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A new groundfish survey technique examining Georges Bank Yellowtail Flounder.

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Abstract

The objective of this research is to improve estimates of the abundance, spatial distribution, size structure, and length-weight relationship of the Georges Bank yellowtail flounder stock using a combination of fishermen's knowledge, advanced video observations designed for nets and state-of-the art benthic imagery. Here we report on our first two research cruises to Georges Bank, describing the sampling techniques, and provide a preliminary estimate of 870 mt of yellowtail in the sampled area using a swept-area analysis.

Introduction

New England groundfish have the estimated potential to produce approximately 150 thousand metric tons of annual yields (NEFSC 2008) worth approximately $300 million at the dock and over $600 million to the region (assuming $1.00 per lb). The 2012 scallop fishery was valued at nearly $600 million in landings. The most recent stock assessment estimated that the adult biomass of yellowtail flounder in the Georges Bank stock is extremely low (826 mt), and the resulting low allowable catch will likely restrict landings in both the scallop and groundfish fleets causing major economic hardship in Massachusetts fishing communities. There are several issues with the recent yellowtail flounder stock assessments; a fundamental one is the limited amount of time the dredge spends on the sea floor during a survey.

To enhance the spatial resolution of groundfish surveys on Georges Bank we are developing a new groundfish survey that combines traditional fishermen's knowledge with advanced video observations. This technology will allow the net to sample more of the sea floor without harming the observed fish. Our objective is to estimate the abundance, spatial distribution, size structure, and length-weight relationship of the Georges Bank yellowtail flounder stock on the southern flank of Georges Bank. We are also working on these parameters for cod, haddock, monkfish, skate and other groundfish. This will be a non-intrusive ecosystem-based sampling effort.

Methods/Results

We conducted a pilot research cruise from April 14th through April 17th 2013. For this cruise we modified a groundfish net used for flatfish surveys in the Great South Channel. We added a cylinder to the codend to support the camera mounts. Three separate camera mounting locations were tested, the camera looking back into the codend, looking forward from the codend and looking down at the footrope. During the cruise, 11 tows were made totaling 6 hours of bottom time. Four tows had the codend closed to allow for validation of the species caught in the net. The video footage from many of the tows had large periods of the view hindered by a cloud of silt, limiting the ability to count fish. The final tow had the clearest footage and was used to compare the number of fish caught in the net to those that were counted from the video. In the final tow, 720 flatfish were captured, and the catch was comprised of yellowtail, summer, windowpane, 4-spot and witch flounder. After the trip, the video from this tow was reviewed and 653 flatfish were counted, representing 91% of the flatfish that were caught in the net during the tow (Table 1).

The second survey sampled the southern portion of Closed Area II from November 8th to November 13th, 2013. The fishing vessel was equipped with a new groundfish otter trawl net (designed specifically for yellowtail flounder by Reidar's manufacturing Inc) with a video sampling system installed in the codend (Figure 1). The net had a hanging ratio of 0.42, a 120 mm mesh and 3 mm twine, with a 27 m chain sweep. Adaptations were also made to the belly of the net to reduce sediment disturbance. A FX80 camera system and PI50 sensor system were leased from SIMRAD for the trip (Figure 1 and 2). The FX80 camera system consisted of a single camera and light facing the codend of the net, mounted within an adapted polyethylene tank. The PI50 sensor system allowed for the real-time measurement of net characteristics (spread, height of head rope, etc.).

Four transects on the southern flank of Georges Bank including Closed Area II, were chosen based on the available observer data, SMAST study fleet data, and the recent NOAA cooperative trawl survey station locations (Figure 3, 4, 5, and 6). The transects were designed to follow the depth contours on Georges Bank, and the total length of the two transects that were sampled during the trip was approximately 175 km (Figure 7). Two of the four transects were completed, but the other transects were excluded due to technical difficulties limiting surveying time (Figure 7). Once each morning and afternoon the codend of the net was closed for a 30 min tow, and a sample of fish was collected for verification of species identification, and length/weight measurements. Groundfish associate with depth; by following the depth contours we assumed that the closed codend tows made in the morning and evening would reflect the species composition and size distribution we observed in the video footage during the open codend tows. Therefore, species proportions and length frequencies from the tows will be extrapolated over each 8 hour video section for the final density estimates once the video has been processed.

Ten tows with an open codend, covering approximately 175 km and 8 closed codend tows were conducted and filmed (Figure 7). The fishing vessel was able to continually tow the net with an open codend over most of the 70 m and 80 m depth contours. Images of fish passing through the net were recorded in high resolution using the system designed by SIMRAD (Figure 2). The video is being analyzed in the SMAST scallop digitizing laboratory, which has 14 years of experience and an extensive species identification system.

In the closed codend samples yellowtail flounders were the most frequently observed flatfish, and the third most common fish species (dogfish and skate were first and second). A total of 1,993 yellowtail flounder were caught during the eight closed codend tows (Table 2). On average about 250 yellowtail flounder were caught per tow (SD = 150). Following the completion of the eight closed codend tows, the total length of each yellowtail flounder was measured to the nearest centimeter. Yellowtail flounder captured during the closed codend tows ranged from 20 to 47 cm (mean = 35.6 cm; Figure 8).

Area Swept Estimates

The weight of each yellowtail flounder was calculated using the length-weight relationship established for yellowtail flounder captured during the fall NEFSC annual bottom trawl survey (Wigley et al., 2003):

ln weight (kg) = -11.8381 + (3.0559 * ln length (cm))

As a preliminary analysis, estimates of yellowtail flounder density (kg/km^2) and biomass (mt) were calculated by examining the observed catch of yellowtail flounder and the area swept by the survey net during each of the eight closed codend tows. The mean doorspread and vessel speed observed for each tow was used in the area swept calculations. For the eight closed codend tows, the mean observed doorspread ranged from 53.2 to 69.8 m, and the mean observed tow speed ranged from 4.82 to 5.87 km/hr. The closed codend tows ranged from 30 to 34 minutes in duration.

The area swept (km^2) by the survey net was calculated for each tow as:

Area swept (km^2) = doorspread (km) * tow speed (km/hr) * tow duration (hr)

After the area swept during each tow was calculated, we were able to calculate the density of yellowtail flounder observed during each survey tow. The density of yellowtail flounder was calculated for each survey tow as:

Yellowtail flounder density (kg/km^2) = yellowtail flounder catch (kg)/area swept (km^2)

The size of the study area was estimated in ArcGIS by calculating the area of a polygon that encompassed the start and end locations of the eight survey tows (Figure 9). The size of the study area was estimated to be 1483 km^2. The biomass of yellowtail flounder in the study area was estimated as:

Yellowtail flounder biomass (kg) = yellowtail flounder density (kg/km^2) * size of survey area (km^2)

The catchability of the survey net is unknown. Therefore, our calculations of yellowtail flounder density and biomass are conservative because they assume that the survey net is able to catch 100% of the flounder that are within the path of the trawl. The calculations also assume that all of the yellowtail flounder that are present between the doors are captured by the survey net (i.e., the net has 100% herding efficiency).

Discussion/Conclusions/Summary/Recommendations

Our preliminary estimate of the adult biomass of yellowtail flounder in the study area was 870 mt. The biomass estimate assumes the net operated with 100% efficiency, (i.e. that it caught every fish in its path). The size of our study area during the fall survey was approximately 1,483 km^2, which sampled prime yellowtail flounder habitat, but is only about 4% of the entire Georges Bank stock area. These results suggest that the NMFS stock assessment of 826 mt may be an underestimate.

The mean length of yellowtail flounder sampled was 35.6 cm (SD = 3.90), which is similar to the length frequencies collected in September 1998 for the same area (37.0 cm SD = 5.66). These fish were collected during the 1998 cooperative CMAST/NMFS sea scallop survey, so the selectivity of the gear is different. In 2008 the average size of yellowtail flounder in the southern portion of CAII was 35.2 cm (SD = 3.71) collected with commercial fishing vessels (Melgey 2010). This suggests little change in the yellowtail size distribution over the past 16 years. The L50 for maturity of Georges Bank yellowtail flounder is 21 cm and 26 cm for males and females respectively (O'Brien et al., 1993), indicating that the trawl net used in this survey primarily caught adult yellowtail flounder.

We have begun the analysis of the video data. It appears that we are seeing about 50 to 90% of the flatfish in the video compared to the closed trawl samples. However, we did have technical difficulties during several of these sets. Tow 16 was the best collection in that the video ran the full time the net was in the water (Table 4).

We are continuing to develop this sampling protocol as it seems highly promising and has already served to increase the dialogue and examination of the data supporting the yellowtail flounder stock assessments. This research has been funded by the commercial fishing industry, Department of Fisheries oceanography-SMAST, and the state of Massachusetts.

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O'Brien, L., Burnett, J., and Mayo, R.K. 1993. Maturation of nineteen species of finfish off the northeast coast of the United States, 1985-1990. NOAA Tech. Report NMFS 113, 66p.

Wigley, S.E., McBride, H.M., and McHugh, N.J. 2003. Length-weight relationships for 74 fish species collected during NEFSC research vessel bottom trawl surveys, 1992-99. NOAA Tech. Memo. NMFS NE 171; 26p.

Table 1. Catch and video counts by species, including a pooled flatfish category from the final tow of the pilot study that was completed in April 2013. The % counted column indicates the percent of each species that was counted in the video compared to what was caught in the codend.

Species	Catch numbers	Video Counts	% Counted
Fluke	34	75	221%
Sand Dab	279	113	41%
Yellowtail	107	79	74%
4Spot	291	380	131%
Greysole	9	6	67%
Skate	226	157	69%
Barndoor	9	4	44%
Dogfish	21	166	790%
Monk	6	5	83%
Flatfish	***720***	***653***	***91%***

Table 2. Catch by species, from the eight closed codend tows that were completed during the fall 2013 research cruise.

Tows	**3**	**5**	**7**	**10**	**12**	**13**	**16**	**18**	**Totals**
Dogfish	4	6	5430	205	3764	355	10	0	9774
Skates	447	291	882	362	832	547	387	418	4166
Scallops	222	548	106	90	199	115	1797	821	3898
YellowTail	501	84	395	67	301	270	233	142	1993
FourSpot	11	66	122	73	275	196	109	147	999
Longhorn Sculpin	26	0	39	12	112	65	12	3	269
Haddock	0	0	180	5	14	5	4	0	208
SandDab	18	1	43	28	55	31	0	0	176
Whiting	9	0	11	11	78	29	7	1	146
ShortFinSquid	0	0	33	32	21	8	11	0	105
Barndoor skates	6	12	3	4	3	7	36	32	103
hake	0	0	0	0	69	3	3	0	75
Butterfish	0	0	2	21	13	0	6	0	42
Monkfish	2	1	3	4	5	4	1	5	25
Lobsters	0	3	2	7	0	2	5	1	20
crabs	0	0	0	0	0	0	4	2	6
Fluke	3	0	0	1	0	1	0	0	5
WinterFlounder	1	1	1	1	0	1	0	0	5
loligo squid	0	0	0	0	0	0	2	0	2
shorthorn sculpin	0	0	0	0	0	1	0	0	1

Table 3. Summary of the eight closed codend tows completed during the survey.

Tow #	Tow Duration (hr)	Mean Tow Speed (km/hr)	Mean Doorspread (m)	Area Swept (km^2)	Yellowtail Catch (kg)	Yellowtail Density (kg/km^2)	Yellowtail Biomass (mt)
3	0.50	5.6	53.2	0.15	220	1475	2150
5	0.52	5.0	59.8	0.15	35	240	350
7	0.50	5.7	69.8	0.20	175	870	1260
10	0.50	5.2	67.6	0.18	25	150	210
12	0.50	5.1	69.7	0.18	120	680	990
13	0.50	4.8	66.8	0.16	115	700	1020
16	0.57	5.3	66.9	0.20	85	420	610
18	0.50	5.9	69.5	0.20	50	250	360

Table 4. Comparison of counts of flatfish in closed codend tows to video counts from the same tows. The "entire video" column shows the results from continuously counting flatfish for all video footage of the tow. The other columns represent results from video footage broken into five minute intervals. Observers (Ob 1-3) were asked to count flatfish during the first and last minute of each five minute segment. They also reviewed randomly assigned five minute segments. Tow 16 (bold) was the only tow in which filming occurred the entire time the net was in the water.

Tow #	Codend Count	Entire Video	Last Minute of Video		First Minute of Video		Random Five Minutes Interval of Video		
		Ob 1%	Ob 2%	Ob 3%	Ob 2%	Ob 3%	Ob 2%	Ob 3%	Ob 4%
3	534	49	64	66	46	44	54	69	75
7	561	35	46	48	35	36	52	42	80
12	631	31	46	43	47	30	23	21	45
13	499	63	64	63	48	52	80	77	128
16	**342**	**69**	**96**	**88**	**76**	**62**	**60**	**62**	**101**
18	289	47	26	24	21	19	17	8	96

Figure 1. Sample net on the F/V Justice, November 2014. The hard container in the codend is the mounting for the video camera.

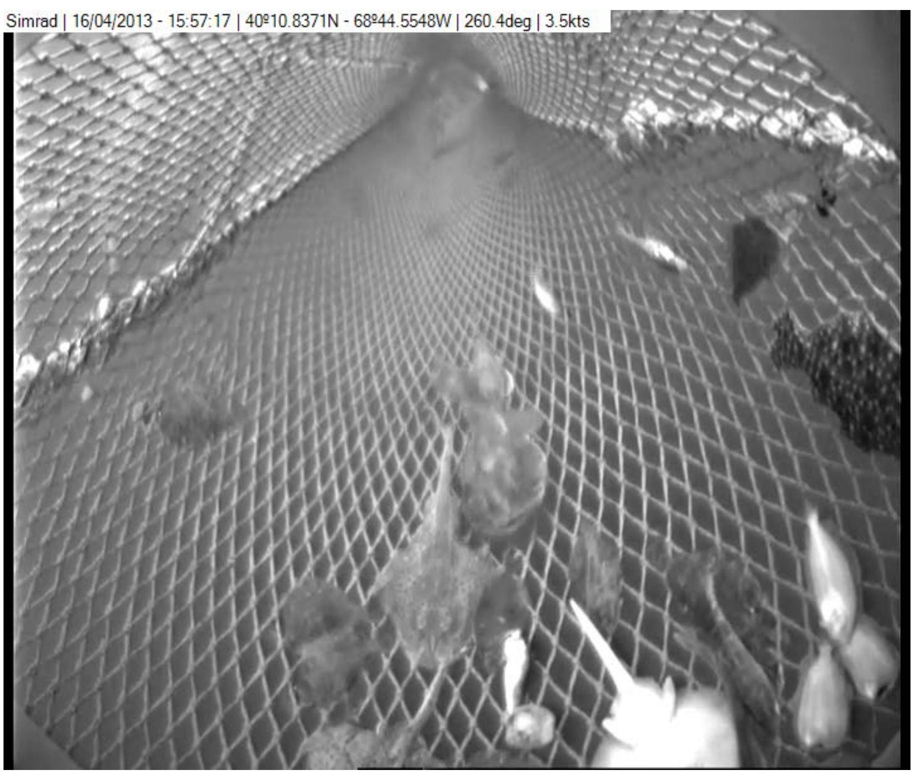
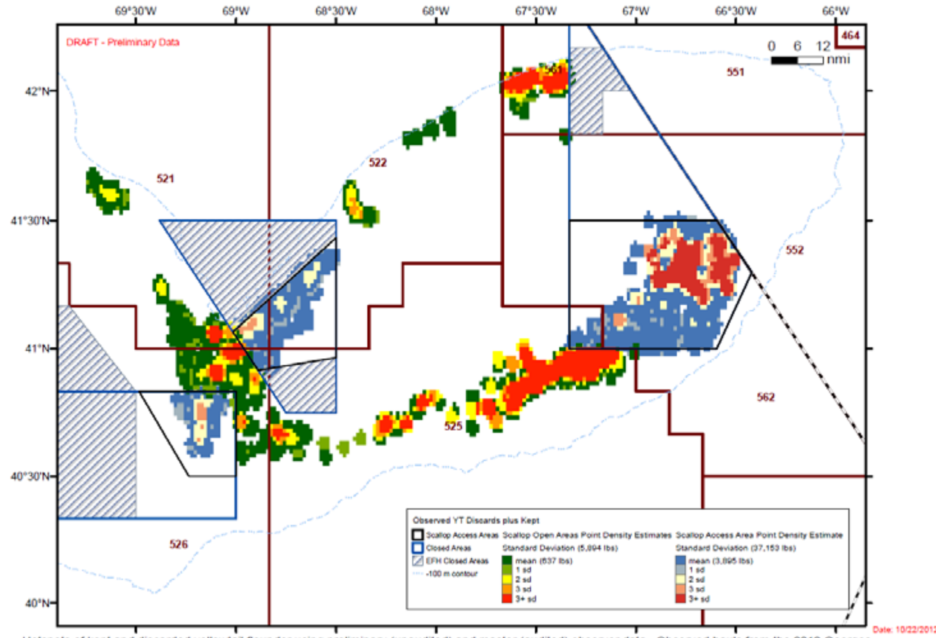


Figure 2. Frame capture from the SIMRAD video system in the codend of the net.



Hotspots of kept and discarded yellowtail flounder using preliminary (unaudited) and master (audited) observer data. Observed hauls from the 2012 Georges Bank Scallop Access Areas were rasterized using the point density tool in ArcGIS to a 1 minute square using a 2 nautical mile neighborhood (blue to red hues). Open area trips were from 01 July 2011 - 30 June 2012 and were rasterized using the same procedures (green to red hues). Data are displayed in standard deviations to show relative hotspots.

Figure 3. NOAA observer data of yellowtail flounder hot spots.

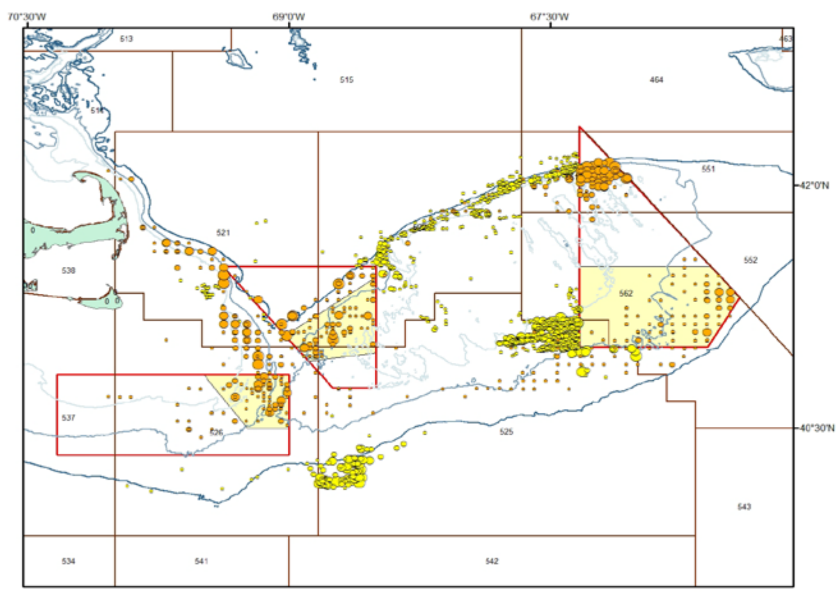


Figure 4. SMAST study fleet groundfish abundance data, 2006 to 2010 (yellow dots) and orange dots are 2012 SMAST scallop video survey.

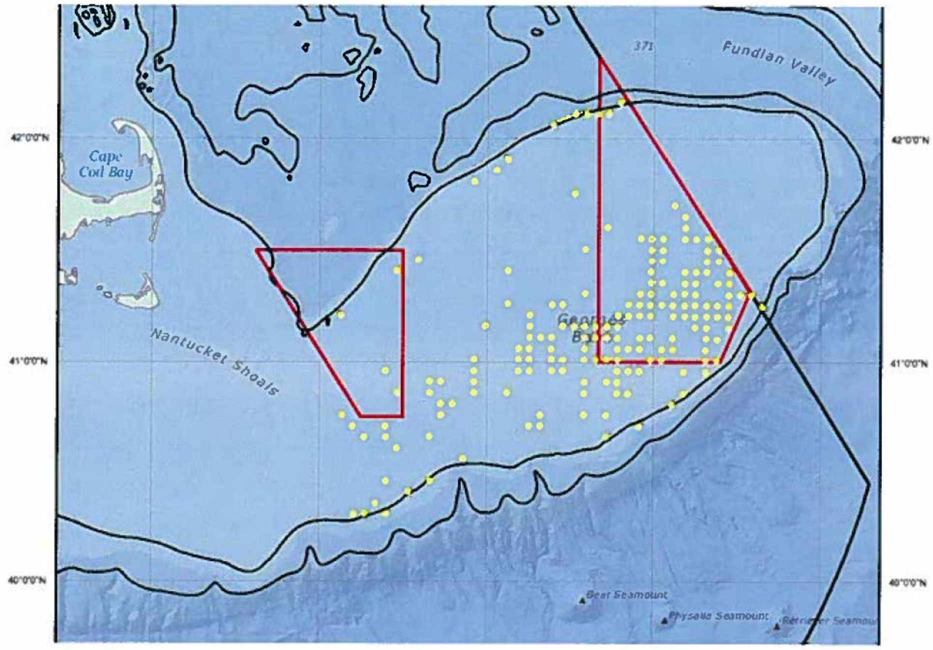


Figure 5. Location of survey tows that were completed during the NOAA cooperative groundfish trawl survey August 2013.

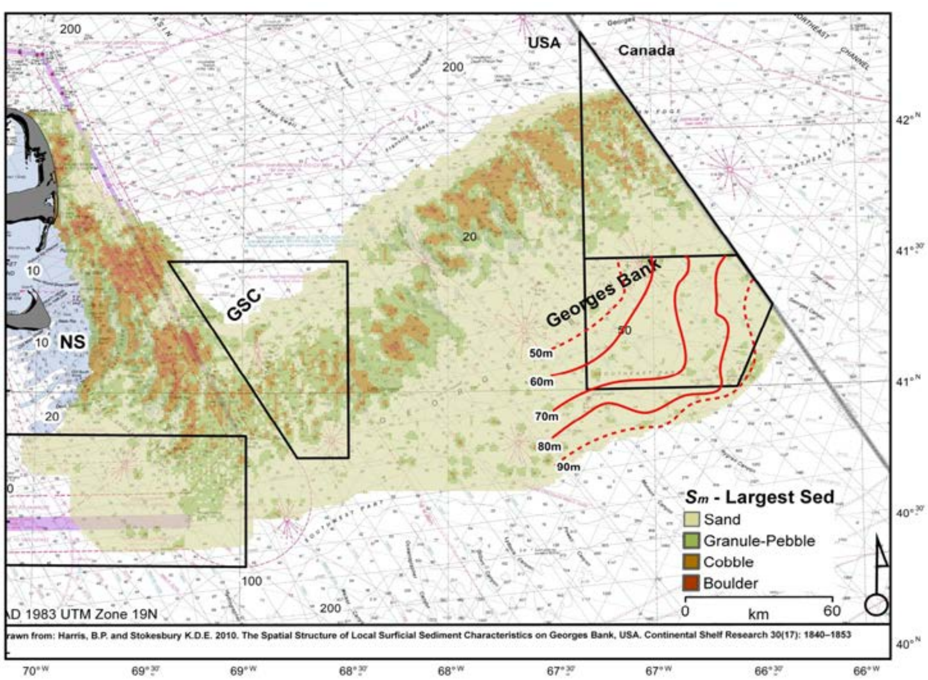


Figure 6. SMAST target video transect lines (equaling 500 km) covering the southern flank of Georges Bank including Closed Area II overlaid on the substrate data from the SMAST video survey (Harris and Stokesbury 2010).

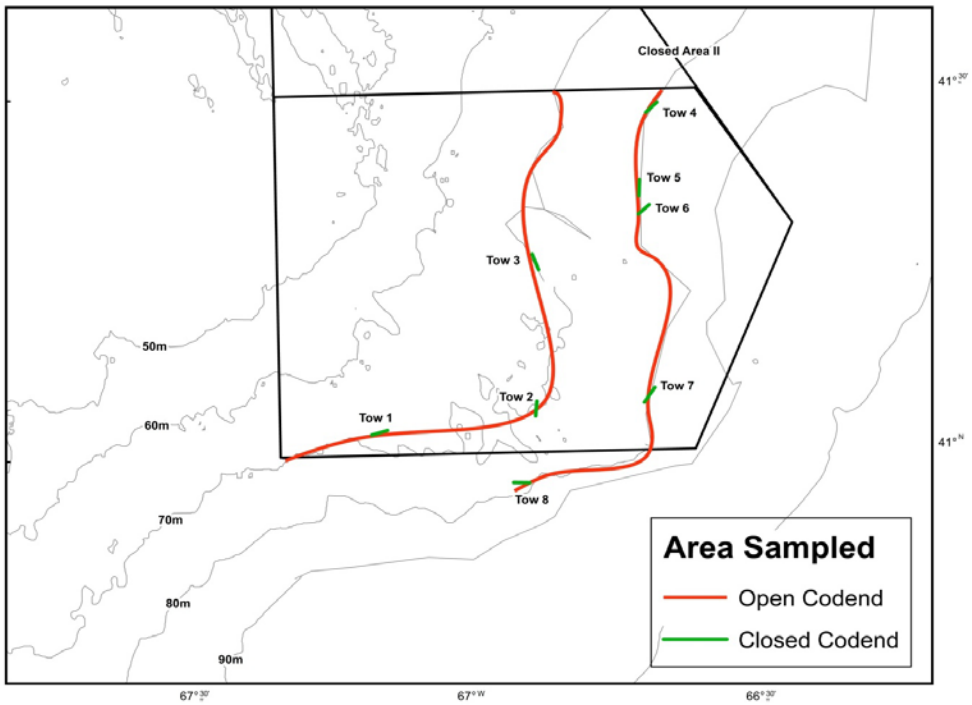


Figure 7. SMAST video trawl transect lines (equaling 175 km) that were sampled on the southern flank of Georges Bank including Closed Area II during the Fall 2013 survey trip.

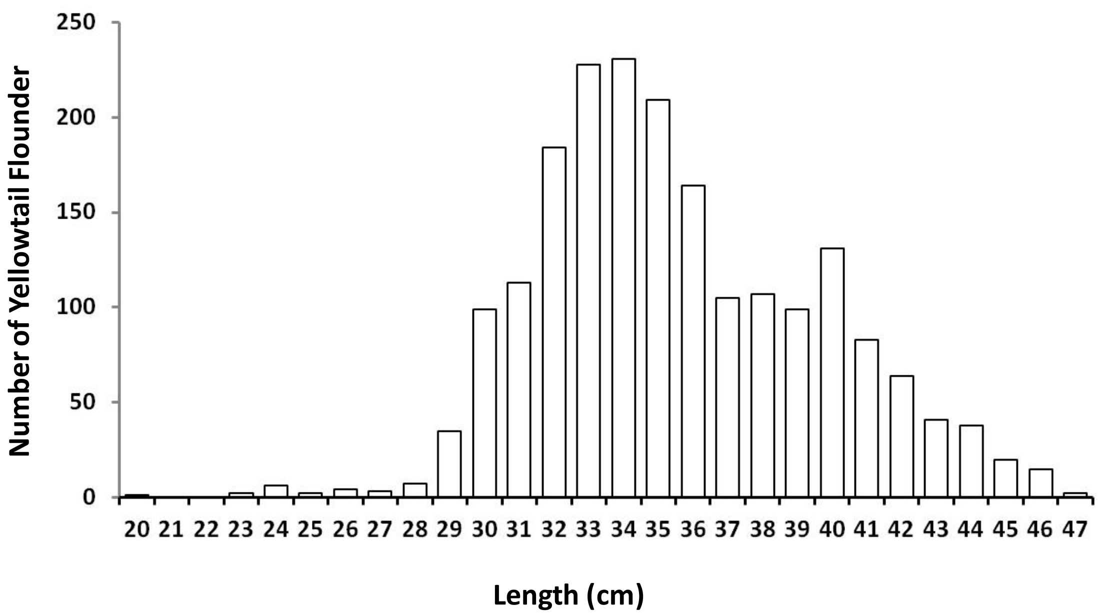


Figure 8. Length frequency distribution of yellowtail flounder observed in the eight closed codend tows that were completed during the fall survey.

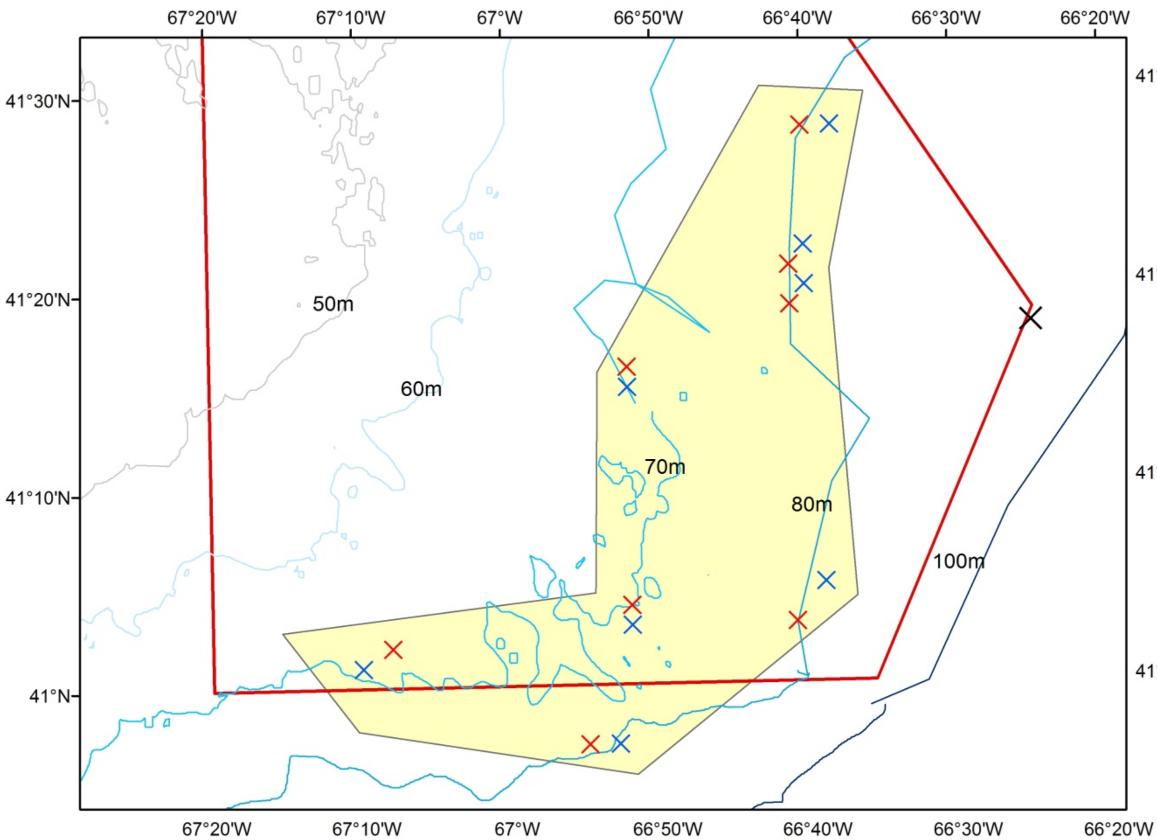


Figure 9. Start and end locations of the eight closed codend tows that were completed during the survey. The polygon shown in yellow was used to calculate the size of the study area, for the area-swept biomass calculation.