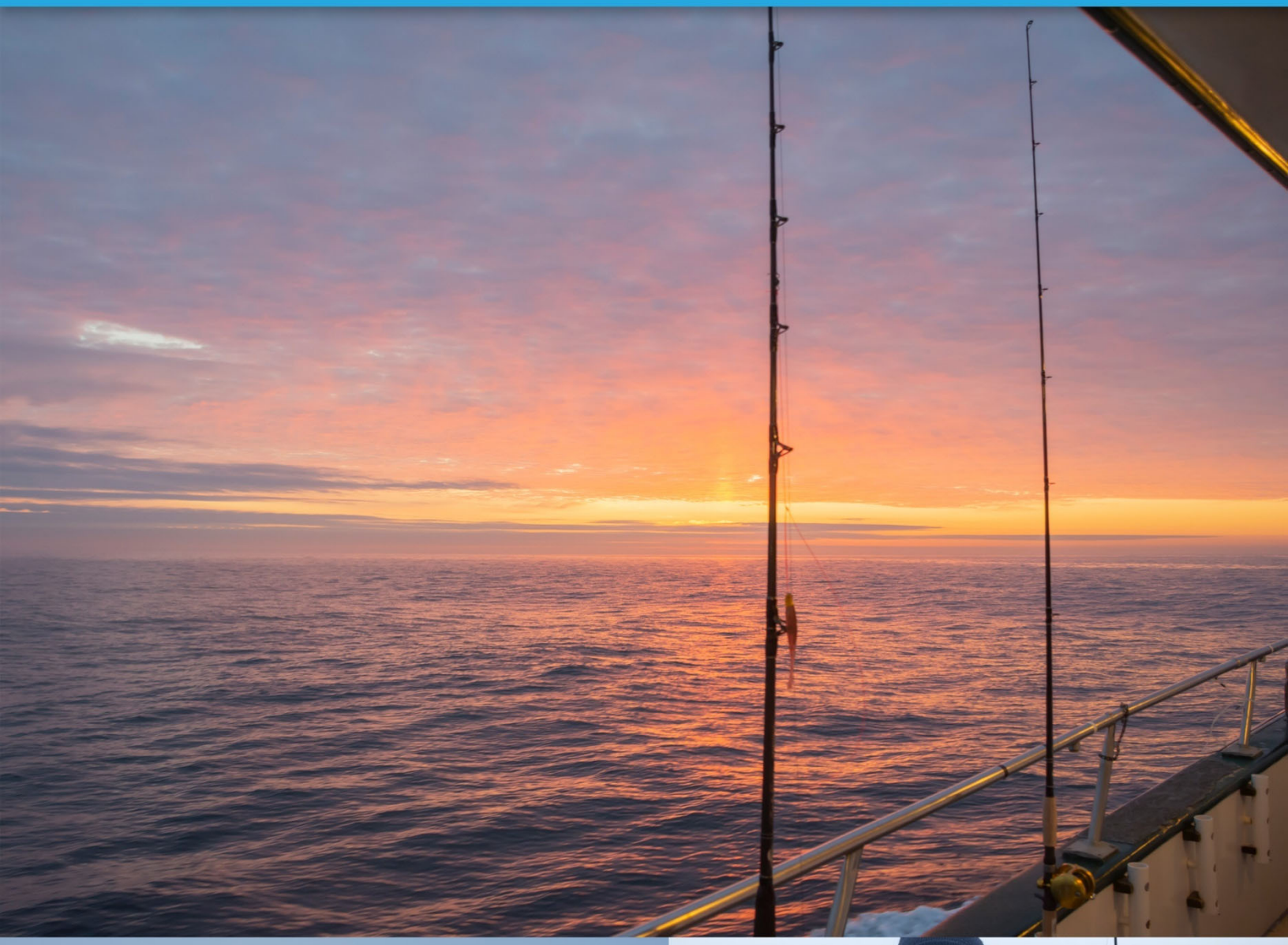
SOUTH FORK WIND FARM

South Fork Wind Farm
Atlantic Cod Spawning Survey



Final Report
January through April 2018

Prepared by
INSPIRE ENVIRONMENTAL

South Fork Wind Farm
Reconnaissance Atlantic Cod Spawning Survey
January - April 2018
Final Report

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April 2019

REVISION HISTORY

Date	Revision	Note	Prepared	Reviewed	Approved
04/03/2019	3	Revised Fig 4-5. Final Distribution	EBF	BG	BG
01/07/2019	2	Revised Final Report	RB	DW	RB
12/07/2018	1	Final Delivery to Client	RB, EBF	RB	DC
05/23/2018	0	Submittal for Client Review	RB, EBF	DW	JB
05/21/2018	0	Internal Review	RB, EBF	DW	RB

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LIST OF ACRONYMS

ARW	Work Area West Survey Grid Cell
ARE	Work Area East Survey Grid Cell
BOEM	Bureau of Ocean Energy Management
COP	Construction and Operations Plan
CPUE	Catch per Unit Effort
DO	Dissolved Oxygen
HSE	Health, Safety, and Environmental [plan]
HSR	Hot Spot Area
NOAA	National Oceanic and Atmospheric Administration
QA/QC	Quality Assurance/Quality Control
REF	Habitat Comparison Area
SFWF	South Fork Wind Farm
TL	Total Length

1.0 INTRODUCTION

INSPIRE Environmental designed and conducted a reconnaissance Atlantic cod (*Gadus morhua*) spawning survey (survey) at the request of Deepwater Wind South Fork LLC. to support the South Fork Wind Farm (SFWF) project (Figure 1-1). The survey was comprised of a hook and line investigation to assess the presence of Atlantic cod spawning activity at the proposed SFWF work area and at nearby designated areas during the winter and spring of 2018. The SFWF work area is a 1000 m buffered region around the proposed wind turbine generator locations, and comprises the area where work, including anchoring, may occur in the region. The hook and line survey assessed site-specific spawning activity of Atlantic cod by determining the maturation stage of collected adult Atlantic cod. Additionally, the survey collected environmental data at each survey location and documented the catch of other fish species present. This final survey report provides the rationale, design, methods, and results of the reconnaissance Atlantic cod spawning survey conducted from January through April 2018.

The survey was designed and conducted in consideration of several federal regulations and guidelines, as well as concerns raised by stakeholders regarding Atlantic cod spawning in the area of the SFWF:

1. Construction and Operations Plan (COP) requirements pursuant to 30 CFR Part 585, specifically:
    - § 585.626 – Provide results of biological surveys with supporting data on fish populations.
    - § 585.627 – Assist BOEM in complying with NEPA and other relevant laws by providing detailed information on fish biological resources.
2. BOEM Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 dated August 13, 2013, specifically;
    - “Identify and confirm the dominant benthic, demersal, and pelagic fish species within the project footprint and surrounding areas.”
    - “Collect additional information aimed at reducing uncertainty associated with existing fish data and/or to help inform the interpretation of survey results.”
    - Produce survey results that identify “seasonal presence/absence of commercially and recreationally important fish and shellfish.”
3. Concerns raised by federal and state regulators as well as the recreational and commercial fishing industry about the potential presence and habitat utilization of spawning Atlantic cod in the SFWF work area.

Data presented in this final survey report are used to characterize Atlantic cod and other marine fish sampled from January to April 2018, prior to permitting or construction of the SFWF. Atlantic cod spawning stage was assessed for all individuals caught at each location. In addition,

environmental conditions including surface and bottom water temperature, salinity, and dissolved oxygen (DO) were collected to allow the investigation of additional mechanisms that may contribute to Atlantic cod presence and spawning activity.

1.1 Survey Goals and Objectives

The reconnaissance Atlantic cod spawning survey aimed to:

- Identify if spawning stage Atlantic cod occur within the SFWF work area and at nearby designated areas.
    - Nearby designated areas included an area of comparable habitat to the SFWF work area, and a 'floating hot spot' area, designated by the fishing vessel captain to maximize Atlantic cod catch.
- Identify and compare areas having relatively high catches of spawning stage Atlantic cod and areas having relatively low, or no spawning stage Atlantic cod.
- Provide descriptive results from this survey.
    - The reconnaissance survey is designed to provide scientifically sound information on cod spawning activity and is not suited to statistical tests of whether spawning cod abundances in the SFWF work area differed significantly from that of nearby designated survey areas.

1.2 Survey Rationale

Atlantic cod is historically an important cultural and commercial species in New England and the population in southern New England has been declining in recent decades. Atlantic cod is believed to be dependent on geographically-specific (on the scale meters to tens of meters) spawning areas. Cod spawning on or near Cox Ledge, are thought to belong to a southern, winter-spawned complex to the south of Cape Cod (Zemeckis et al., 2014a). Cod spawning has been associated with bottom water temperatures that range from 0°C to 10°C (Brander, 1993) and areas of rough bottom habitat (Siceloff and Howell, 2013), such as rocky slopes (Meager et al., 2010) and cobble or boulder outcrops (Dean et al., 2012). Inter-annual spawning site fidelity has been well described through tagging/telemetry studies (Robichaud and Rose, 2001; Skjæraasen et al., 2011; Dean et al., 2014; Zemeckis et al., 2014b). These characteristics emphasize the importance of gathering site-specific information on Atlantic cod spawning near proposed offshore development.

Atlantic cod abundance data are sparse in federal or state databases for the Rhode Island-Massachusetts Wind Energy Area and the Massachusetts Wind Energy Area. This includes areas within and around the SFWF work area. The data that do exist are too sparse in both time and space to conduct meaningful assessments. Much of the data that are available do not include spawning maturation staging, making the identification of spawning grounds impossible. The area in and around the SFWF work area is too rocky to be sampled by bottom trawls, effectively limiting the survey effort in the region by the NEFSC spring and fall trawl surveys. Therefore, the reconnaissance Atlantic cod spawning survey was designed to collect additional

data, using a proven fishing methodology for the habitat and species, to expand our knowledge of the area. Prior studies have used the maturity stage of haddock (*Melanogrammus aeglefinus*) as a proxy for the likelihood of spawning occurring at a location (Burchard et al., 2013, 2014). The reconnaissance Atlantic cod spawning survey provides an initial set of data by which to assess potential spawning in and around the SFWF work area.

Atlantic cod are known to actively feed while in spawning stage (Michalsen et al., 2008; Krumsick and Rose, 2012). Therefore, the use of hook and line methods, including jigging and baited hooks, was considered a prudent sampling methodology. The survey protocol incorporated various elements of recent studies that utilized angling techniques with feather hooks and jigs to capture spawning Atlantic cod (Robichaud and Rose, 2003; Dean et al., 2012; 2014; Hernandez et al., 2013). In general, compared with gill netting, hook and line sampling was viewed by researchers as a safer sampling technique to reduce bycatch and return immature Atlantic cod to the ecosystem.

The survey protocol (INSPIRE, 2018) was distributed to state and federal agencies for review and comment in the fall of 2017. Written and verbal (webinar) comments and edits provided by agency personnel were incorporated into the survey design to the extent practicable.

2.0 METHODS

The proposed sampling methodology is detailed in the INSPIRE South Fork Wind Farm: Atlantic Cod Spawning Survey Protocol (January 2018). Atlantic cod and demersal fisheries resources in the SFWF study area (within the SFWF work area, one reference block, and a 'hot spot' comparison area) were surveyed using a for-hire fishing vessel staffed with scientific research anglers and INSPIRE scientists onboard to process the catch. The sampling took place using standardized methods on a planned weekly basis from January to April 2018.

2.1 Sampling Design

For-hire fishing vessels were chartered for weekly hook and line survey trips from January to April 2018, totaling 15 cruises. Efforts were made to sample during known cod lunar behavioral cycles. Peak Atlantic cod spawning activity has been identified in the semi-lunar cycle to coincide with the spring tide about 0.5-1.6 days after a full or new moon (Grabowski et al. 2015). Atlantic cod also tend to spawn more frequently during the waning phases of the moon with peaks during both spring tides. However, timing of surveys was predominantly determined by prevailing weather conditions. When weather precluded sampling during a week, two survey cruises were planned to be conducted the following week to return to the weekly schedule.

Three standard survey grid regions and one non-standard broad sampling region were sampled per cruise (Figure 2-1). The SFWF work area was split into two sampling grid cells of equal size, an eastern (Work Area East – ARE) and a western area (Work Area West- ARW). A third sampling grid cell (REF) was positioned to the east of the SFWF in an area with generally similar bottom habitat to the SFWF work area as determined by reconnaissance sediment profile and plan view imaging of habitat (INSPIRE, 2018).

A fourth fishing location was sampled on each survey day and these locations were collectively termed 'floating hot spots.' The floating hot spot fishing locations were designated on each survey day in consultation with contracted vessel captains with knowledge of recent cod catch rates in the region. When cod fishing reports were nonexistent due to weather, or poor for the region, historically active cod fishing locations were selected by the captains. The floating hot spot fishing locations were implemented as part of the survey to increase the likelihood of catching adult Atlantic cod (e.g., were Atlantic cod biting anywhere in the region?) on a given sampling day. The floating hot spot fishing area (HSR) was not limited to a constrained grid cell with the same area as the ARE, ARW, and REF blocks. However, fishing in the HSR area was restricted to the same time limitation as the other survey grid cells and to an overall area in the general region of the SFWF (NW – 41.28N, 71.475W, SE – 40.99N, 70.926W, Figure 2-1). Catch and spawning stage data from the 'floating hot spot' grid cell provide information for qualitative comparisons with the SFWF work area. The inclusion of a floating hot spot sampling area also ensured that the survey included dedicated effort in 'fishing how the fishermen fish', in other words, it allowed the captains to fish an area or wreck that they may have fished for trips outside of the survey. Equal sampling effort (time) was applied to each grid location per cruise.

The sampling order of survey grids was determined in consultation with the vessel captain for each cruise and was dependent in part on prevailing weather conditions in consideration of vessel safety through the course of the day. A 'two-stage' survey design was implemented at each respective fishing location (multiple fishing locations could occur within each grid cell on each day). The captain navigated the vessel to an area within the survey grid where fishing was planned to occur. The vessel then conducted an echosounder ('fish finder') survey in an effort to identify aggregations (haystacks) of cod, bait fish, and/or locate a wreck. The echosounder survey was conducted for a summed maximum of 30 minutes per grid cell. When an aggregation or location suitable for fishing was identified the captain determined if anchoring or drifting was the preferable fishing method based on prevailing wind and swell conditions. Each area that was fished was referred to as a sampling station. The total time fishing at all sampling stations within a grid cell sum to 45 minutes per cruise. Scientists onboard recorded the beginning latitude and longitude of each sampling station.

2.2 Angling Methods

Cod were fished with rod and reel using jigs and teasers (jig and teaser of angler choice, ~15" apart, unbaited) and baited hooks (6/O hooks with bottom hook, 10-12" line, sinker, additional 15" of line and a second hook), which were expected to maximize survival for catch and release of small individuals (Nøstvik and Pedersen, 1999; Milliken et al., 2009) and minimize the disruption of cod spawning activity relative to other fishing gears (Morgan et al., 1997; Dean et al., 2012). To standardize fishing effort (to the degree feasible) eight anglers fished at all times. Four rods were fished with jigs and four with bait (clam). Anglers were able to provide their own rod and reel, or, use equipment available on the for-hire vessel.

2.3 Landed Fish

When Atlantic cod were landed the total length (TL cm), weight (g), gear (jig or bait), angler, sex, spawning maturation stage (Table 2-1), and gonad weight were recorded. All fish landed were sacrificed and dissected (Hutchings et al., 1999; Siceloff and Howell, 2013; Dean et al., 2014) to determine maturation stage. Only individuals exceeding the female 20th percentile of maturity by size were planned to be dissected as part of the survey protocol (>28 cm total length for George's Bank females; O'Brien et al., 1993). The maturity stage of each individual dissected was assigned based on guidelines determined by Burnett et al. (1989) and updated by O'Brien et al. (1993): immature, developing, ripe, ripe and running, spent, resting, unknown (Figure 2-1). Photographs of gonads were recorded for all individuals dissected for QA/QC analysis.

When other species of fish (bycatch) were landed their species, length, weight, and catch location were recorded.

2.4 Physical and Oceanographic Conditions

The physical characteristics of each respective survey grid cell were recorded at the first fishing station each day. Data collected included surface and bottom temperature, salinity, and DO concentrations. A YSI 6820 V2 multi parameter sonde coupled with a YSI 650 MDS display

system was used to measure temperature, DO, and salinity. Depth at each echosounder and fishing station location was recorded from the onboard depth sounder. Sea surface conditions were also recorded in each respective survey grid cell including air temperature (°C), wind speed (knots) and direction, and swell height (feet) and direction.

2.5 Data Analysis

The following sections describe the methods used to present and evaluate each of the various types of data collected during the reconnaissance Atlantic cod spawning survey. Summary tables and graphical presentations of the results are used to illustrate the results among the sampling grid cells across the entire survey time period.

2.5.1 Physical and Oceanographic Conditions

Recorded physical and oceanographic conditions are reported tabularly in Appendix A (water quality) and Appendix B (sea state) and graphically in Section 4.0.

2.5.2 Fishing Location Summary

The location, time, and water depth were recorded at the initiation of echosounding at every survey station. These stations are presented tabularly in Appendix C. The location, time, and water depth were recorded at the initiation of fishing at every survey station. Fishing stations are presented graphically in Section 4.0 and tabularly in Appendix D.

2.5.3 Cod Catch and Spawning Stage

Descriptive summaries of locations of landed cod are presented tabularly and graphically in Section 4.0. Descriptive summaries of cod spawning stage by location are presented tabularly and graphically in Section 4.0. Because fishing effort was standardized across all cruises and survey station, no data corrections are needed to correct for catch per unit effort across time or location. All cod and bycatch landing data are presented as number of individuals caught per 45-minute fishing effort.

2.5.4 Bycatch Species

Descriptive summaries of locations of landed bycatch are presented tabularly and graphically in Section 4.0.

2.6 Cruise Summary Reports

Following the completion of each survey cruise, cruise summary reports were created. These reports were distributed to Deepwater Wind and the National Oceanic and Atmospheric Administration (NOAA). Each cruise summary report included information on where fishing occurred, how many cod were caught, and what individuals participated in the survey.

Table 2-1. Maturity Staging Criteria Used During the Northeast Fisheries Science Center Trawl Surveys Used in Determining Atlantic Cod Maturity (from O'Brien et al., 1993)

Stage	Description and Criteria
Female	
Immature	Ovary paired, tube-like, small relative to body cavity; colorless to pink jell-like tissue, no visible eggs; thin transparent outer membrane.
Developing	Ovaries large, occupying up to 2/3 of the body cavity; blood vessels prominent when present; ovary appears granular as yellow to orange yolked eggs develop. A mix of yolked and hydrated eggs.
Ripe	Ovaries large, may fill entire body cavity; hydrated eggs present. Transparent ovary wall.
Ripe and Running	Eggs flow from vent with little or no pressure to abdomen.
Spent	Ovaries flaccid, sac-like similar in size to ripe ovaries; color red to purple; ovary wall thickened, cloudy and translucent; some hydrated eggs may adhere to ovary wall.
Resting	Ovaries smaller than ripe ovaries, but larger than immature. Interior jell-like, no visible eggs.
Male	
Immature	Testes small relative to body cavity, colorless to gray and translucent. Testes narrow, lobed and elongated, resembles crimped ribbon.
Developing	Testes large, grey to off-white, firm consistency with very little or no milt present.
Ripe	Testes larger than 'Developing', chalk white, consistency mostly liquid. Milt flows easily when testes dissected.
Ripe and Running	Chalk white milt flows easily from the vent with little or no pressure on abdomen. Once dissected, milt flows easily.
Spent	Testes flaccid, may contain residual milt, less robust than 'Ripe'. Edges or other parts of testes starting to turn reddish to brown or grey as milt recedes.
Resting	Testes shrunken in size relative to 'Ripe'. Color is yellow, brown or grey with little or no milt.

3.0 QUALITY ASSURANCE AND QUALITY CONTROL

3.1 Vessel Safety

A safety briefing was given to all anglers ('scientific researchers') by the captain or mate regarding vessel safety equipment and protocol. An additional safety briefing regarding health and safety (HSE) while performing the duties of a scientific researcher were given by the INSPIRE chief scientist onboard. HSE literature was available to all scientific researchers onboard (Appendix E). Scientific researchers signed an acknowledgment sheet indicating that they would adhere to the safety procedures set forth by INSPIRE Environmental and Deepwater Wind.

3.2 Angling

The chief scientist provided rigging details to the vessel captain and mates to standardize angling equipment among cruises. The chief scientist, scientist, and mate worked together with the scientific research anglers to ensure that fishing effort was standardized across equipment (four bait and four jig) at all times. When inconsistencies in fishing effort arose, they were immediately corrected.

Photographs were taken of all cod gonads to allow for a second round of review regarding onboard delineations of spawning stage. Photographic evidence was used to correct one spawning stage delineation from the first week of the survey.

3.3 Data Management

INSPIRE Environmental conducted a comprehensive review of all data collected during the weekly cod surveys. Hard copy data sheets were reviewed for data entry errors prior to importing into a relational database. Fish sampling stations were plotted to ensure fishing occurred within designated grid cell boundaries. Fish sampling station locations (lat/long) for every cruise were provided in cruise summary reports.

4.0 RESULTS

4.1 Summary of Survey Sampling Effort

For-hire vessels were chartered out of Pt. Judith, RI (Frances Fleet and Seven B's) and Montauk, NY (Viking Fleet). Twelve cruises originated from Pt. Judith (~25 nautical miles to survey location) and three from Montauk (~38 nautical miles to survey location). Cruise details are provided in Table 4-1.

4.2 Physical and Oceanographic Conditions

The reconnaissance Atlantic cod spawning survey was conducted from the second week of January (1/10/2018) until the final week of April (4/29/2018). During the study period the water column was well-mixed at and near Cox Ledge with similar water temperatures and DO values found in both surface and bottom waters (Figures 4-1 and 4-2). Surface water temperatures ranged from 2.8°C (37.0°F) to 8.0°C (46.4°F) with a mean of 5.0°C (41.0°F). Bottom water temperatures ranged from 2.8°C (37.0°F) to 6.6°C (43.9°F) with a mean of 4.8°C (40.6°F), nearly identical to surface water temperatures. Surface DO ranged from 7.4 mg/L to 11.1 mg/L with a mean of 9.7 mg/L. Bottom DO ranged from 7.2 mg/L to 10.9 mg/L with a mean of 9.5 mg/L; values nearly identical to the surface DO conditions.

The sea state on survey days was frequently calm, characterized by small swells and light winds. Relatively calm sea conditions were required for vessel and scientific researcher safety during the survey. Mean wind speed during surveys was 4 knots (7 ft/s) with a maximum sustained wind speed of 12 knots (20 ft/s). Mean swell height during surveys was 0.3 m (2 feet) with a maximum swell of approximately 1.5 m (5 feet). The mean air temperature during surveys was 3.5°C (38.3°F) with a minimum air temperature of -7°C (19.4°F) and a maximum of 14°C (57.2°F). Recorded physical and oceanographic conditions are reported tabularly in Appendix A (water quality) and Appendix B (sea state).

4.3 Fishing Location Summary

All locations fished as part of the survey are shown in Figure 4-3. Fishing was concentrated on known wrecks and reefs in the region as well as at areas of relatively rapid changes in bottom elevation (slopes). There were several NOAA plotted wrecks within the ARE and ARW blocks that were frequently targeted. High slope areas were the primary targets in the REF block, where there are no confirmed wreck locations. HSR fishing locations were informed by the captain's knowledge of the area and of cod fishing, as well as reports from other active vessels (Figure 4-4). The HSR fishing locations were primarily clustered to the south and southwest of the ARW block. One particular HSR fishing station located to the southwest of the ARW block was targeted much more frequently than other locations. A large Atlantic cod spawning aggregation occurred at this location for several weeks in January and early February, evidenced visually on the echosounder, high cod catches at this location, cod spawning stage, and many private and for-hire vessels fishing the location. During the third cruise (18-03 on 1/22/2018) five (5) 50+ ft for-hire vessels, several 'six-pack' for-hire vessels, and at least eight (8) private vessels were simultaneously present and actively catching large numbers of cod at

this location. This cod aggregation persisted for several weeks until the catch reduced quickly at the end of January. The aggregation was still clearly visible on echosounders for several weeks into early February, but no fish were caught at this location during this time.

Lower effort was fished at HSR locations to the north and west-northwest of the ARW block compared with areas south and southwest of the ARW block. Only a single HSR fishing location occurred east of the SFWF work area. The starting latitude and longitude, time, and depth where echosounding occurred prior to fishing is presented in Appendix C. The starting latitude and longitude, time, and depth where fishing occurred is presented in Appendix D.

4.4 Cod Catch and Spawning Stage

A total of 17 Atlantic cod were caught during the survey, with collections occurring in all months from January through April. The majority (59%) of cod collected were males. Among the seven females collected, four were immature. The relationship between length and weight (Le Cren, 1951; Jakob et al., 1996), was related to spawning status for males (Figure 4-5), with longer, heavier fish in either a ripe and running or spent state. For females, individual length-weight was not related to spawning status, i.e., developing and spent individuals were similar in size to immature fish (Figure 4-5). Cod catch by cruise, and station (Table 4-2) and summarized by area and spawning stage (Table 4-3) are presented tabularly. The locations of all cod caught are shown in Figure 4-6. The locations of all cod caught in a spawning stage (ripe, ripe and running, or spent) are shown in Figure 4-7. The most cod were caught at HSR fishing locations (10) with 5 cod caught in a spawning stage (ripe, ripe and running, or spent). Four (4) cod were caught in the ARW block with three (3) in spawning stage and three (3) cod were caught in the ARE block with two (2) in spawning stage. No cod were caught in the REF block. Example images of cod ovaries in immature, ripe and running, and spent stages are shown in Figure 4-8.

4.5 Bycatch Species

Seven (7) bycatch species were landed during the survey. Cunner (*Tautogolabrus adspersus*) was the most commonly caught species and accounted for 74% of the total bycatch by number. Atlantic mackerel were the second most commonly caught species and accounted for 9% of the total bycatch by number. Bycatch summarized by survey block is summarized in Table 4-4. The locations of all fishing locations where bycatch was landed are presented in Figure 4-9.

4.6 Health and Safety

No safety incidents, near misses, or injuries were reported on any cruise during the survey.

Table 4-1. Cruise Details for Atlantic Cod Spawning Survey

Cruise ID	Date	Port	Vessel	Captain	Mate
18-01	1/10/2018	Pt. Judith, RI	Seven B's V	Andy D'Angelo	Lucas Berg
18-02	1/16/2018	Pt. Judith, RI	Seven B's V	Andy D'Angelo	Lucas Berg
18-03	1/22/2018	Pt. Judith, RI	Gail Frances	Mike O'Grady	Greg Hamilton
18-04	1/31/2018	Pt. Judith, RI	Gail Frances	Mike O'Grady	Greg Hamilton
18-05	2/6/2018	Pt. Judith, RI	Seven B's V	Andy D'Angelo	Lucas Berg
18-06	2/14/2018	Pt. Judith, RI	Gail Frances	Mike O'Grady	Greg Hamilton
18-07	2/19/2018	Pt. Judith, RI	Seven B's V	Andy D'Angelo	Lucas Berg
18-08	2/26/2018	Pt. Judith, RI	Lady Frances	Mike O'Grady	Matthew Cox
18-09	3/11/2018	Montauk, NY	Viking Fivestar	Steven Forsberg	Brian Priest
18-10	3/19/2018	Montauk, NY	Viking Fivestar	Steven Forsberg	Brian Priest
18-11	3/29/2018	Pt. Judith, RI	Seven B's V	Andy D'Angelo	Lucas Berg
18-12	4/2/2018	Montauk, NY	Viking Star	Anonymous	Kevin Logie
18-13	4/11/2018	Pt. Judith, RI	Lady Frances	Mike O'Grady	Matthew Cox
18-14	4/24/2018	Pt. Judith, RI	Lady Frances	Mike O'Grady	Matthew Cox
18-15	4/29/2018	Pt. Judith, RI	Seven B's V	Russell Benn	Lucas Berg

Table 4-2. Summary Detail of Atlantic Cod Caught During Survey by Cruise and Station ID

Cruise ID	Station ID	Location ID	Weight (kg)	Total Length (cm)	Sex	Spawning Stage
18-01	HSR	01	1.20	48.4	F	Developing
18-02	HSR	03	1.04	50.0	F	Immature
18-03	HSR	01	2.76	65.0	F	Ripe
18-03	HSR	02	3.30	67.0	M	Spent
18-03	HSR	04	3.44	67.0	M	Spent
18-04	HSR	01	1.62	54.5	F	Immature
18-04	HSR	02	1.94	60.0	M	Ripe and Running
18-04	HSR	02	3.60	71.0	M	Ripe and Running
18-10	ARE	01	1.13	48.0	F	Immature
18-10	ARE	01	1.79	59.0	M	Ripe and Running
18-10	ARE	01	2.00	60.0	M	Spent
18-10	ARW	02	1.41	55.0	M	Ripe
18-13	ARW	02	0.99	46.5	M	Immature
18-14	HSR	02	0.85	45.5	M	Immature
18-14	HSR	02	0.87	45.0	F	Immature
18-15	ARW	01	2.10	60.0	M	Ripe and Running
18-15	ARW	01	1.02	48.0	F	Spent

Table 4-3. Summary Detail of Atlantic Cod Caught During Survey by Station ID and Maturity Stage

	Station ID			
	ARE	**ARW**	**REF**	**HSR**
All Cod	3	4	0	10
Immature	1	1	0	4
Developing	0	0	0	1
Ripe	0	1	0	1
Ripe and Running	1	1	0	2
Spent	1	1	0	2
Resting	0	0	0	0

Table 4-4. Summary Detail of Bycatch Species by Station ID

Common Name	Scientific Name	Station ID				
		ARE	ARW	REF	HSR	Total
Atlantic herring	*Clupea harengus*	0	0	2	0	2
Atlantic mackerel	*Scomber scombrus*	1	0	0	7	8
Cunner	*Tautogolabrus adspersus*	20	21	1	25	66
Little skate	*Leucoraja erinacea*	3	1	1	0	5
Longhorn sculpin	*Myoxocephalus octodecemspinosus*	2	1	1	2	6
Ocean pout	*Zoarces americanus*	0	0	0	1	1
Winter skate	*Leucoraja ocellata*	0	0	0	1	1
Total # of Bycatch Species Individuals Caught		26	23	5	36	89

5.0 SUMMARY

The reconnaissance Atlantic cod spawning survey was designed and conducted to provide qualitative descriptions of Atlantic cod spawning locations, if they existed, in and around the SFWF work area during the winter and spring of 2018. One large cod spawning aggregation was identified outside the SFWF work area in the region southwest of the ARW block. This aggregation was documented through three clear lines of evidence; echosounder identification, the number and spawning stage of landed cod during the survey, and from the physical presence and fishing reports of other for-hire and recreational anglers at the location. After several days of high catch rates at this aggregation, fishing slowed and fewer fish were landed until the location was no longer targeted as an Atlantic cod fishing location. However, it should be noted that while the catch declined greatly at this spawning location in early February, the cod 'haystack' remained clearly visible at the location indicating that the cod were still present, but were no longer feeding. As no fish were landed at this location after early February (when the aggregation was still present), it is unknown if the cod continued to spawn at this location, or if the majority of individuals had progressed to the 'spent' spawning stage. The drop off in catch, but continued presence of the aggregation was confirmed by several other vessel captains during this time period. Though this is only a single data point, it suggests limitations in the effectiveness of rod and reel sampling across the complete Atlantic cod spawning cycle.

As demonstrated by this study and reported by for-hire fishing captains, the winter of 2018 was not a productive Atlantic cod fishing season in southern New England waters. In total only seventeen (17) Atlantic cod were caught as part of this survey. Only one large Atlantic cod spawning aggregation was located and fished in an area southwest of the ARW block. This location produced the greatest number of spawning stage cod in this study. Spawning stage cod were also caught in the ARW and ARE blocks, though no large spawning aggregations were identified through echosounder or catch rates.

For-hire fishing vessels equipped with modern fish finder technology and captained by knowledgeable anglers are an excellent way to locate Atlantic cod spawning locations. By being a part of a large fishing community, captains are able to effectively 'crowd source' information about where large aggregations of fish may be located. As spawning Atlantic cod remain in a single point location, identifying these areas is straightforward. When cod spawning aggregations are large, echosounders provide a clear image of where, and how large the aggregation is. For-hire fishing vessels, like those used in this survey, provide an adequate amount of room for eight or more anglers to fish at the same time. Having more hooks in the water at the same time greatly increases the likelihood of catch at a location and should be a priority for any hook and line survey.

A drawback of using large for-hire fishing vessels is vessel speed. Due to the limitations in vessel speed it is difficult to both cover a large area attempting to locate aggregations of cod with an echosounder, and/or fish numerous locations during a standard 12-hour survey day. When attempting to cover a large area and identify relatively small, spatially explicit cod spawning aggregations, vessel speed can be a major limitation. A smaller, faster fishing vessel

would provide a greater opportunity to cover a larger area, but would limit the number of potential anglers contributing to the survey (and therefore reduce potential catch once aggregations are identified).

Gill nets provide another possible gear type for the collection of spawning cod from rocky benthic habitats. Gill netting would provide direct tradeoffs with a hook and line survey: catch would most likely be increased at identified cod aggregations, while the total number of locations fished would be decreased.

The reconnaissance Atlantic cod spawning survey confirmed the presence of spawning cod in and around the SFWF work area, though no spawning aggregation ‘haystacks’ were identified within the work area as part of this reconnaissance survey. One large spawning aggregation was located southwest of the ARW block and no large spawning aggregations were identified within the SFWF work area. The hook and line survey was proven to a be a successful methodology for identifying Atlantic cod spawning aggregations and collecting spawning cod.

6.0 ACKNOWLEDGEMENTS

INSPIRE Environmental is grateful to the for-hire vessels, captains, mates, and anglers who participated in this survey. This survey would not have been possible without their expertise, participation, and positive attitudes. Special thanks to the vessel owners and captains who helped to inform the survey design and methods. Participating anglers are listed in Appendix F.

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South Fork Wind Farm

Reconnaissance Atlantic Cod Spawning Survey

January - April 2018

Final Report

FIGURES

Prepared for:

SOUTH FORK WIND FARM

Deepwater Wind South Fork, LLC

Prepared by:

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Brian Gervelis
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April 2019

LIST OF FIGURES

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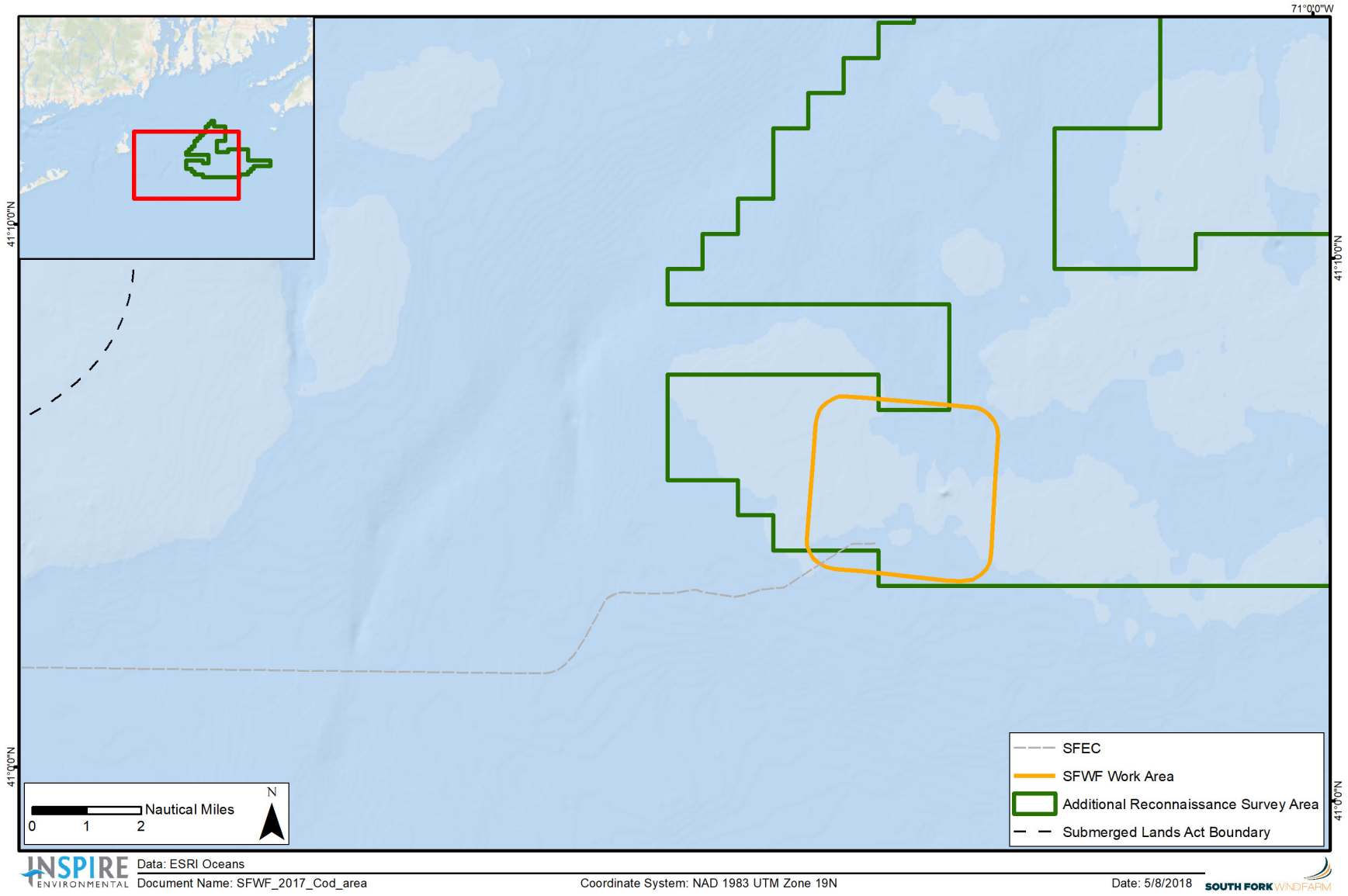


Figure 1-1. Location of the SFWF work area

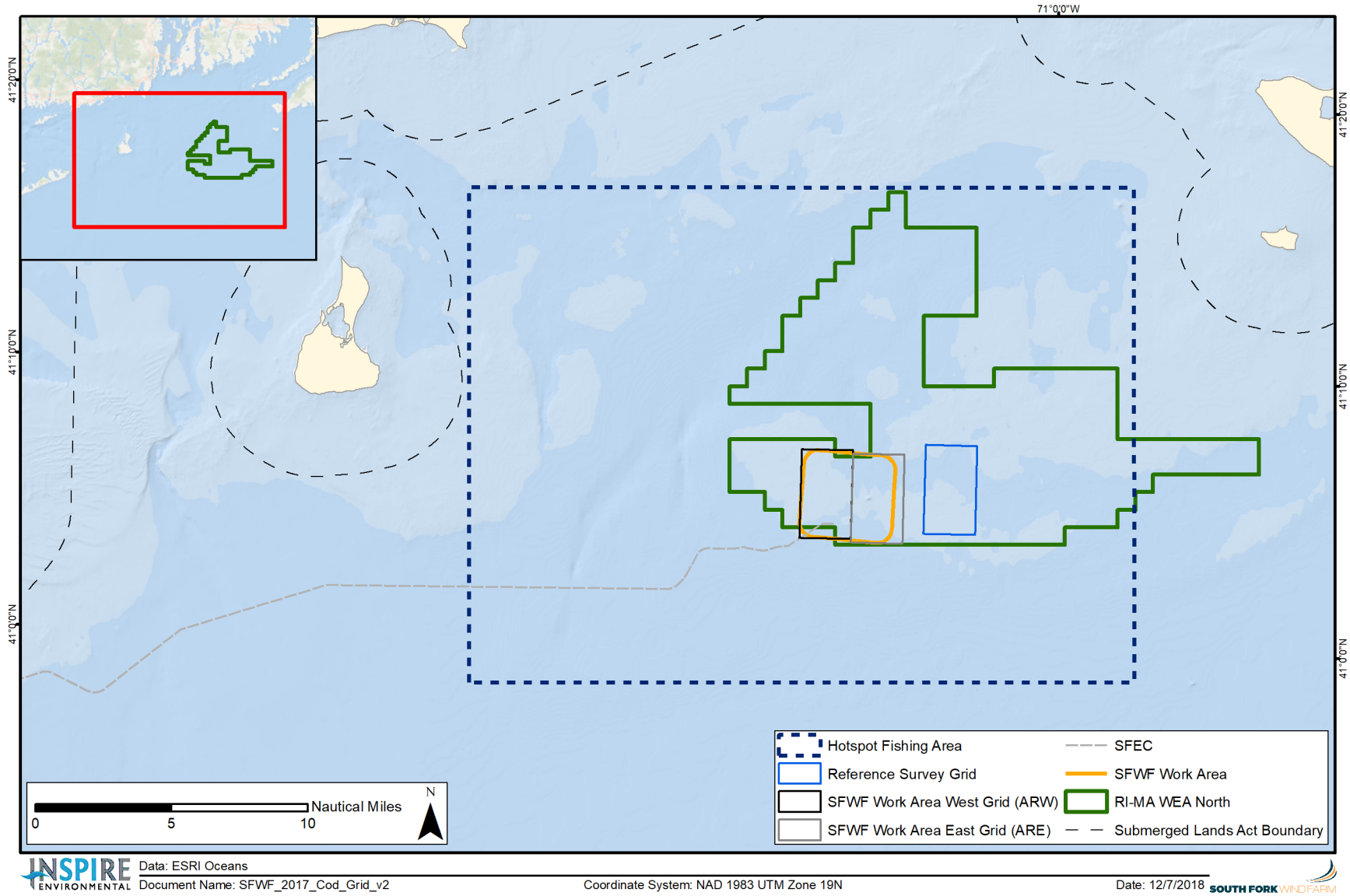


Figure 2-1. Reconnaissance Atlantic cod spawning survey grid locations

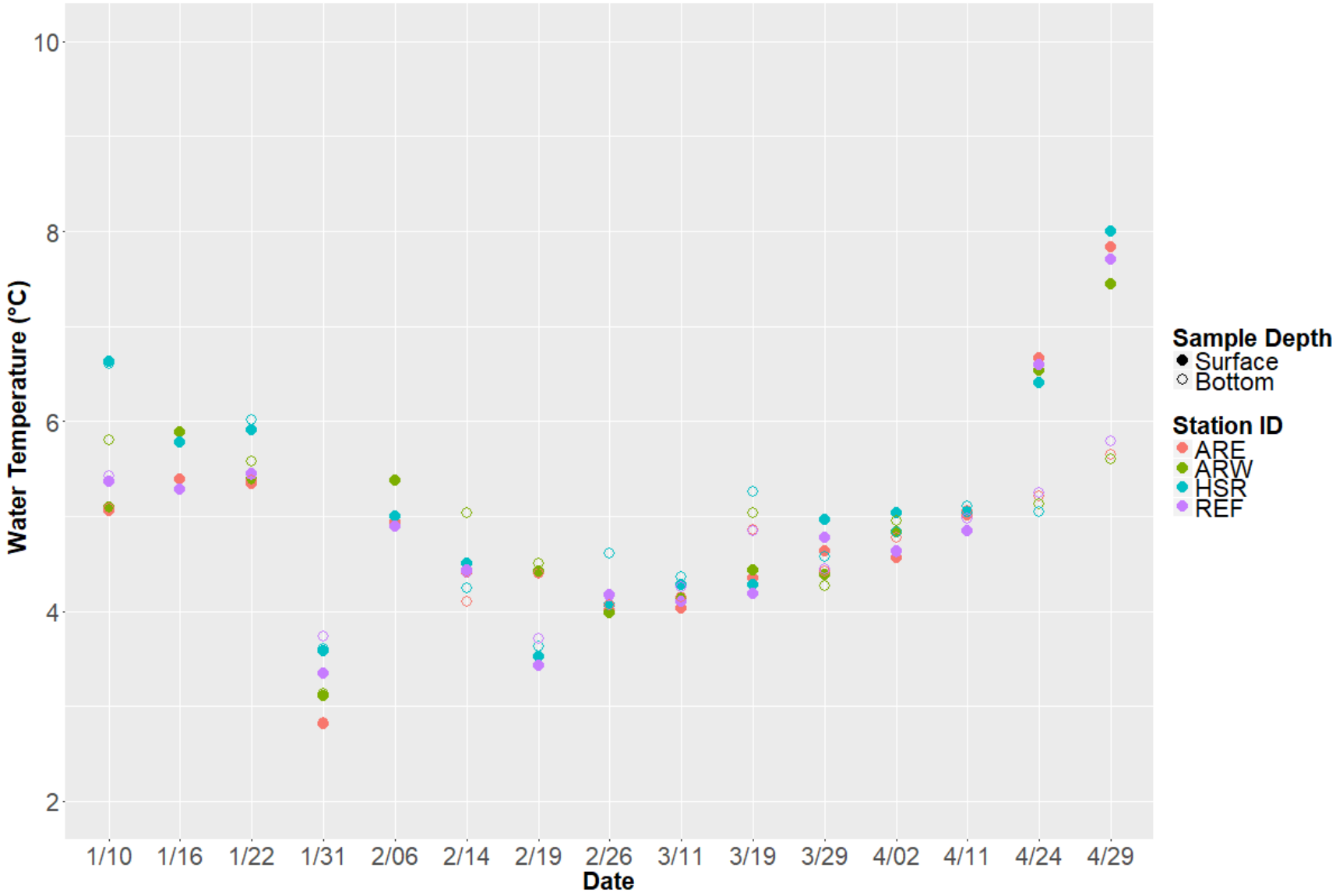


Figure 4-1. Surface and bottom water temperatures across the survey

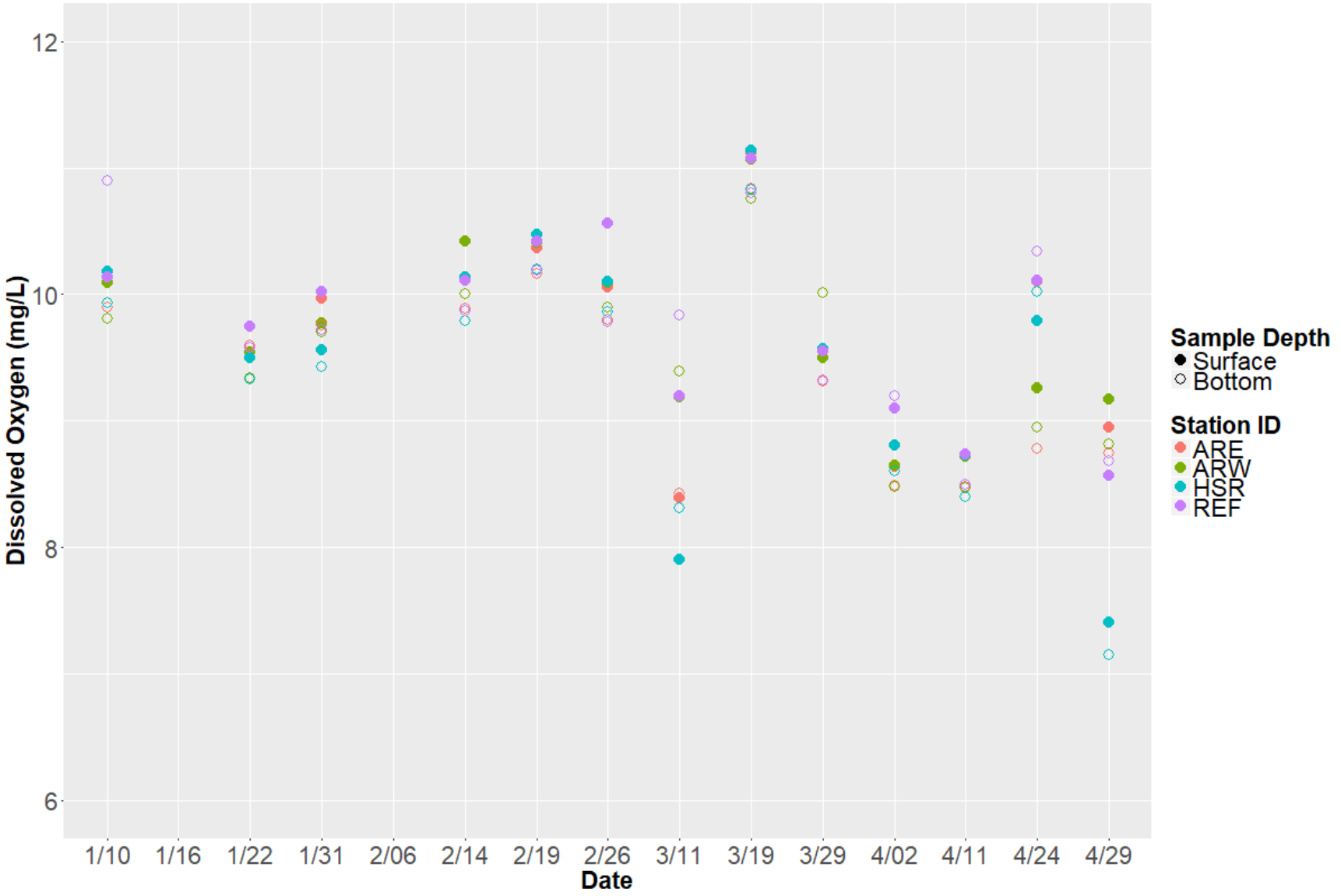


Figure 4-2. Surface and bottom dissolved oxygen conditions measured across the survey

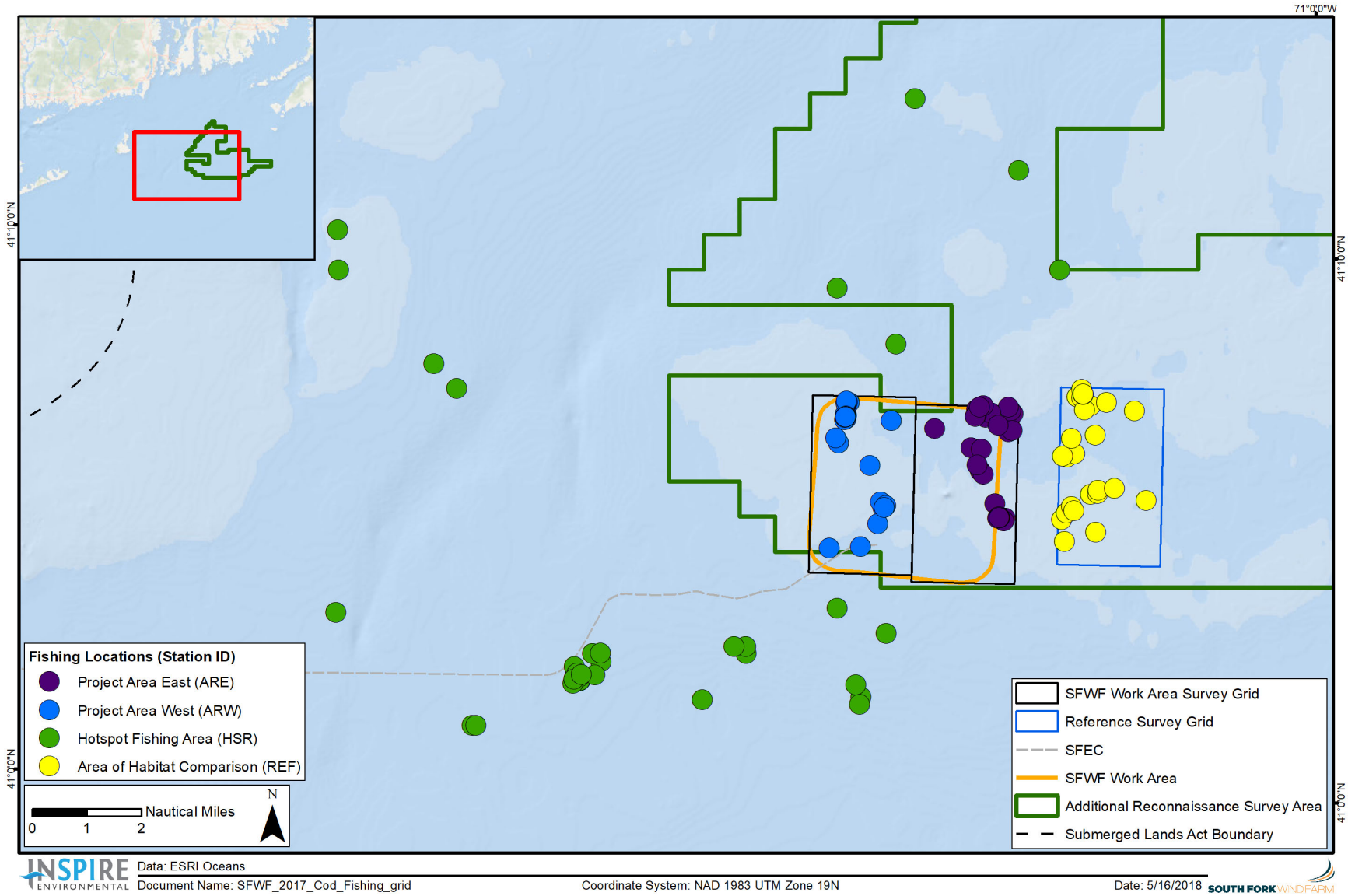


Figure 4-3. Starting location of all fishing survey stations that occurred throughout the reconnaissance Atlantic cod spawning survey

Figure 4-4. Example image of fishing near another for-hire vessel at an HSR fishing location

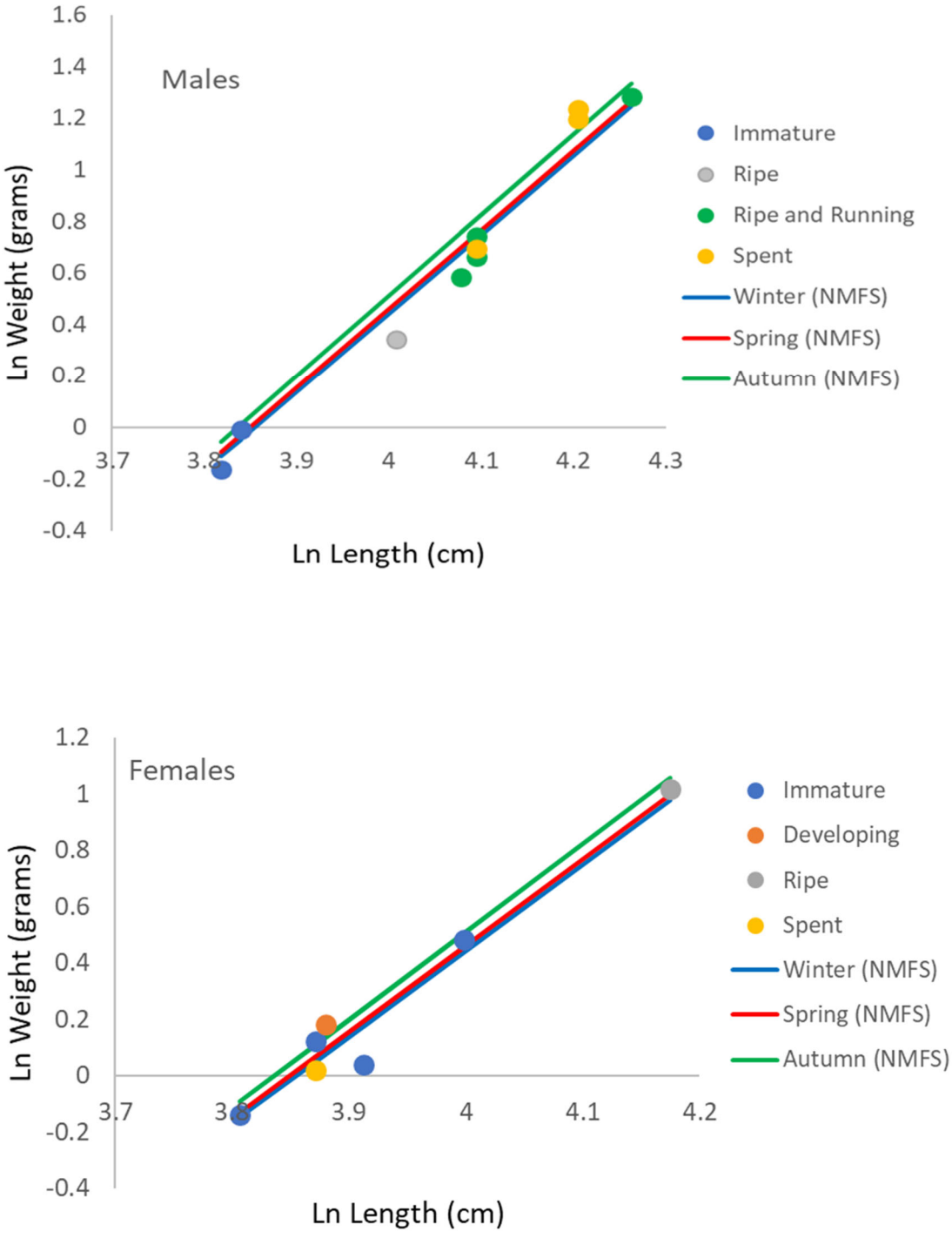


Figure 4-5. Condition of male and female Atlantic cod plotted by spawning status as the log-log relationship of weight (grams) to length (cm). Length-weight relationships for cod derived from NMFS NEFSC bottom trawl survey data plotted for reference from Wigley et. al 2003.

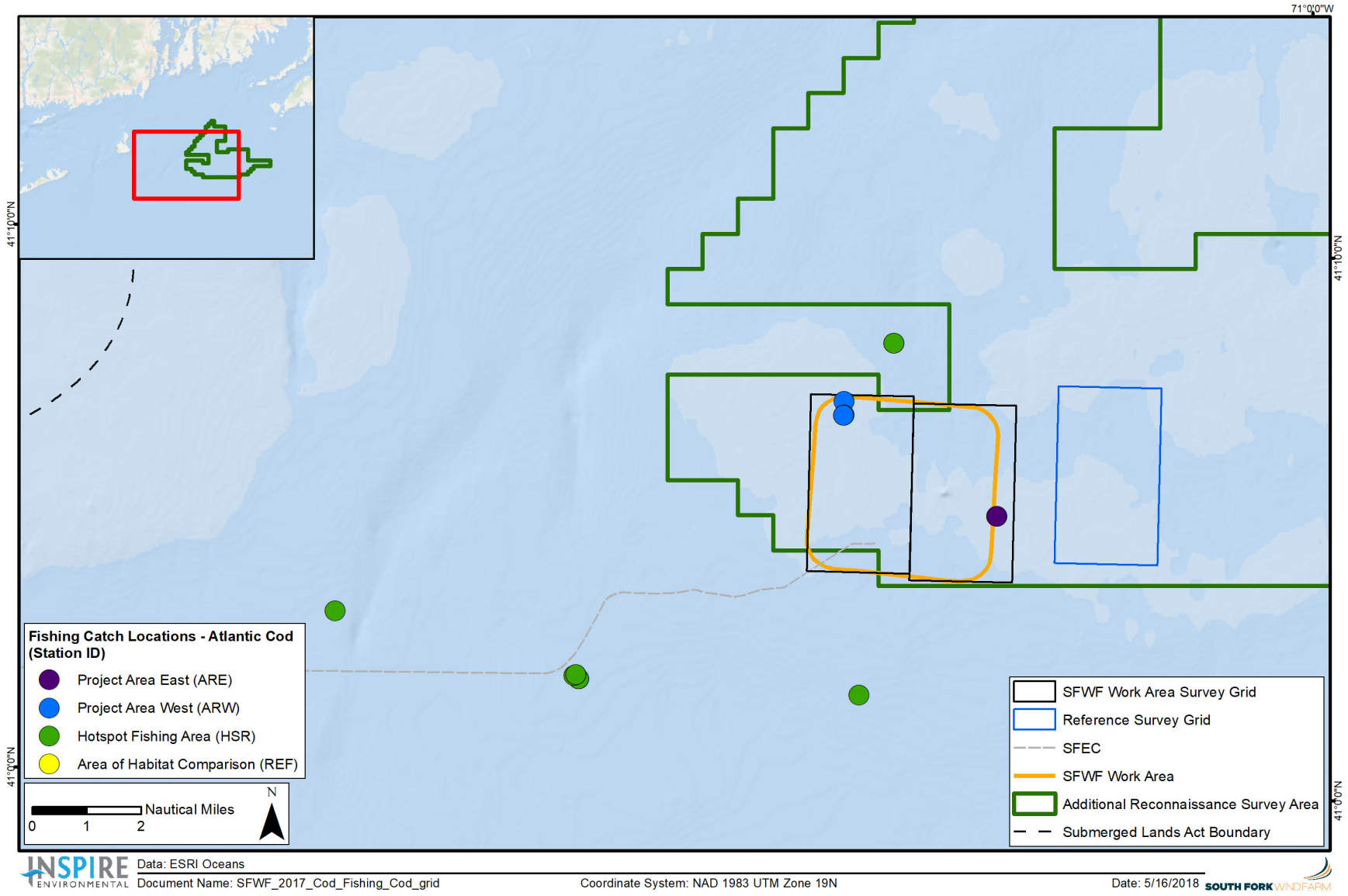


Figure 4-6. Start fishing location where Atlantic cod were caught during survey

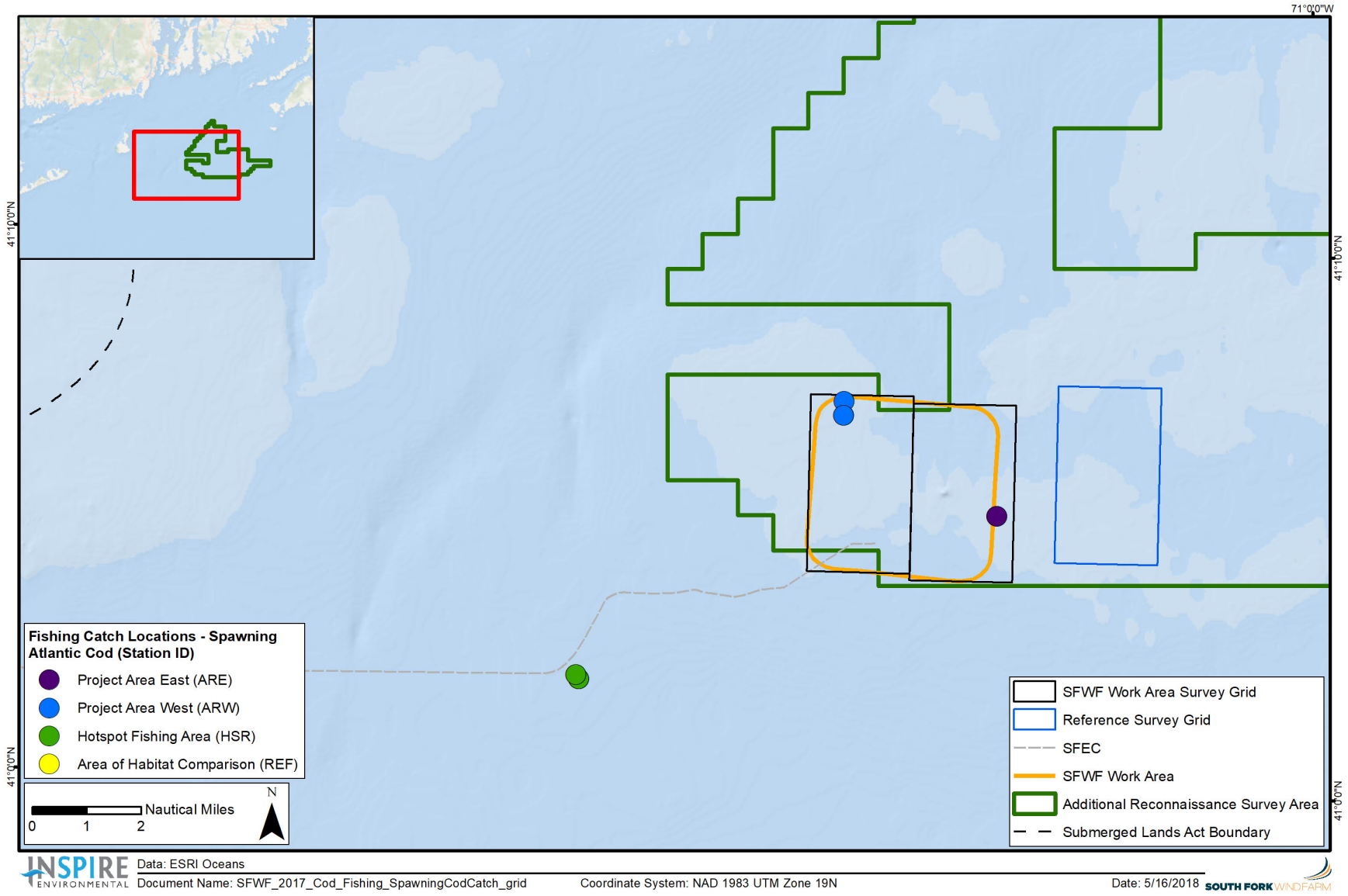
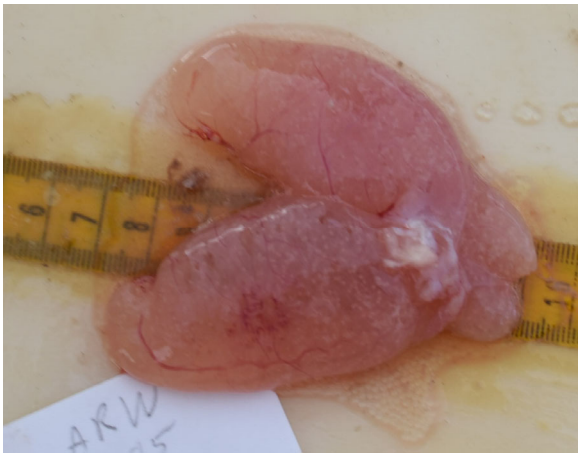


Figure 4-7. Start fishing location where ripe, ripe and running, and/or spent Atlantic cod were caught during survey

Immature

Ripe and Running



Spent

Figure 4-8. Example images of ovaries collected during the reconnaissance Atlantic cod spawning survey: immature (top), ripe and running (middle), and spent (bottom)

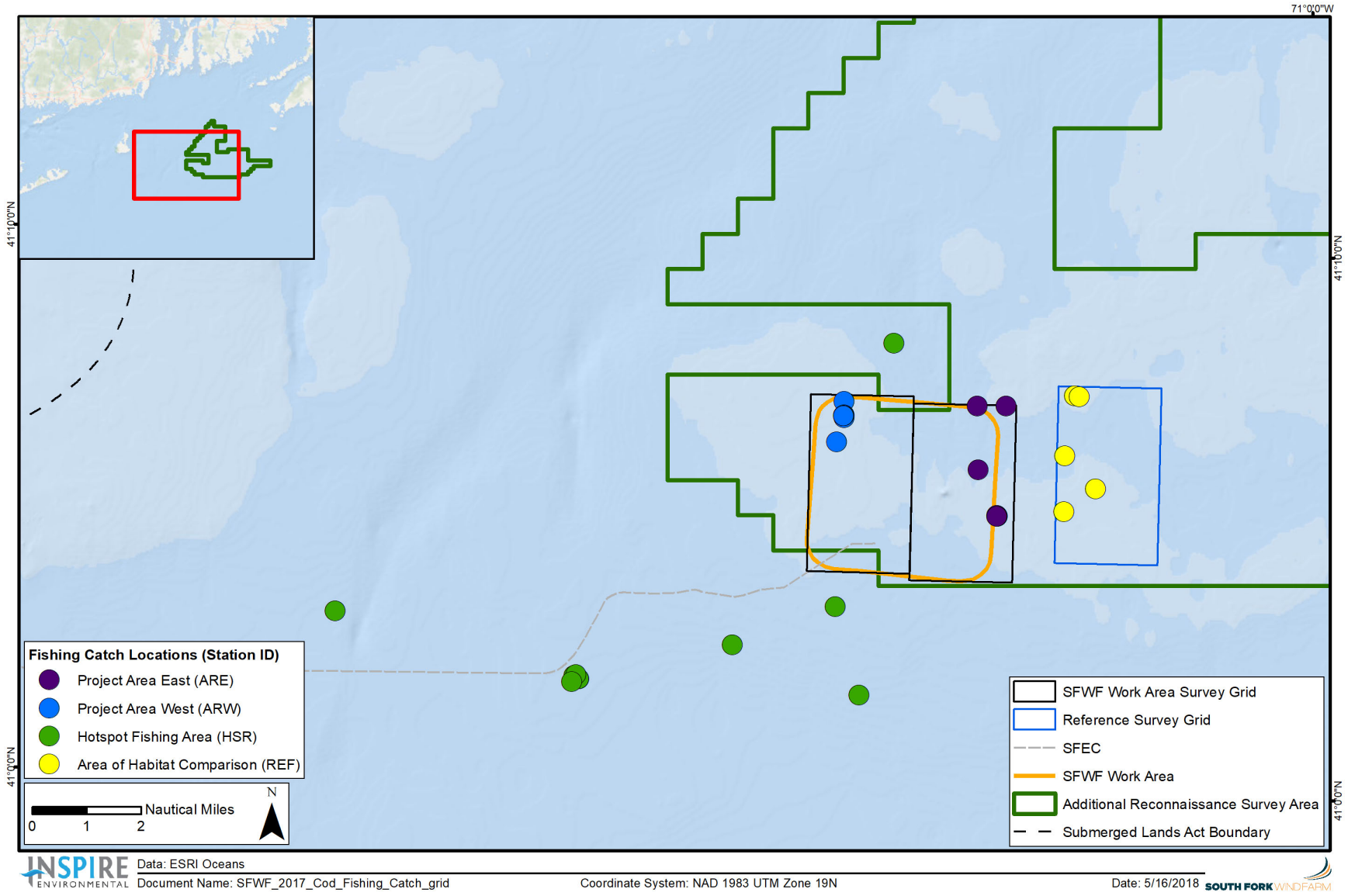


Figure 4-9. Start fishing location where fish (bycatch) were caught during survey

South Fork Wind Farm

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APPENDICES

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Appendix A: Water Quality

Cruise ID	Station ID	Surface Temperature (°C)	Bottom Temperature (°C)	Surface Dissolved Oxygen (mg/L)	Bottom Dissolved Oxygen (mg/L)
18-01	ARE	5.06	5.08	10.18	9.90
18-01	ARW	5.09	5.80	10.09	9.81
18-01	HSR	6.63	6.61	10.18	9.93
18-01	REF	5.36	5.42	10.14	10.90
18-02	ARE	5.39	-	-	-
18-02	ARW	5.89	-	-	-
18-02	HSR	5.78	-	-	-
18-02	REF	5.28	-	-	-
18-03	ARE	5.34	5.38	9.75	9.60
18-03	ARW	5.39	5.58	9.54	9.34
18-03	HSR	5.91	6.02	9.50	9.33
18-03	REF	5.45	5.44	9.75	9.58
18-04	ARE	2.81	2.82	9.97	9.76
18-04	ARW	3.11	3.13	9.77	9.70
18-04	HSR	3.58	3.60	9.56	9.43
18-04	REF	3.34	3.73	10.02	9.72
18-05	ARE	4.94	-	-	-
18-05	ARW	5.38	-	-	-
18-05	HSR	5.00	-	-	-
18-05	REF	4.89	-	-	-
18-06	ARE	4.41	4.10	10.12	9.89
18-06	ARW	4.50	5.03	10.42	10.00
18-06	HSR	4.50	4.24	10.14	9.79
18-06	REF	4.43	4.41	10.11	9.87
18-07	ARE	4.41	4.40	10.37	10.16
18-07	ARW	4.42	4.50	10.41	10.19
18-07	HSR	3.52	3.63	10.47	10.20
18-07	REF	3.43	3.71	10.42	10.19
18-08	ARE	4.01	4.06	10.06	9.80
18-08	ARW	3.98	4.16	10.09	9.90
18-08	HSR	4.07	4.61	10.10	9.86
18-08	REF	4.17	4.16	10.56	9.78
18-09	ARE	4.03	4.15	8.39	8.43
18-09	ARW	4.14	4.36	9.19	9.39
18-09	HSR	4.28	4.36	7.90	8.31
18-09	REF	4.10	4.25	9.20	9.84
18-10	ARE	4.35	4.86	11.12	10.84
18-10	ARW	4.43	5.03	11.07	10.76
18-10	HSR	4.28	5.26	11.14	10.83
18-10	REF	4.18	4.84	11.08	10.80
18-11	ARE	4.63	4.42	9.55	9.31
18-11	ARW	4.38	4.27	9.50	10.01
18-11	HSR	4.96	4.57	9.57	9.32
18-11	REF	4.77	4.44	9.55	9.32
18-12	ARE	4.56	4.78	8.64	8.49
18-12	ARW	4.83	4.95	8.65	8.48

Cruise ID	Station ID	Surface Temperature (°C)	Bottom Temperature (°C)	Surface Dissolved Oxygen (mg/L)	Bottom Dissolved Oxygen (mg/L)
18-12	HSR	5.03	4.83	8.81	8.60
18-12	REF	4.63	4.62	9.10	9.20
18-13	ARE	5.01	5.06	8.72	8.48
18-13	ARW	5.05	5.10	8.72	8.47
18-13	HSR	5.05	5.10	8.73	8.40
18-13	REF	4.85	4.98	8.74	8.50
18-14	ARE	6.66	5.21	10.10	8.78
18-14	ARW	6.54	5.13	9.26	8.95
18-14	HSR	6.40	5.05	9.79	10.02
18-14	REF	6.60	5.25	10.11	10.34
18-15	ARE	7.84	5.65	8.95	8.75
18-15	ARW	7.45	5.60	9.17	8.82
18-15	HSR	8.00	5.79	7.41	7.15
18-15	REF	7.71	5.79	8.57	8.68

Hyphen indicates that there was an issue with the YSI multi parameter sonde and values were not collected on the cruise. On these days surface temperatures were measured by on-vessel thermometers.

Appendix B: Sea State

Cruise ID	Station ID	Wind Speed (knots)	Wind Direction	Air Temperature (°C)	Swell Height (feet)	Swell Direction
18-01	ARE	2-3	NE	2	2-3	NE
18-01	ARW	3	NE	1	2-3	NE
18-01	HSR	2-3	NE	4	1-2	NE
18-01	REF	2-3	NE	3	1-2	NE
18-02	ARE	4	S	5	2-3	S
18-02	ARW	3	SW	5	2-3	S
18-02	HSR	5	SW	1	3-4	S
18-02	REF	2-3	S	5	2-3	S
18-03	ARE	2-3	SE	5	2-3	SE
18-03	ARW	2-3	SE	5	1-2	SE
18-03	HSR	2-3	SE	6	1-2	SE
18-03	REF	2-4	SE	5	2	SE
18-04	ARE	9	NW	0	3-4	S
18-04	ARW	10	NW	-4	3-4	SW
18-04	HSR	10	NW	-7	4-5	SW
18-04	REF	7	W	0	3-4	S
18-05	ARE	3	S	2	2-3	S
18-05	ARW	4	SW	0	3-4	SSW
18-05	HSR	2	SW	3	2-3	S
18-05	REF	5	S	2	2-3	S
18-06	ARE	3-4	SW	3	2-3	S
18-06	ARW	2-3	SW	3	2-3	S
18-06	HSR	6	S	3	2-3	S
18-06	REF	3-4	SW	3	2-3	S
18-07	ARE	8-10	S	3	2-3	S
18-07	ARW	8-10	S	2	2-3	S
18-07	HSR	5-10	S	7	2-3	S
18-07	REF	10	S	5	2-3	S
18-08	ARE	2-3	NE	4	2-3	S
18-08	ARW	2-4	NE	4	2-3	S
18-08	HSR	4-5	N	6	2-3	S
18-08	REF	2-3	N	3	2-3	SW
18-09	ARE	10	W	5	3-4	SW
18-09	ARW	10-12	W	3	3-4	SW
18-09	HSR	5-6	NW	6	3-4	SW
18-09	REF	6-9	W	6	3-4	W
18-10	ARE	6-7	NE	1	3-4	NE
18-10	ARW	8-10	NE	0	3-4	NE
18-10	HSR	6-7	NE	3	3-4	NE
18-10	REF	6-7	NE	1	3-4	NE
18-11	ARE	2-3	W	6	2-3	W
18-11	ARW	2-3	W	4	1-3	W
18-11	HSR	0-3	SW	8	1-3	SE
18-11	REF	2-3	W	4	2-3	SE
18-12	ARE	5-6	NNE	1	1-2	NE
18-12	ARW	4-5	NNE	3	1-2	NE

Cruise ID	Station ID	Wind Speed (knots)	Wind Direction	Air Temperature (°C)	Swell Height (feet)	Swell Direction
18-12	HSR	3-4	NE	3	1-2	NE
18-12	REF	8	NNE	0	3-4	NE
18-13	ARE	2-3	N	4	1-2	S
18-13	ARW	2-3	N	2	1-2	SE
18-13	HSR	1-2	NNE	0	1	SE
18-13	REF	2-3	N	4	1-2	SW
18-14	ARE	4-5	SE	6	0-1	SE
18-14	ARW	6-7	S	8	0-1	SE
18-14	HSR	3-4	S	2	0-1	SE
18-14	REF	4-5	S	3	0-1	SE
18-15	ARE	5-6	SW	10	2-3	SE
18-15	ARW	3-4	WNW	8	2-3	SE
18-15	HSR	2-3	NW	14	2-3	SE
18-15	REF	4-5	SW	12	1-2	SE

Appendix C: Echosounder Locations

Cruise ID	Station ID	Location ID	Start Time	End Time	Latitude (N) NAD1983	Start Longitude (W) NAD1983	Start Depth (Ft)
18-01	ARW	01	7:25	7:25	41.11	71.19	106
18-01	ARW	02	7:50	7:50	41.11	71.19	107
18-01	ARW	03	8:16	8:16	41.11	71.19	108
18-01	ARE	01	8:55	8:55	41.12	71.12	112
18-01	ARE	02	9:13	9:13	41.12	71.12	110
18-01	ARE	03	9:35	9:35	41.12	71.12	110
18-01	REF	01	10:04	10:04	41.12	71.09	113
18-01	HSR	01	11:30	11:30	41.03	71.18	133
18-02	ARW	01	7:55	8:00	41.11	71.19	113
18-02	ARE	01	9:10	9:20	41.09	71.13	112
18-02	ARE	02	9:43	9:45	41.10	71.13	120
18-02	REF	01	10:30	10:30	41.10	71.10	119
18-02	REF	02	10:46	10:46	41.11	71.09	118
18-02	HSR	01	12:10	12:15	41.04	71.28	138
18-02	HSR	02	12:30	12:35	41.04	71.29	142
18-02	HSR	03	13:10	13:12	41.05	71.39	134
18-03	REF	01	7:23	7:26	41.12	71.09	110
18-03	REF	02	7:45	7:45	41.12	71.09	114
18-03	ARE	01	8:20	8:28	41.11	71.12	123
18-03	ARE	02	8:48	8:48	41.12	71.13	124
18-03	ARE	03	9:10	9:10	41.12	71.12	120
18-03	ARW	01	9:34	9:40	41.09	71.17	114
18-03	HSR	01	10:53	10:58	41.04	71.29	144
18-03	HSR	02	11:15	11:15	41.04	71.29	144
18-03	HSR	03	11:31	11:31	41.04	71.29	144
18-03	HSR	04	11:49	11:49	41.04	71.29	144
18-03	HSR	05	12:04	12:04	41.04	71.29	144
18-04	HSR	01	6:55	7:02	41.04	71.29	143
18-04	HSR	02	7:21	7:21	41.03	71.29	143
18-04	HSR	03	7:34	7:34	41.03	71.29	144
18-04	HSR	04	7:50	7:50	41.03	17.29	144
18-04	ARW	01	8:30	8:33	41.07	71.19	119
18-04	ARW	02	9:10	9:10	41.09	71.17	114
18-04	ARE	01	9:33	9:35	41.11	71.14	120
18-04	REF	01	10:02	10:02	41.10	71.10	122
18-04	REF	02	10:33	10:35	41.11	71.10	109
18-04	ARE	02	11:08	11:09	41.12	71.13	122
18-05	ARW	01	7:20	7:28	41.12	71.19	106
18-05	ARW	02	7:35	7:35	41.11	71.19	109
18-05	ARW	03	7:43	7:43	41.11	71.19	109
18-05	ARW	04	7:49	7:49	41.11	71.19	109
18-05	ARW	05	7:56	7:56	41.11	71.19	109
18-05	ARW	06	8:03	8:03	41.11	71.19	109
18-05	ARW	07	8:13	8:13	41.11	71.19	109
18-05	ARW	08	8:19	8:19	41.11	71.19	109

Cruise ID	Station ID	Location ID	Start Time	End Time	Latitude (N) NAD1983	Start Longitude (W) NAD1983	Start Depth (Ft)
18-05	ARE	01	8:50	8:55	41.09	71.12	112
18-05	ARE	02	9:27	9:27	41.10	71.13	113
18-05	REF	01	9:56	10:05	41.10	71.10	119
18-05	REF	02	10:30	10:33	41.13	71.09	109
18-05	HSR	01	11:56	12:03	41.04	71.29	142
18-05	HSR	02	12:17	12:17	41.03	71.29	141
18-05	HSR	03	12:36	12:36	41.03	71.29	141
18-06	ARW	01	7:06	7:18	41.12	71.17	113
18-06	ARW	02	7:30	7:33	41.12	71.19	108
18-06	ARW	03	7:56	8:03	41.08	71.17	113
18-06	ARE	01	8:39	8:44	41.08	71.12	110
18-06	REF	01	9:37	9:37	41.09	71.09	109
18-06	REF	02	10:16	10:19	41.08	71.08	106
18-06	HSR	01	11:10	11:12	41.03	71.24	155
18-06	HSR	02	11:35	11:37	41.03	71.29	140
18-06	HSR	03	12:25	12:26	41.12	71.34	118
18-07	ARW	01	7:20	7:35	41.11	71.19	111
18-07	ARW	02	7:57	7:58	41.11	71.19	112
18-07	ARW	03	8:08	8:09	41.11	71.19	112
18-07	ARW	04	8:20	8:20	41.11	71.19	115
18-07	ARE	01	8:57	8:59	41.12	71.13	124
18-07	ARE	02	9:18	9:21	41.12	71.13	129
18-07	ARE	03	9:49	9:49	41.12	71.13	115
18-07	REF	01	10:15	10:30	41.08	71.10	115
18-07	REF	02	10:59	11:04	41.09	71.10	112
18-07	HSR	01	12:13	12:20	41.05	71.22	136
18-07	HSR	02	12:53	12:59	41.04	71.12	140
18-08	REF	01	6:42	6:56	41.12	71.09	112
18-08	ARE	01	7:52	7:52	41.11	71.13	129
18-08	ARW	01	8:48	8:52	41.10	71.18	112
18-08	ARW	02	9:29	9:32	41.11	71.19	110
18-08	HSR	01	10:20	10:25	41.13	71.35	126
18-08	HSR	02	10:57	10:58	41.15	71.39	102
18-08	HSR	03	11:19	11:24	41.17	71.40	106
18-09	ARW	01	8:00	8:25	41.12	71.19	111
18-09	ARE	01	9:20	9:36	41.12	71.13	115
18-09	REF	01	10:39	10:55	41.09	71.08	112
18-09	HSR	01	12:39	12:50	41.02	71.34	152
18-09	HSR	02	13:03	13:03	41.02	71.33	152
18-10	ARW	01	8:11	8:20	41.12	71.19	112
18-10	ARW	02	8:28	8:37	41.12	71.19	112
18-10	ARE	01	9:43	9:55	41.08	71.12	113
18-10	REF	01	10:55	11:09	41.09	71.09	114
18-10	HSR	01	12:24	12:35	41.03	71.18	141
18-11	ARW	01	8:44	8:59	41.10	71.19	113

Cruise ID	Station ID	Location ID	Start Time	End Time	Latitude (N) NAD1983	Start Longitude (W) NAD1983	Start Depth (Ft)
18-11	ARW	02	9:07	9:07	41.12	71.19	111
18-11	ARW	03	9:19	9:19	41.11	71.19	110
18-11	ARW	04	9:33	9:33	41.11	71.19	111
18-11	ARW	05	9:47	9:49	41.12	71.19	110
18-11	ARW	06	9:56	9:56	41.12	71.19	110
18-11	ARE	01	10:44	10:48	41.09	71.12	114
18-11	REF	01	11:45	11:49	41.08	71.10	109
18-11	HSR	01	12:50	12:57	41.05	71.16	115
18-11	HSR	02	13:19	13:24	41.03	71.18	132
18-11	HSR	03	13:54	13:58	41.04	71.22	132
18-12	REF	01	7:22	7:25	41.10	71.10	110
18-12	REF	02	7:57	7:57	41.09	71.10	112
18-12	ARE	01	8:17	8:18	41.08	71.12	110
18-12	ARE	02	8:39	8:40	41.08	71.12	112
18-12	ARE	03	8:51	8:53	41.08	71.12	111
18-12	ARW	01	9:20	9:20	41.09	71.17	113
18-12	ARW	02	9:36	9:38	41.09	71.17	113
18-12	ARW	03	9:58	10:15	41.12	71.19	110
18-12	HSR	01	11:25	11:27	41.04	71.28	140
18-12	HSR	02	11:43	11:45	41.03	71.29	142
18-12	HSR	03	12:01	12:05	41.03	71.29	143
18-13	HSR	01	7:51	7:55	41.04	71.23	138
18-13	HSR	02	8:25	8:28	41.06	71.19	123
18-13	ARW	01	9:02	9:02	41.08	71.18	119
18-13	ARE	01	9:31	9:33	41.08	71.13	112
18-13	ARE	02	9:45	9:47	41.08	71.13	112
18-13	REF	01	10:14	10:16	41.09	71.06	118
18-13	REF	02	10:42	10:44	41.09	71.08	114
18-13	ARE	03	11:15	11:16	41.10	71.13	121
18-13	ARW	02	11:47	11:49	41.11	71.19	108
18-14	HSR	01	7:28	7:30	41.16	71.19	118
18-14	HSR	02	7:54	7:56	41.14	71.17	127
18-14	REF	01	8:43	8:45	41.12	71.08	115
18-14	REF	02	9:14	9:15	41.11	71.08	120
18-14	ARE	01	9:42	9:43	41.11	71.12	121
18-14	ARE	02	9:58	9:59	41.11	71.12	125
18-14	ARE	03	10:20	10:21	41.11	71.15	118
18-14	ARW	01	10:38	10:40	41.11	71.17	114
18-14	ARW	02	10:58	11:02	41.11	71.18	109
18-14	ARW	03	11:18	11:22	41.11	71.19	109
18-15	ARW	01	8:22	8:32	41.11	71.19	109
18-15	ARW	02	8:47	8:48	41.11	71.19	109
18-15	ARW	03	8:56	8:58	41.12	71.19	108
18-15	ARW	04	9:05	9:06	41.11	71.19	109
18-15	ARW	05	9:11	9:15	41.11	71.19	109

Cruise ID	Station ID	Location ID	Start Time	End Time	Latitude (N) NAD1983	Start Longitude (W) NAD1983	Start Depth (Ft)
18-15	ARW	06	9:21	9:22	41.11	71.19	107
18-15	ARE	01	9:55	10:03	41.09	71.13	112
18-15	ARE	02	10:19	10:19	41.08	71.12	110
18-15	ARE	03	10:25	10:26	41.09	71.12	111
18-15	ARE	04	10:39	10:39	41.09	71.12	110
18-15	ARE	05	10:51	10:51	41.09	71.12	110
18-15	REF	01	11:21	11:26	41.12	71.09	107
18-15	REF	02	11:35	11:42	41.12	71.09	112
18-15	REF	03	12:05	12:10	41.12	71.07	115
18-15	HSR	01	12:46	12:52	41.16	71.10	113
18-15	HSR	02	13:12	13:20	41.19	71.12	126
18-15	HSR	03	13:49	13:52	41.21	71.16	119

Appendix D: Fishing Locations

Cruise ID	Station ID	Location ID	Fishing Start Time	Fishing End Time	Latitude (N) NAD1983	Longitude (W) NAD1983	Depth at Start of Fishing (ft)	Drift or Anchor	Were Fish Caught?
18-01	ARW	01	7:30	7:45	41.11	71.19	106	Drift	Yes
18-01	ARW	02	7:50	8:10	41.11	71.19	107	Drift	No
18-01	ARW	03	8:16	8:26	41.11	71.19	108	Drift	No
18-01	ARE	01	8:55	9:10	41.12	71.12	112	Drift	No
18-01	ARE	02	9:13	9:29	41.12	71.12	110	Drift	No
18-01	ARE	03	9:35	9:49	41.12	71.12	110	Drift	Yes
18-01	REF	01	10:04	10:49	41.12	71.09	113	Drift	Yes
18-01	HSR	01	11:30	12:15	41.03	71.18	133	Drift	Yes
18-02	ARW	01	8:00	8:45	41.11	71.19	113	Anchor	Yes
18-02	ARE	01	9:20	9:30	41.09	71.13	113	Anchor	No
18-02	ARE	02	9:45	10:20	41.10	71.13	120	Anchor	Yes
18-02	REF	01	10:30	10:43	41.10	71.10	119	Drift	Yes
18-02	REF	02	10:46	11:18	41.11	71.09	118	Drift	No
18-02	HSR	01	12:15	12:30	41.04	71.28	138	Drift	No
18-02	HSR	02	12:35	12:42	41.04	71.29	142	Drift	No
18-02	HSR	03	13:12	13:35	41.05	71.39	134	Drift	Yes
18-03	REF	01	7:26	7:41	41.12	71.09	111	Drift	Yes
18-03	REF	02	7:45	8:15	41.12	71.09	114	Drift	No
18-03	ARE	01	8:28	8:43	41.11	71.12	123	Drift	No
18-03	ARE	02	8:48	9:06	41.12	71.13	120	Drift	No
18-03	ARE	03	9:10	9:22	41.12	71.13	121	Drift	No
18-03	ARW	01	9:40	10:25	41.09	71.17	114	Drift	No
18-03	HSR	01	10:58	11:08	41.03	71.29	144	Drift	Yes
18-03	HSR	02	11:15	11:25	41.03	71.29	144	Drift	Yes
18-03	HSR	03	11:31	11:41	41.03	71.29	144	Drift	No
18-03	HSR	04	11:49	11:59	41.03	71.29	144	Drift	Yes
18-03	HSR	05	12:04	12:09	41.03	71.29	144	Drift	No
18-04	HSR	01	7:02	7:17	41.03	71.29	143	Drift	Yes
18-04	HSR	02	7:21	7:31	41.03	71.29	143	Drift	Yes
18-04	HSR	03	7:34	7:44	41.03	71.29	144	Drift	No
18-04	HSR	04	7:50	8:00	41.03	71.29	144	Drift	No
18-04	ARW	01	8:33	9:03	41.07	71.19	117	Drift	No
18-04	ARW	02	9:10	9:25	41.09	71.17	117	Drift	No
18-04	ARE	01	9:35	9:55	41.11	71.14	126	Drift	No
18-04	REF	01	10:02	10:27	41.10	71.10	122	Drift	No
18-04	REF	02	10:35	10:55	41.11	71.10	109	Drift	No
18-04	ARE	02	11:09	11:34	41.12	71.13	126	Drift	No
18-05	ARW	01	7:28	7:33	41.12	71.19	109	Drift	No
18-05	ARW	02	7:35	7:40	41.11	71.19	109	Drift	No
18-05	ARW	03	7:43	7:48	41.11	71.19	109	Drift	No
18-05	ARW	04	7:49	7:54	41.11	71.19	109	Drift	No
18-05	ARW	05	7:56	8:01	41.11	71.19	109	Drift	No
18-05	ARW	06	8:03	8:11	41.11	71.19	109	Drift	No
18-05	ARW	07	8:13	8:17	41.11	71.19	109	Drift	No

Cruise ID	Station ID	Location ID	Fishing Start Time	Fishing End Time	Latitude (N) NAD1983	Longitude (W) NAD1983	Depth at Start of Fishing (ft)	Drift or Anchor	Were Fish Caught?
18-05	ARW	08	8:19	8:27	41.11	71.19	109	Drift	No
18-05	ARE	01	8:55	9:20	41.09	71.12	113	Drift	No
18-05	ARE	02	9:27	9:47	41.10	71.13	113	Drift	No
18-05	REF	01	10:05	10:28	41.12	71.09	118	Drift	No
18-05	REF	02	10:33	10:55	41.12	71.09	111	Drift	No
18-05	HSR	01	12:03	12:13	41.04	71.29	142	Drift	No
18-05	HSR	02	12:17	12:32	41.03	71.29	141	Drift	No
18-05	HSR	03	12:36	12:56	41.03	71.29	141	Drift	No
18-06	ARW	01	7:18	7:28	41.12	71.19	109	Drift	No
18-06	ARW	02	7:33	7:43	41.12	71.19	108	Drift	No
18-06	ARW	03	8:03	8:28	41.08	71.17	116	Drift	No
18-06	ARE	01	8:44	9:29	41.08	71.12	108	Drift	No
18-06	REF	01	9:37	10:12	41.09	71.09	109	Drift	No
18-06	REF	02	10:19	10:29	41.08	71.08	106	Drift	No
18-06	HSR	01	11:12	11:22	41.03	71.24	156	Drift	No
18-06	HSR	02	11:37	11:57	41.03	71.29	140	Drift	Yes
18-06	HSR	03	12:26	12:41	41.12	71.34	118	Drift	No
18-07	ARW	01	7:35	7:50	41.11	71.19	109	Anchor	No
18-07	ARW	02	7:58	8:04	41.11	71.19	112	Drift	No
18-07	ARW	03	8:09	8:17	41.11	71.19	112	Drift	No
18-07	ARW	04	8:20	8:36	41.11	71.19	115	Drift	No
18-07	ARE	01	8:59	9:14	41.12	71.13	125	Drift	No
18-07	ARE	02	9:21	9:45	41.12	71.13	133	Drift	No
18-07	ARE	03	9:49	9:55	41.12	71.13	115	Drift	No
18-07	REF	01	10:30	10:51	41.08	71.10	112	Drift	No
18-07	REF	02	11:04	11:28	41.09	71.08	119	Drift	No
18-07	HSR	01	12:20	12:34	41.04	71.22	137	Drift	No
18-07	HSR	02	12:59	13:30	41.03	71.29	143	Drift	No
18-08	REF	01	6:56	7:41	41.12	71.09	114	Drift	No
18-08	ARE	01	7:52	8:37	41.11	71.13	129	Drift	No
18-08	ARW	01	8:52	9:21	41.10	71.18	112	Drift	No
18-08	ARW	02	9:32	9:48	41.12	71.19	112	Drift	No
18-08	HSR	01	10:25	10:45	41.13	71.35	131	Drift	No
18-08	HSR	02	10:58	11:14	41.16	71.39	104	Drift	No
18-08	HSR	03	11:24	11:33	41.17	71.39	101	Drift	No
18-09	ARW	01	8:25	9:10	41.11	71.19	108	Anchor	Yes
18-09	ARE	01	9:36	10:21	41.12	71.13	113	Anchor	Yes
18-09	REF	01	10:55	11:40	41.09	71.08	115	Anchor	Yes
18-09	HSR	01	12:50	12:58	41.02	71.33	156	Drift	No
18-09	HSR	02	13:03	13:40	41.02	71.33	152	Anchor	No
18-10	ARW	01	8:20	8:23	41.12	71.19	115	Anchor	No
18-10	ARW	02	8:37	9:19	41.12	71.19	112	Anchor	Yes
18-10	ARE	01	9:55	10:40	41.08	71.12	115	Anchor	Yes
18-10	REF	01	11:09	11:54	41.09	71.10	113	Anchor	Yes

Cruise ID	Station ID	Location ID	Fishing Start Time	Fishing End Time	Latitude (N) NAD1983	Longitude (W) NAD1983	Depth at Start of Fishing (ft)	Drift or Anchor	Were Fish Caught?
18-10	HSR	01	12:35	13:20	41.03	71.18	137	Anchor	No
18-11	ARW	01	8:59	9:04	41.11	71.19	115	Drift	No
18-11	ARW	02	9:07	9:16	41.12	71.19	111	Drift	No
18-11	ARW	03	9:19	9:27	41.11	71.19	110	Drift	No
18-11	ARW	04	9:33	9:43	41.11	71.19	111	Drift	No
18-11	ARW	05	9:49	9:54	41.12	71.19	117	Drift	No
18-11	ARW	06	9:56	10:04	41.12	71.19	110	Drift	No
18-11	ARE	01	10:48	11:33	41.08	71.12	113	Drift	No
18-11	REF	01	11:49	12:34	41.08	71.10	108	Drift	No
18-11	HSR	01	12:57	13:10	41.05	71.17	121	Drift	No
18-11	HSR	02	13:24	13:39	41.03	71.18	132	Drift	No
18-11	HSR	03	13:58	14:15	41.04	71.22	132	Drift	No
18-12	REF	01	7:25	7:55	41.09	71.09	111	Drift	No
18-12	REF	02	7:57	8:12	41.09	71.09	112	Drift	No
18-12	ARE	01	8:18	8:38	41.08	71.12	111	Drift	No
18-12	ARE	02	8:40	8:50	41.08	71.12	111	Drift	No
18-12	ARE	03	8:53	9:08	41.08	71.12	115	Drift	No
18-12	ARW	01	9:20	9:35	41.09	71.17	113	Drift	No
18-12	ARW	02	9:38	9:48	41.09	71.17	116	Drift	No
18-12	ARW	03	10:15	10:35	41.12	71.19	117	Drift	No
18-12	HSR	01	11:27	11:42	41.04	71.28	140	Drift	No
18-12	HSR	02	11:45	12:00	41.03	71.29	143	Drift	No
18-12	HSR	03	12:05	12:20	41.03	71.29	141	Drift	No
18-13	HSR	01	7:55	8:15	41.04	71.23	140	Drift	Yes
18-13	HSR	02	8:28	8:53	41.06	71.19	124	Drift	Yes
18-13	ARW	01	9:02	9:19	41.08	71.18	119	Drift	No
18-13	ARE	01	9:33	9:44	41.08	71.12	113	Drift	No
18-13	ARE	02	9:47	10:00	41.09	71.12	114	Drift	No
18-13	REF	01	10:16	10:39	41.09	71.06	122	Drift	No
18-13	REF	02	10:44	11:06	41.09	71.08	112	Drift	No
18-13	ARE	03	11:16	11:37	41.10	71.13	123	Drift	No
18-13	ARW	02	11:49	12:17	41.11	71.19	111	Drift	Yes
18-14	HSR	01	7:30	7:45	41.15	71.19	120	Drift	No
18-14	HSR	02	7:56	8:26	41.14	71.17	126	Drift	Yes
18-14	REF	01	8:45	9:10	41.12	71.08	118	Drift	No
18-14	REF	02	9:15	9:35	41.11	71.09	120	Drift	No
18-14	ARE	01	9:43	9:57	41.11	71.12	121	Drift	No
18-14	ARE	02	9:59	10:13	41.11	71.12	125	Drift	No
18-14	ARE	03	10:21	10:38	41.11	71.15	119	Drift	No
18-14	ARW	01	10:40	10:54	41.11	71.17	115	Drift	No
18-14	ARW	02	11:02	11:17	41.11	71.19	108	Drift	Yes
18-14	ARW	03	11:22	11:38	41.11	71.19	110	Drift	Yes
18-15	ARW	01	8:32	8:42	41.11	71.19	109	Drift	Yes
18-15	ARW	02	8:48	8:54	41.11	71.19	109	Drift	Yes

Cruise ID	Station ID	Location ID	Fishing Start Time	Fishing End Time	Latitude (N) NAD1983	Longitude (W) NAD1983	Depth at Start of Fishing (ft)	Drift or Anchor	Were Fish Caught?
18-15	ARW	03	8:58	9:04	41.11	71.19	109	Drift	No
18-15	ARW	04	9:06	9:11	41.11	71.19	109	Drift	No
18-15	ARW	05	9:15	9:20	41.11	71.19	110	Drift	Yes
18-15	ARW	06	9:22	9:35	41.11	71.19	109	Drift	Yes
18-15	ARE	01	10:03	10:13	41.09	71.12	110	Drift	Yes
18-15	ARE	02	10:19	10:24	41.08	71.12	111	Drift	No
18-15	ARE	03	10:26	10:36	41.09	71.12	110	Drift	Yes
18-15	ARE	04	10:39	10:49	41.09	71.12	110	Drift	Yes
18-15	ARE	05	10:51	11:01	41.08	71.12	110	Drift	Yes
18-15	REF	01	11:26	11:31	41.12	71.09	109	Drift	No
18-15	REF	02	11:42	12:02	41.12	71.09	111	Drift	No
18-15	REF	03	12:10	12:30	41.12	71.07	115	Drift	No
18-15	HSR	01	12:52	13:00	41.16	71.10	115	Drift	No
18-15	HSR	02	13:20	13:35	41.19	71.12	127	Drift	No
18-15	HSR	03	13:52	14:14	41.21	71.16	120	Drift	No

Appendix E: Health and Safety Protocol

HEALTH, SAFETY & ENVIRONMENTAL PLAN – COD SPAWNING SURVEY

INSPIRE Environmental, LLC.
01/04/2018

1. Introduction

Inspire Environmental is committed to conducting strong scientific research in a safe and responsible manner. For this reason, our health, safety and environment (HSE) plan is focused on the prevention of incidents that may cause harm to our employees and contractors as well as the environment. The following sections describe the measures to be implemented to eliminate or minimize risks associated with the activity. By working for Inspire Environmental you agree to adhere to the Environmental Compliance protocol (Section 4.0) outlined in this document.

Inspire will follow the DWW South Fork Wind Farm's HSE Procedure and Emergency Response Procedure requirements and establish them as minimum expectations for their contractors.

2. Stop Work Policy

You are fully authorized to stop any work that you consider to be unsafe.

This means that you have the right - and the responsibility - to stop your own or other's work if you believe that it threatens the safety for personnel or may result in material damage or an environmental incident.

Upon stopping work, the Lead Scientist must be immediately notified and provided with information regarding the nature of the safety, health or environmental concern.

3. Safety Rules

3.1. Before getting to the vessel

Arrive promptly to allow for a smooth departure. The vessel leaves the dock at the assigned time, every time.

Dress for cold weather – Waterproof, warm jackets/coats, hats, boots, long underwear, and gloves. Hand and foot warmers are suggested on very cold days.

It is prohibited to be under the influence of alcohol or illegal drugs during the survey.

If you take prescription drugs, take enough with you for a 24 hours period.

Notify the Lead Scientist of any relevant medical conditions and allergies you have.

3.2. At the vessel

All Health and Safety policies and practices must be observed.

Report all injuries or situations that could have resulted in injuries (near misses) to the Lead Scientist onboard the vessel.

All are mandated to participate in the vessel's safety and emergency response plan debriefing. Make sure you are familiar with all emergency instructions provided.

Use handrails when ascending or descending stairways and crossing gangways.

Be aware of slippery surfaces, uneven flooring and trip hazards on the deck.

Never go out on the deck alone. Always have a buddy with you.

Do not operate any vessel equipment.

The use of alcohol and illegal drugs is not permitted during the survey.

Smoking is only permitted in designated areas.

The possession of weapons, firearms, explosives and explosive devices is prohibited.

3.3. In the case of an emergency

Remain calm and immediately notify the Lead Scientist and/or the vessel Captain.

Follow the instructions given at the Emergency Debriefing and obey the instructions given by the vessel crew.

In the case of a medical emergency the vessel will return to port and an ambulance will be called to the take the person to an emergency hospital or an urgent care unit. At least one person trained in first aid will be on the vessel for first response.

4. Environmental Compliance

- Do not litter. Trash receptacles and ash trays are provided within the vessel.
- Fishing is occurring under a State of Rhode Island Type 3 Collector's Permit and a Federal Letter of Acknowledgment for Atlantic Cod.
    - Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act provisions, 50 CFR 600.745, the activities conducted in accordance with the Letter of Acknowledgement and the Scientific Research Plan are presumed to be scientific activities conducted by a scientific research vessel. Therefore, the research vessels are not subject to the Magnuson-Stevens Act or to fishery regulations published at 50 CFR part 648 while participating in the scientific research activities and while under the control of Inspire Environmental during the study period.

- You may keep up to ten (10) Atlantic cod above 22” (Rhode Island State law).
    - We are fishing with a Scientific Collection Permit, so fish below the legal limit will be sacrificed. These fish will not be kept by fishermen.
    - You are not permitted to commercially sell fish.
    - Fish cleaning and filleting will be conducted according to the rules and regulations on the chartered vessels.
    - You will not be able to keep any other species caught, regardless if state and federal regulations are met.
- All cruise reports and data collected as part of this research will be delivered to NOAA NMFS pursuant to the Letter of Acknowledgment
- Refer any biological or environmental questions to Inspire staff.

Appendix F: Participating Anglers

Participating Anglers	
Nicholus Apostolides	Jason Jarvis
Tim Baker	James Kelly
Richard Balouskus	Stephen Kenyon
Richard A Balouskus	Wayne Kenyon
Lance Banfield	Joe Langan
Robert Barrett	Peter Lauda
Harry Benn	Kevin Logie
Chris Benn	Paul Lomedico
Lucas Berg	Walter Marti
David Capodiece	Benis Mavros
Scott Carroll	John McCann
Fred Chowanes	Ben McCarron
Michael Clini	Joe McDonald
Jim Costello	Laura Messier
Matthew Cox	Troy Metzler
David Dailey	Michael O'Grady
AJ D'Angelo	Andrew Pflomm
Andrew D'Angelo	Benjamin Piquette
Matthew Davidson	Ed Porter
Stephen Denaro	Brian Priest
Joe Devine	Jaime Quaresimo
Steven Forsberg	John Rainone
Barry Gootkind	Al Randazzo
Mike Gootkind	Craig Schoenberg
Matthew Grennan	William Schuman
Matt Griffin	Justin Seiler
Brandon Hagopian	Donald Smith
Greg Hamilton	Kelly Smith
Michael Hansen	Peter Spungin
Shawn Hayes-Costello	Jacob Strock
Rich Hittinger	Nick Sullivan
Steve Houston	Peter Vican
Bill Hubert	Michael Warner
Russell Hubert	Stephen Werbecki
Dylan James	Joe Zattolli
Fred Jarosz	