16 July 2010

CRUISE RESULTS

R/V HENRY B. BIGELOW
Cruise No. HB09-03

Shake-down Cetacean and Turtle Abundance Survey

CRUISE PERIOD AND AREA

The cruise was scheduled for August 3-17, 2009. The actual days the ship sailed were August 5-17, 2009. The study area included area within the US Exclusive Economic Zone, North of 37° N latitude, to the southern portions of Georges Bank that is south of 41°N and between approximately the 100 and 4000 m depth contours (Figure 1).

OBJECTIVES

The overall objective was to prepare for the 60-day June/July 2010 abundance line transect survey.

During daylight hours, the primary objectives were to train observers on the species identifications of warm water cetaceans and test and trial the following: 1) passive acoustic hydrophone arrays, 2) new data entry computers and programs, 3) new equipment to electronically record the distance between the ship and animal, 4) active acoustic equipment (EK60, ME70, and ADCP), and 5) data collection procedures for the visual cetacean line transect survey.

During nighttime hours, the primary objectives were to document, within the study area the distribution of the hydrographic characteristics and the distribution and relative abundance of plankton. These data can then be related to the distribution and abundance of cetaceans that were visually and acoustically detected.

METHODS

VISUAL MARINE MAMMAL-TURTLE SIGHTING TEAM

A line transect survey was conducted during daylight hours (approximately 0600-1800 with a 1 hour break at lunchtime) using the two independent team procedure. Surveying was conducted during good weather conditions (Beaufort four and below) while traveling at about 10 to 12 knots, as measured over the ground.

Scientific personnel formed two visual marine mammal-sea turtle sighting teams. The teams were on the flying bridge (15.1 m above the water line) and anti-roll tank sighting platform (11.8 m above the water line). To detect animal groups, both teams were composed of two on-effort observers who searched using 25x150 powered binoculars, one on-effort observer who searched using naked eye and recorded the sightings data detected by all team members, and one off-effort observer who could rest. Every 30 minutes observers on each team rotated positions within the team. Observers did not rotate between teams.

Position, date, time, ship's speed and course, water depth, surface temperature, salinity, and conductivity, along with other variables (Table 1) were obtained from the ship's Science Computer System (SCS). These data were routinely collected and recorded every second while during visual survey operations. At the end of the visual survey day (after 1800) these data were made available to the Chief Scientist who then merged them with the sighting and effort data. Sightings and effort data were entered by the scientists onto hand held data entry computerized systems.

At times when it was not possible to positively identify a species or when training the observers on species identifications, survey effort was discontinued and the ship headed in a manner to intercept the animals in question. When the species identification and group size information were obtained, the ship proceeded back to the point on the track line where effort ended (or close to this point).

Both teams searched waters from 90˚ starboard to 90˚ port, where 0˚ is the track line. On either team, when an animal group (porpoise, dolphin, whale, seal, turtle or a few large fish species) was detected the following factors were recorded onto a computerized data entry device ("PingleNet"):

1) Time of sighting, recorded to the nearest second,
2) Species composition of the group,
3) Radial distance between the team's platform and the location of the sighting when initially detected, estimated either visually when not using the binoculars or by reticles when using binoculars,
4) Bearing between the line of sight to the group and the track line; measured by a polarus mounted near the observer or a polarus at the base of the binoculars,
5) Best, high and low estimate of group size,
6) Direction of swim,
7) Number of calves,
8) Initial sighting cue,
9) Initial behavior of the group, and
10) Any comments on unusual markings or behavior.

The location (latitude and longitude) of the ship when a sighting was detected was recorded by GPS units that were either internal to the data entry computer or was determined subsequently by matching the time of the sighting to the time of the recorded position of the ship as recorded by the ship's sensors, which was recorded every second.

The following effort data were recorded every time one of the factors changed (usually ever 30 minutes when the observers rotate):

1) Time of recording,
2) Position of each observer, and
3) Weather conditions: swell direction and height, Beaufort sea state, presence of rain or fog, percentage of cloud coverage, visibility (i.e., approximate distance to the horizon), vertical position of the sun, and glare width and strength.

PASSIVE ACOUSTIC DETECTION TEAM

We towed a sensor array, containing two high-frequency elements and three medium frequency elements, 300m behind the ship.

Signals from the high-frequency elements were routed via an amplifier box to a National Instruments PCI 6250 data acquisition card in a desktop computer. They were further processed using a high frequency version of IFAW's Rainbow Click software (IFAW 2007), which provided automatic detection of harbor porpoise clicks. Scheduled high frequency recordings were also saved on the hard drive every hour for 30 seconds and will be used to assess noise levels in later data processing.

Three medium frequency signals were routed via an amplifier box to an external RME FireFace 400 soundcard that was connected to a second desktop computer which ran PAMGUARD (http://www.pamguard.org/home.shtml). Data from these 3 channels were recorded continuously at a sample rate of 192 kHz. PAMGUARD was set up to run an online mid-frequency click detector module, which calculated and plotted bearings to individual clicks, based on the distance between hydrophone elements and speed of sound in the water column. Bearing data were automatically written to an Access database, which was also collecting data on the ship's position, speed and heading from the externally connected ship's GPS. Additionally, the medium frequency data were displayed as a scrolling spectrogram, to aid operators with acoustic event detection.

CTD casts made at the start of each day and at noon provided data on temperature, depth, and salinity at the tow depth of the array (7-9 meters depending on deployment length and ship's speed). These data were used to calculate sound speed for the purpose of estimating bearing to vocal animals (see above).

The acoustic monitoring team consisted of three people who operated the system in two hour shifts from 6am to 6pm. This schedule followed the observation schedule of the visual team. The hydrophone was hauled in for the noon CTD cast and at the end of the visual survey day. During the core survey period acoustic monitoring was only stopped because of inclement weather, technical problems, or when the array compromised the safe operation of the vessel, *e.g.*, in areas with high concentration in shipping traffic or fishing gear. While the array was in the water the harbor porpoise click detector ran continuously and at least one of the acoustic monitors listened for any vocalizing marine mammals in the mid frequency range and made comments about any acoustic events, using PAMGUARD's Graphical User Interface (GUI).

Acoustic survey lines followed those laid out for the visual survey and were extended when track lines happened to end in the middle of an acoustic detection. On a few occasions acoustic effort did continue when the visual survey stopped due to inclement weather (*e.g.*, fog).

HYDROGRAPHIC AND PLANKTON CHARACTERISTICS

In addition to the ship's SCS logger system that continuously recorded oceanographic data from the ship's sensors, a SEACAT 19 Profiler (CTD) was used to measure water column conductivity, temperature and depth. The CTD was mounted on a 322 conducting core cable allowing the operator to see a real time display of the instrument depth and water column temperature, salinity, density and sound speed on a computer monitor in the ship's Dry Lab. Once a day, at the end point of the day's cetacean survey transect (usually at 1800), the CTD was lowered to within 5 meters of the bottom or to 505m depth if the bottom depth was greater than 500m. During each vertical profile a Niskin bottle was attached to the wire above the CTD to collect a water sample which will be used to calibrate the conductivity sensor of the CTD.

A 61cm bongo plankton net equipped with one 333µm and one 505µm mesh net with the CTD mounted on the wire 1m above the nets was deployed three times a day: once before the day's surveying started (about 0500-0530), at lunch time (about 1200 when the ship stopped surveying), and again after surveying was completed for the day (approximately 1800, depending on weather and the time of sunset). The bongo was towed in a double oblique profile using standard MARMAP protocols. The ship's speed through the water was approximately 1.5 knots. Wire out speed was 50m/min and wire in speed was 20m/min. Tows were to within 5m of the bottom or 200m if the bottom depth exceeded 205m. Upon retrieval, samples were rinsed from the nets using seawater and preserved in 5% formaldehyde and seawater. Samples were transported to the Narragansett, RI NMFS lab for future identification.

Special zooplankton collections of salps for Dr. Larry Madin and euphausiids for Dr. Gareth Lawson of the Woods Hole Oceanographic Institution (WHOI) were conducted using a 1m square neuston net equipped with a 980µm mesh net with the CTD mounted on the wire 1.5m above the net. The net was towed targeting layers of zooplankton seen by the 120kHz and 200kHz sensors of the ship's EK60 echo sounder. Upon retrieval the samples were washed from the net using seawater and preserved in 5% formaldehyde and seawater. Samples were transported to the WHOI in Woods Hole, MA for future identification.

During the night time hours, tows were made along the visual team's previous day's transect lines using a Seascan V-fin mounted, internally recording, black and white Video Plankton Recorder (VPR). The VPR was also equipped with a Seabird Fastcat CTD, a Wetlabs fluorometer / turbidity sensor and a Benthos altimeter. A second SEACAT 911 CTD profiler was mounted under the V-fin and connected to the 322 conducting core cable to provide real time data on gear depth and oceanographic conditions. The camera and strobe were set to image a 4cm x 5cm x 11cm volume of water 20 times a second. The VPR was towed in an undulating pattern along the transect line targeting layers of plankton shown on the EK60 or bracketing oceanographic features. Upon retrieval, the data were downloaded to one of two computers in the Chemical Lab for processing. In focus regions of interest (ROIs) individual plankton pictures were extracted from each image frame using Autodeck programming from Seascan. Along track profiles of temperature, salinity, density, raw chlorophyll and raw turbidity values were created for each tow using MATLAB programs. Plankton images were stored for identification at the NMFS Woods Hole lab. Images will be used to create 1m depth stratified plankton profiles for comparison with the echo profiles from the 120kHz and 200kHz sensors of the EK60.

RESULTS

The scientists involved in this survey are detailed in Table 2.

VISUAL MARINE MAMMAL-TURTLE SIGHTING TEAM

The visual marine mammal and turtle team surveyed about 1730 km (934 nmi; Figure 1). About 55% of the survey transects were conducted in very good weather conditions, Beaufort sea state 2 or less (Table 3).

During the on-effort track lines, there were 15 species of identifiable cetaceans and 2 identifiable sea turtles (Table 4). For cetaceans, the upper team detected 290 groups (3571 individuals) and the lower team detected 297 groups (2625 individuals). For turtles, the upper team detected 20 groups (21 individuals) and the lower team detected 14 groups (15 individuals). Note some, but not all, groups of cetaceans and turtles detected by one team were also detected by the other team. No seals were detected.

Distribution maps of sighting locations of the cetaceans, turtles and sunfish are displayed in Figures 2 to 16. Note these are locations of sightings seen by both teams, where some groups of animals were seen by both teams and other groups were seen by only one of the teams.

PASSIVE ACOUSTIC DETECTION TEAM

The passive acoustic system ran successfully during this cruise with only minor technical problems, allowing for continuous data collection on both the high frequency and the mid-frequency systems during all times when the visual observers were on effort. The mid-frequency system recorded data for approximately 10 hours a day for 10 days, for a total of over 103 hours (the high frequency system for slightly less due to initial troubleshooting).

Mid-frequency recordings were collected continuously whilst the hydrophone was in the water. The system recorded at least 135 acoustic cetacean encounters, 38 of which were confirmed groups of sperm whales. Figure 17 details locations of these acoustic detections. Bearings and ranges to detected clicks could be estimated online using the PAMGUARD GUI (see Figure 18 for an example track of a group of sperm whale clicks).

Preliminary comparisons were conducted to estimate the overlap between visual and acoustic cetacean detections (Table 5). Acoustic data for four days were reviewed manually, and the timing and location of vocal events were compared qualitatively with records from the visual observation team. Of the 33 acoustic events that were evaluated, 45% were considered “probable” or “likely” to correspond to visual sightings, while no visual sightings were reported for 30% of acoustic detections. Visual confirmation is uncertain for the remainder (25%) of the analyzed acoustic events. Sperm whale acoustic detections, which occurred on all survey days, were not included in this evaluation.

Further analyses, including the analysis of data collected by the High Frequency system, localization and estimation of acoustic detection distances and species ID for dolphin groups, sperm whales and baleen whales, are still pending.

For future surveys on the BIGELOW it will be important to continue working on isolating the sources of electrical interference, preferably before the start of the survey.

HYDROGRAPHIC/BONGO/PLANKTON SAMPLES

A total of 11 vertical CTD profiles, 25 double oblique CTD with bongo hauls, 8 CTD with neuston net hauls and 24 CTD with VPR hauls were conducted (Table 6; Figures 1 and 19).

Oceanographic profiles varied strongly within the study area (Figures 20-23). All profiles except those from the Gulf Steam featured strong thermoclines varying from 15-50m in depth and 5-17ºC in strength. Salinities varied widely from 31.5 psu on the shelf to 36.0 psu in the Gulf Stream.

Plankton layers in or above the thermocline that were sampled with the neuston net (found by targeting echo layers on the EK60) were predominately gelatinous zooplankton with the salp, *Thalia democratica,* as the dominant species (Figure 24). The echo layer that was observed most evenings at dusk migrated upwards from 300+m (the sampling depth of the higher frequencies of the EK60) to just under the thermocline and was predominately Euphausiids (krill). At least 4 species of Euphausiid were noted including*:* *Meganyctiphanes norvegica*, *Euphausia superba* and *Nematoscelis* spp. (Figure 25). The net samples also included notable numbers of larval fish, in particular myctophidae and larval eel, in particular leptocephalus.

Images from the VPR (Figuree 26) also showed gelatinous zooplankton which were damaged or destroyed by the sampling nets. Both the adult blastozooid with juveniles and the solitary oozoid forms of the salp T*halia democratica* were imaged (Figure 24). Ctenphora of the species *Pleurobrachia pileus, Bolinopsis* sp. and Beroe sp. and the hydromedusae of numerous species were also detected (Figure 26). In addition, images also included smaller zooplankton such as copepods and chaetognaths, as well as larger colonial phytoplankton.

DISPOSITION OF THE DATA

All visual and passive acoustic data collected will be maintained by the Protected Species Branch at the Northeast Fisheries Science Center (NEFSC) in Woods Hole, MA. Visual sightings data will be available from the NEFSC's Oracle database.

All hydrographic data collected will be maintained by the Fishery Oceanography Branch at the NEFSC in Woods Hole, MA. Hydrographic data can be accessed through the Oceanography web site http://www.nefsc.noaa.gov/epd/ocean/MainPage/ioos.html or the NEFSC Oracle database.

All plankton samples collected will be maintained by the Fishery Oceanography Branch at the NEFSC in Narragansett RI. Plankton data are currently available by request only.

All VPR data will be maintained Fishery Oceanography Branch at the NEFSC in Woods Hole, MA. VPR data are currently available by request only.

REFERENCES

IFAW. 2007. IFAW free cetacean software, available from http://www.ifaw.org/ifaw/general/default.aspx?oid=35818.

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Figure 22. Oceanographic profiles of the temperature, salinity, turbidity raw counts and chlorophyll raw counts from the shelf slope near Lydonia canyon, when traveling from deep to shallow depths. The closest way points were 10 – 11.

Figure 23. Oceanographic profiles of the temperature, salinity, turbidity raw counts and chlorophyll raw counts, when traveling from offshore southwest to NE. The closest way points were 5 (7), 4 (11 in the Gulf Stream), 2 (19).

Figure 24. VPR images of the salp, *Thalia democratica.*

Figure 25. VPR images of euphausiids and fish.

Figure 26. VPR images of gelatinous zooplankton.

Table 1. SCS data collected continuously every second during the visual survey time periods (6am to 6pm).

Date	
Time	TSG-Conductivity (s/m)
EK60-38kHz-Depth (m)	TSG-External-Temp (ºC)
EK60-18kHz-Depth (m)	TSG-InternalTemp (ºC)
ADCP-Depth (m)	TSG-Salinity (PSU)
ME70-Depth (m)	TSG-Sound-Velocity (m/s)
ES60-50kHz-Depth (m)	MX420-Time (GMT)
Doppler-Depth (m)	MX420-COG (º)
Air-Temp (ºC)	MX420-SOG (Kts)
Barometer-2 (mbar)	MX420-Lat (DDMM.MM)
YOUNG-TWIND-Direction (º)	MX420-Lon (DDMM.MM)
YOUNG-TWIND-Speed (Kts)	Doppler-F/A-BottomSpeed (Kts)
Rel-Humidity (%)	Doppler-F/A-WaterSpeed (Kts)
Rad-Case-Temp (ºC)	Doppler-P/S-BottomSpeed (Kts)
Rad-Dome-Temp (ºC)	Doppler-P/S-WaterSpeed (Kts)
Rad-Long-Wave-Flux (W/m^2)	
Rad-Short-Wave-Flux (W/m^2)	

Table 2. Scientific personnel.

Personnel	Title	Organization
Debra Palka	Cruise leader	NOAA, NEFSC, Woods Hole, MA
Gordon Waring	Lead visual team	NOAA, NEFSC, Woods Hole, MA
Betsy Broughton	Lead oceanographer	NOAA, NEFSC, Woods Hole, MA
Denise Risch	Lead acoustic team	Integrated Statistics, Woods Hole, MA
Carol Fairfield	Observer	NOAA, SEFSC, New Hampshire
Carol Roden	Observer	Mineral Management Service, New Orleans, LA
Allison Glass	Observer	Integrated Statistics, Woods Hole, MA
Betty Lentell	Observer	Integrated Statistics, Woods Hole, MA
Danielle Cholewiak	Observer	Integrated Statistics, Woods Hole, MA
Irene Briga	Observer	Integrated Statistics, Woods Hole, MA
Joy Stanistreet	Observer	Integrated Statistics, Woods Hole, MA
Kalyn MacIntyre	Observer	Integrated Statistics, Woods Hole, MA
Melissa Warden	Observer	Integrated Statistics, Woods Hole, MA
Peter Duley	Observer	Integrated Statistics, Woods Hole, MA
Catherine Silver	Volunteer	Teacher-at-sea

Table 3. Within each Beaufort sea state condition, total length of visual teams' track lines (in km).

Beaufort	Total	
Sea State	Length	%
0	35.0	0.02
1	504.0	0.29
2	408.0	0.24
3	495.6	0.29
4	287.6	0.17
Total	1730.2	1.00

Table 4. Number of groups and individuals of marine mammals, turtles and large fish species detected by the visual teams. Note, some, but not all, groups detected by one team were also detected by the other team.

Species		Upper Team		Lower Team	
Common Name	**Scientific Name**	**Groups**	**Indivs**	**Groups**	**Indivs**
Atlantic spotted dolphin	*Stenella frontalis*	4	81	4	50
bottlenose dolphin	*Tursiops truncatus*	20	386	20	411
common dolphin	*Delphinus delphis*	3	54	1	8
Risso's dolphin	*Grampus griseus*	62	608	47	337
Striped dophin	*Stenella coeruleoalba*	14	1195	16	702
White-sided dolphin	*Lagenorhynchus acutus*	4	52	4	14
unid Stenella	*Stenella* (Genus)	1	48	0	0
Unid dolphin	*Delphinidae* (Family)	76	749	108	837
Unid toothed whale	*Odontoceti* (Suborder)	3	3	12	18
Fin whale	*Balaenoptera physalus*	10	16	7	9
Gervais beaked whale	*Mesoplodon europaeus*	2	14	0	0
Goosebeaked whale	*Ziphius cavirostris*	1	1	1	1
Killer whale	*Orcinus orca*	1	2	1	6
Pilot whale spp.	*Globicephala spp.*	26	251	12	129
Sei whale	*B. borealis*	1	1	0	0
Sowerby beaked whale	*M. bidens*	1	5	0	0
Sperm whale	*Physeter macrocephalus*	31	59	37	66
Fin or Sei whale	*B. physalus or B. borealis*	6	6	1	1
Unid beaked whale	*Mesoplodon spp*	10	19	9	18
Unid whale		14	21	17	18
TOTAL CETACEANS		**290**	**3571**	**297**	**2625**
Leatherback turtle	*Dermochelys Coriacea*	2	2	5	6
Loggerhead turtle	*Caretta caretta*	9	10	5	5
Unid turtle		9	9	4	4
TOTAL TURTLES		**20**	**21**	**14**	**15**
Manta ray	*Manta birostris*	1	1	1	1
sharks	*Selachimorpha* (superorder)	1	1	4	4
Sunfish	*Mola mola*	12	14	15	19

Table 5. Initial comparison of visual sighting data with manually evaluated acoustic events for four survey days. Note that both the acoustic, as well as the visual data used for this comparison, were considered to be preliminary. Further analyses with cleaned data sets are pending.

Date (Aug 2009)	# Acoustic Event Groups	Probable Visual Confirm	Possible Visual Confirm	Visual Confirm Unknown Or Unlikely	No Visual Detection	Sperm Whale Acoustic Detections
7	10	4	4	0	2	X
8	11	2	2	5	2	X
9	4	0	0	1	3	X
10	8	1	2	2	3	X
11		Visual data not available for comparison				
12						
13						
14						
15						
16						
TOTALS	33	7	8	8	10	

Table 5. Locations and timing of deploying the VPR, CTD, bongo nets, and neuston nets

Date-GMT	Start Time GMT	End Time GMT	Gear type	CTD Cast	Closest Waypoint	VPR haul	Start Lat	Start Long	end Lat	end Long	Bottom Depth (m)	Sampling Depth (m)
6-Aug-09	0356	0605	VPR	301	018	001	3929.6	7124.9	3932.8	7124.6	2199	300
6-Aug-09	0909		bongo	001	018		3929.5	7124.4			2211	200
6-Aug-09	1553		bongo	002	019		3938.4	7218.4			115	114
6-Aug-09	2216		bongo	003	020		3901.2	7220.9			1531	200
6-Aug-09	2256		CTD	004	020		3902.2	7221.5			1478	500
6-Aug-09	2330	0102	VPR	302	020	002	3901.6	7223.4	3904.3	7230.4	1508	300
7-Aug-09	0135	0235	VPR	303	020	003	3903.7	7233.7			1056	100
7-Aug-09	0437	0540	VPR	304	021	004	3903.7	7233.8	3904.5	7236.5	1148	100
7-Aug-09	1617		bongo	005	021		3833.8	7258.1				200
7-Aug-09	2258		bongo	006	022		3827.2	7341.9			72	68
7-Aug-09	2310		CTD	007	022		3826.8	7342.1			73	50
8-Aug-09	0024	0120	VPR	305	022	005	3827.9	7340.9	7332.1	7339.6	72	68
8-Aug-09	0205	0256	VPR	306	022	006	3826.4	7336.5	3825.7	7332.1	102	100
8-Aug-09	0310		neuston	008	022		3825.8	7331.5			375	200
8-Aug-09	0905		bongo	009	005		3843.3	7232.3			2314	200
8-Aug-09	1604		bongo	010	005		3817.2	7117.0			3000+	200
8-Aug-09	2221		bongo	011	005		3756.6	7014.7			3757	200
8-Aug-09	2329		CTD	012	005		3756.8	7013.5			3762	503
9-Aug-09	0030	0150	VPR	307	005	007	3756.8	7011.6	3759.5	7011.1	3779	100
9-Aug-09	0255	0420	VPR	308	005	008	3800.2	7020.5	3800.1	7018.8	3648	112
9-Aug-09	0504	0613	VPR	309	005	009	3800.4	7024.8	3759.0	7022.0	3609	100
9-Aug-09	1620		bongo	013	004		3730.4	6858.2			4269	200
9-Aug-09	2217		bongo	014	004		3805.5	6855.4			3913	201
9-Aug-09	2301		CTD	015	004		3804.6	6854.5			3927	504
9-Aug-09	2350		neuston	016	004		3805.3	6853.0			3926	275
10-Aug-09	0155	0305	VPR	310	004	010	3755.7	6850.5	3753.9	6846.9	4056	198
10-Aug-09	0342	0455	VPR	311	004	011	3753.2	6846.6	3751.1	6836.9	4122	197
10-Aug-09	0823		CTD	017	004		3755.6	6850.1			4062	205
10-Aug-09	1614		bongo	018	003		3907.9	6850.7			3023	200

Date-GMT	Start Time GMT	End Time GMT	Gear type	CTD Cast	Closest Waypoint	VPR haul	Start Lat	Start Long	end Lat	end Long	Bottom Depth (m)	Sampling Depth (m)
10-Aug-09	2226		bongo	019	003		3944.6	6832.8			2476	201
10-Aug-09	2303		CTD	020	003		3944.7	6832.8			2511	503
11-Aug-09	0245	0412	VPR	312	012	012	4006.6	6814.1	3959.6	6818.6	1599	100
11-Aug-09	0550	0704	VPR	313	012	013	4013.1	6811.0	4012.0	6814.1	640	103
11-Aug-09	0901		bongo	021	012		3957.2	6817.8			2259	203
11-Aug-09	1210		bongo	022	011		4032.8	6755.4			101	92
11-Aug-09	2226		bongo	023	010		4012.4	6717.0			2271	222
11-Aug-09	2306		CTD	024	010		4011.6	6716.8			2354	504
11-Aug-09	2345		neuston	025	010		4011.6	6715.9			2459	175
12-Aug-09	0043	0200	VPR	314	010	014	4010.6	6714.2	4014.1	6718.4	2575	123
12-Aug-09	0235	0334	VPR	315	010	015	4014.1	6718.6	4015.0	6721.6	1913	79
12-Aug-09	0420	0514	VPR	316	011	016	4017.7	6727.8	4021.7	6731.9	1390	100
12-Aug-09	0553	0620	VPR	317	011	017	4020.1	6732.1	4020.1	6732.8	760	206
12-Aug-09	1625		bongo	026	010		3959.3	6624.7			3584	201
12-Aug-09	2332		bongo	027	002		3927.3	6528.9			3256	202
13-Aug-09	0009		CTD	028	002		3927.1	6529.2			3211	504
13-Aug-09	0014		neuston	029	002		3928.0	6528.1			3483	59
13-Aug-09	0404	0505	VPR	319	002	019	3930.5	6530.6	3927.0	6527.2	4390	75
13-Aug-09	1616		bongo	030	002		3908.5	6610.8			4542	201
14-Aug-09	0405		CTD	031	012		4000.6	6825.1			2029	505
14-Aug-09	0445	0523	VPR	320	012	020	4000.7	6825.8	4001.6	6826.6	2074	103
14-Aug-09	0530		neuston	032	012		4001.7	6826.6			1843	76
14-Aug-09	0630		neuston	033	012		4003.1	6826.4			1544	35
14-Aug-09	0900		bongo	034	012		3957.8	6818.0			2248	202
14-Aug-09	1630		bongo	035	013		4003.3	6907.0			165	155
15-Aug-09	0002		bongo	036	014		3951.1	6934.4			1511	202
15-Aug-09	0043		CTD	037	014		3951.5	6935.1			1428	501
15-Aug-09	0147	0257	VPR	321	014	021	3951.3	6935.6	3953.8	6935.7	1250	67
15-Aug-09	0622	0742	VPR	322	014	022	3954.6	6941.8	3950.3	6946.9	325	63
15-Aug-09	1621		bongo	038	016		3957.3	7015.9			700	200
15-Aug-09	2356		CTD	039	016		3946.6	7040.1			1544	501

Date-GMT	Start Time GMT	End Time GMT	Gear type	CTD Cast	Closest Waypoint	VPR haul	Start Lat	Start Long	end Lat	end Long	Bottom Depth (m)	Sampling Depth (m)
16-Aug-09	0045	0056	VPR	323	016	023	3947.1	7040.2	3947.6	7040.7	1419	69
16-Aug-09	0107	0205	VPR	324	016	024	3947.8	7040.8	3951.1	7043.3	1313	76
16-Aug-09	0245	0325	VPR	325	017	025	3955.2	7048.0	3957.2	7049.3	507	67
16-Aug-09	0345		neuston	040	017		3957.3	7049.1			451	37
16-Aug-09	0436		neuston	041	017		4000.1	7050.6			292	26
16-Aug-09	0715		bongo	042	016		3941.4	7036.4			2104	202
16-Aug-09	1609		bongo	043	017		4003.7	7109.6			208	198
16-Aug-09	2205		bongo	044	018		3931.5	7124.0			2287	206

Figure 1. Track lines for the August 5-17, 2009 cetacean and turtle abundance shake-down cruise and locations of tows of neuston nets (▲), CTD's only (■), and a combination of a bongo and CTD (●).

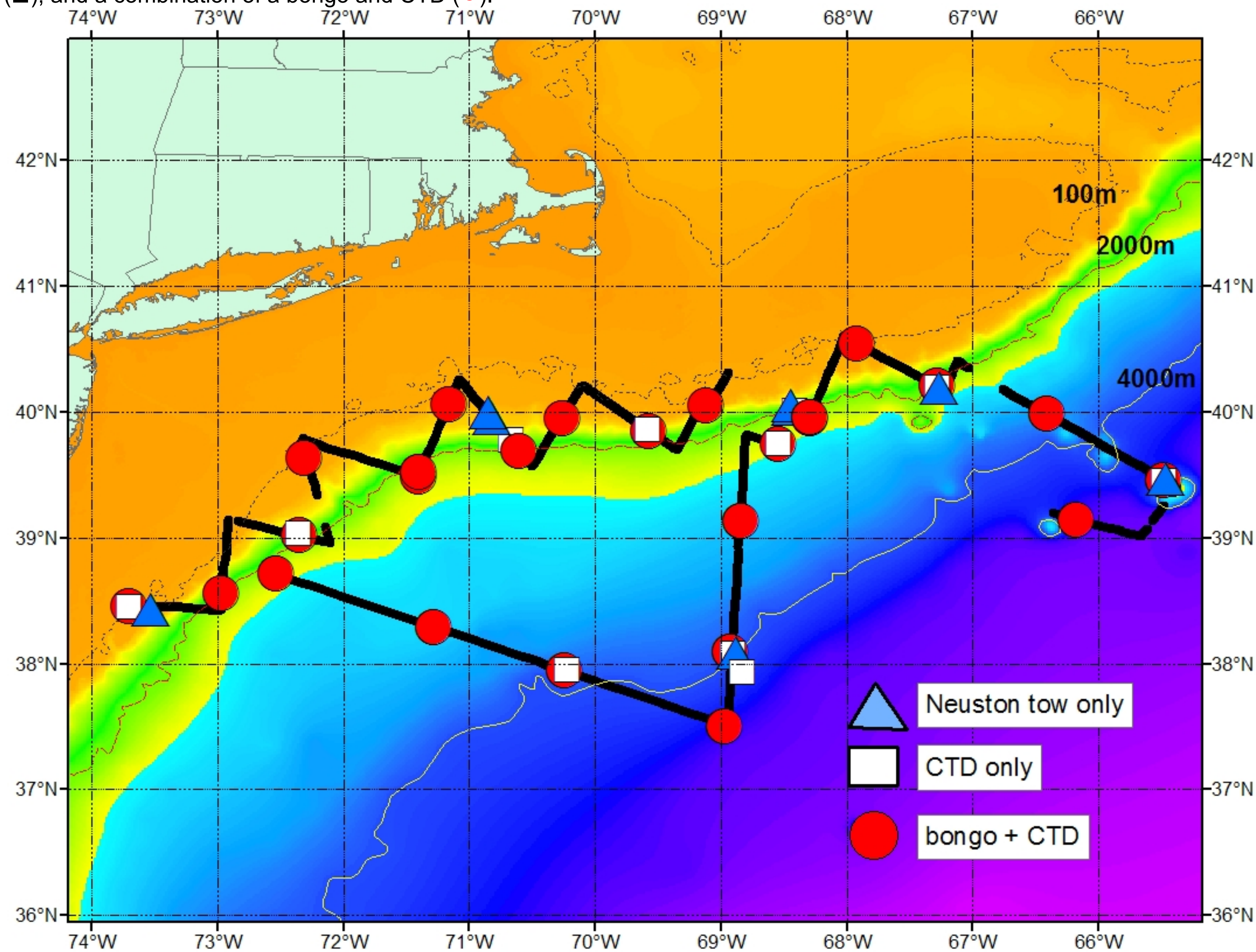


Figure 2. Locations of groups of Atlantic spotted dolphins, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

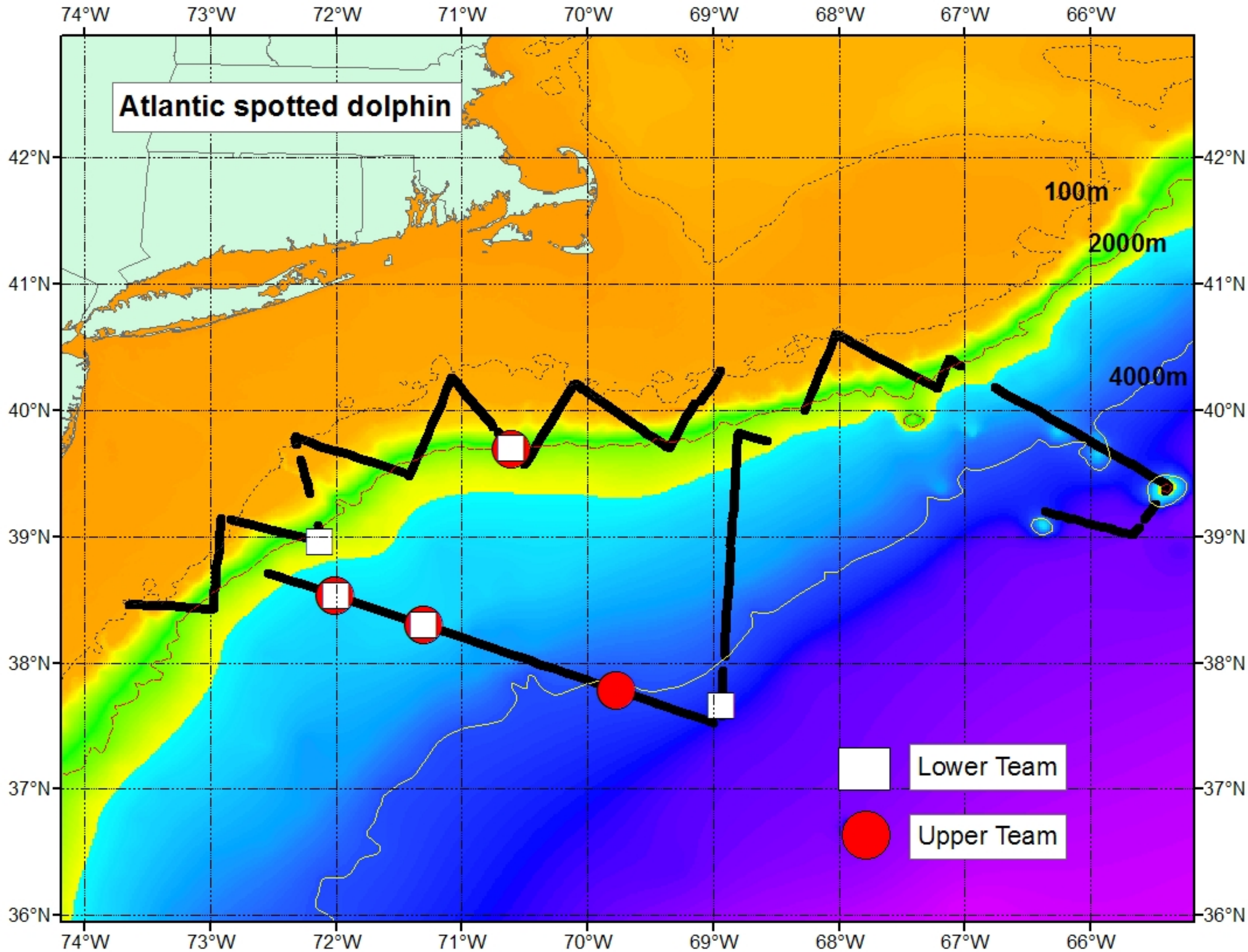


Figure 3. Locations of groups of bottlenose dolphins, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

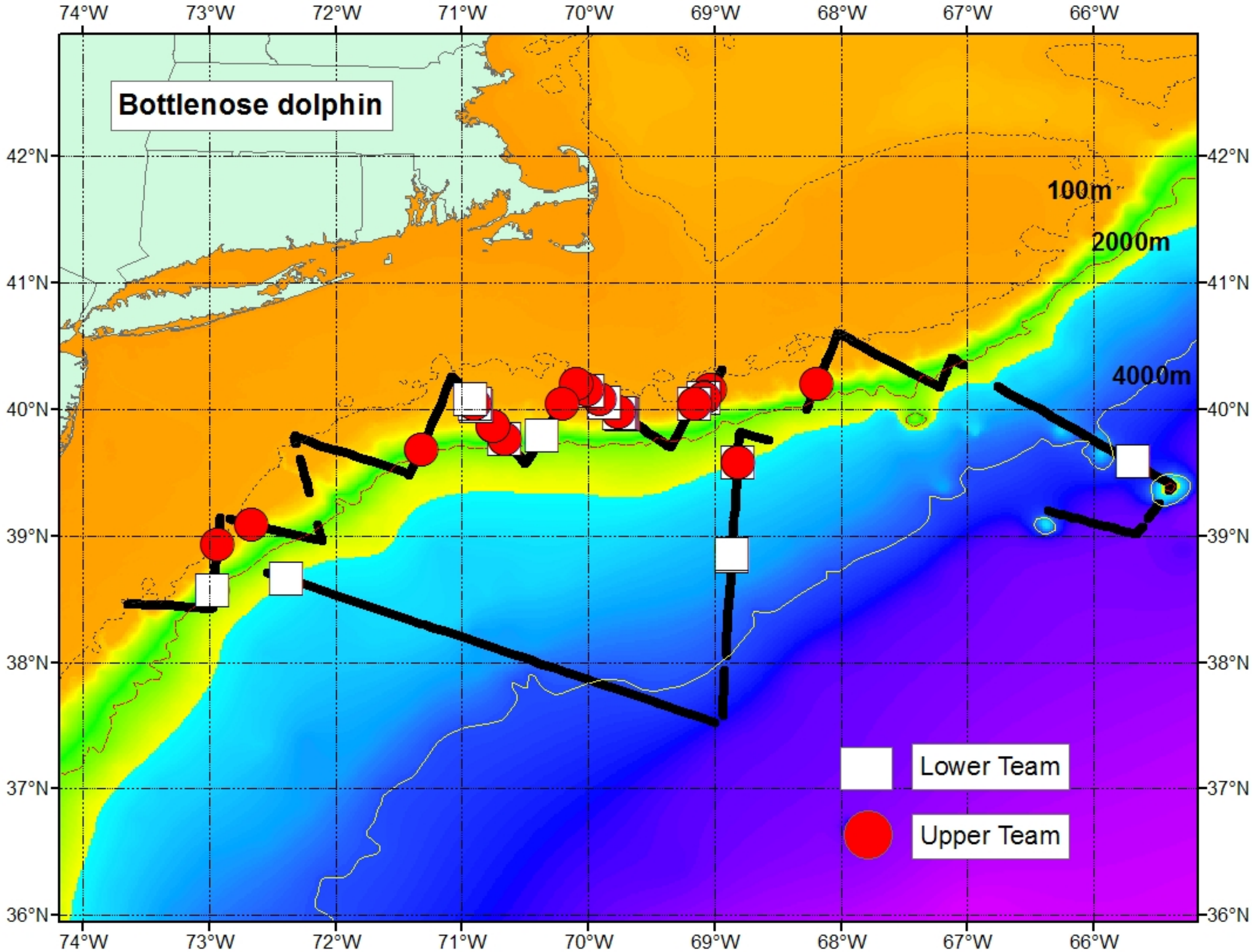


Figure 4. Locations of groups of Risso's dolphins, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

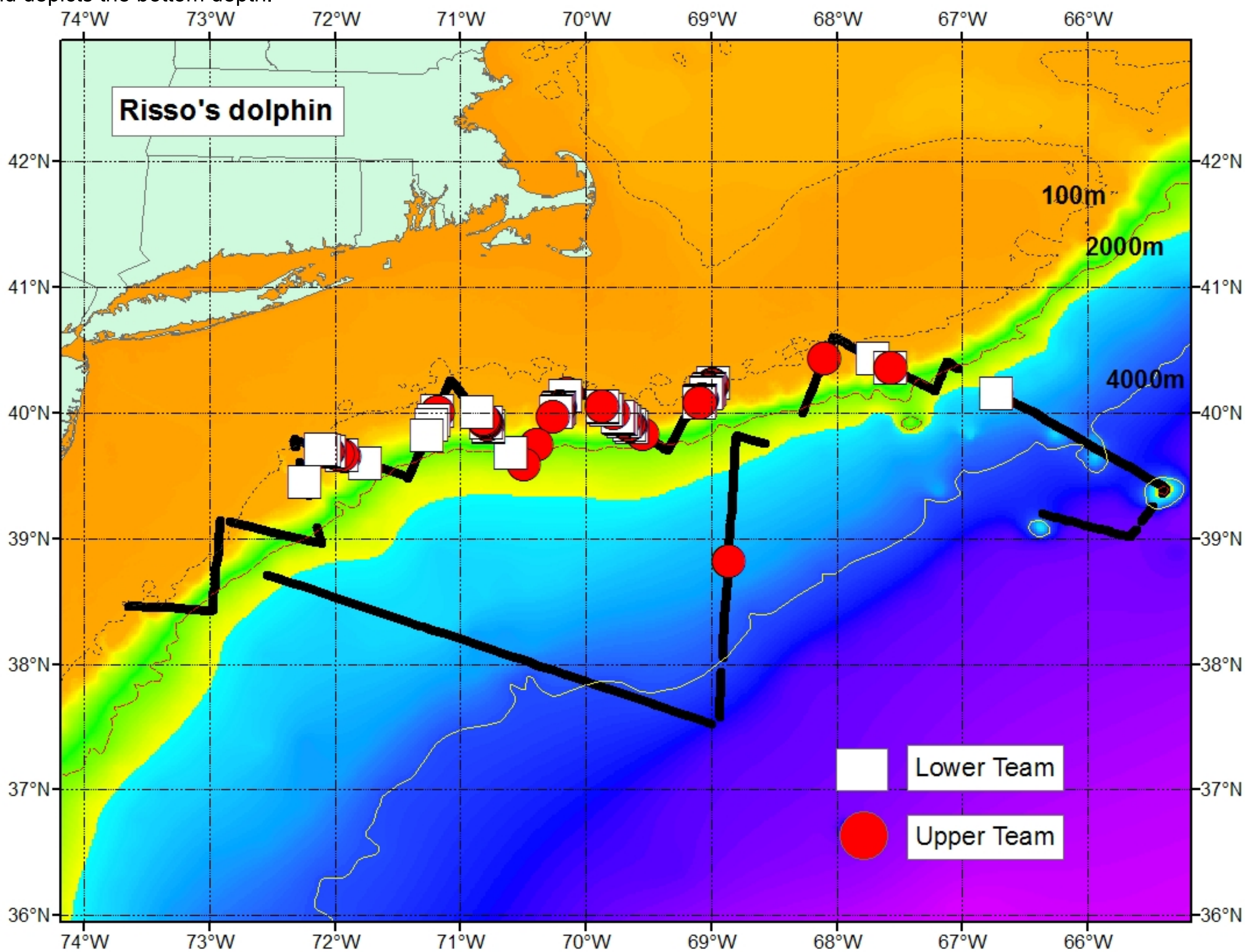


Figure 5. Locations of groups of striped dolphins, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

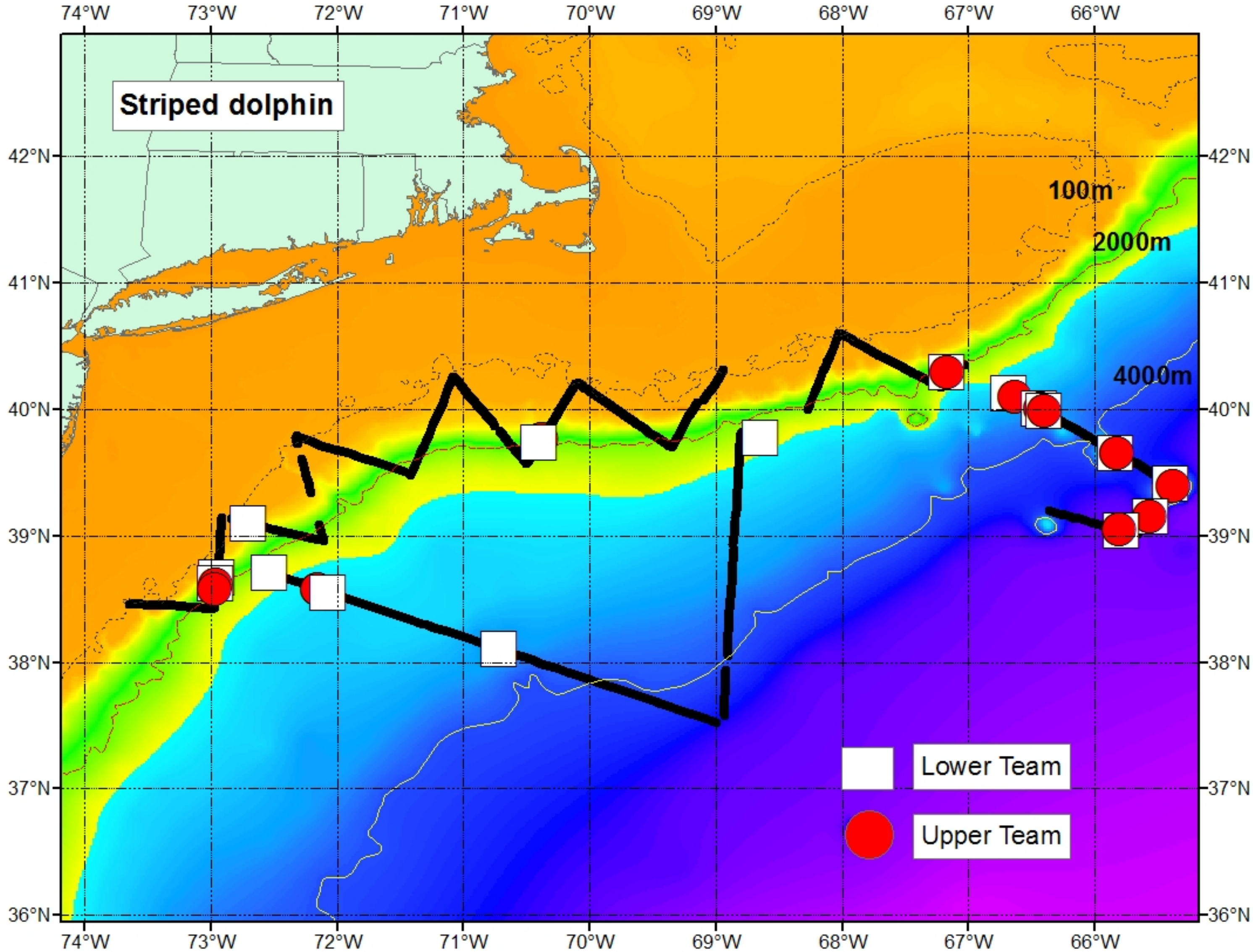


Figure 6. Locations of groups of white-sided dolphins, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

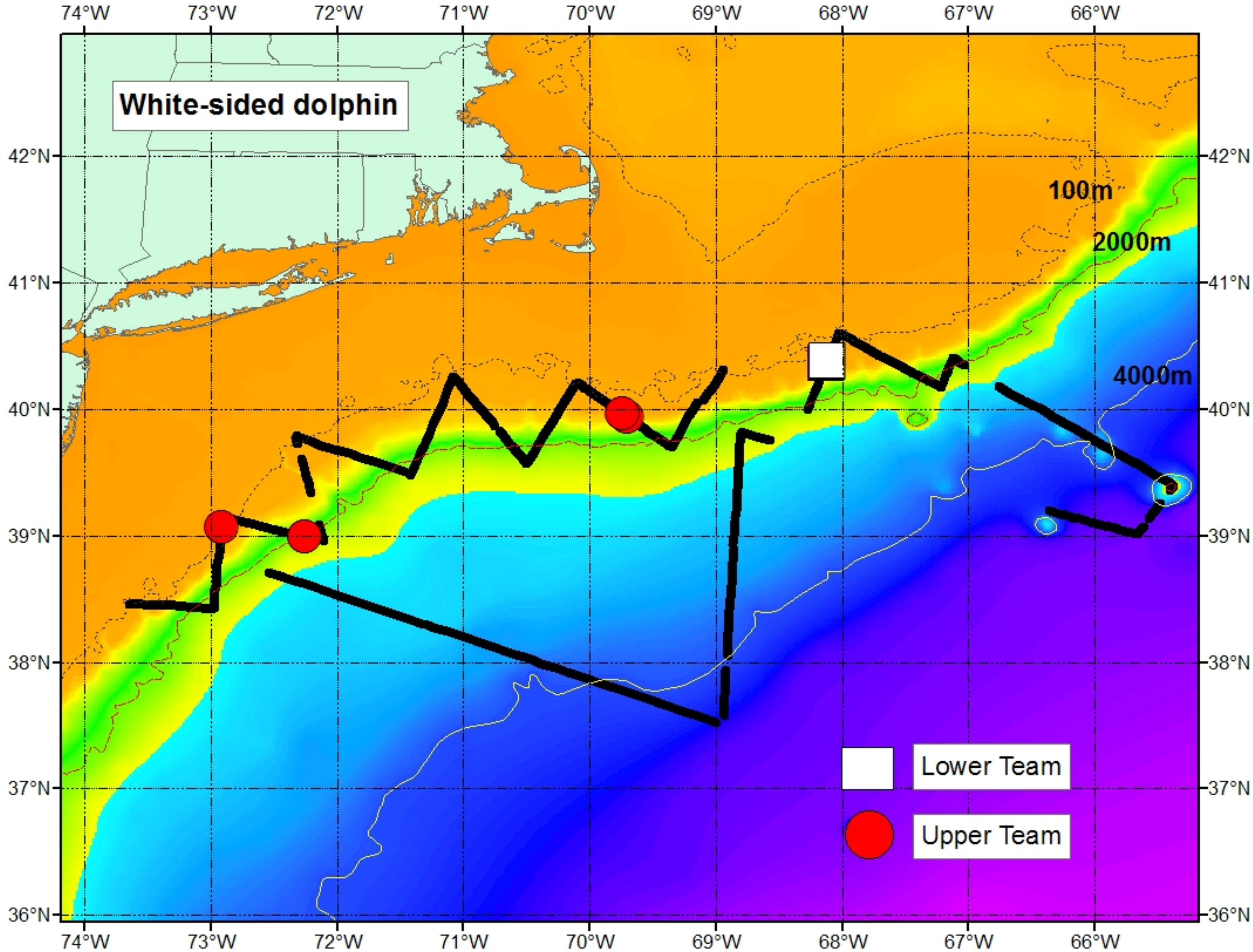


Figure 7. Locations of groups of fin whales, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

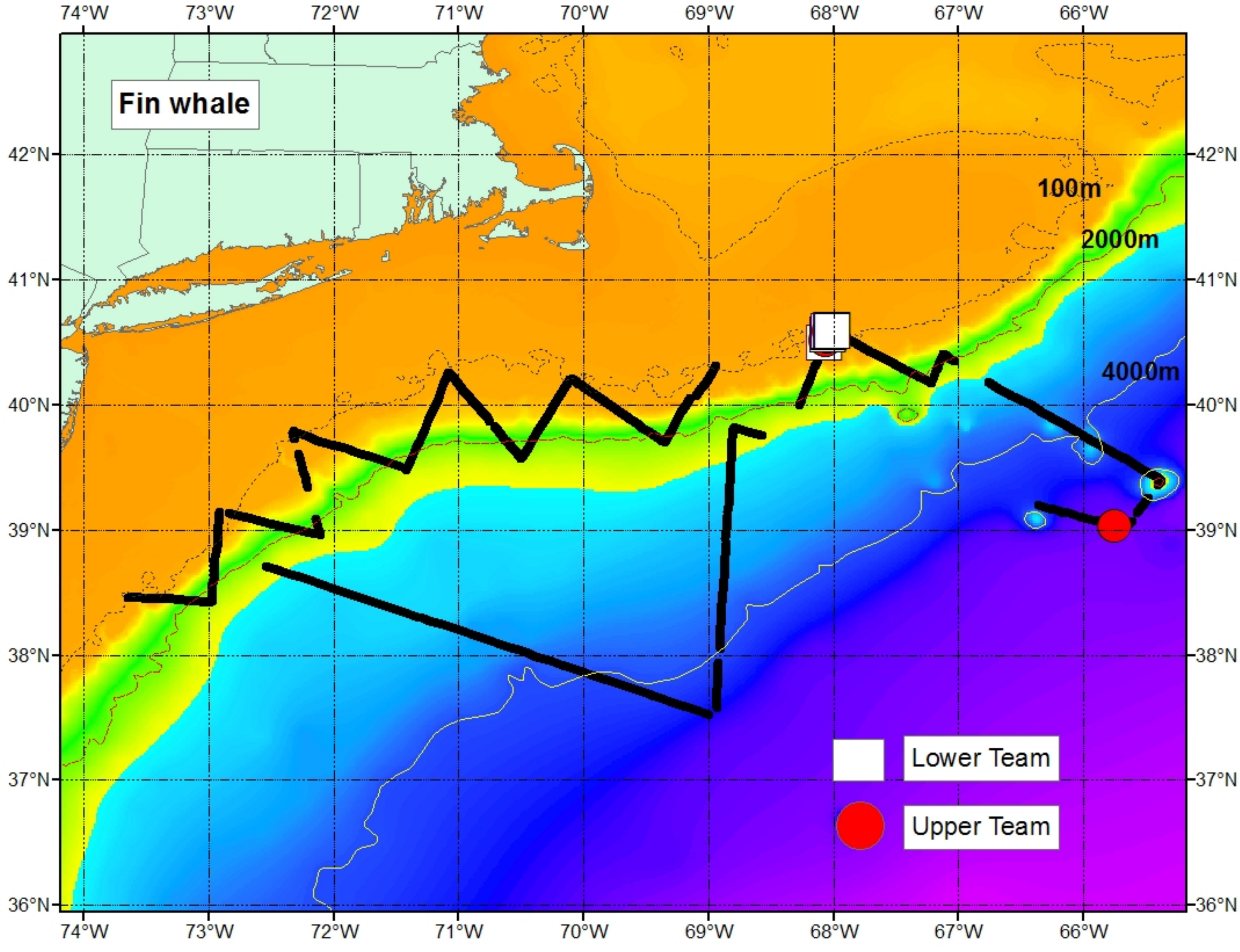


Figure 8. Locations of groups of sei whales and groups that could either a fin or sei whale, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

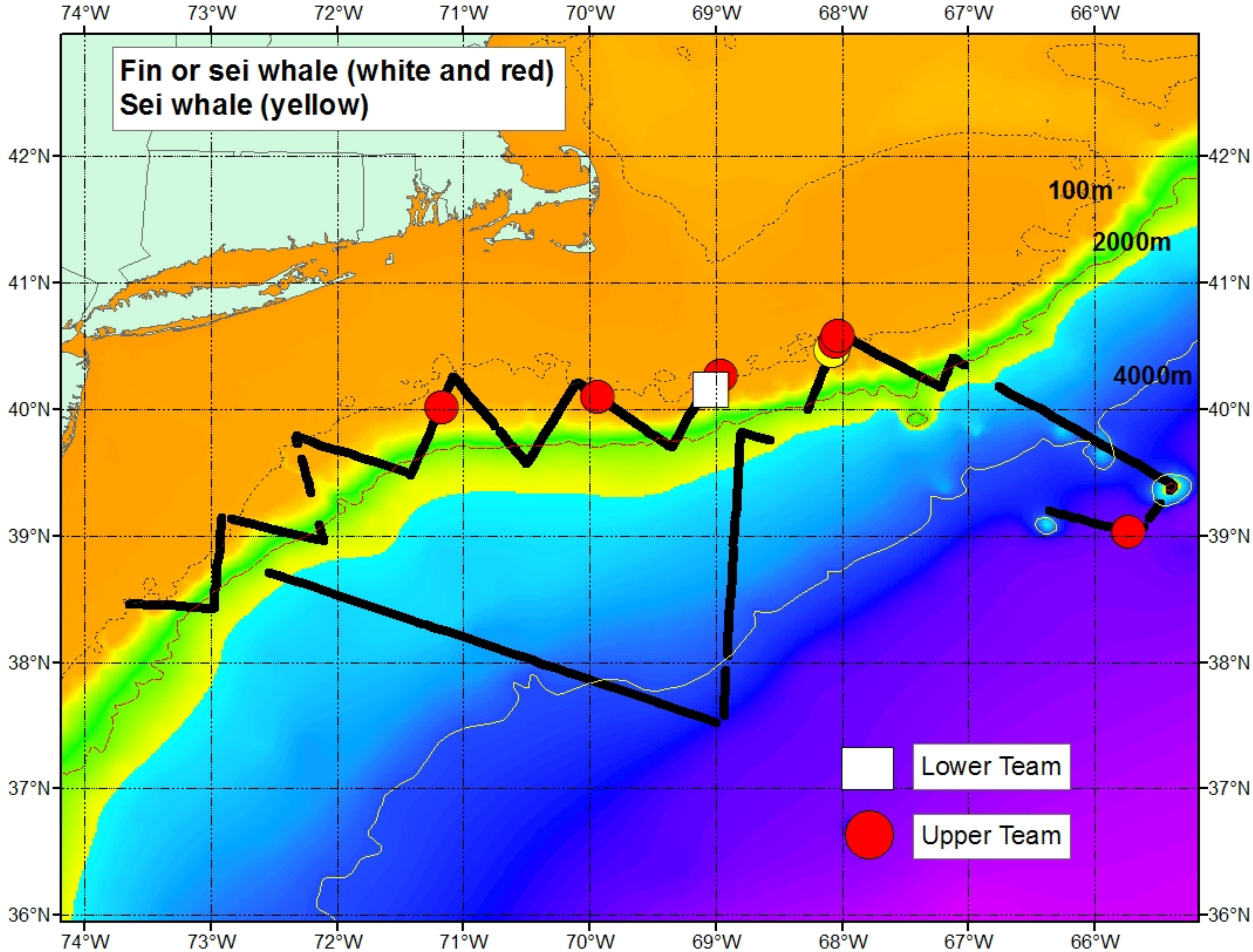


Figure 9. Locations of groups of beaked whales, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

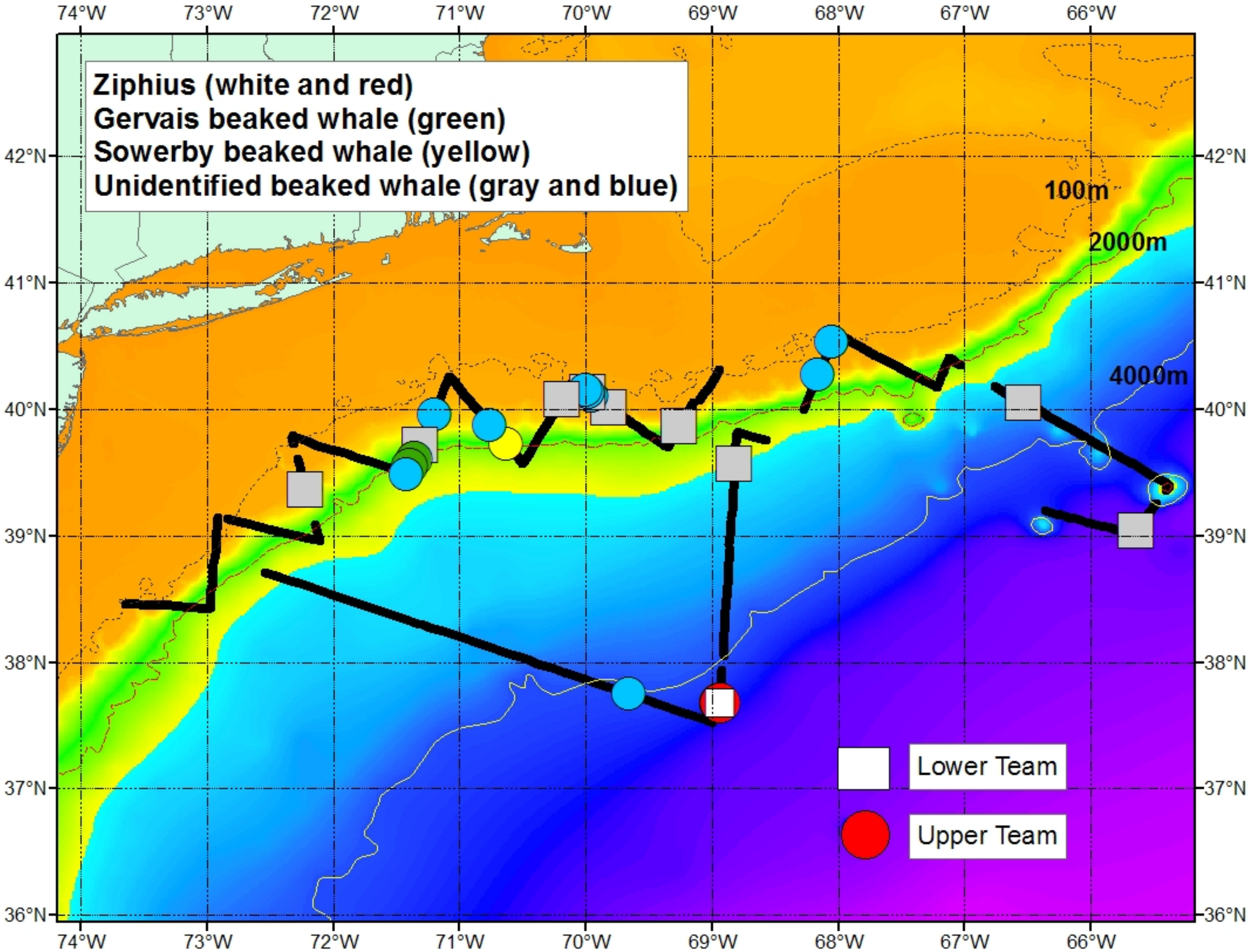


Figure 10. Locations of groups of killer whales, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

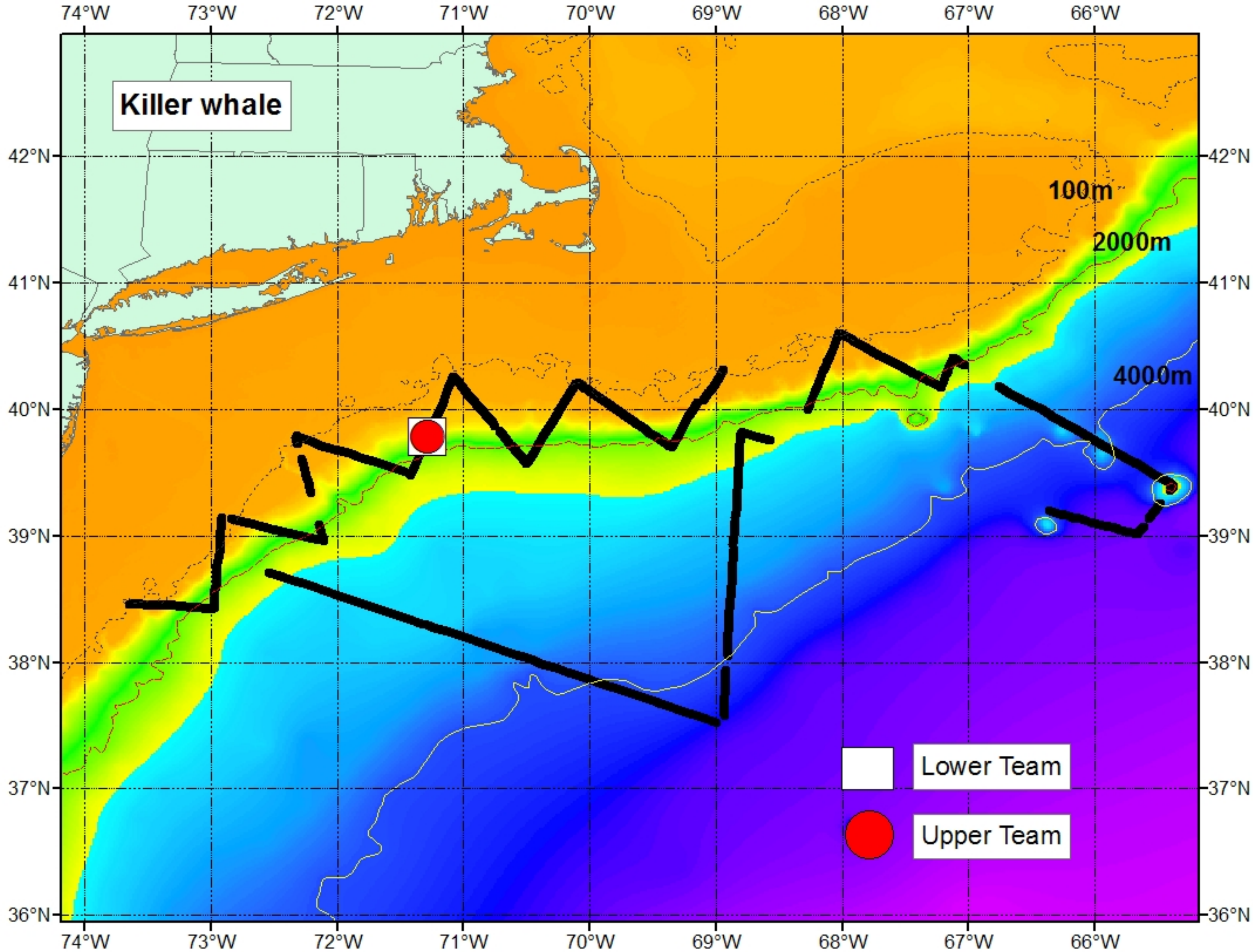


Figure 11. Locations of groups of pilot whales, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

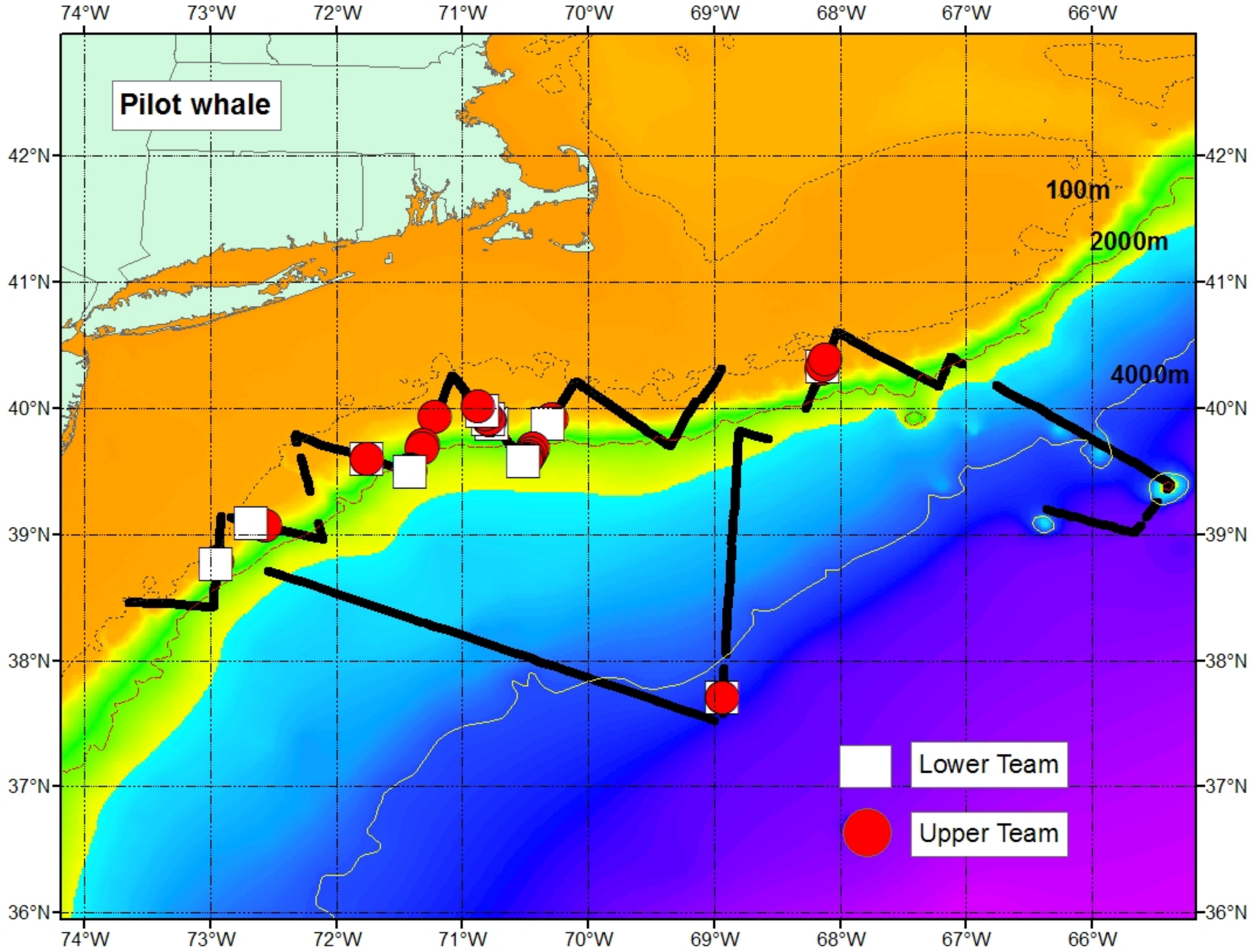


Figure 12. Locations of groups of sperm whales, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

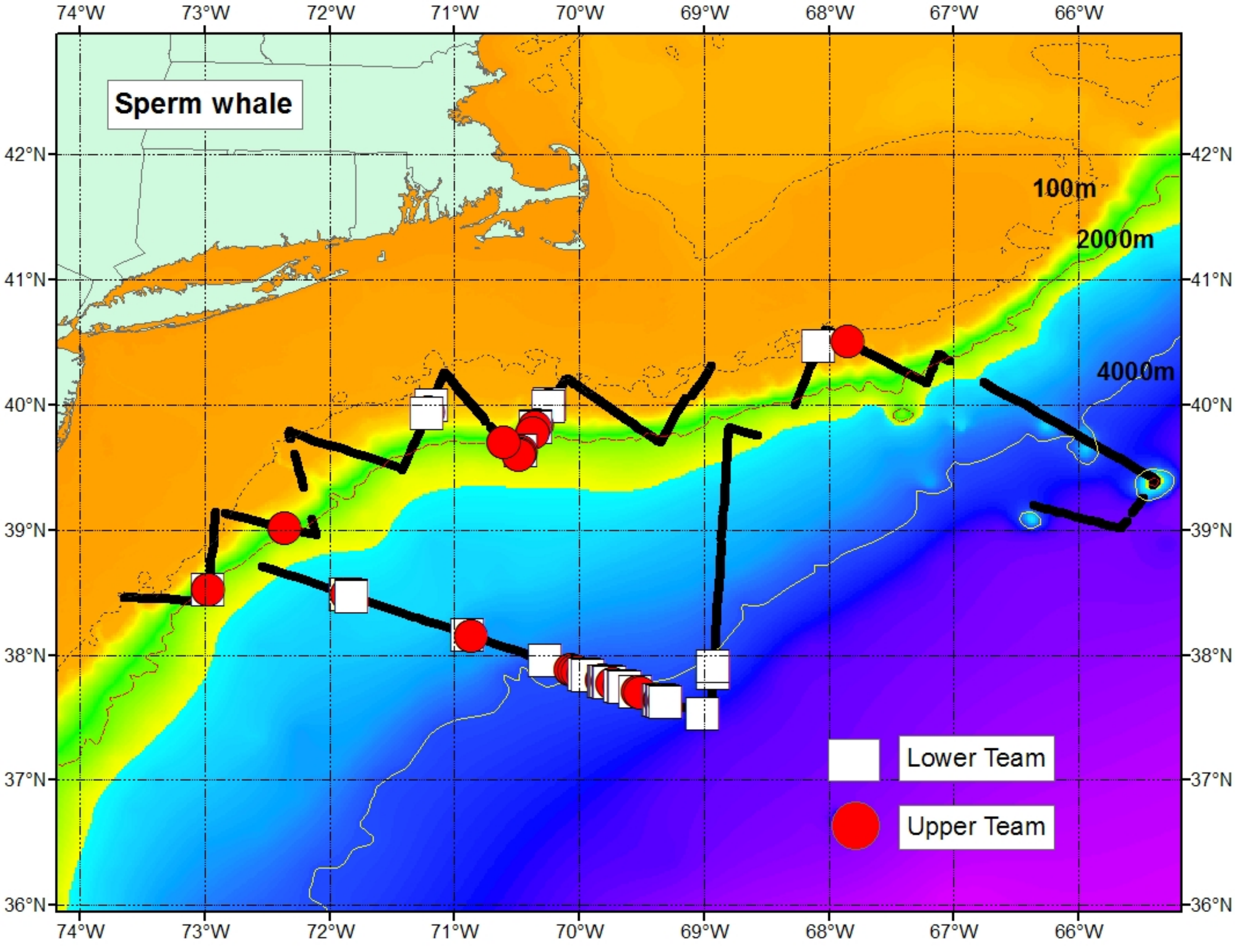


Figure 13. Locations of groups of leatherback turtles, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

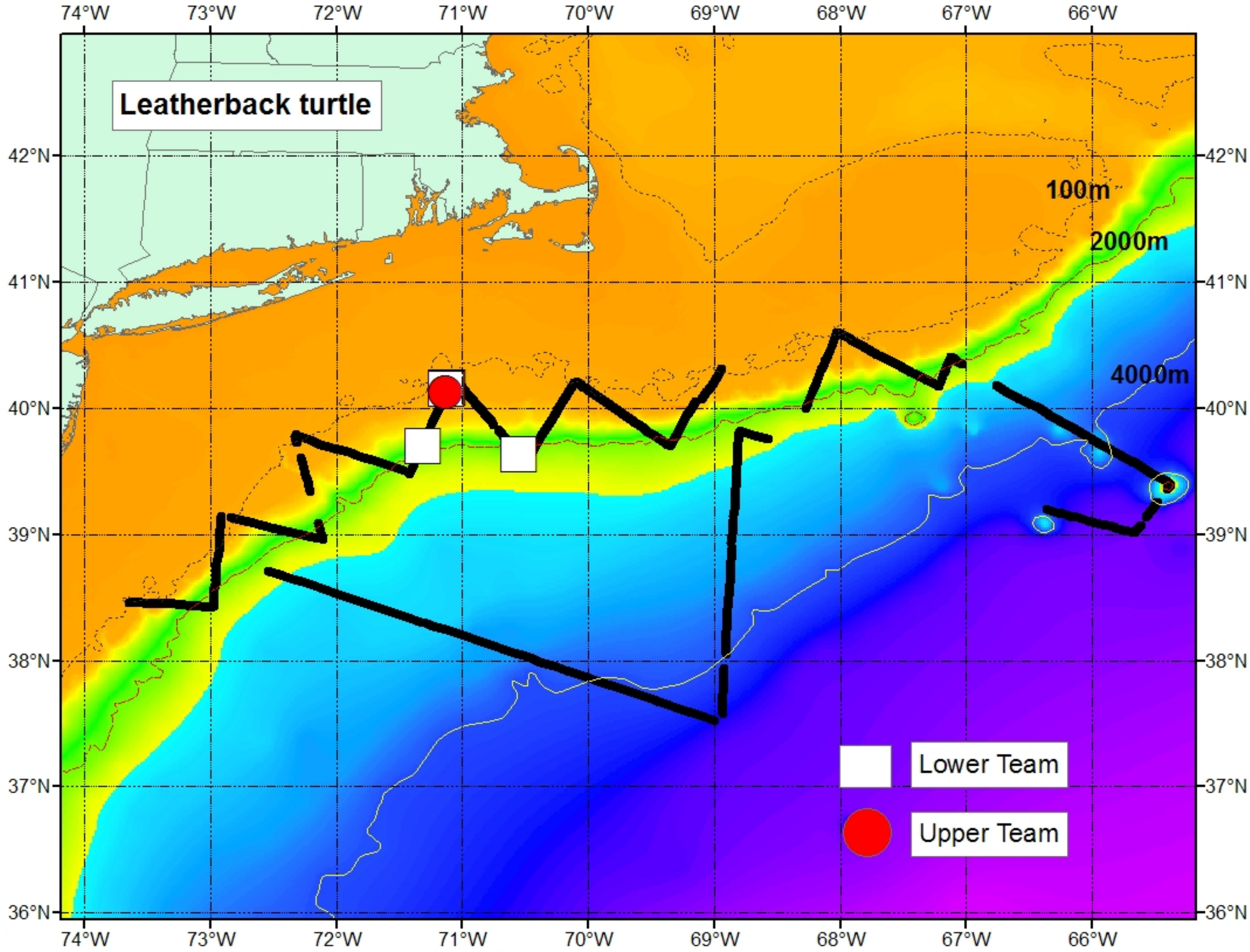


Figure 14. Locations of groups of loggerback turtles, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

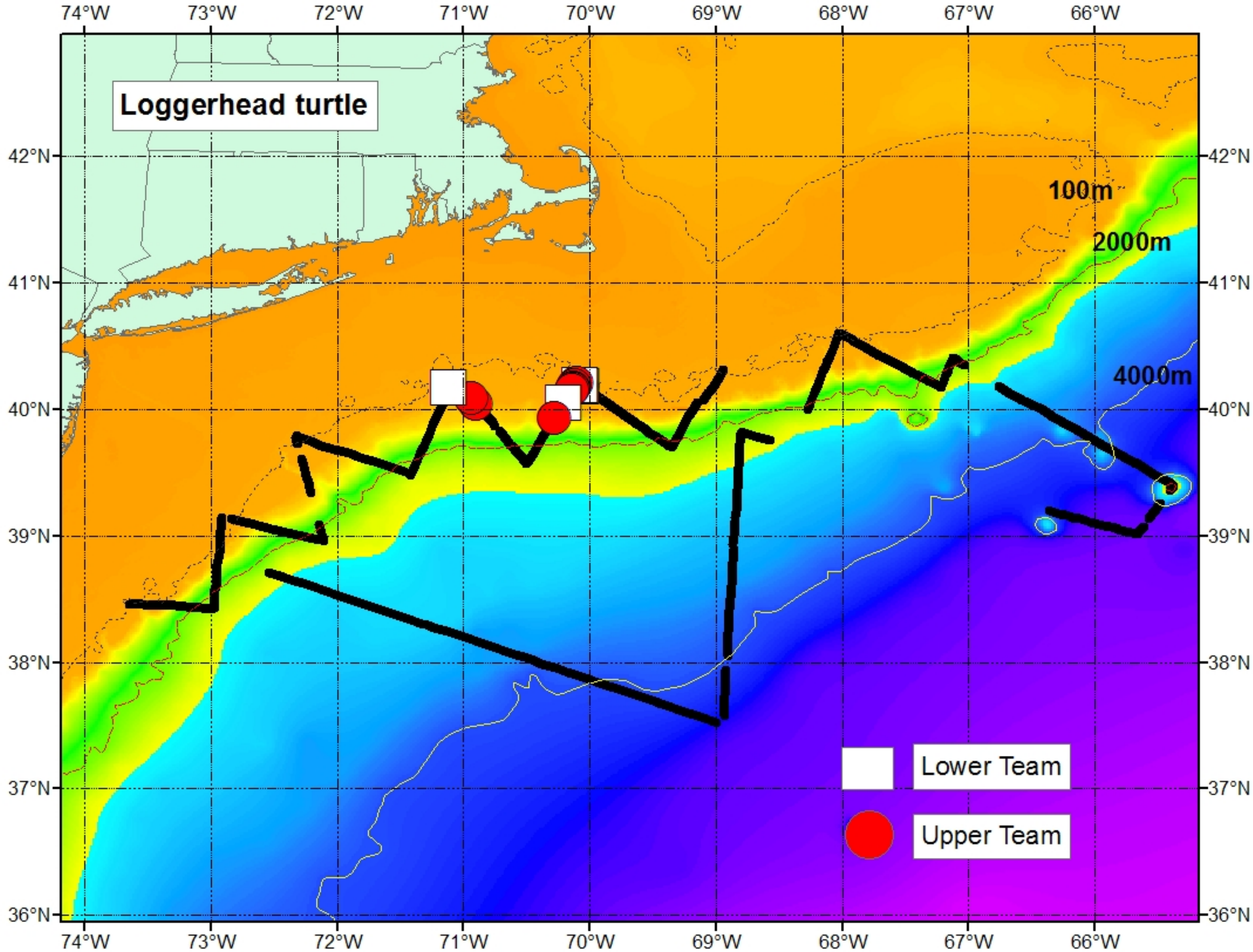


Figure 15. Locations of groups of unidentified turtles, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

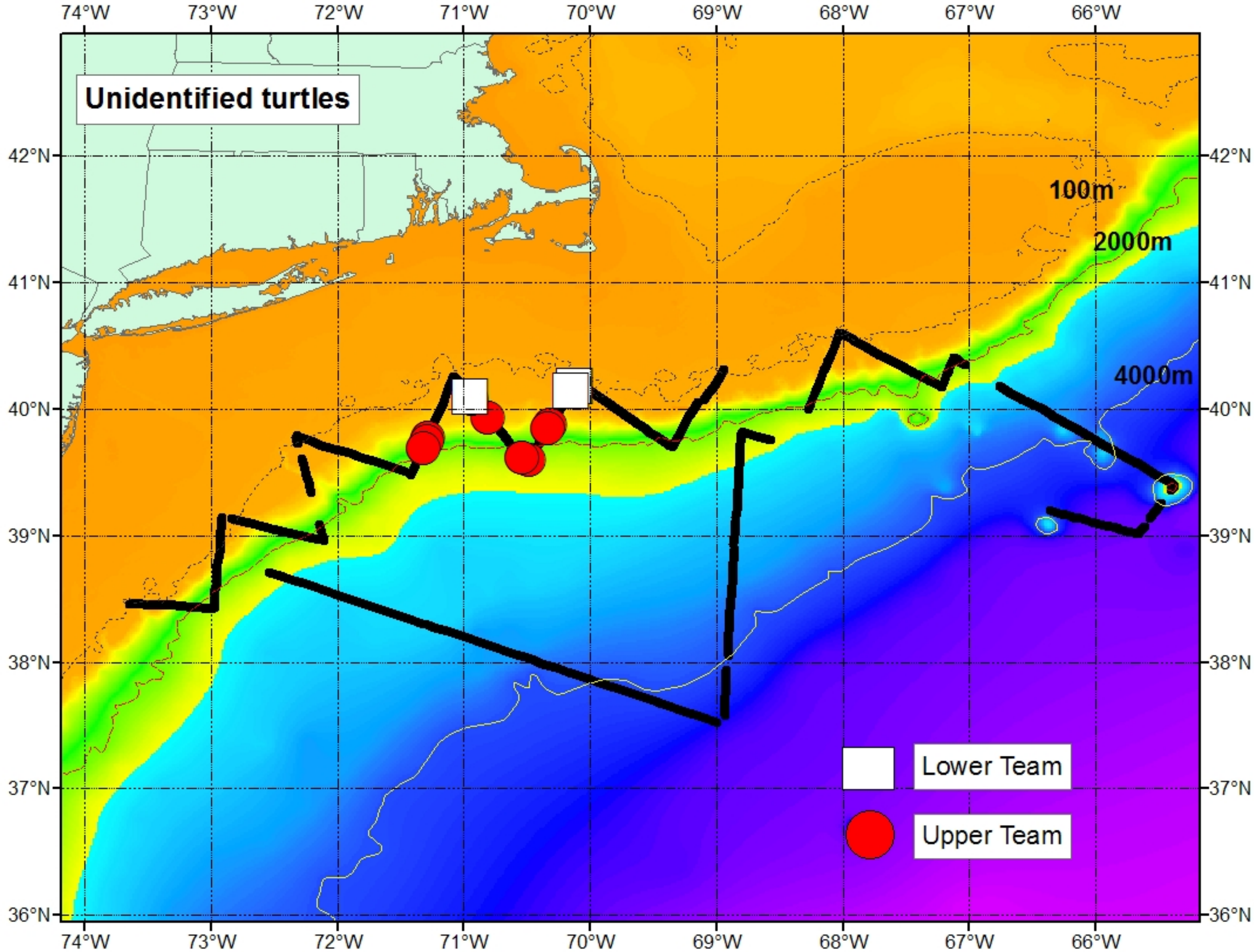


Figure 16. Locations of groups of sunfish, as seen by the upper and lower teams. Note, some groups were seen by both teams. Color background depicts the bottom depth.

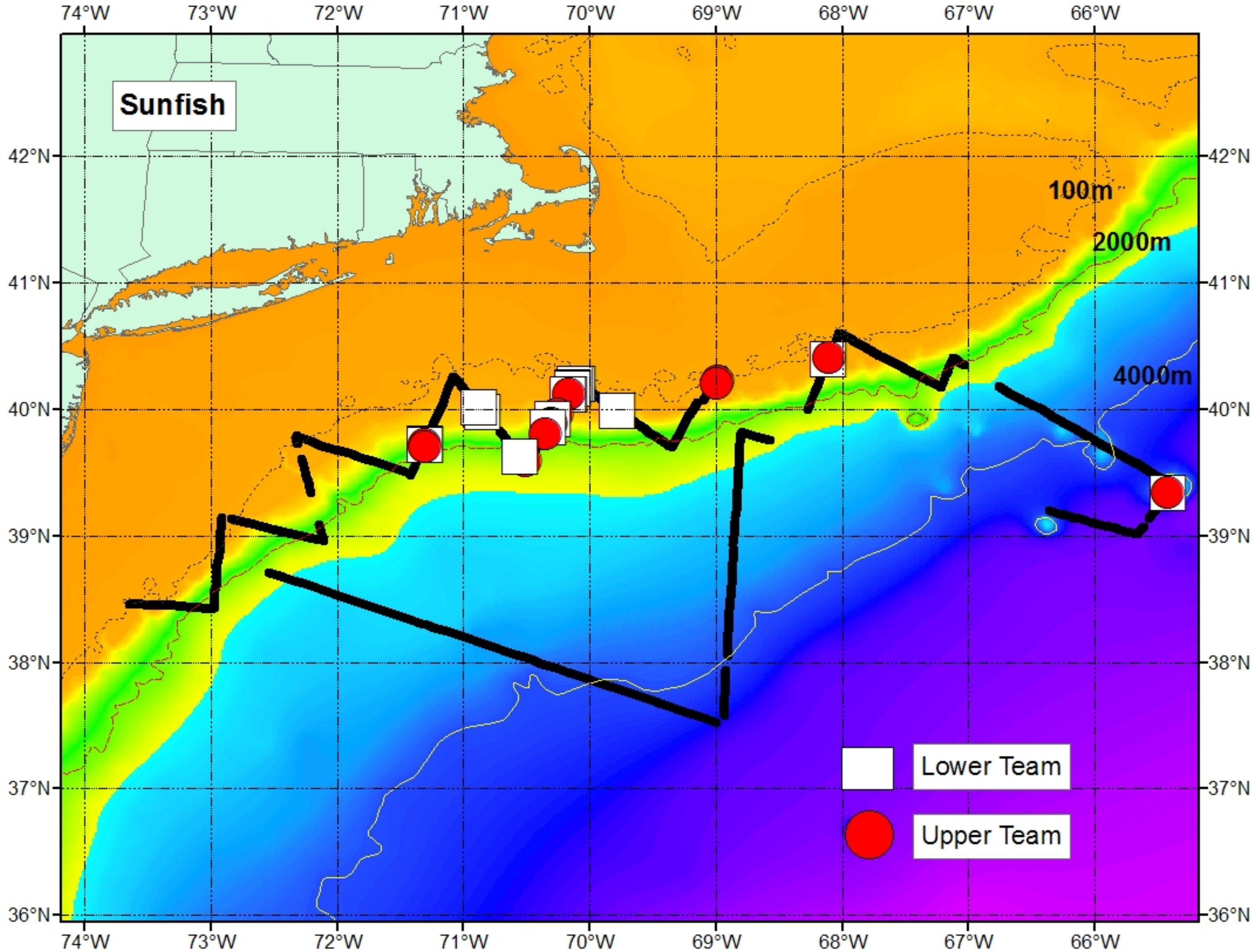


Figure 17. Map depicting all detections with the Mid Frequency acoustic system. Sperm whale detections are indicated in yellow.

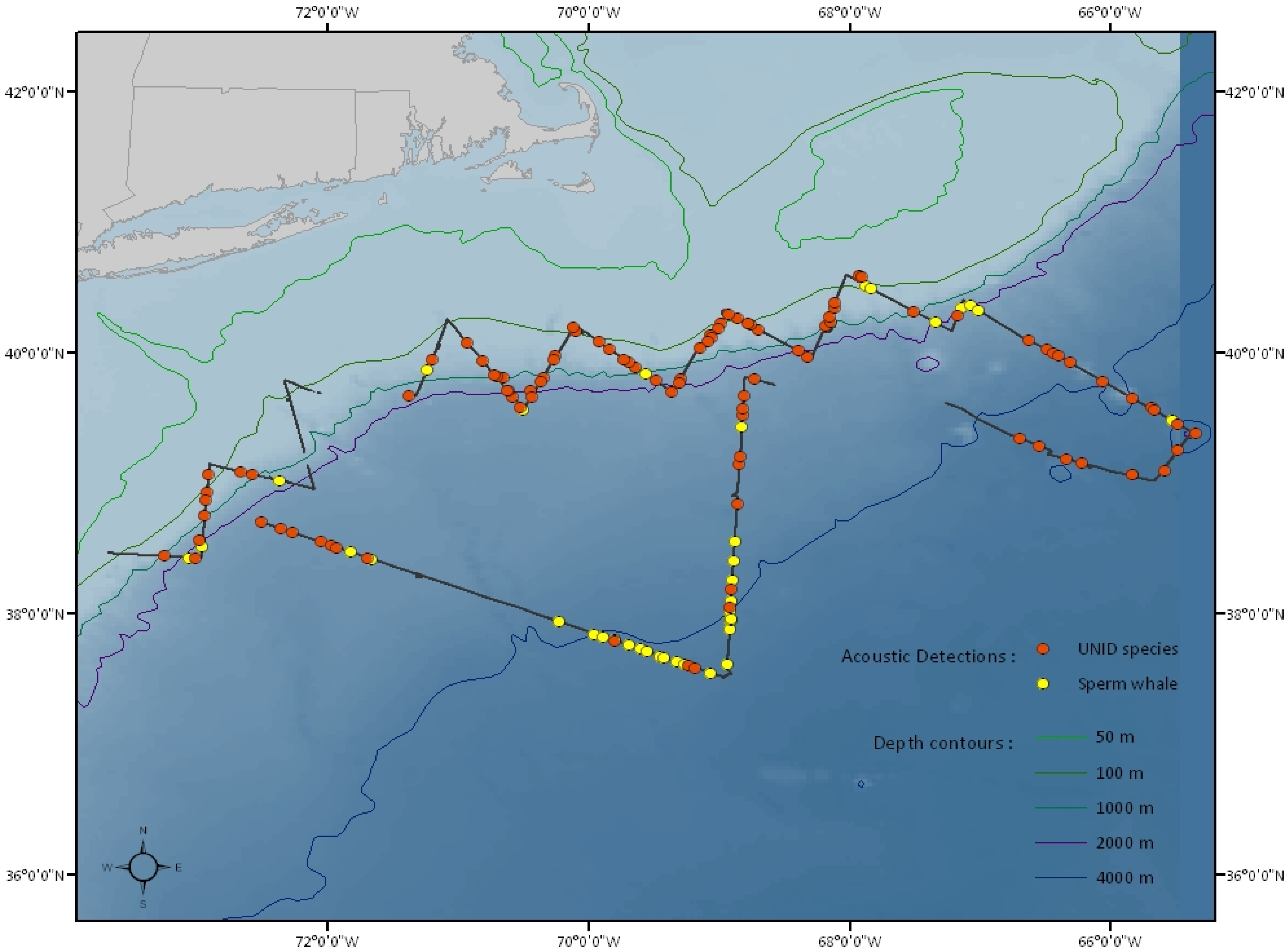


Figure 18. Screenshot example of the PAMGUARD GUI. Individual lines show bearings to detected clicks (with left/right ambiguity). Crossings of these bearing lines indicate the range of the acoustically tracked group from the trackline.

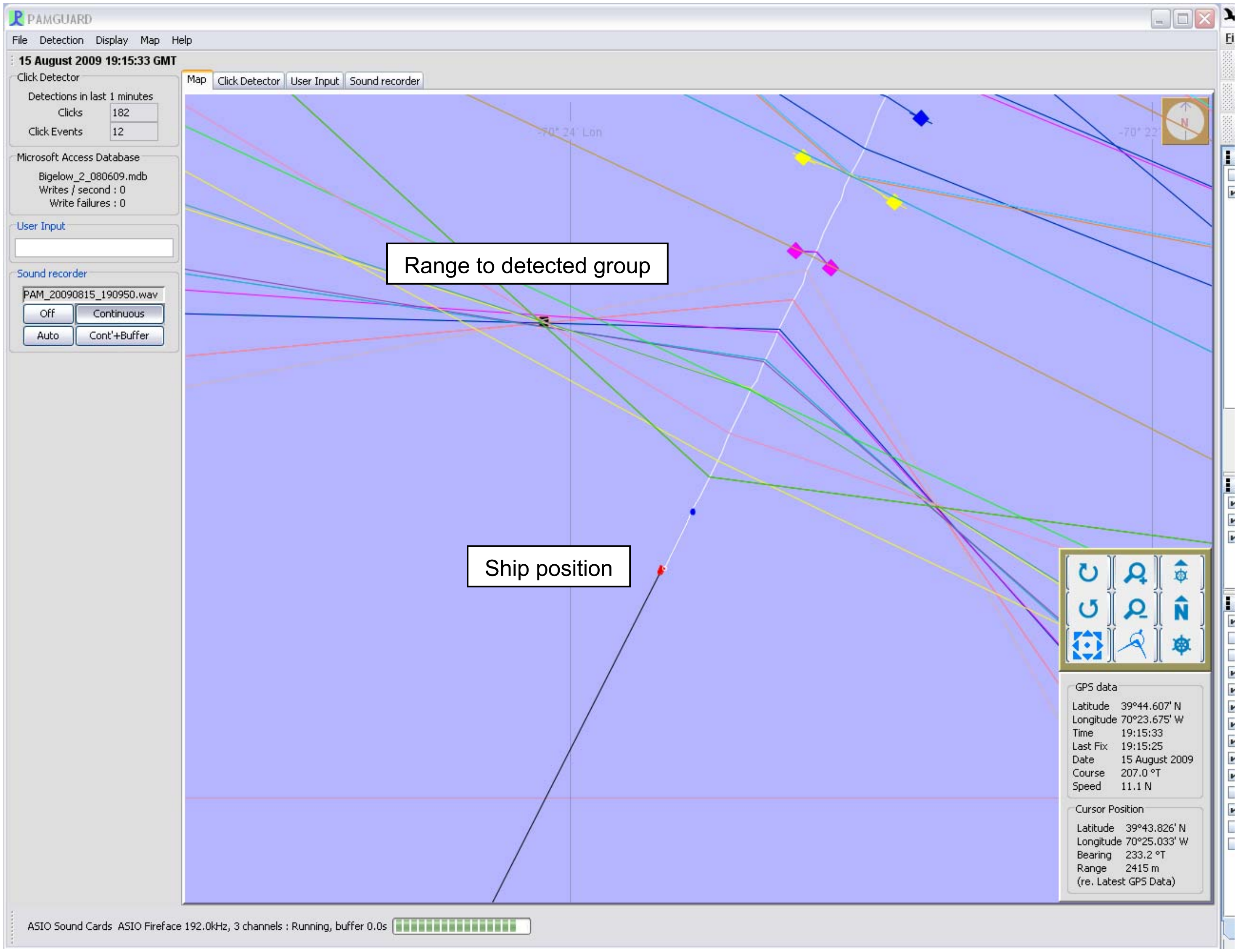


Figure 19. Location of VPR tows.

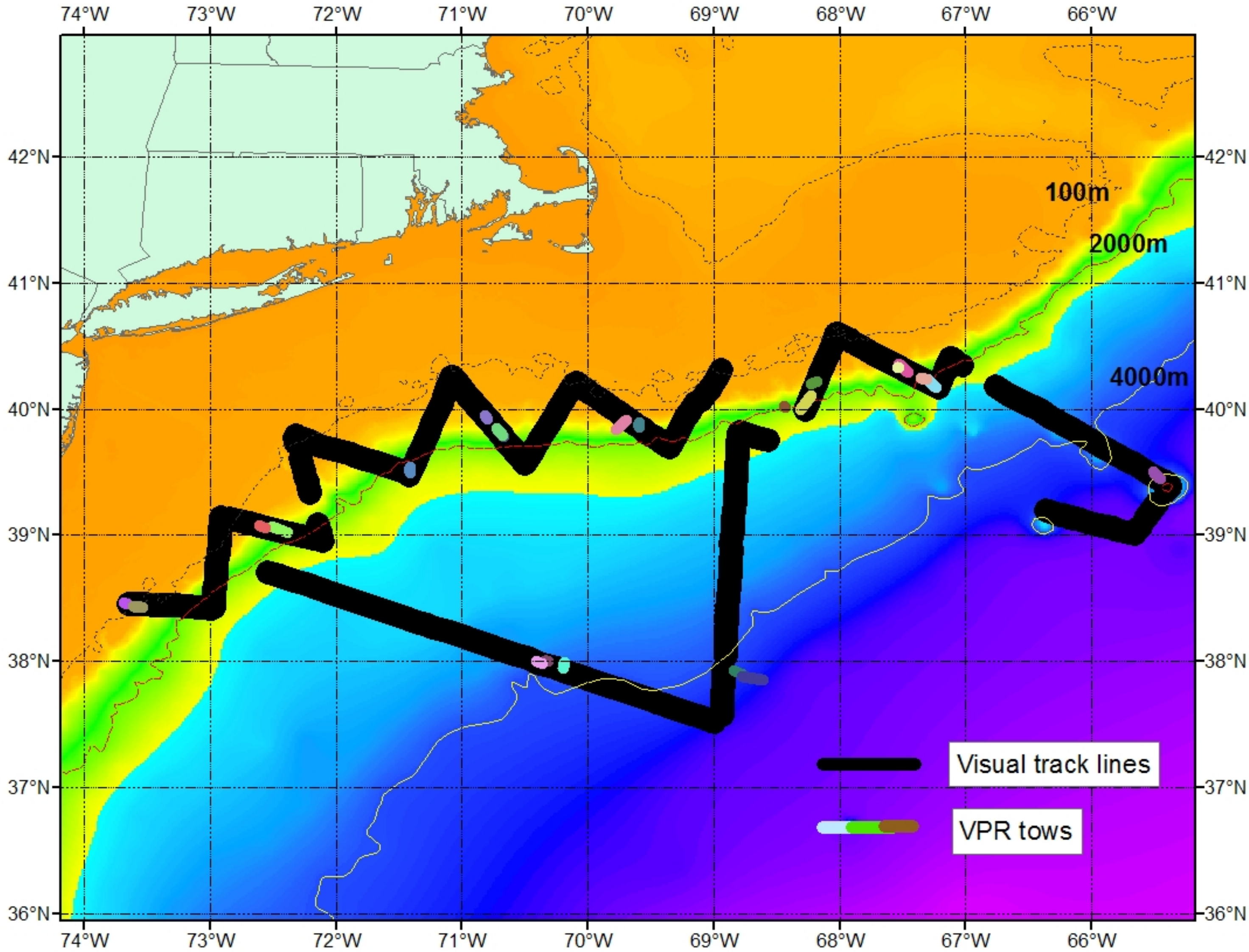


Figure 20. Oceanographic profiles of the temperature, salinity, turbidity raw counts and chlorophyll raw counts from the Shelf when traveling west to east. The closest way points were 20 (5) and 22 (3).

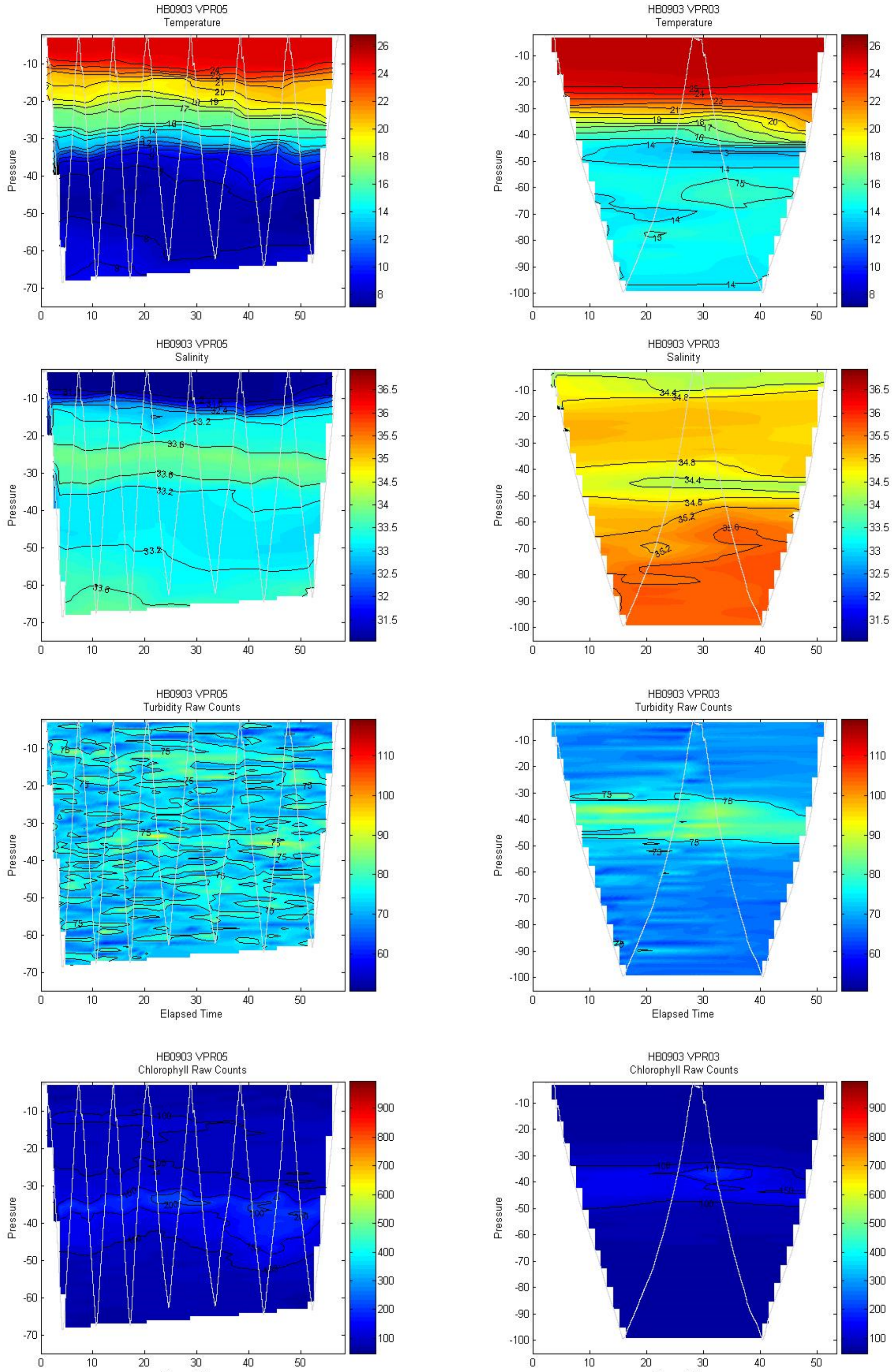


Figure 21. Oceanographic profiles of the temperature, salinity, turbidity raw counts and chlorophyll raw counts from the shelf slope when traveling west to east. The closest way points were 16 (24), 14 (21), 12 (13).

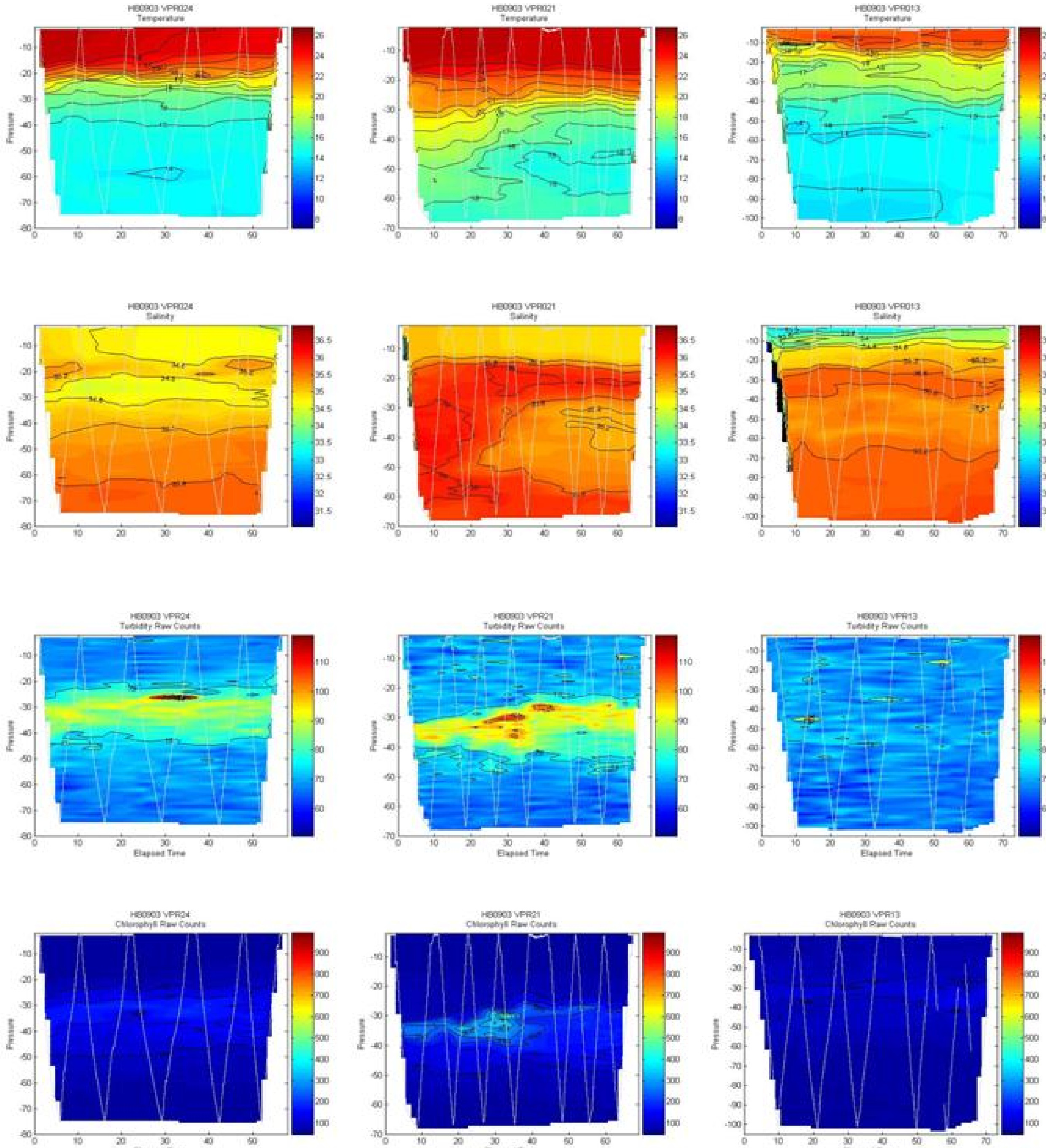


Figure 22. Oceanographic profiles of the temperature, salinity, turbidity raw counts and chlorophyll raw counts from the shelf slope near Lydonia canyon, when traveling from deep to shallow depths. The closest way points were 10 – 11.

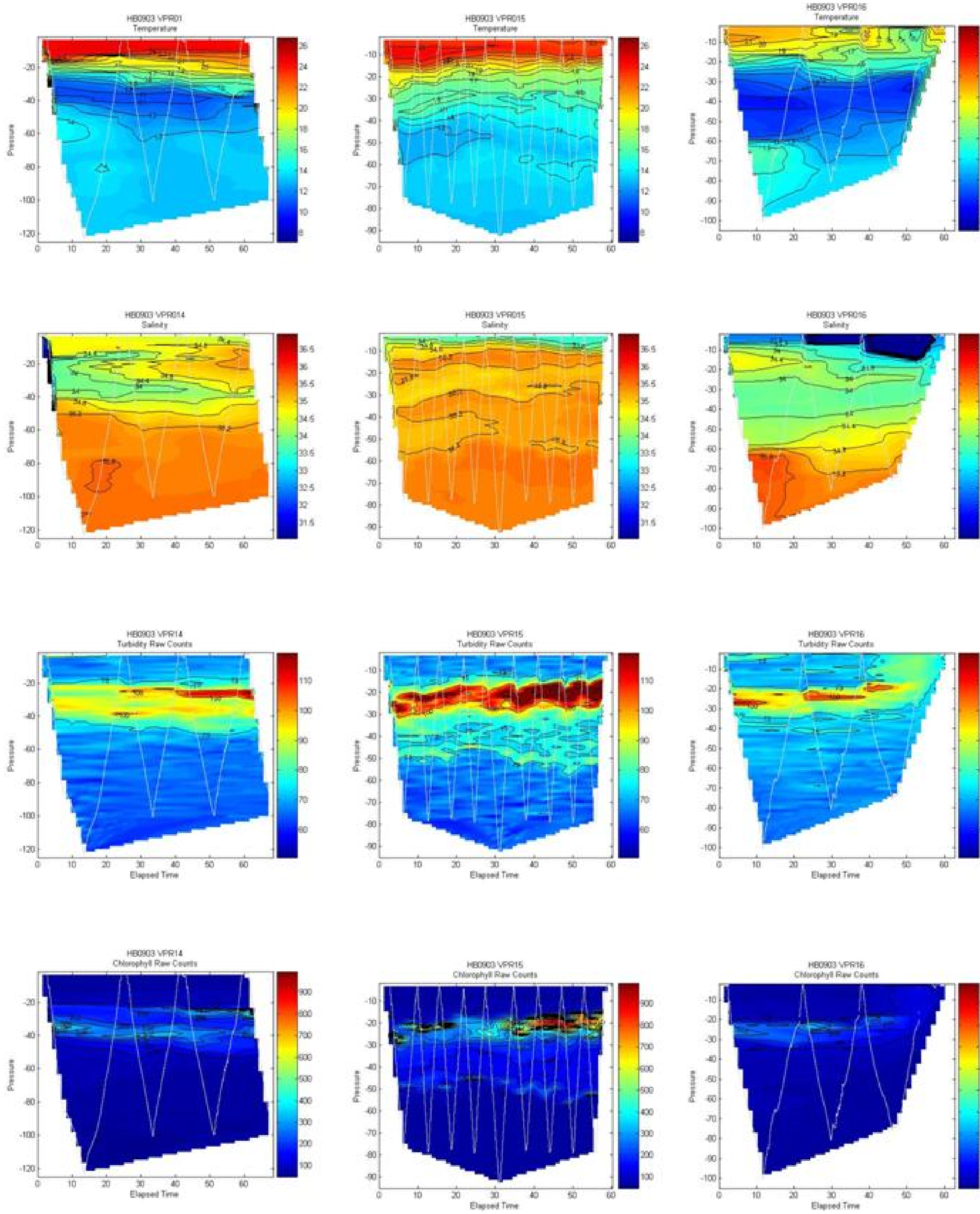


Figure 23. Oceanographic profiles of the temperature, salinity, turbidity raw counts and chlorophyll raw counts, when traveling from offshore southwest to NE. The closest way points were 5 (7), 4 (11 in the Gulf Stream), 2 (19).

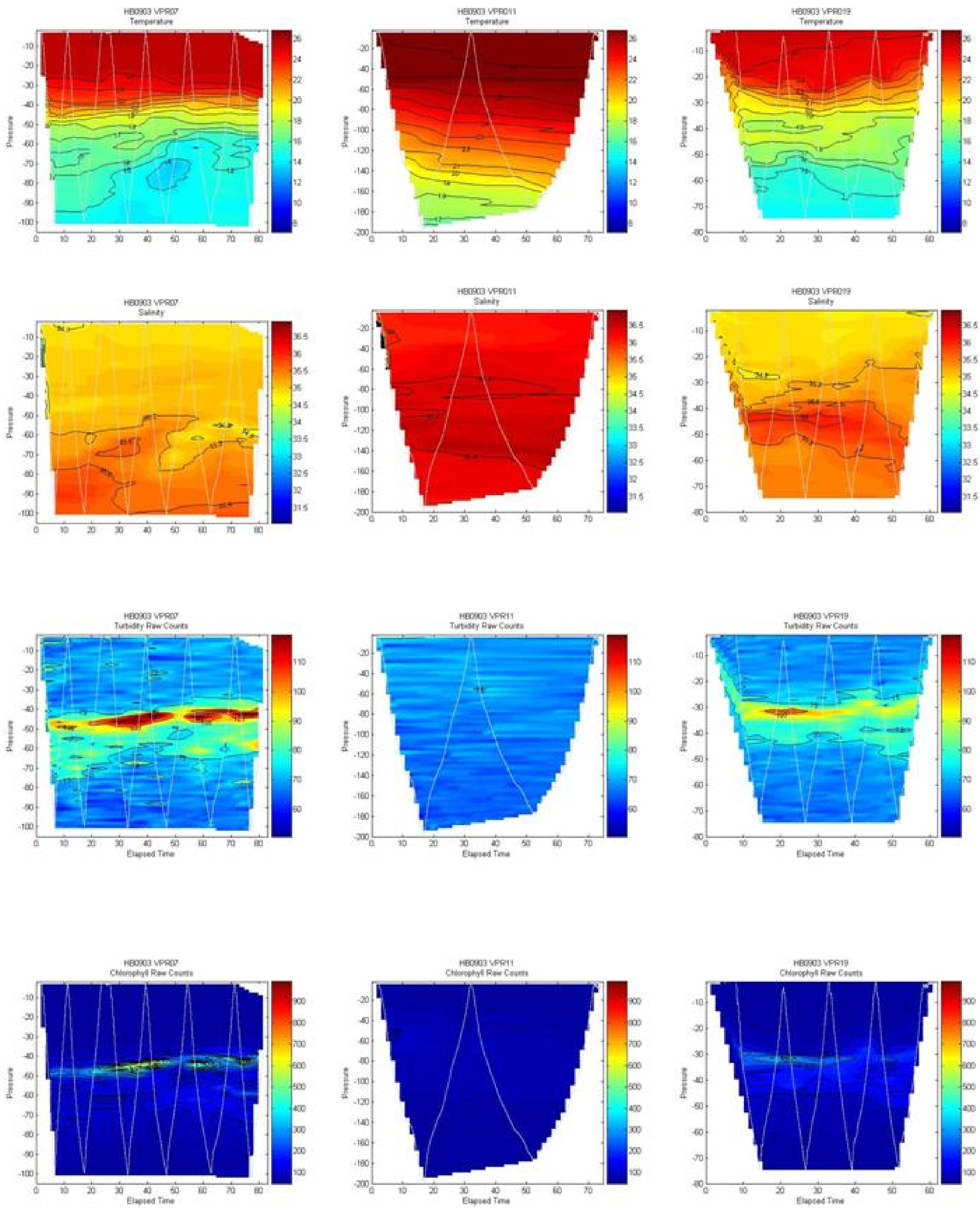


Figure 24. VPR images of the salp, *Thalia democratica*.

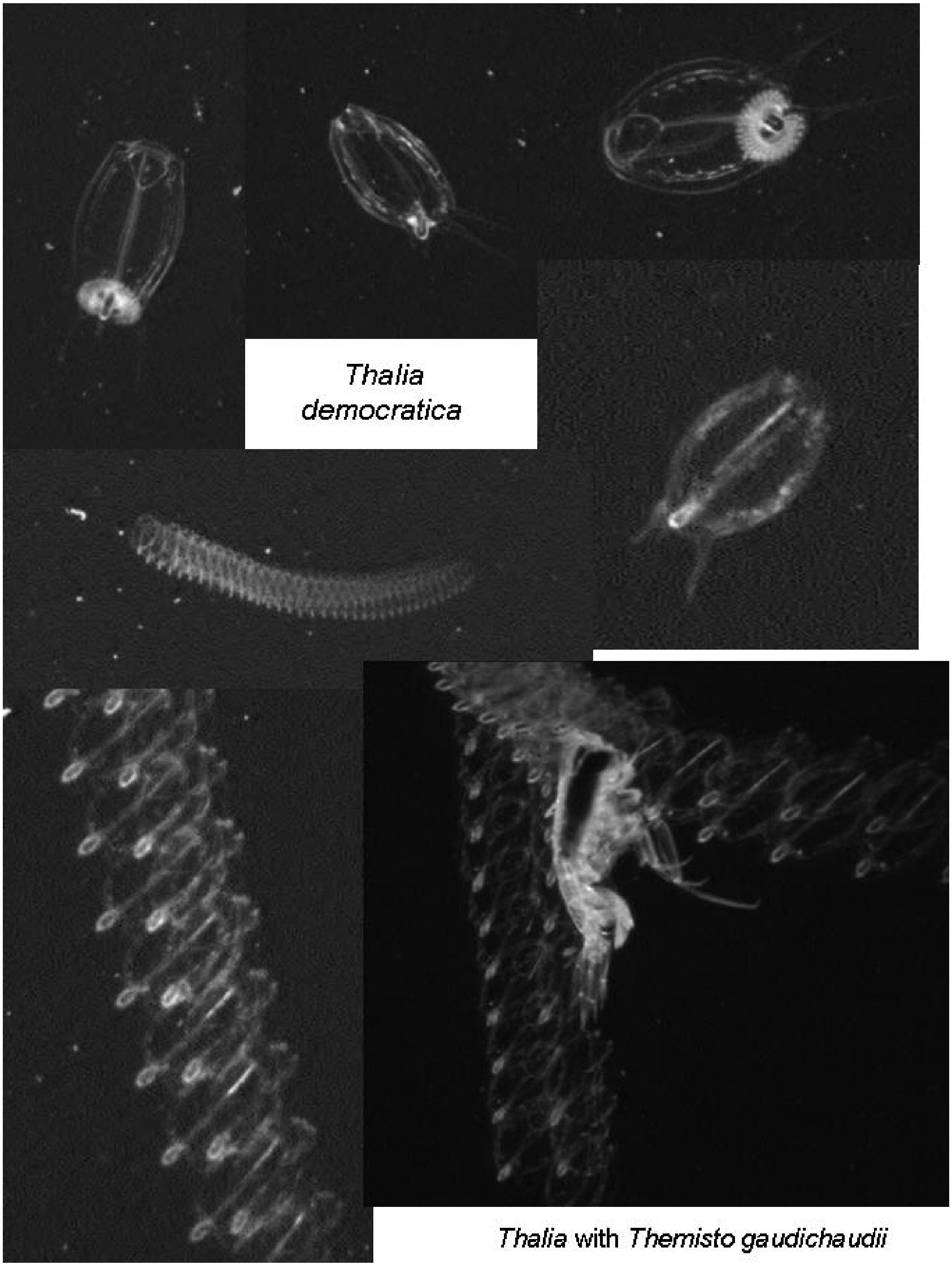


Figure 25. VPR images of euphausiids and fish.

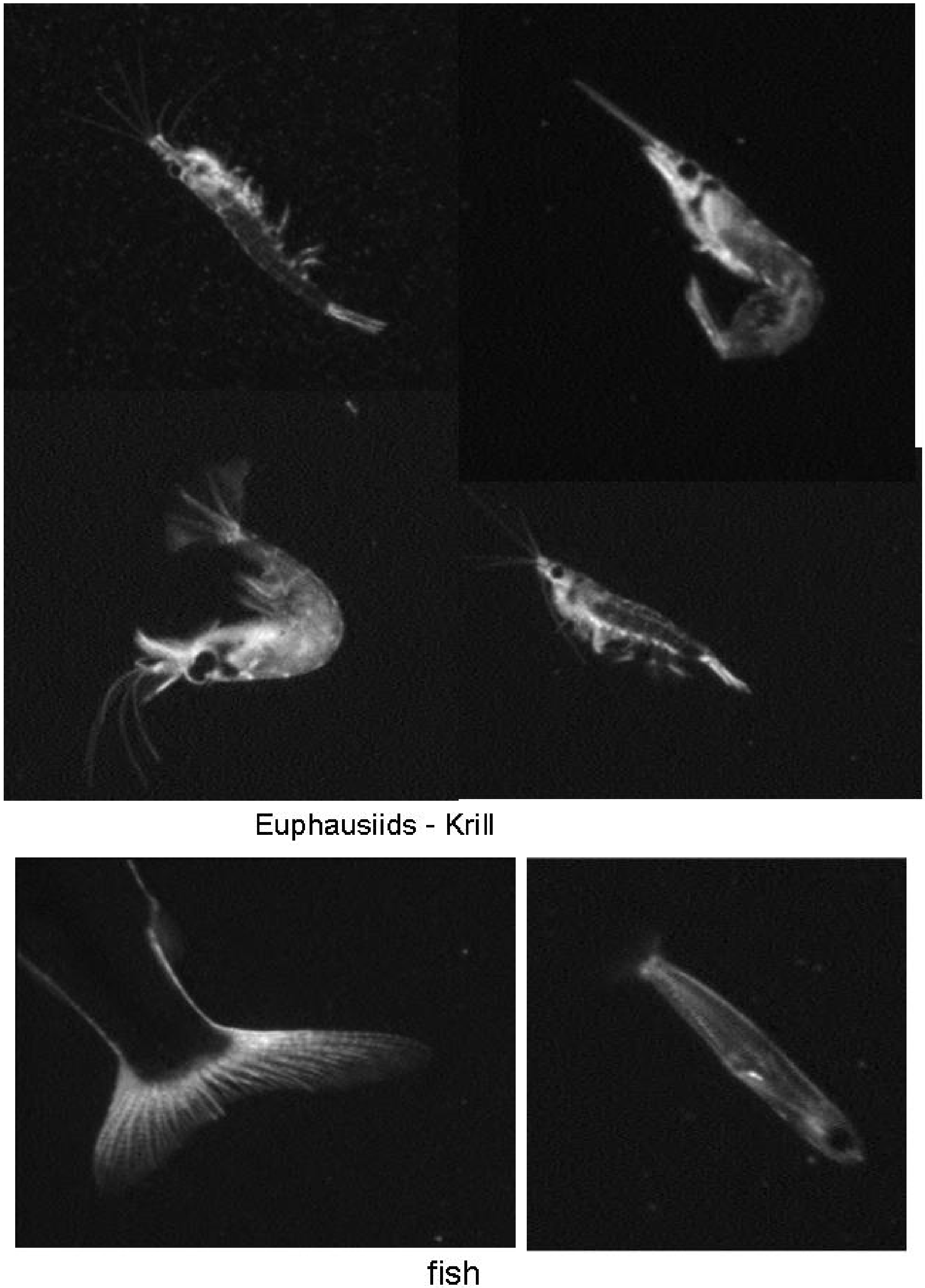
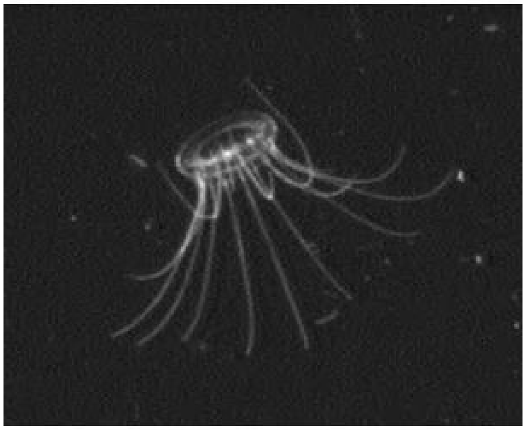
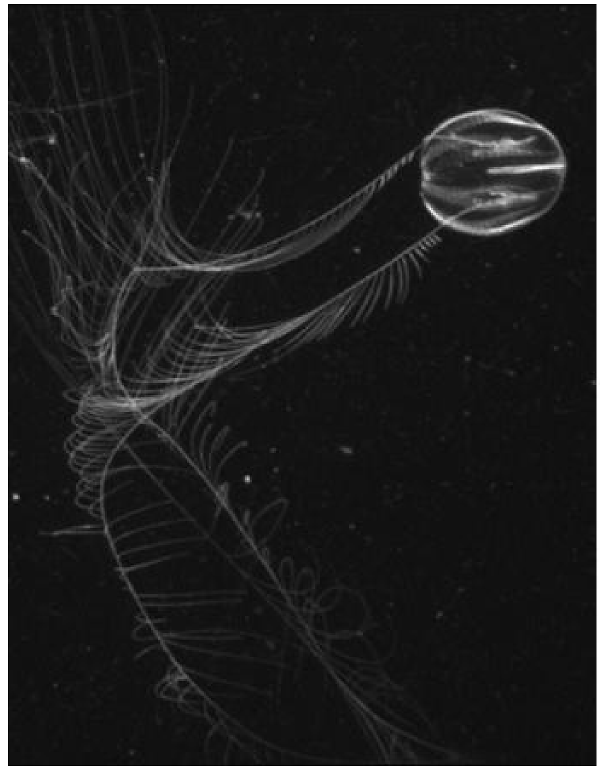


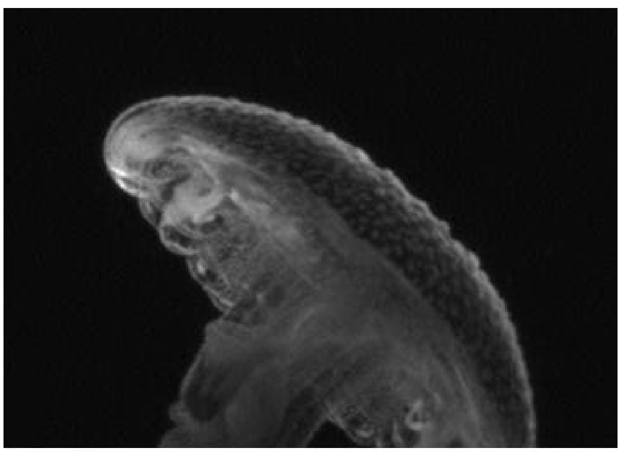
Figure 26. VPR images of gelatinous zooplankton.



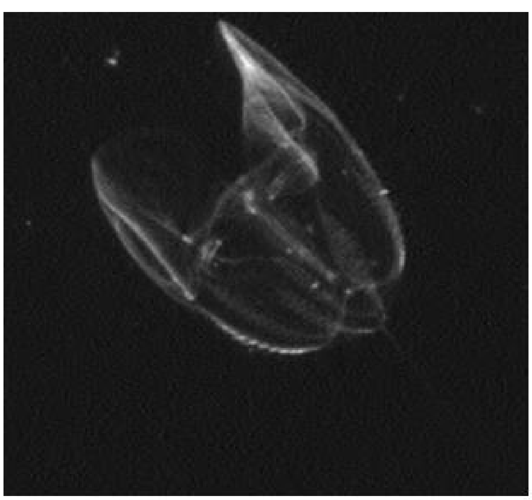
Hydromedusa

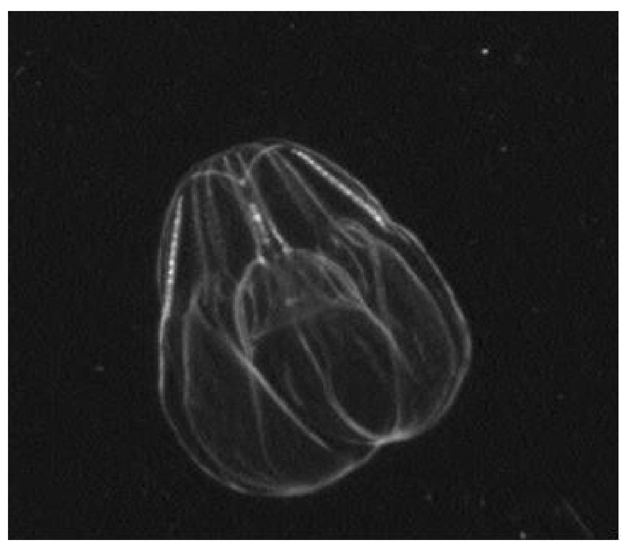


Ctenophora - *Pleurobrachia pileus*



Jellyfish





Ctenphophora – *Bolinopsis* spp.