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Assessing Essential Fish Habitat for Bluefish Pomatomus saltatrix (Linnaeus, 1766), in Virginia's Portion of Chesapeake Bay and Near Shore Coastal Waters, 1988-1999

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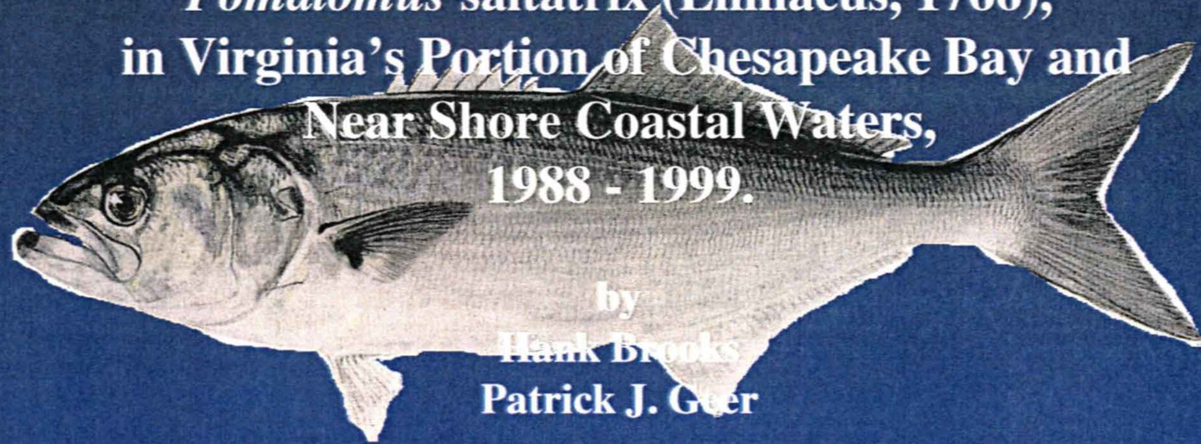

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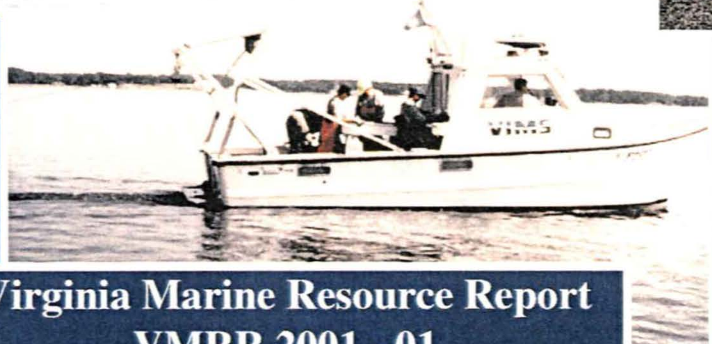

Virginia Marine Resource Report
VMRR 2001 - 01
Submitted to
The Chesapeake Bay Program's
Bluefish Management Plan
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INTRODUCTION

The Magnuson – Stevens Fishery Conservation and Management Act of 1996 strengthened the ability of the National Marine Fisheries Service and other Fisheries Management Councils to protect and conserve habitats of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. The 1996 amendments to the act require the identification and description of essential habitat for the managed species, minimization of adverse effects on essential fish habitat (EFH) caused by fishing, and encouragement toward the conservation and enhancement of essential fish habitats. "Essential fish habitat" is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity " (NMFS 2000). The National Marine Fisheries Service identified bluefish (*Pomatomus saltatrix*) as a species for which EFH must be described. Bluefish are considered one of the most important recreational species along the Atlantic coast of the United States and have long captured the attention of saltwater anglers. Our objective is the dissemination of information about bluefish essential fish habitat in Virginia's tidal waters based on long-term data collections.

Life History

The bluefish is the only species in its genus that, with the exception of portions of the Pacific Ocean, inhabits temperate and tropical continental shelves and estuaries worldwide (Murdy et al. 1997, Oliver et al. 1989, Wilks 1977, Briggs1960). The bluefish is a moderate-sized to large fish with a stout compressed body, large head and pointed snout (Murdy et al. 1997). Bluefish have large mouths with sharp, triangular, somewhat compressed teeth and a projecting lower jaw (Murdy et al. 1997, Dahlberg 1975). Adult bluefish are bluish or greenish above and silvery below (Oliver et al. 1989,Jordan and Evermann 1896).

Bluefish are a schooling, migratory, pelagic species generally traveling northward in spring and summer and southward in fall and winter along the east coast of North America (Oliver et al. 1989). Schools are usually comprised of similar sized fish and can form shoals that cover tens of square miles (Murdy et al. 1997). A spawning event occurs during the spring migration in the offshore waters from northern Florida to southern North Carolina. In the Chesapeake Bay region, a second spawning event occurs during the summer in the waters over the outer continental shelf, with peak spawning seemingly taking place in July (Murdy et al. 1997, Norcross et al. 1974). Among bluefish researchers, it is often argued whether or not bluefish spawn continuously (from spring until August), beginning near the coast of the southeastern United States and ending in the northern reaches of the Mid-Atlantic Bight (Murdy et al. 1997, Norcross et al. 1974). After the spring spawn, fish in the smaller size classes migrate shoreward into estuaries, while larger fish continue their trek northward (Murdy et al. 1997). Murdy et al. 1997 suggests small juveniles (25-50 mm TL) enter the lower Chesapeake Bay and its tributaries in late summer and early fall. However, Virginia Institute of Marine Science (VIMS) Seine Survey data suggests small bluefish enter the Bay in mid-spring or early summer (Seaver 2000, pers. comm.). In early autumn, bluefish begin migrating out of the Bay and southward along the East Coast. Bluefish are visual predators and feed throughout the water column. Small blues feed on a plethora of fishes and invertebrates while larger individuals are almost exclusively piscivorous (Murdy et al. 1997). Bluefish attain sexual maturity at about two years (approx. 36 cm TL) and can live in excess of 12 years (Murdy et al. 1997).

Trawl Survey

The Virginia Institute of Marine Science regularly conducts a bottom trawl survey monitoring relative abundances of marine finfish and mega-invertebrates in Virginia's portion of Chesapeake Bay and its tributaries. One of the objectives of this program is the production of annual indices of juvenile abundance for recreationally, commercially and ecologically important species of sufficient accuracy and precision for both immediate resource management needs as well as long-term understanding of environmental influences on fisheries resources (Geer et al. 1999). Another objective of the survey is documentation and monitoring of habitat utilization by juveniles and small adults of species inhabiting the Bay.

The program began in 1955, functioning as a multi-species survey of the Bay and major tributaries. Methods and sampling designs have varied over the years depending on funding sources and/or state and federal priorities. The survey has used several configurations of a 9.1m semi-balloon otter trawl through the years, with various sample design methods (fixed station transects, random stations, monthly, semi-annually.) Since 1979, gear has remained relatively constant, with effort increasing in the form of new random stratified surveys and further expansion into new areas. Today we collect 120 samples monthly with a stratified random design based on depth and geographic region (Figures 1 - 4). Fixed stations historically sampled are incorporated into this design providing a past perspective. A full history of the program is available in Geer et al. 1999.

Seine Surveys

The Virginia Institute of Marine Science has monitored striped bass spawning rivers since 1967 (the VIMS Juvenile Striped Bass Survey) concentrating on tidal tributaries (Figure 5). In the fall of 1993, the VIMS Juvenile Bluefish Seine Survey began as an extension of this survey as a means of monitoring juvenile bluefish abundance (Austin et al. 1996). The Bluefish Seine Survey operated autonomously from the spring of 1994 until the end of 1996 at which time it was once again operated as an extension of the Striped Bass Survey. This survey concentrated on Virginia's Eastern Shore (both the bayside creeks and the seaside lagoons) and south side ocean beaches sampling for bluefish and several other recreationally and ecologically important species (Figure 5). The primary objective of both surveys is to monitor trends in relative abundance of bluefish and striped bass. Currently, bluefish field sampling is conducted during thirteen approximately biweekly sampling periods from April through October. The striped bass sampling occurs approximately biweekly from July to mid-September.

METHODS

Trawl Survey

Since September 1990, sampling has been performed exclusively aboard the research vessel *Fish Hawk,* using a 9.1m (30 ft) semi-balloon otter trawl (Marinovich Gulf Shrimp Trawl) with a 38.1mm (1.5 in) stretch mesh body, a 6.35 mm (0.25 in) mesh cod end liner, attached tickler chain, 18.29 m (60 ft) bridle length with a 3:1 warp, and steel china-v doors (71cm x 48 cm, 28 x 19 in). The tow duration was typically five minutes bottom time at a speed of approximately 2.5 knots (1.29 m/s). A sample day was defined as the period between sunrise and sunset.

At each location the following station information was collected: station identification number, beginning and ending latitude/longitude, depth (m), tidal stage, tow duration (minutes), tow start and end times (24 hr), scope (m), net number, and speed over ground (nautical miles per hour, kts). In addition, the following atmospheric data were collected: air temperature (°C), wind speed (m/s), wind direction, current weather condition and sea state. Immediately following the tow, surface and bottom hydrographic information were collected using a Hydrolab Data Sonde 4 or similar Hydrolab unit. On board processing of a catch consisted of separation and identification to species and measuring individual lengths, to the nearest millimeter. For fish species, all lengths were recorded as fork lengths when appropriate, otherwise total length was recorded. Invertebrates were separated and species-specific information collected. These data were entered directly into computer files using electronic measuring boards. Subsampling was performed when large homogeneous catches of a single species were made. On these occasions, a subsampling protocol was followed with enumeration of the discarded specimens taking priority over subsampling by volume.

Seine Surveys

At each station, collections were made using a 30.48 m (100 ft.) long x 6.35 mm (0.25 in) bar mesh seine. The bluefish seine was 1.83 m (6 ft.) tall with a 6.35 mm (0.25 in) bar mesh bag. The striped bass seine was only 1.22m (4 ft) tall with no bag (Austin et al. 1996). The net was deployed perpendicular to the shoreline (extended either until the depth reached four feet or until the net was completely stretched) and swept down current and back to shore. Alternately, the net was carried out to a depth of four feet, extended parallel to the beach and then hauled onto the shore. This was necessary whenever a strong longshore current was present, or when winds were blowing across the area and the net was ballooning. All fish from the first haul were removed from the net and placed in buckets of water until completion of the second sample. All fish were identified, enumerated and measured to the nearest millimeter fork length (or total length when appropriate). When sample sizes were large, a subsample of at least 25 individuals was measured and the remainder enumerated. Atmospheric and hydrographic data were also recorded and included salinity (ppt), water temperature (°C), pH, dissolved oxygen (mg/l), time (24 hr), air temperature (°C), wind speed (m/s), and wind direction.

RESULTS

Trawl Survey 1988-1999

Over the last twelve years 460 bluefish were captured on the trawl survey. Of these fish, 456 were considered juveniles based on length frequencies. The bluefish catch per unit of effort (CPUE) during this time period was 0.04 fish per trawl. Almost two-thirds (62.6%) were captured in the mainstem bay, 30.9% from the lower tributaries, and 6.5% coming from less frequently sampled areas such as Mobjack Bay (Figure 6). The hydrographic preferences of these fish are displayed in Figure 7. These hydrographic plots show the percent of stations and catch occurring within each interval. If the catch data is skewed differently from that of the sampling effort, it is speculated there is a preference shown to those type waters. Stations were sampled with D.O. concentrations ranging from 0 to 14 mg/l. Fish were collected from waters with DO concentrations ranging from 2 to 12 mg/l. 87.5% of the catch came from water with D.O. between 5 and 9 mg/l. Bottom water temperatures at all stations ranged between 1 and 31 °C. Bottom water temperatures where fish were caught ranged between 11 and 29 °C. Most fish (68.7%) were sampled from waters between 15 and 25 °C. Salinities at all stations ranged between 1 and 31 ppt. Bluefish were caught in salinities from 3 ppt to 31 ppt with over half (59.0%) captured in the 15 to 30 ppt range. Water depths ranging from 1 to 25 m were sampled. Fish were collected from waters 1 to 23 m deep. Of the total catch, 75.9% of all bluefish captured were taken in water ranging in depths from 5 to 13 m.

<u>Bluefish Seine Survey</u> 1994-1999

Over the last six years 1,980 bluefish were handled on the Bluefish Seine Survey. All fish captured were considered juveniles. The CPUE for bluefish during this period was 1.43 fish per trawl (Figure 8). The hydrographic preferences of these fish are displayed in Figure 9. All stations sampled on this survey had D.O. concentrations between 2 mg/l and 11 mg/l. Fish were collected from waters with D.O. ranging from 3mg/l to 9mg/l with a mean of 6.9mg/l. Nearly all fish (97.3%) were from water with D.O. concentrations between 6 and 8 mg/l. Water temperatures surveyed ranged between 5 and 33 °C. Water temperatures where bluefish were caught ranged between 17 and 29 °C. Waters between 20 and 27 °C accounted for 98.4% of catch. Salinities of all stations ranged between 7 and 31 ppt. Bluefish were caught in salinities from 7 ppt to 31 ppt with most (97%) fish captured in the 19 to 30 ppt range. The mean salinity was 21.4 ppt. The recorded pH at all stations ranged from 5.8 to 9.0. Most bluefish (98%) were captured at stations with pH ranging from 7.4 to 8.6. The survey had a mean pH of 8.0.

<u>Striped Bass Seine Survey</u> 1994-1999

Over the past five years only 88 bluefish were captured on the striped bass seine survey. All of these fish were juveniles. The CPUE for bluefish during the survey was 0.05(Figure 8). The hydrographic preferences of these fish are displayed in Figure 10. All stations had D.O. concentrations between 2 and 13 mg/ with a mean of 6.2 mg/l. Fish were collected from waters with D.O. concentrations ranging from 3 to 9mg/l. Most fish caught (93.4%) were from water with D.O. between 5 and 8 mg/l. Temperatures at all stations sampled were between 13 and 33 C° with a mean of 27.8°C. Water temperatures where fish were caught ranged between 19 and 33 °C. Most fish (92.3%) were sampled from waters between 25 and 31 °C. All stations had salinities between 1 ppt and 23 ppt. Bluefish were caught in salinities from 1 ppt to 19 ppt with most fish (78.5%) captured in the 1 to 11 ppt range. The mean salinity for this survey was 3.2 ppt. The pH at all stations ranged between 5.8 and 9. Bluefish were captured at stations with pH ranging from 5.8 to 8.6 with a mean pH of 7.3. Most fish (89.5%) were captured at stations with pH between 6.2 and 8.2.

CONCLUSIONS

The sampling methodology and spatial coverages of these three surveys preclude any single conclusion of habitat preference by bluefish in Chesapeake Bay. Both seine surveys have limited temporal coverage (May to October) with minimal depth (≤ 1.22 m), and specific sampling areas for target species. The striped bass survey samples on the spawning and nursery grounds of striped bass in the upper tributaries while the bluefish survey concentrates on bluefish nursery grounds. In contrast, the trawl survey's multi-species monthly sampling provides both greater spatial and temporal coverage, but at the same time may not be very efficient and capturing fast swimming pelagic species such as bluefish.

Regardless, the results from each survey show similar patterns (Table 1). Dissolved oxygen, pH (seines), and depth (trawl) show very little difference between the percent catch at a given interval as compared to the number of samples (stations) where that interval occurred (Figures 7,9,10). Results for these three variables are a function of sampling location (i.e., pH's are lower in the upper tributaries where the striped bass survey takes place as compared to sampling areas of the bluefish survey). Catches were highest in waters with dissolved oxygen between 4.5 and 9.5 mg/l (Table 1). Middaugh et al. (1981) conducted a study supporting this lower value (4.5). They found small bluefish avoided preying on Atlantic silversides (*Menidia menidia*) at concentrations below 4 mg/l. Bluefish have not shown preferences for pH. The data from the coastal stations of the bluefish survey indicate most fish are captured between 7.6 and 8.8, while the tributary based seine survey sees lower values from 6.0 to 8.4. Depth does not seem to be a factor in bluefish distribution since they can quickly exchange gases in and out of the swim bladder allowing for rapid changes in depth (Bentley and Wiley 1982). Temperature and salinity have the most pronounced effect on bluefish distribution. Spawning in the Mid-Atlantic Region occurs at 17 to 24 °C and salinities of 30 to 32 ppt (Norcross et al. 1974). Juveniles require temperatures higher than 10 °C for survival (Lund and Maltezos 1970). These surveys reveal a similar pattern with the major portion of catches occurring at bottom temperatures ranging from 14 to 26 °C. Trawl catches occur in slightly lower temperatures as bluefish migrate toward the estuary in the spring and out of the estuary in the fall. Juvenile bluefish prefer salinities from 16 to 32 ppt, with a large skew toward the higher values. This skew is very evident in bluefish seine and trawl surveys. Another water parameter often associated with location is turbidity. Secchi disk readings are generally higher on the eastern side of the Bay as compared to the upper tributaries. Since bluefish are visual predators, water clarity would play a vital role in their feeding success (Oliver et al. 1982).

These three surveys concentrate efforts on juvenile fishes, and in the case of bluefish, little data is available to support habitat and distributional preferences of adult specimens. However, the surveys do indicate acceptable coverage for both spatial and temporal distributions of juvenile bluefish. These data appear to be a reliable source to assess essential fish habitat for juvenile bluefish.

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Table 1. Summary of bluefish catch, length, and habitat preferences for the VIMS seine and trawl surveys. Total number refers to bluefish caught, CPUE is based on total number / N (number of samples taken), and the number of samples in which bluefish were captured is shown as occur.

Survey	Years	Total Number	CPUE	Occur	N	Length Information (in mm)					Habitat Preferences				
						Mean	Standard Error	Minimum	Maximum	Number Measured	Temperature (°C)	Salinity (ppt)	D.O. (mg/l)	Depth (m)	pH
Bluefish Seine	1994-99	1980	1.43	226	1,381	86.66	0.72	29	267	1,948	18-28	18-32	4.5-8.5	n/a	7.6-8.8
Striped Bass Seine	1994-99*	88	0.05	49	1,505	96.88	4.09	42	323	88	24-32	0-16	4.5-8.5	n/a	5.6-8.4
Trawl Survey	1988-99	460	0.04	211	12,308	182.48	3.77	22	820	460	14-26	16-28	4.5-9.5	4-14	n/a

* The striped bass seine has been in existence since 1967. To be consistent with the less established bluefish survey, only data collected after 1993 were used for this comparison.

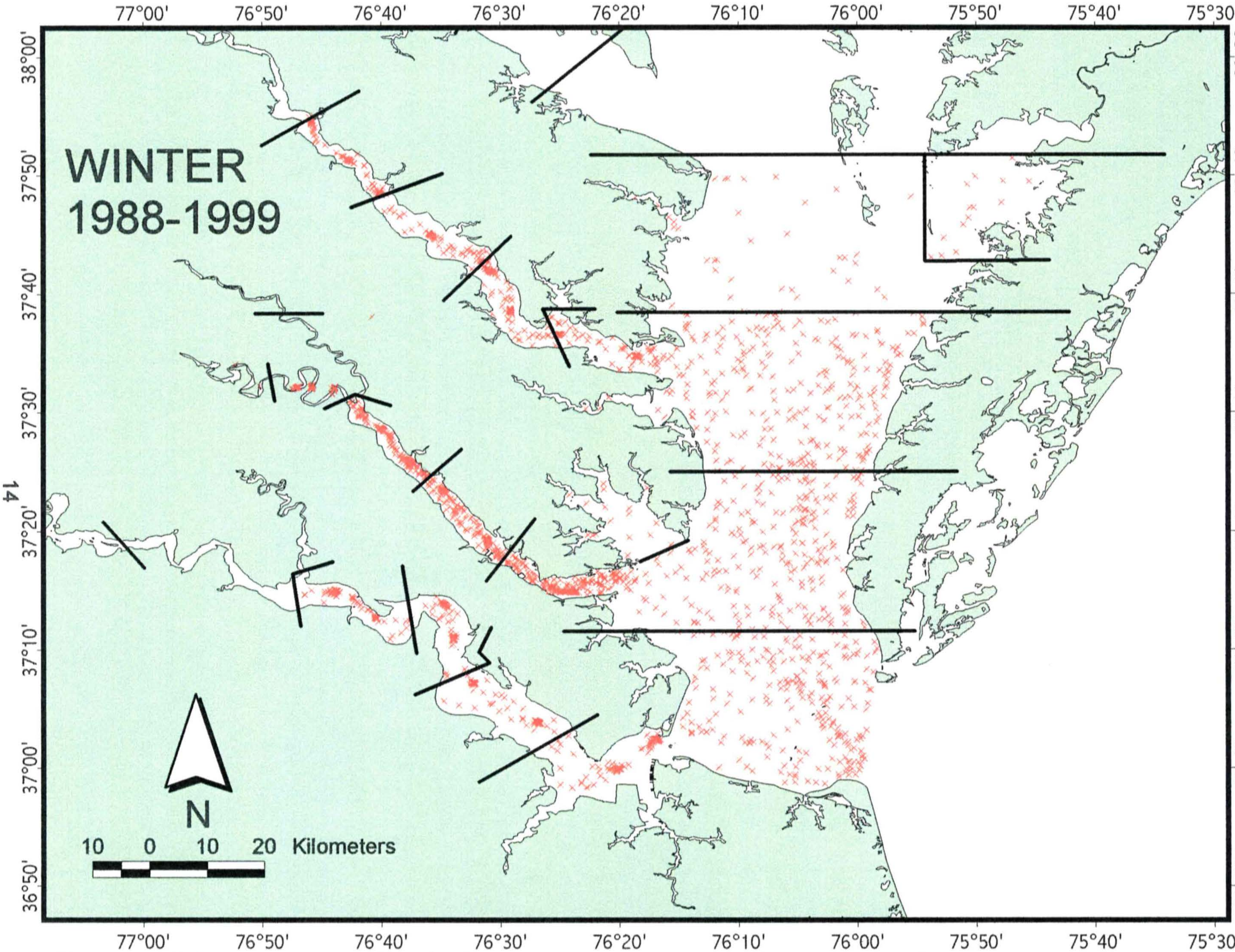

Figure 1. VIMS trawl survey stations for the Winter season (January - March), 1988 - 1999.

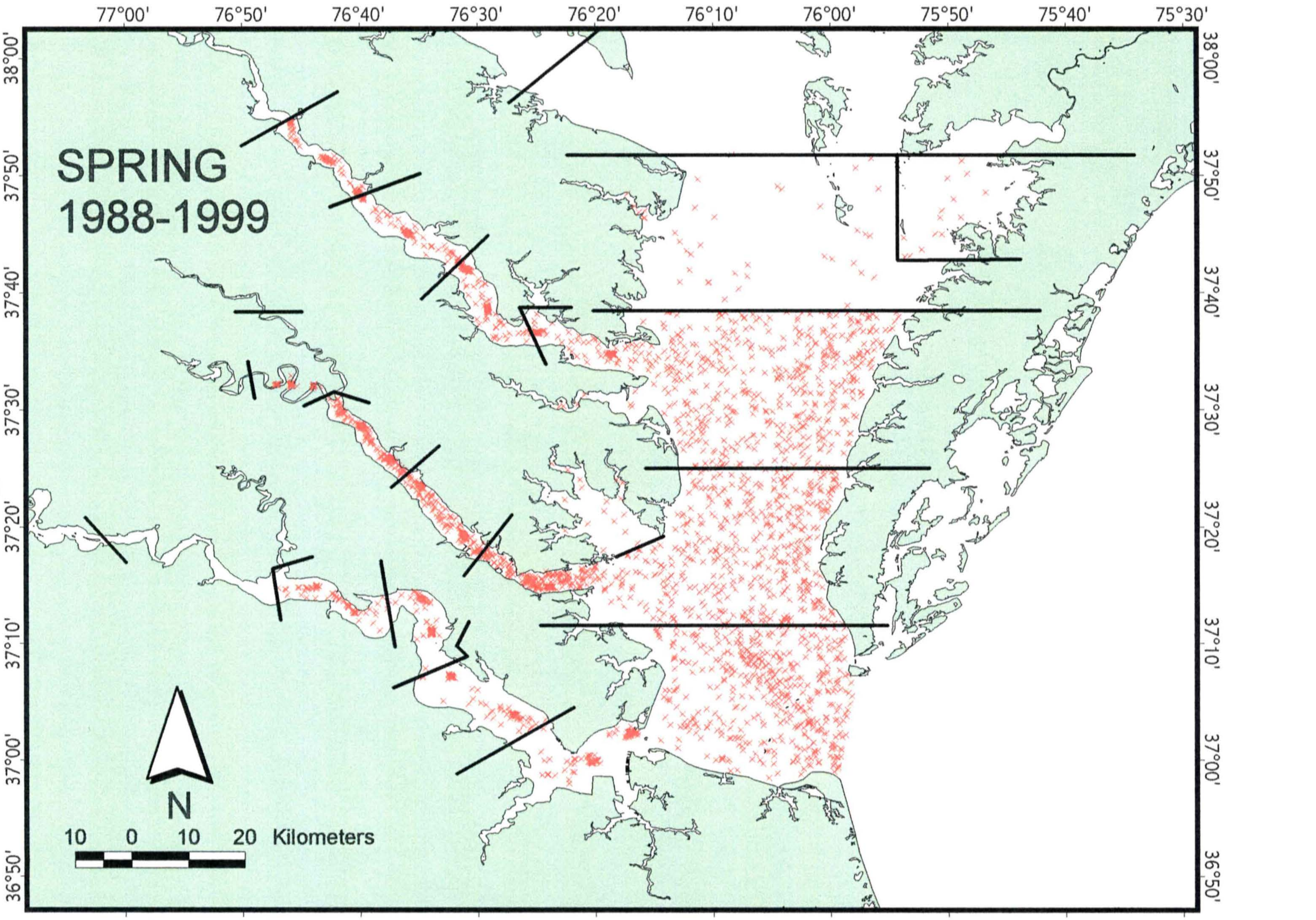

Figure 2. VIMS trawl survey stations for the Spring season (April - June), 1988 - 1999.

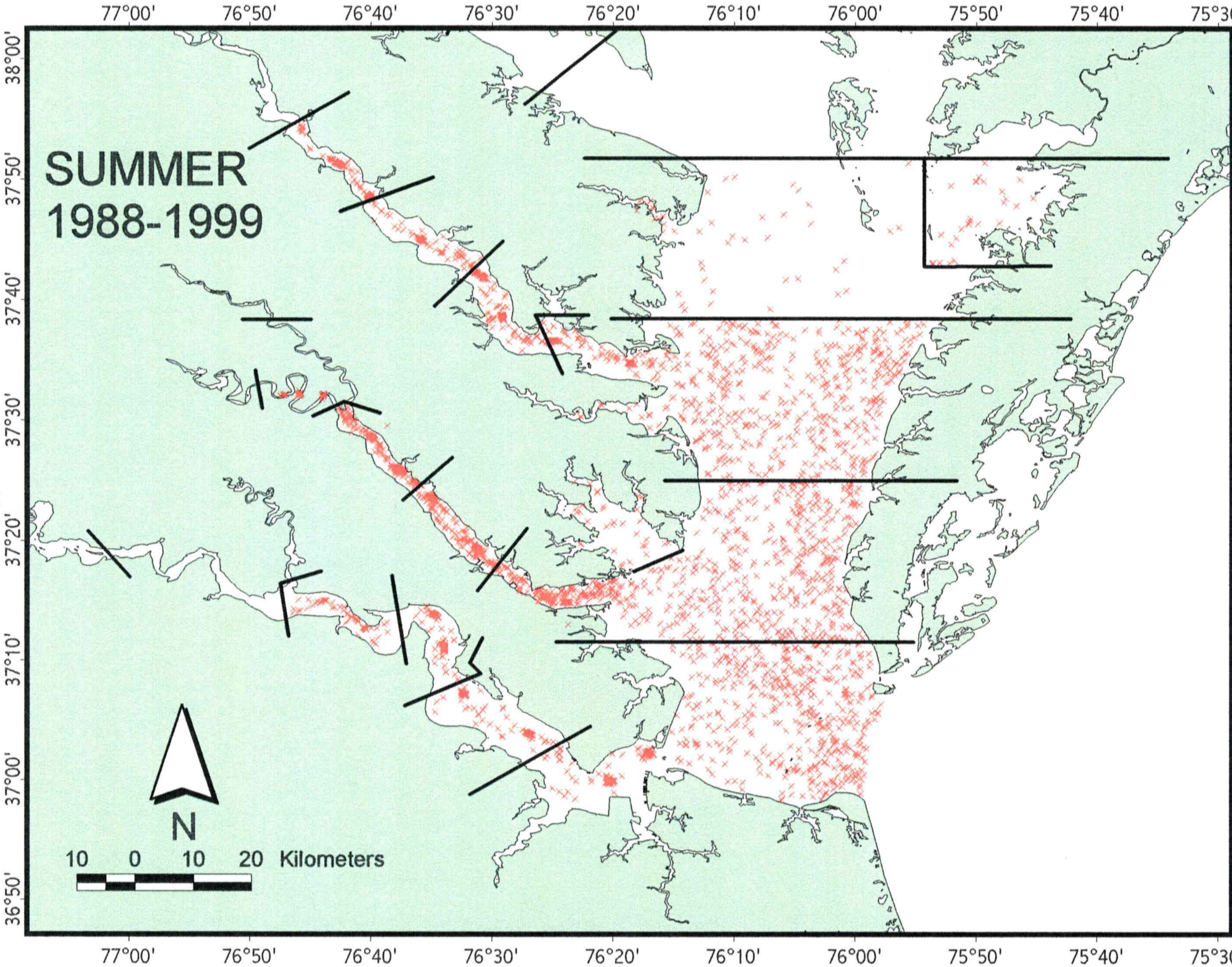

Figure 3. VIMS trawl survey stations for the Summer season (July - September), 1988 - 1999.

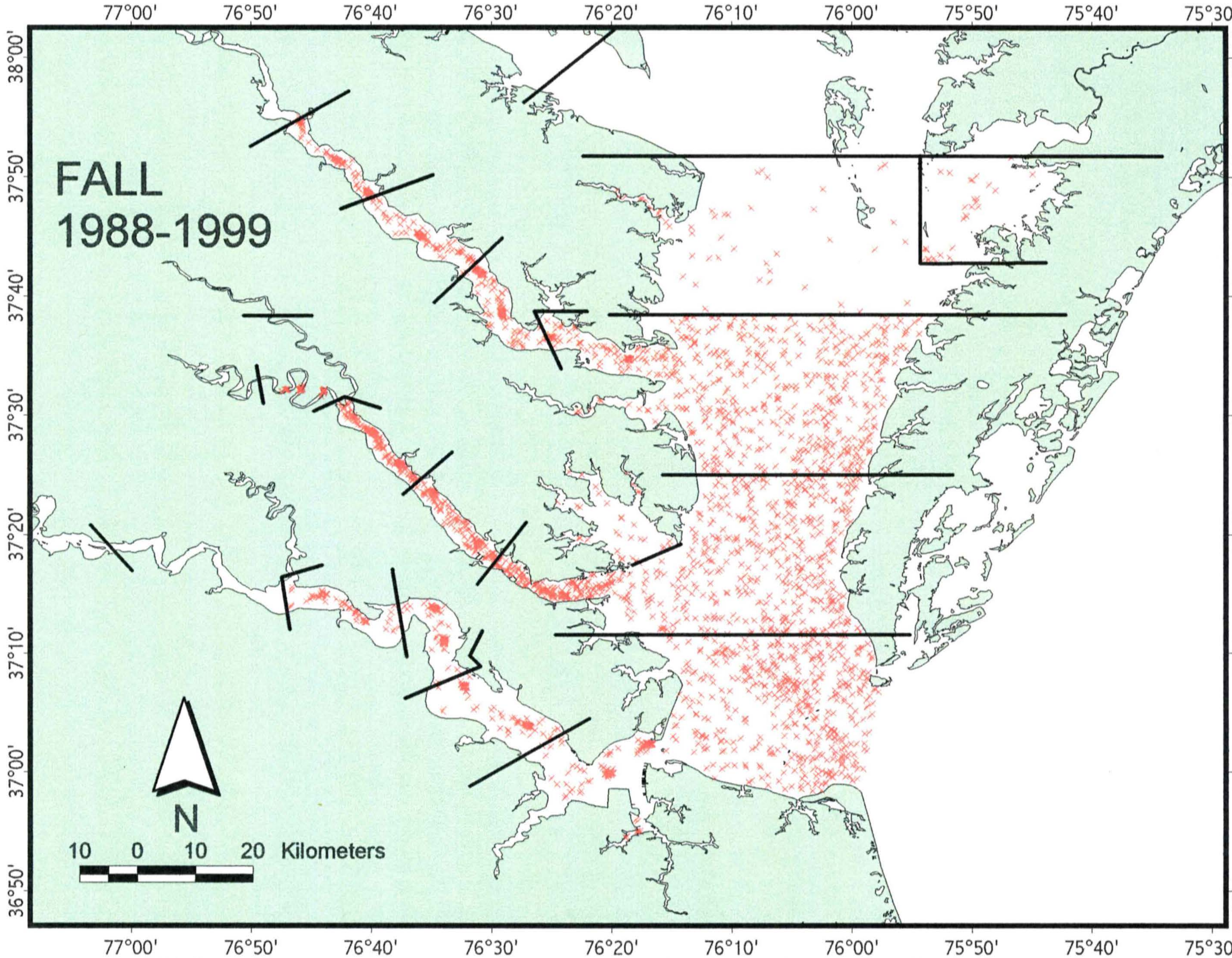

Figure 4. VIMS trawl survey stations for the Fall season (October - December), 1988 - 1999.

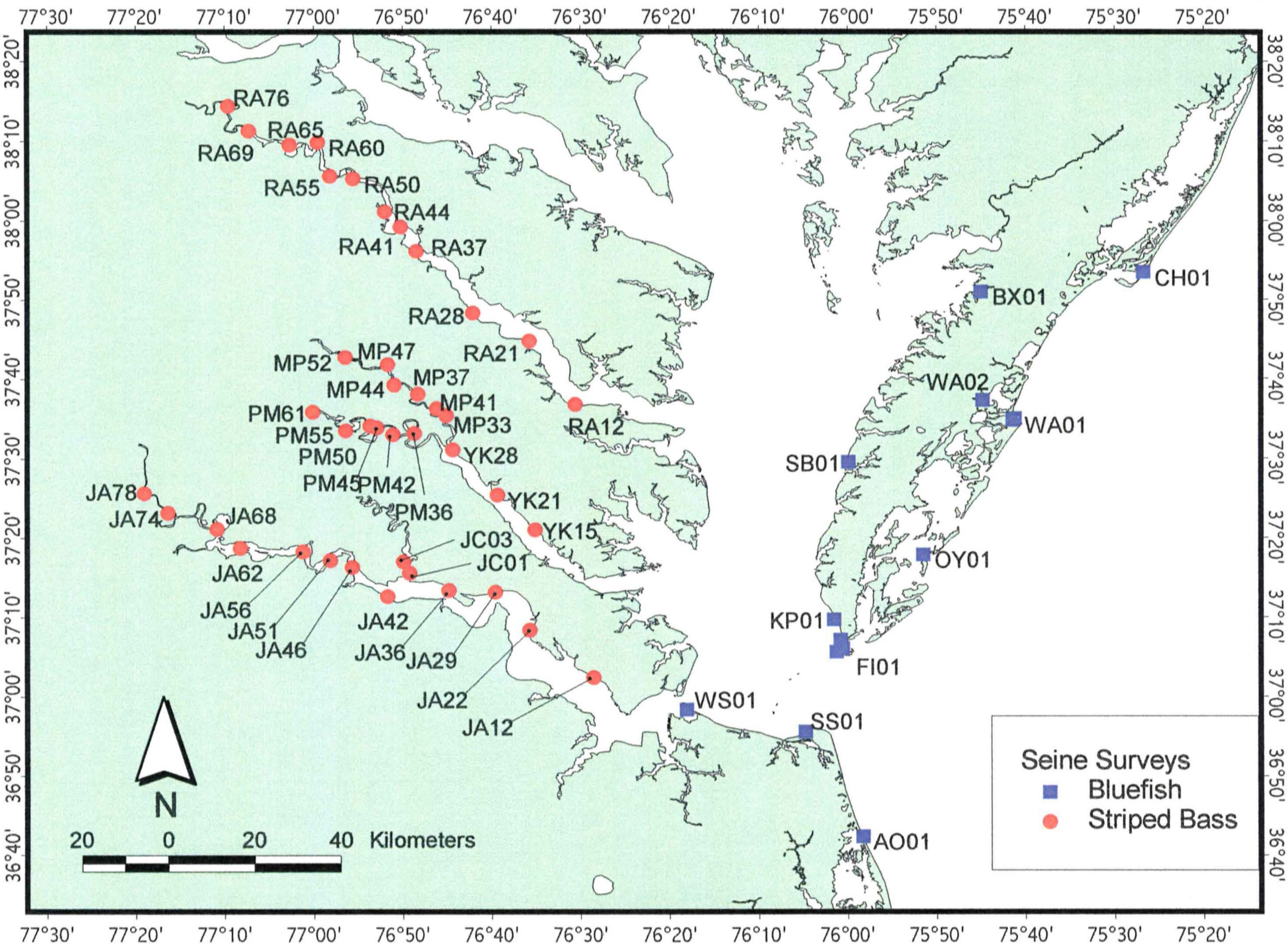

Figure 5. VIMS Seine Survey Station Locations, 1994 - 1999.

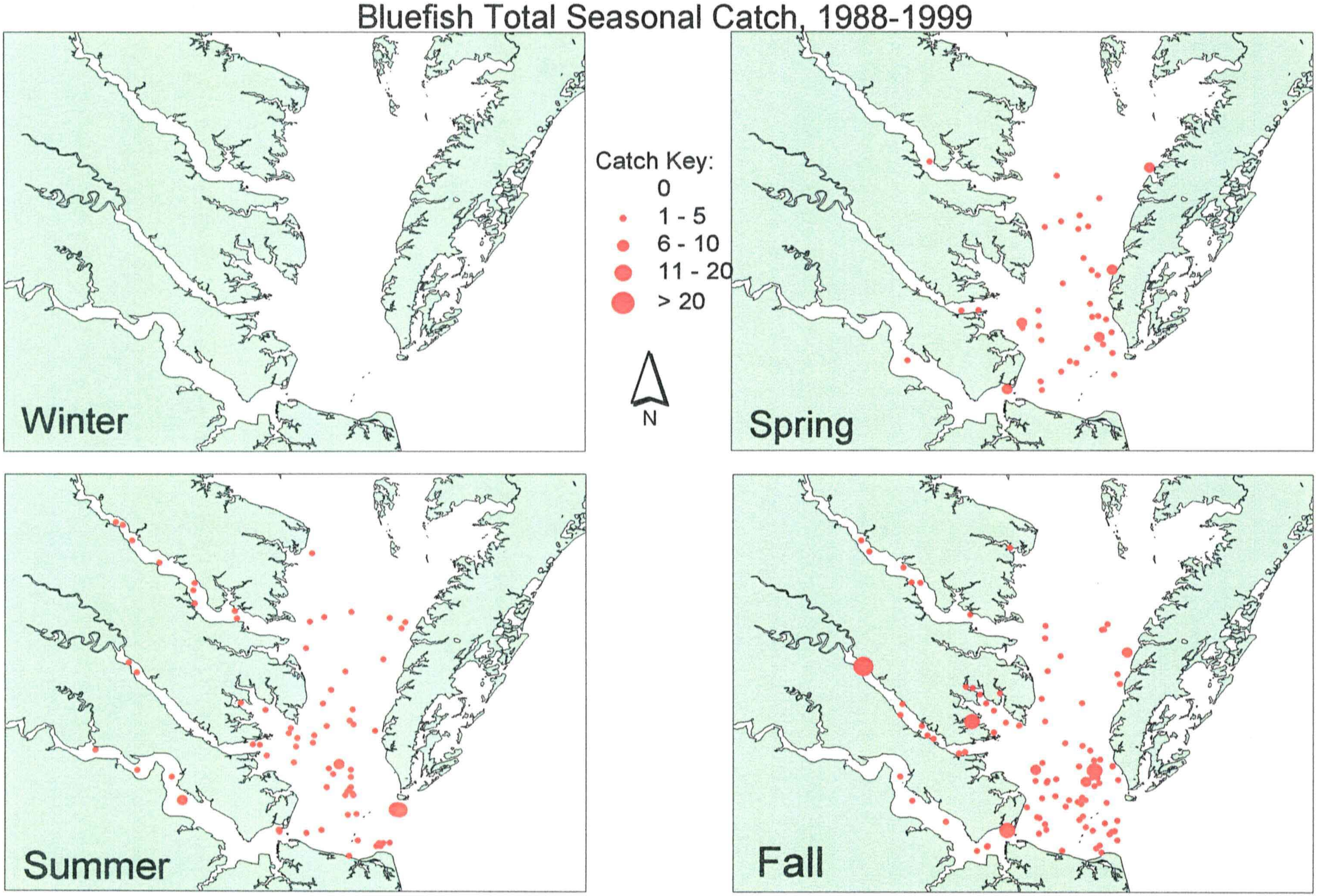

Figure 6. Seasonal catch of bluefish from the VIMS trawl survey, 1988 - 1999. Zero values are transparent for clarity.

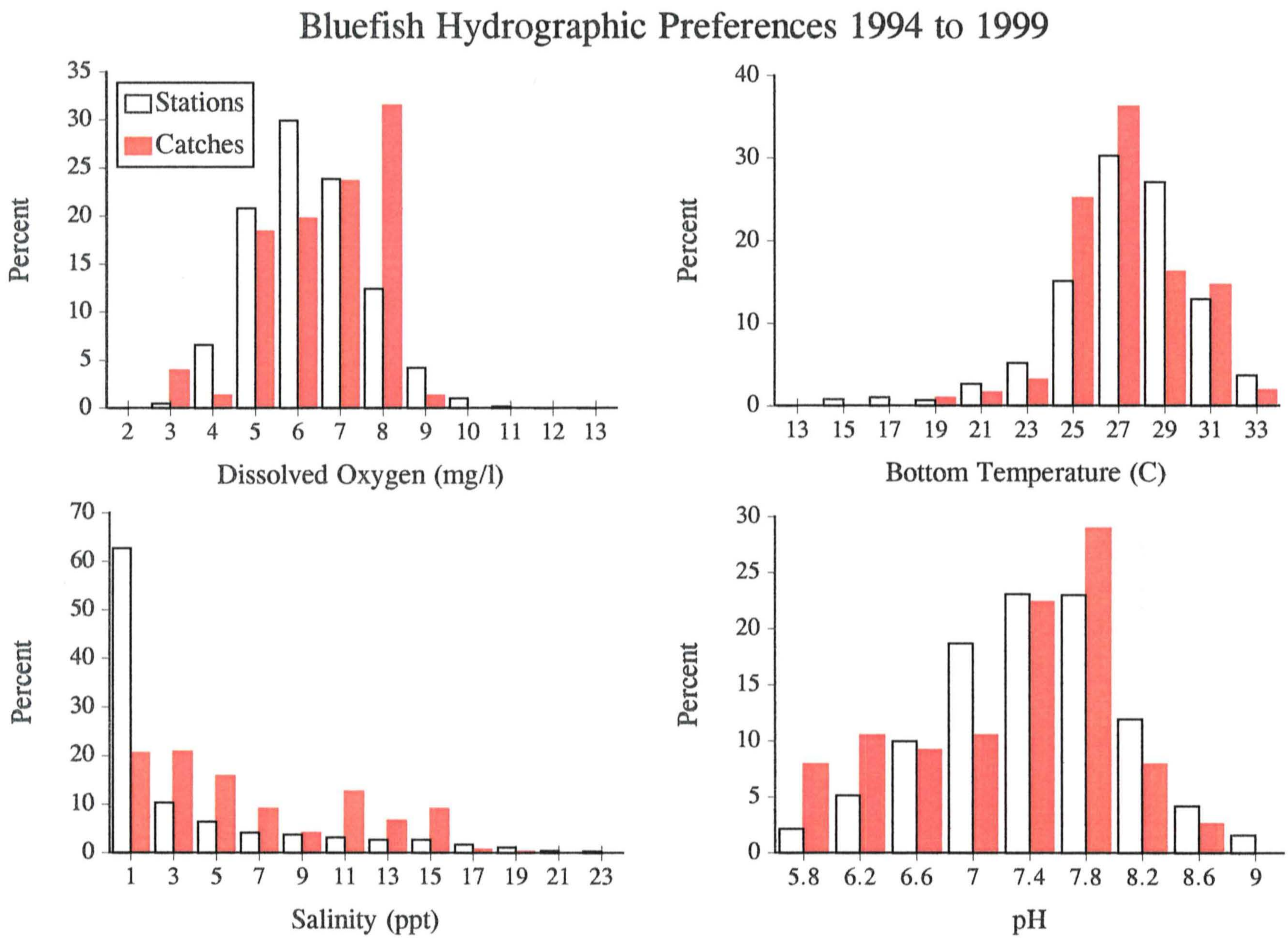

Figure 10. Bluefish hydrographic preferences from the VIMS striped bass seine survey, 1994-99.