb_early	40.959	-71.331	0	17	4	9	0.35	1	0	0	0	sand
Feb_early	40.959	-71.437	0	28	6	16	0.45	1	0	1	0	sand
Feb_early	40.955	-71.547	0	8	3	23	2.9	1	0	0	0	sand
Feb_early	40.953	-71.651	2	15	0	30	1.8	1	0	0	0	sand
Feb_early	40.888	-71.298	1	9	1	21	2.5	1	0	0	0	sand
Feb_early	40.895	-71.411	1	7	1	10	0.8	1	0	0	0	sand
Feb_early	40.893	-71.523	0	4	2	20	1	1	0	0.1	0	sand
Feb_early	40.886	-71.642	0	8	1	14	4	1	0	0	0	sand
Feb_early	40.970	-71.036	0	5	0	18	3	1	0	0	0	sand

Month	Latitude	Longitude	WinterF	WPF	YTF	Monkfish	Scallops (bushels)	Sand	Gravel	Sand dollars	Rocks	Substrate
Feb_late	41.143	-70.635	1	1	0	3	2	1	0	0.97	0	sand
Feb_late	41.136	-70.744	0	2	0	1	0.07	1	0	1	0	sand
Feb_late	41.136	-70.860	0	2	0	0	0.02	1	0	0	0	sand
Feb_late	41.136	-70.966	0	5	0	0	0.04	1	0	0	0	sand
Feb_late	41.136	-71.080	0	0	0	0	0	0.5	0.5	0	11	rocky
Feb_late	41.136	-71.188	0	11	0	2	1.4	0.58	0.42	0	0	mixed
Feb_late	41.136	-71.307	0	2	0	7	0.06	1	0	0	0	sand
Feb_late	41.136	-71.419	1	2	0	0	0.12	0.74	0.26	0	2	mixed
Feb_late	41.045	-70.649	0	1	0	5	0.45	1	0	1	0	sand
Feb_late	41.062	-70.764	0	0	1	1	1.1	1	0	0.21	0	sand
Feb_late	41.044	-70.871	0	1	0	1	2.7	1	0	0.72	0	sand
Feb_late	41.059	-70.982	0	1	0	1	2	1	0	1	0	sand
Feb_late	41.050	-71.090	0	0	0	0	0	1	0	0	11	rocky
Feb_late	41.053	-71.201	0	11	1	0	0.15	0.91	0.09	0	7	rocky
Feb_late	41.052	-71.309	1	18	2	7	2.2	0.82	0.18	0	1	sand
Feb_late	41.052	-71.427	1	11	0	4	0.75	0.84	0.16	0	4	sand
Feb_late	41.052	-71.530	4	3	0	23	1.2	1	0	0	0	sand
Feb_late	41.053	-71.638	0	2	0	2	0.07	1	0	0	0	sand
Feb_late	40.960	-70.657	0	4	0	12	0.03	1	0	0	0	sand
Feb_late	40.978	-70.761	0	4	0	0	0.07	1	0	0	0	sand
Feb_late	40.957	-70.875	0	13	0	5	0.4	1	0	0	0	sand
Feb_late	40.975	-70.983	0	10	0	4	0.7	1	0	0	0	sand
Feb_late	40.968	-71.106	1	60	1	27	2.25	1	0	0	0	sand
Feb_late	40.968	-71.215	0	31	4	24	0.35	1	0	0	0	sand
Feb_late	40.968	-71.324	0	13	1	5	1.2	1	0	1	0	sand
Feb_late	40.968	-71.435	0	4	0	4	1.6	1	0	0	0	sand
Feb_late	40.968	-71.550	0	6	0	23	0.4	1	0	0	0	sand
Feb_late	40.965	-71.659	0	3	0	3	0.38	1	0	0	0	sand
Feb_late	40.884	-71.434	0	13	0	28	0.8	1	0	0	0	sand
Feb_late	40.884	-71.420	0	1	1	17	0.65	1	0	0.1	0	sand
Feb_late	40.884	-71.527	0	2	0	23	1.5	1	0	0	0	sand
Feb_late	40.884	-71.642	0	8	3	25	1.3	1	0	0	0	sand

Month	Latitude	Longitude	WinterF	WPF	YTF	Monkfish	Scallops (bushels)	Sand	Gravel	Sand dollars	Rocks	Substrate
Mar	41.234	-70.682	0	0	0	0	0	1	0	0	0	sand
Mar	41.137	-70.652	0	1	0	0	0.01	1	0	0.97	0	sand
Mar	41.135	-70.753	0	0	0	0	0.01	1	0	1	0	sand
Mar	41.137	-70.878	0	1	0	0	0.15	1	0	0	0	sand
Mar	41.136	-70.986	0	0	0	0	0.06	1	0	0	0	sand
Mar	41.136	-71.097	1	0	0	0	0	0.5	0.5	0	11	rocky
Mar	41.135	-71.325	0	0	0	0	0.07	1	0	0	0	sand
Mar	41.132	-71.434	0	2	0	0	0.02	0.74	0.26	0	2	mixed
Mar	41.048	-70.650	1	9	0	8	0.35	1	0	1	0	sand
Mar	41.053	-70.757	0	1	1	3	0.4	1	0	0.21	0	sand
Mar	41.053	-70.866	0	1	1	2	1.25	1	0	0.72	0	sand
Mar	41.053	-70.979	1	7	0	9	0.9	1	0	1	0	sand
Mar	41.052	-71.082	0	0	0	0	0.02	1	0	0	11	rocky
Mar	41.053	-71.199	0	1	0	1	0.1	0.91	0.09	0	7	rocky
Mar	41.051	-71.311	0	20	5	10	3.25	0.82	0.18	0	1	sand
Mar	41.052	-71.423	0	2	1	0	0.9	0.84	0.16	0	4	sand
Mar	41.053	-71.530	0	3	0	22	0.16	1	0	0	0	sand
Mar	41.051	-71.646	0	5	0	16	0.2	1	0	0	0	sand
Mar	40.970	-70.656	0	5	0	5	0.02	1	0	0	0	sand
Mar	40.968	-70.765	0	10	0	4	0.35	1	0	0	0	sand
Mar	40.967	-70.871	0	3	0	8	0.5	1	0	0	0	sand
Mar	40.968	-70.986	0	16	2	15	2.5	1	0	0	0	sand
Mar	40.967	-71.099	0	25	1	13	2	1	0	0	0	sand
Mar	40.967	-71.208	0	14	0	13	0.35	1	0	0	0	sand
Mar	40.969	-71.322	0	18	0	5	1.3	1	0	1	0	sand
Mar	40.968	-71.436	0	10	1	33	2.4	1	0	0	0	sand
Mar	40.967	-71.544	0	8	0	59	0.85	1	0	0	0	sand
Mar	40.962	-71.651	0	2	0	16	1.9	1	0	0	0	sand
Mar	40.885	-71.308	0	13	2	27	0.5	1	0	0	0	sand
Mar	40.884	-71.533	0	1	0	19	2	1	0	0	0	sand
Mar	40.884	-71.645	0	6	5	23	5.5	1	0	0	0	sand

Table A2. *Catch number per station for winter flounder in each reproductive stage and substrate details for each station.*

Month	Latitude	Longitude	Immature	Developing	Ripe	Spent	Resting	Sand	Gravel	Sand dollars	Rocks	Substrate
Dec	41.230	-70.650	0	0	0	0	0	1	0	0	0	sand
Dec	41.138	-70.643	0	2	0	0	0	1	0	0.97	0	sand
Dec	41.136	-70.754	0	3	0	0	1	1	0	1	0	sand
Dec	41.136	-70.864	0	0	0	0	1	1	0	0	0	sand
Dec	41.136	-70.974	0	0	0	0	0	1	0	0	0	sand
Dec	41.136	-71.054	0	0	0	0	0	0	1	0	11	rocky
Dec	41.136	-71.193	0	3	0	0	0	0.58	0.42	0	0	mixed
Dec	41.136	-71.299	0	0	0	0	0	1	0	0	0	sand
Dec	41.136	-71.413	0	1	0	0	0	0.74	0.26	0	2	mixed
Dec	41.057	-70.655	0	0	1	0	0	1	0	1	0	sand
Dec	41.052	-70.769	0	2	0	0	0	1	0	0.21	0	sand
Dec	41.052	-70.881	0	0	0	0	0	1	0	0.72	0	sand
Dec	41.052	-70.982	0	1	0	0	0	1	0	1	0	sand
Dec	41.052	-71.103	0	1	0	0	0	1	0	0	11	rocky
Dec	41.052	-71.213	0	1	0	0	0	0.91	0.09	0	7	rocky
Dec	41.052	-71.326	0	0	0	0	1	0.82	0.18	0	1	sand
Dec	41.052	-71.439	0	1	0	0	0	0.84	0.16	0	4	sand
Dec	41.056	-71.545	0	0	0	0	0	1	0	0	0	sand
Dec	40.987	-70.630	0	0	0	0	0	1	0	0	0	sand
Dec	40.968	-70.760	0	0	0	0	0	1	0	0	0	sand
Dec	40.968	-70.869	0	0	0	0	0	1	0	0	0	sand
Dec	40.968	-70.976	0	0	0	0	0	1	0	0	0	sand
Dec	40.968	-71.087	0	1	0	0	0	1	0	0	0	sand
Dec	40.968	-71.203	0	0	0	0	0	1	0	0	0	sand
Dec	40.968	-71.309	0	0	0	0	0	1	0	1	0	sand
Dec	40.968	-71.423	0	0	0	0	0	1	0	0	0	sand
Dec	40.968	-71.533	0	0	0	0	0	1	0	0	0	sand
Dec	40.968	-71.637	0	1	0	0	0	1	0	0	0	sand
Dec	40.884	-71.327	0	0	0	0	0	1	0	0	0	sand
Dec	40.884	-71.441	0	0	0	0	0	1	0	0.1	0	sand
Dec	40.884	-71.549	0	1	0	0	0	1	0	0	0	sand
Dec	40.897	-71.660	0	1	0	0	0	1	0	0	0	sand

Month	Latitude	Longitude	Immature	Developing	Ripe	Spent	Resting	Sand	Gravel	Sand dollars	Rocks	Substrate
Feb_early	41.218	-70.646	0	0	1	0	0	1	0	0	0	sand
Feb_early	41.137	-70.655	0	0	0	0	0	1	0	0.97	0	sand
Feb_early	41.132	-70.765	0	0	0	0	0	1	0	1	0	sand
Feb_early	41.129	-70.885	0	0	0	0	0	1	0	0	0	sand
Feb_early	41.130	-70.989	0	0	0	0	0	1	0	0	0	sand
Feb_early	41.132	-71.095	0	0	0	0	1	0.5	0.5	0	11	rocky
Feb_early	41.130	-71.214	0	0	1	1	0	0.58	0.42	0	0	mixed
Feb_early	41.136	-71.321	1	0	0	0	0	1	0	0	0	sand
Feb_early	41.124	-71.425	0	0	0	0	0	0.74	0.26	0	2	mixed
Feb_early	41.047	-70.640	0	0	0	0	0	1	0	1	0	sand
Feb_early	41.054	-70.746	0	0	0	0	0	1	0	0.21	0	sand
Feb_early	41.053	-70.858	0	0	0	0	0	1	0	0.72	0	sand
Feb_early	41.042	-70.975	0	0	1	0	0	1	0	1	0	sand
Feb_early	41.045	-71.087	0	0	0	0	0	1	0	0	11	rocky
Feb_early	41.055	-71.191	0	0	2	0	0	0.91	0.09	0	7	rocky
Feb_early	41.047	-71.304	0	1	1	0	0	0.82	0.18	0	1	sand
Feb_early	41.050	-71.418	0	0	0	0	0	0.84	0.16	0	4	sand
Feb_early	41.058	-71.530	0	0	0	0	0	1	0	0	0	sand
Feb_early	41.056	-71.640	0	0	1	0	0	1	0	0	0	sand
Feb_early	40.972	-70.653	0	0	0	0	0	1	0	0	0	sand
Feb_early	40.966	-70.772	0	0	1	0	0	1	0	0	0	sand
Feb_early	40.965	-70.881	0	0	0	0	0	1	0	0	0	sand
Feb_early	40.955	-71.104	0	0	0	0	0	1	0	0	0	sand
Feb_early	40.958	-71.216	0	0	0	0	0	1	0	0	0	sand
Feb_early	40.959	-71.331	0	0	0	0	0	1	0	0	0	sand
Feb_early	40.959	-71.437	0	0	0	0	0	1	0	1	0	sand
Feb_early	40.955	-71.547	0	0	0	0	0	1	0	0	0	sand
Feb_early	40.953	-71.651	0	0	2	0	0	1	0	0	0	sand
Feb_early	40.888	-71.298	0	0	0	1	0	1	0	0	0	sand
Feb_early	40.895	-71.411	0	0	1	0	0	1	0	0	0	sand
Feb_early	40.893	-71.523	0	0	0	0	0	1	0	0.1	0	sand
Feb_early	40.886	-71.642	0	0	0	0	0	1	0	0	0	sand
Feb_early	40.970	-71.036	0	0	0	0	0	1	0	0	0	sand

Month	Latitude	Longitude	Immature	Developing	Ripe	Spent	Resting	Sand	Gravel	Sand dollars	Rocks	Substrate
Feb_late	41.143	-70.635	1	0	0	0	0	1	0	0.97	0	sand
Feb_late	41.136	-70.744	0	0	0	0	0	1	0	1	0	sand
Feb_late	41.136	-70.860	0	0	0	0	0	1	0	0	0	sand
Feb_late	41.136	-70.966	0	0	0	0	0	1	0	0	0	sand
Feb_late	41.136	-71.080	0	0	0	0	0	0.5	0.5	0	11	rocky
Feb_late	41.136	-71.188	0	0	0	0	0	0.58	0.42	0	0	mixed
Feb_late	41.136	-71.307	0	0	0	0	0	1	0	0	0	sand
Feb_late	41.136	-71.419	0	0	1	0	0	0.74	0.26	0	2	mixed
Feb_late	41.045	-70.649	0	0	0	0	0	1	0	1	0	sand
Feb_late	41.062	-70.764	0	0	0	0	0	1	0	0.21	0	sand
Feb_late	41.044	-70.871	0	0	0	0	0	1	0	0.72	0	sand
Feb_late	41.059	-70.982	0	0	0	0	0	1	0	1	0	sand
Feb_late	41.050	-71.090	0	0	0	0	0	1	0	0	11	rocky
Feb_late	41.053	-71.201	0	0	0	0	0	0.91	0.09	0	7	rocky
Feb_late	41.052	-71.309	0	0	0	1	0	0.82	0.18	0	1	sand
Feb_late	41.052	-71.427	0	1	0	0	0	0.84	0.16	0	4	sand
Feb_late	41.052	-71.530	0	1	0	2	1	1	0	0	0	sand
Feb_late	41.053	-71.638	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.960	-70.657	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.978	-70.761	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.957	-70.875	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.975	-70.983	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.968	-71.106	0	1	0	0	0	1	0	0	0	sand
Feb_late	40.968	-71.215	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.968	-71.324	0	0	0	0	0	1	0	1	0	sand
Feb_late	40.968	-71.435	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.968	-71.550	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.965	-71.659	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.884	-71.434	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.884	-71.420	0	0	0	0	0	1	0	0.1	0	sand
Feb_late	40.884	-71.527	0	0	0	0	0	1	0	0	0	sand
Feb_late	40.884	-71.642	0	0	0	0	0	1	0	0	0	sand

Month	Latitude	Longitude	Immature	Developing	Ripe	Spent	Resting	Sand	Gravel	Sand dollars	Rocks	Substrate
Mar	41.234	-70.682	0	0	0	0	0	1	0	0	0	sand
Mar	41.137	-70.652	0	0	0	0	0	1	0	0.97	0	sand
Mar	41.135	-70.753	0	0	0	0	0	1	0	1	0	sand
Mar	41.137	-70.878	0	0	0	0	0	1	0	0	0	sand
Mar	41.136	-70.986	0	0	0	0	0	1	0	0	0	sand
Mar	41.136	-71.097	0	0	0	1	0	0.5	0.5	0	11	rocky
Mar	41.135	-71.325	0	0	0	0	0	1	0	0	0	sand
Mar	41.132	-71.434	0	0	0	0	0	0.74	0.26	0	2	mixed
Mar	41.048	-70.650	1	0	0	0	0	1	0	1	0	sand
Mar	41.053	-70.757	0	0	0	0	0	1	0	0.21	0	sand
Mar	41.053	-70.866	0	0	0	0	0	1	0	0.72	0	sand
Mar	41.053	-70.979	1	0	0	0	0	1	0	1	0	sand
Mar	41.052	-71.082	0	0	0	0	0	1	0	0	11	rocky
Mar	41.053	-71.199	0	0	0	0	0	0.91	0.09	0	7	rocky
Mar	41.051	-71.311	0	0	0	0	0	0.82	0.18	0	1	sand
Mar	41.052	-71.423	0	0	0	0	0	0.84	0.16	0	4	sand
Mar	41.053	-71.530	0	0	0	0	0	1	0	0	0	sand
Mar	41.051	-71.646	0	0	0	0	0	1	0	0	0	sand
Mar	40.970	-70.656	0	0	0	0	0	1	0	0	0	sand
Mar	40.968	-70.765	0	0	0	0	0	1	0	0	0	sand
Mar	40.967	-70.871	0	0	0	0	0	1	0	0	0	sand
Mar	40.968	-70.986	0	0	0	0	0	1	0	0	0	sand
Mar	40.967	-71.099	0	0	0	0	0	1	0	0	0	sand
Mar	40.967	-71.208	0	0	0	0	0	1	0	0	0	sand
Mar	40.969	-71.322	0	0	0	0	0	1	0	1	0	sand
Mar	40.968	-71.436	0	0	0	0	0	1	0	0	0	sand
Mar	40.967	-71.544	0	0	0	0	0	1	0	0	0	sand
Mar	40.962	-71.651	0	0	0	0	0	1	0	0	0	sand
Mar	40.885	-71.308	0	0	0	0	0	1	0	0	0	sand
Mar	40.884	-71.533	0	0	0	0	0	1	0	0	0	sand
Mar	40.884	-71.645	0	0	0	0	0	1	0	0	0	sand

Month	Latitude	Longitude	Immature	Developing	Ripe	Spent	Resting	Sand	Gravel	Sand dollars	Rocks	Substrate
Apr	41.233	-70.681	0	0	0	0	0	1	0	0	0	sand
Apr	41.137	-70.643	0	0	0	0	0	1	0	0.97	0	sand
Apr	41.137	-70.758	0	0	0	0	0	1	0	1	0	sand
Apr	41.137	-70.871	0	0	0	0	0	1	0	0	0	sand
Apr	41.136	-70.980	0	0	0	0	0	1	0	0	0	sand
Apr	41.137	-71.092	0	0	0	0	0	0.5	0.5	0	11	rocky
Apr	41.136	-71.203	0	0	0	0	0	0.58	0.42	0	0	mixed
Apr	41.136	-71.315	0	0	0	0	0	1	0	0	0	sand
Apr	41.137	-71.428	0	0	0	0	1	0.74	0.26	0	2	mixed
Apr	41.055	-70.643	0	0	0	0	0	1	0	1	0	sand
Apr	41.719	-70.761	0	0	0	0	0	1	0	0.21	0	sand
Apr	41.052	-70.876	0	0	0	0	0	1	0	0.72	0	sand
Apr	41.053	-70.983	0	0	0	0	0	1	0	1	0	sand
Apr	41.052	-71.095	0	0	0	0	0	1	0	0	11	rocky
Apr	41.053	-71.206	0	0	0	0	0	0.91	0.09	0	7	rocky
Apr	41.054	-71.320	0	0	0	0	0	0.82	0.18	0	1	sand
Apr	41.054	-71.428	0	0	0	0	0	0.84	0.16	0	4	sand
Apr	41.051	-71.531	0	0	1	0	0	1	0	0	0	sand
Apr	41.052	-71.647	0	0	0	0	0	1	0	0	0	sand
Apr	40.967	-70.647	0	0	0	0	0	1	0	0	0	sand
Apr	40.968	-70.760	0	0	0	0	0	1	0	0	0	sand
Apr	40.967	-70.868	0	0	0	0	0	1	0	0	0	sand
Apr	40.967	-70.983	0	0	0	0	0	1	0	0	0	sand
Apr	40.967	-71.102	0	0	0	0	0	1	0	0	0	sand
Apr	40.968	-71.204	0	0	0	0	0	1	0	0	0	sand
Apr	40.969	-71.314	0	0	0	0	0	1	0	1	0	sand
Apr	40.969	-71.425	0	0	0	0	0	1	0	0	0	sand
Apr	40.969	-71.534	0	0	0	0	2	1	0	0	0	sand
Apr	40.969	-71.649	0	0	0	0	1	1	0	0	0	sand
Apr	40.885	-71.427	0	0	0	0	0	1	0	0	0	sand
Apr	40.884	-71.541	0	0	0	0	0	1	0	0	0	sand
Apr	40.884	-71.648	0	0	0	0	0	1	0	0	0	sand

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under US administration.

The Bureau of Ocean Energy Management

As a bureau of the Department of the Interior, the Bureau of Ocean Energy (BOEM) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS) in an environmentally sound and safe manner.

The BOEM Environmental Studies Program

The mission of the Environmental Studies Program (ESP) is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments.