# Ocean/Wind Power Ecological Baseline Studies

January 2008 – December 2009

FINAL REPORT

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF SCIENCE

## Volume IV: Fish and Fisheries Studies

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GMI
A Subsidiary of Applied Research Associates, Inc.

# New Jersey Department of Environmental Protection
# Baseline Studies

## Final Report

### Volume IV:
### Fish and Fisheries Studies

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ° | Degree(s) |
| °C | Degree(s) Celsius |
| °F | Degree(s) Fahrenheit |
| ANOVA | Analysis of Variance |
| ASMFC | Atlantic States Marine Fisheries Commission |
| CFR | Code of Federal Regulations |
| cm | Centimeter(s) |
| DPS | Distinct Population Segment |
| EEZ | Exclusive Economic Zone |
| EFH | Essential Fish Habitat |
| EIS | Environmental Impact Statement |
| ELMR | Estuarine Living Marine Resources |
| ESA | Endangered Species Act |
| FL | Fork Length |
| FMC | Fishery Management Council |
| FMP | Fishery Management Plan |
| ft | Foot(Feet) |
| $ft^2$ | Square Foot(Feet) |
| g | Gram(s) |
| gal | Gallons |
| GMFMC | Gulf of Mexico Fishery Management Council |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| HAPC | Habitat Areas of Particular Concern |
| HMS | Highly Migratory Species |
| ICCAT | International Committee for the Conservation of Atlantic Tunas |
| IFMP | Interstate Fishery Management Plan |
| in. | Inch(es) |
| ISFMP | Interstate Fisheries Management Program |
| kg | Kilogram(s) |
| km | Kilometer(s) |
| $km^2$ | Square Kilometer(s) |
| kt(s) | Knot(s) |
| L | Liters |
| lb | Pound |
| LCS | Large Coastal Sharks |
| LME | Large Marine Ecosystem |
| MAB | Mid-Atlantic Bight |
| MAFMC | Mid-Atlantic Fishery Management Council |
| m | Meter(s) |
| $m^2$ | Square Meter(s) |
| mi | Mile(s) |
| $mi^2$ | Square Mile(s) |
| min | Minute(s) |
| mm | Millimeter(s) |
| mph | Mile(s) per Hour |
| MRFSS | Marine Recreational Fishery Statistics Survey |
| MRIP | Marine Recreational Information Program |
| MSFCMA | Magnuson-Stevens Fishery Conservation and Management Act |
| MU | Management Unit |
| mt | Metric Ton(s) |
| N | North |
| NAO | North Atlantic Oscillation |
| NDPSWG | Northeast Data Poor Stocks Working Group |

## LIST OF ACRONYMS AND ABBREVIATIONS (*continued*)

| | |
|---|---|
| NE | Northeast |
| NEFMC | New England Fishery Management Council |
| NEFSC | Northeast Fisheries Science Center |
| NEPA | National Environmental Policy Act |
| NJAA | New Jersey Anglers Association |
| NJDEP | New Jersey Department of Environmental Protection |
| NM | Nautical Mile(s) |
| $NM^2$ | Square Nautical Mile(s) |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| OSA | Ocean Stock Assessment |
| PS | Pelagic Sharks |
| psu | Practical Salinity Unit(s) |
| SAB | South Atlantic Bight |
| SAFMC | South Atlantic Fishery Management Council |
| SCS | Small Coastal Sharks |
| SFA | Sustainable Fisheries Act |
| spp. | Species |
| SSB | Spawning Stock Biomass |
| SST | Sea Surface Temperature |
| T | Ton(s) |
| TRP | Take Reduction Plan |
| U.S. | United States |
| USFWS | United States Fish and Wildlife Service |
| W | West |
| YOY | Young-of-the-Year |

## LIST OF METRIC TO U.S. MEASUREMENT CONVERSIONS

| To convert from | To | Multiply by |
|---|---|---|
| **LENGTH** | | |
| Kilometer (km) | Mile, statute (mi) | 0.6214 |
| | Nautical mile (NM) | 0.5400 |
| Nautical Mile (NM) | Mile, statute (mi) | 1.151 |
| Meter (m) | Foot (ft) | 3.281 |
| | Inch (in.) | 39.37 |
| Centimeter (cm) | Inch (in.) | 0.3937 |
| Millimeter (mm) | Inch (in.) | 0.03937 |
| Micrometer or Micron (µm) | Microinch (µ in.) | 39.37 |
| **DISTANCE PER UNIT TIME** | | |
| Meter per second (m/s) | Mile per second (mi/s) | 0.0006214 |
| | Foot per second (ft/s) | 3.281 |
| Centimeter per second (cm/s) | Inches per second (in./s) | 0.3937 |
| Kilometers per hours (k/h) | Mile per hour (mph) | 0.6214 |
| | Knot (nautical mile/hour) | 0.5400 |
| Knot (nautical mile/hour) | Mile per hour (mph) | 1.151 |
| **AREA** | | |
| Square kilometer ($km^2$) | Square mile ($mi^2$) | 0.3861 |
| | Square nautical mile ($NM^2$) | 0.2916 |
| Square nautical mile ($NM^2$) | Square mile ($mi^2$) | 1.324 |
| Square meter ($m^2$) | Square foot ($ft^2$) | 10.76 |
| **VOLUME** | | |
| Cubic meter ($m^3$) | Cubic foot ($ft^3$) | 35.31 |
| | Gallon (gal) | 264.2 |
| Liter (L) | Gallon (gal) | 0.2642 |
| **VOLUME PER UNIT TIME** | | |
| Cubic meter per second ($m^3/s$) | Cubic foot per second ($ft^3/s$) | 35.31 |
| | Gallon per minute (gal/min) | 15,850 |
| Sverdrup (Sv) = $10^6$ $m^3/s$ | Gallon per second (gal/s) | 264.2 |
| **WEIGHT** | | |
| Metric Ton (MT) | Ton, short (T) | 1.102 |
| Kilogram (kg) | Pound (lb) | 2.205 |
| **DENSITY** | | |
| Kilograms per cubic meter ($kg/m^3$) | Pounds per cubic foot ($lb/ft^3$) | 0.06243 |
| **CONCENTRATION** | | |
| Microgram per liter (µg/L) | Ounces per gallon (oz/gal) | $1.336 \times 10^{-7}$ |
| **TEMPERATURE** | | |
| Degree Celsius (°C) | Degree Fahrenheit (°F) | 1.8*(°C + 32) |

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# 1.0 INTRODUCTION

Volume IV presents the fish and fisheries information for the New Jersey Department of Environmental Protection (NJDEP) Ocean/Wind Power Ecological Baseline Studies project. Project location, project goals, and project objectives related to fish and fisheries are presented in **Volume I** of this study report.

This volume is divided into 10 chapters. These chapters are: 1.0 Introduction, 2.0 Fish and Invertebrates, 3.0 Fisheries Resources, 4.0 New Jersey Independent Fisheries Monitoring Data, 5.0 Essential Fish Habitat Managed Species, 6.0 Atlantic States Marine Fisheries Commission Managed Species, 7.0 Federal and State Protected Species, 8.0 Climate Change, 9.0 Summary of Results, 10.0 Literature Cited, and 11.0 Websites Accessed. Acronyms and abbreviations and a list of metric to United States (U.S.) measurement conversions are provided in the Table of Contents.

This volume provides an overview of the ichthyofauna in the Mid-Atlantic Bight (MAB) and within the inshore/offshore environments encompassing the Study Area and the ancillary fishes observed during the onboard ship surveys. A description of the federal and state level fishery management is presented for commercial and recreational fisheries. Commercial fisheries include target species, top fishing gear types utilized, monetary values, landings, closed areas, fishing ports, and commercial fishing vessels observed during the onboard ship surveys in the study area. Recreational fisheries include the various popular fishing locations, fishing effort and catch characteristics, and active fishing tournaments. A statistical analysis was conducted on the data collected in the New Jersey Trawl Fisheries Independent Monitoring Program during the years 2003 to 2008 to evaluate spatial and temporal variability of fish of commercial and recreational importance. Information is also provided for fish species designated with essential fish habitat (EFH), managed by the Atlantic States Marine Fisheries Commission, or protected by federal or state of New Jersey legislation. Climate change as it pertains to the fish and fisheries is addressed for the Northeastern U.S. Continental Shelf Large Marine Ecosystem. In-depth information for the various managed EFH species, a glossary of selected terms used within this volume, and a supplemental literature bibliography are provided in the fish and fisheries appendices.

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# 2.0 FISH AND INVERTEBRATES

## 2.1 MID-ATLANTIC BIGHT FISHES

The Study Area, located within the MAB, is one of the most productive fishing areas on the east coast of the U.S. The MAB is bounded by Massachusetts (Georges Bank) to the north and North Carolina (Cape Hatteras) to the south. In the Study Area, and similar to other temperate communities, seasonal temperature fluctuations are one of the primary factors that influence fish distribution (Sherman et al. 1996). In the MAB, a high proportion of fishes are seasonal in distribution, while few (<5%) are resident (Sherman et al. 1996). Furthermore, only 15% of the approximately 250 fish species found in the waters of the MAB are temperate species. Of the remaining species, approximately 75% are classified as subtropical-tropical species (i.e., species with preferences for temperatures above 20 degrees Celsius (°C; 68 degrees Fahrenheit [°F]; Briggs 1974; Froese and Pauly 2005).

In addition to the vast number of temperate and subtropical-tropical fish species, the Study Area supports a variety of macroinvertebrates (e.g., ocean quahog [*Arctica islandica*] and Atlantic surfclam [*Spisula solidissima*]). The distribution of macroinvertebrates is influenced by the availability of benthic habitat (Theroux and Wigley 1998). Many fish and squid species (i.e., longfin inshore squid [*Loligo pealei*]) found within the Study Area demonstrate seasonal migration patterns, moving offshore during the winter to utilize warmer waters and inshore during the spring and summer to feed and spawn (Casey et al. 1987; Chase 2002; Hatfield and Cadrin 2002). Highly migratory pelagic fishes (i.e., billfishes, tunas, swordfish [*Xiphias gladius*], and sharks) are found mostly offshore, both adjacent to or within the Study Area. These species are influenced by the Gulf Steam Current and thermal oceanic fronts (Casey et al. 1987; Block et al. 1998).

For juvenile fishes and invertebrates, especially those of commercial importance, estuarine and coastal regions provide critical nursery and settlement habitat. Most of the species found in these inshore regions are abundant in the early spring through summer (Able and Fahay 1998). For example, many larvae of subtropical-tropical species spawned in warmer waters are transported to inshore habitats via the currents of the Study Area (Epifanio and Garvine 2001; Hare et al. 2001). The coastal habitats of the Study Area are quite diverse, consisting of intertidal mudflats, wetlands, and seagrass beds (Roman et al. 2000).

## 2.2 NEW JERSEY ICHTHYOFAUNA

The marine ichthyofauna of New Jersey consists of 336 fish species represented by 116 families occurring from the upper limits of saltwater intrusion in the estuaries (including Delaware Bay) to the 200-meter (m; 656.2-foot [ft]) contour at the edge of the continental shelf (Able 1992). Along the New Jersey coastline, various inshore (e.g., estuaries, bays, salt marshes, tidal creeks, and coastal beaches) and offshore environments (e.g., sand ridges, continental shelf, canyons, hard bottom, and artificial reefs [e.g., ship wrecks and man-made structures]) are important habitats to fish and fisheries. Four distinct habitats are defined within the Study Area: coastal beaches, pelagic zone, demersal/benthic zone, and natural/artificial reef-structures.

The coastal beaches and, in particular, the surf zone is an important habitat for numerous fish species. Studies conducted off northern New Jersey reported 57 species representing 30 families utilize this habitat (Burlas et al. 2001; D.H. Wilber et al. 2003; D.H. Wilber et al. 2003; Able et al. 2010). The species were dominated by Atlantic and rough silversides (*Menidia menidia* and *Membras martinica*), bluefish (*Pomatomus saltatrix*), bay and striped anchovies (*Anchoa mitchilli* and *A. hepsetus*), and northern kingfish (*Menticirrhus saxatilis*). This ichthyofaunal composition was similar to other comparable locations within the Study Area (Avalon, New Jersey), north of the Study Area (Long Island Sound and Great South Bay and Fire Islands, New York), and south of the Study (Hog Island, Virginia; Schaefer 1967; Briggs 1975; Hillman et al. 1977; McDermott 1983; Layman 2000).

The pelagic zone within the Study Area supports large schools of seasonally abundant herrings (i.e., blueback herring [*Alosa aestivalis*], alewife [*A. pseudoharengus*], and Atlantic menhaden [*Brevoortia* *tyrannus*]) along with fast swimming oceanic wanderers (e.g., bluefin tuna [*Thunnus thynnus*] and swordfish), various elasmobranchs (sharks: sand tiger [*Carcharius taurus*] dusky [*Carcharhinus plumbeus*], sandbar [*C. obscurus*], skates: clearnose [*Raja eglanteria*], winter [*Leucoraja ocellata*], and little [*L. erinacea*], and rays: cownose [*Rhinoptera bonasus*], large predatory fishes (e.g., bluefish, various sciaenids), and several species of cephalopods (i.e., longfin inshore squid) (MMS 1999).

The non-vegetated, sandy benthic habitat is important to various demersal fish and invertebrate species within the Study Area (Steimle and Zetlin 2000). It is characterized as a sand or sand-mud plain interrupted by submarine sand ridges separated by mud or clay-bottomed depressions or sloughs. Solitary rather than schooling fishes are found within this habitat which consist of species such as sand lances (*Ammodytes* species [spp.]) and flounders (i.e., winter flounder [*Pseudopleuronectes americanus*], windowpane flounder [*Scophthalmus aquosus*], and witch flounder [*Glyptocephalus cynoglossus*]) and hakes (red hake [*Urophycis chuss*] and silver hake [*Merluccius bilinearis*]) that are an important food resource for many predatory species.) These solitary species tend to prey upon the benthic communities (MMS 1999). Moderate densities of crustaceans (amphipods), polychaetes, mollusks (bivalves), and echinoderms dominate these benthic communities off New Jersey (Wigley and Theroux 1981; Reid et al. 1991; Chang et al. 1992).

An important component of this demersal/benthic zone is the more than 71 shoreface sand ridges that occur along the New Jersey coastal areas (McBride and Moslow 1991). These shoreface sand ridges, especially the near-ridge habitats (e.g., Beach Haven Ridge off Little Egg Inlet), have higher species abundance and richness than to the surrounding inner continental shelf. They possess distinct species assemblages, comprised of important recreational and commercial species (Vasslides and Able 2008). The following fish families, anchovies (Engraulidae), flounders (Pleuronectiformes), cod (Gadidae), searobins (Triglidae), sea basses (Serranidae), drums (Sciaenidae), and butterfishes (Stromateidae), along with the Atlantic surfclam and epibenthic decapod crustaceans (sevenspine bay shrimp [*Crangon septemspinosa*], Atlantic rock crab [*Cancer irroratus*], spider crab [*Libinia emarginata*], and lady crab [*Ovalipes ocellatus*]) are common components of this unique habitat and may be representative of other New Jersey shoreface sand ridges (Viscido et al. 1997; Ma et al. 2006; Vasslides and Able 2008). The dominant fish species were similar to those species found on the inner continental shelf waters off the northeastern (Colvocoresses and Musick 1984; Mahon et al. 1998) and southeastern U.S. (Walsh et al. 2006).

Benthic man-made structures, such as artificial reefs, shipwrecks, and other man-made structures (groins, jetties, seawalls, bridges, and piers) are important habitat types for the fish and fisheries found off New Jersey. These man-made structures add complexity and diversity to the non-vegetated, sandy bottom and open ocean environments (Figley 2005). Nine of the 15 artificial reef sites off New Jersey are located within the Study Area in addition to the 3,500 patch reefs that have been added to these sites since 1984. Depending on the depth and average annual and seasonal water temperatures, artificial structures (reefs, 3,000 documented shipwrecks, etc.) can be colonized by various species of invertebrates (e.g., sponges, crustaceans, and mollusks) and algae, which then attract fish searching for food or refuge (MMS 1999). This was supported in a study conducted over a five-year period off New Jersey which reported that 1 square meter ($m^2$; 10.76 square feet [$ft^2$]) of reef habitat was colonized by 432,000 marine animals consisting of 145 species with a collective biomass of 58,000 grams (g; 128 pounds [lbs]; Figley 2003). Artificial reefs within the Study Area support around 150 different fishes and other marine life that are indigenous to New Jersey waters, such as black sea bass (*Centropristis striata*), tautog (*Tautoga onitis*), red hake, gray triggerfish (*Balistoides viridescens*), Atlantic cod (*Gadus morhua*), pollack (*Pollachius pirens*), American lobster (*Homarus americanus*), and Atlantic rock crab (Figley 2005).

## 2.3 SURVEY ANCILLARY FISH OBSERVATIONS

Ancillary fish observations were collected during the ship surveys from January 2008 to December 2009 and from the aerial surveys from January to June 2009. These sightings are listed by survey date, time, and latitude in **Table 2-1** and **Table 2-2** and were collected opportunistically, usually in very calm sea conditions. Observed species included 19 ocean sunfish (*Mola mola*), 14 unidentified sharks, 4 unidentified rays, 2 basking sharks (*Cetorhinus maximus*), 1 hammerhead shark (*Syhyrna* spp.), and 1 houndfish (*Tylosurus crocodrilus*). On August 3, 2009, a large group of elasmobranchs were observed along the shipboard surveys tracks for three hours.

**Table 2-1. List of fishes observed during the shipboard surveys in the Study Area.**

| Survey Date | Time Observed | Latitude/Longitude | Species Observed |
|---|---|---|---|
| 07/15/2008 | 13:28:10 | 39:36.60°N 073:53.28°W | Ocean sunfish |
| 08/31/2008 | 10:45:46 | 39:38.52°N 073:56.91°W | Ocean sunfish |
| 10/15/2008 | 13:45:24 | 39:48.74°N 073:50.60°W | Ocean sunfish |
| | 13:49:07 | 39:48.35°N 073:51.28°W | Ocean sunfish |
| | 14:42:30 | 39:41.56°N 073:50.01°W | Ocean sunfish |
| 10/16/2008 | 15:36:31 | 39:16.86°N 074:13.31°W | Ocean sunfish |
| 11/12/2008 | 12:46:36 | 39:20.94°N 074:06.99°W | Unidentified shark |
| 11/14/2008 | 12:59:38 | 39:10.78°N 074:23.37°W | Ocean sunfish |
| 06/02/2009 | 13:29:38 | 38:54.77°N 074:27.46°W | Ocean sunfish |
| 06/03/2009 | 16:56:37 | 39:21.37°N 073:59.86°W | Unidentified shark |
| 06/06/2009 | 06:22:41 | 39:25.86°N 074:16.44°W | Ocean sunfish |
| | 12:54:02 | 39:02.32°N 074:28.90°W | Ocean sunfish |
| 08/01/2009 | 08:57:21 | 39:01.33°N 074:41.64°W | Large group unidentified rays |
| | 13:45:49 | 39:10.25°N 074:35.46°W | Unidentified shark |
| 08/03/2009 | 11:38:13 | 39:47.06°N 073:44.66°W | Unidentified shark |
| | 12:22:12 | 39:41.20°N 073:42.15°W | Hammerhead shark |
| | 12:24:14 | 39:40.87°N 073:42.00°W | Unidentified shark |
| | 12:30:50 | 39:39.84°N 073:41.48°W | Houndfish |
| | 12:47:42 | 39:39.61°N 073:41.87°W | Unidentified shark |
| | 12:54:50 | 39:40.56°N 073:42.97°W | Two unidentified shark |
| | 12:59:26 | 39:41.12°N 073:43.67°W | Unidentified shark |
| | 13:07:04 | 39:42.03°N 073:44.80°W | Unidentified shark |
| | 13:11:24 | 39:42.54°N 073:45.44°W | Unidentified shark |
| | 13:50:06 | 39:47.18°N 073:51.12°W | Two unidentified rays |
| | 14:34:52 | 39:50.21°N 073:56.22°W | Large group unidentified rays |
| | 14:37:07 | 39:50.61°N 073:56.26°W | Large group unidentified sharks |
| 10/02/2009 | 08:25:45 | 39:19.03°N 077:00.99°W | Unidentified shark |

**Table 2-2. List of fishes observed during the aerial surveys conducted in the Study Area.**

| Survey Date | Time Observed | Latitude/Longitude | Species Observed |
|---|---|---|---|
| 04/18/2008 | 14:50:21 | 39.71743°N -73.92712°W | Basking shark |
| 05/23/2009 | 18:57:08 | 39.71749°N -73.16521°W | Basking shark |
| 06/23/2009 | 15:14:00 | 39.613258°N -74.13105°W | Ocean sunfish |
| | 15:15:48 | 39.629032°N -74.117714°W | Ocean sunfish |
| | 15:19:35 | 39.595341°N -73.917221°W | Ocean sunfish |
| | 16:59:59 | 39.834251°N -74.042091°W | Ocean sunfish |
| 06/24/2009 | 15:11:37 | 39.455307°N -73.933235°W | Ocean sunfish |
| | 15:23:34 | 39.52765°N -74.1117°W | Ocean sunfish |
| | 15:47:44 | 39.25641°N -74.0328°W | Ocean sunfish |
| | 16:20:42 | 39.15287°N -74.25888°W | Ocean sunfish |
| | 17:26:26 | 38.9988°N -74.71338°W | Unidentified shark |
| | 19:46:08 | 39.07491°N -74.30554°W | Ocean sunfish |

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# 3.0 FISHERIES RESOURCES

The State of New Jersey has many valuable natural resources. The estimated value of goods and services associated with the state's natural resources ranges from $8.6 to $19.8 billion per year (NJDEP 2007b; NJDEP 2007a). Overall, freshwater and marine ecosystems have the highest ecoservice value ranging from $2.8 to $9.7 billion per year. One of the most economically valuable components of marine ecosystems is fishery resources. According to the Rutgers New Jersey Agricultural and Experiment Station, the economic impact of commercial fisheries, recreational fisheries, and aquaculture in New Jersey is around $4.5 billion annually.[1] Commercial fishery operations within or in the vicinity of the Study Area are highly active and key suppliers of marine products to domestic and foreign markets. In addition to commercial fisheries, recreational fisheries are also an important economic activity that occur off the coast of New Jersey and within the Study Area.

The New Jersey coastline consists of various inshore (e.g., estuaries, bays, salt marshes, tidal creeks, and coastal beaches) and offshore environments (e.g., sand ridges, continental shelf, canyons, hard bottom, and artificial reefs [e.g., ship wrecks and man-made structures]) that provide important habitats to many fish and invertebrates. In general, fish habitats off the coast of New Jersey can be categorized as coastal beaches, pelagic, demersal (benthic), and hard bottom (i.e., natural or artificial reef-structures). Within the Study Area, several economically valuable fish and invertebrate species use the area for feeding, spawning, and as nursery grounds. Marine fish depend upon and utilize many types of habitats (e.g., seagrass, salt marsh, solitary corals, and rocky intertidal areas) at different life stages. Because land and water activities can threaten to alter, damage, or destroy these habitats, regional Fishery Management Councils (FMCs) and federal and state agencies work together to address these threats by identifying EFHs for every federally managed fish species. In addition, Habitat Areas of Particular Concern (HAPCs) are also designated, which are defined as discrete subsets of EFH that provide important ecological functions that are especially vulnerable to degradation. Depending on the purpose and need, FMCs may designate a specific habitat area as an HAPC based on one or more of the following reasons: (1) importance of the ecological function provided by the habitat; (2) extent to which the habitat is sensitive to human-induced environmental degradation: (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) rarity of the habitat type (NMFS 2002).

## 3.1 FISHERIES DYNAMICS

The distribution of fish and fishing efforts often vary greatly spatially and temporally. Fish distribution also varies by their life stage (Cross et al. 1999; Taylor et al. 2007). Some of the environmental factors influencing spatial fish distribution include, but are not limited to, salinity, water temperature, dissolved oxygen level, which is often associated with season. In addition, life history requirements and migration behaviors affect seasonal relative abundance (Musick and Mercer 1977; Moser and Shepherd 2009). Although natural patterns of variability in fish populations are expected, anthropogenic activities such as coastal development, pollution (e.g., water quality: nutrients and pH level), commercial and recreational fishing, and habitat alteration/destruction can also affect spatial and temporal distribution of fish (Saila and Pratt 1973; Malakoff 1997; Jiménez-Marrero et al. 1998; Lazaroff 2001). Jackson et al. (2001) stated that nearly all estuarine species (i.e., fishes and macroinvertebrates) have been adversely affected to some degree by human activities, which has negatively altered the relative abundance of many coastal fisheries (e.g., blue crabs [*Callinectes sapidus*], oysters, and Atlantic striped bass [*Morone saxatilis*]). Excess fishing efforts may result in growth and recruitment overfishing, leading to overfished fish populations (Dayton et al. 1995; Jackson et al. 2001; Lazaroff 2001; ASMFC 2009a; NMFS 2009b).

Over the past two centuries, and especially within the last 50 years, the overall commercial and recreational fishing effort has increased significantly because of the high demand for seafood products and for socioeconomic reasons. Yet commercial fishery landings for many marine species have generally decreased with time, which suggests that fish effort is unsustainable for some species (Parker and Dixon 1998; Williams 1998). The development of advanced technology, better and improved access to environmental data (e.g., water temperature and current information), and advancements in commercial fishing gears has improved the catch efficiency for many species (SeaWeb 2002). While improvements in commercial fishing gears and methods continue to evolve, overall commercial catch rates, as a function of fishing effort continues to decline for many species. As commercial landings continue to decline for many economically valuable species, commercial fishermen are adapting toward targeting lower valued species that were once discarded (Caddy et al. 1998; Pauly et al. 1998).

### 3.2 FISHERIES MANAGEMENT

To develop effective fishery management and maintain thriving sustainable fisheries, public involvement and participation by the fishing community has become essential. Through the fishery management process, various federal laws, executive orders, proclamations, and regulations have been created to aid in the conservation and protection of fishery resources. Among the most important statutes was the establishment and implementation of the Magnuson-Stevens Fishery Conservation and Management Act (MSFMCA) or the Sustainable Fisheries Act (SFA). One of the unique mandates of the SFA was the creation of eight regional FMCs; each FMC is responsible for the status of valuable fishery stocks within their jurisdiction. Generally, management jurisdiction is defined as a common geographical area encompassing the federal waters known as the Exclusive Economic Zone (EEZ; i.e., 322-kilometer [km] or 200-mile [mi] limit). For example, the Mid-Atlantic Council (MAFMC) is responsible for the conservation and management of fish stocks within the EEZ off the coasts of New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina. After developing fishery management plans (FMPs) for individual species or species complexes (a group of similar species), the FMCs then use these documents to convey the conservation strategies for specific fishery resources. In general, FMPs are updated at regular intervals in accord with new scientific information or other significant circumstances. In addition to the eight FMCs, the National Marine Fisheries Service (NMFS) also relies on an appointed Highly Migratory Species (HMS) advisory team that is charged with assisting NMFS with implementing the requirements of the International Committee for the Conservation of Atlantic Tunas (ICCAT). The NMFS is responsible for managing 44 species (34 sharks, 5 tunas, 4 billfishes, and 1 swordfish) in domestic and international waters (NMFS-IFD 2004; NMFS 2004).

Marine fisheries resources (fish and invertebrates) that are found in the Study Area are managed through an elaborate process that includes the State of New Jersey, three FMCs (New England Fishery Management Council [NEFMC], MAFMC, and South Atlantic Fishery Management Council [SAFMC], the Atlantic States Marine Fisheries Commission (ASMFC), and the NMFS. In total, NEFMC manages 13 species, MAFMC manages 10 species, SAFMC manages 3 species, and NMFS manages 14 species that are found within the Study Area. In addition, six species are jointly managed by either two FMCs or one FMC and the ASMFC. In general, each FMC is only responsible for managing species within their respected jurisdictional areas. The MAFMC is one of the larger Councils that oversees some of the species found within the Study Area. It is accountable for managing fisheries in federal waters which occur mainly off the mid-Atlantic coast. States with voting representation on the Council include New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina, which is represented by the MAFMC and the SAFMC. The ASMFC manages shared marine fishery resources in state waters through the Interstate Fisheries Management Program (ISFMP). The ASFMC coordinates the conservation and management of 22 Atlantic coastal fish and invertebrate species and 2 species groups (shad/river herring and coastal sharks), which are found in the Study Area or vicinity (ASMFC 2008b). Both the SAFMC and GMFMC jointly manage fishes (i.e., coastal migratory pelagics) seasonally found in the Study Area. These FMCs are responsible for managing fisheries that are found in federal waters in the Gulf of Mexico and South Atlantic Bight (SAB). The HMS Management Division of the NMFS is responsible for managing swordfish, tunas, billfish, and sharks in domestic and international waters (outside of the EEZ). There are several HMS that are found in the Study Area or in the vicinity of the Study Area.

Despite the importance of New Jersey commercial fisheries, there are no comprehensive literature reviews on the commercial fisheries operating off the coast of New Jersey; however, some data are available from mandatory dealer reporting (state and federal: summer flounder, black sea bass, and scup [*Stenotomus chrysops*]) and other programs. For example, the New Jersey Division of Fish and Wildlife requires permit holders to submit monthly catch reports for summer flounder (*Paralichthys dentatus*), black sea bass, scup, tautog, horseshoe crab (*Limulus polyphemus*), Atlantic menhaden (bait), American shad (*Alosa sapidissima*), and American lobster (ASMFC 2008b). Moreover, crab/pot and gill net mesh exemption permit holders must also submit monthly records of catch.

## 3.3 Commercial Fisheries

The total economic value of commercial fisheries in New Jersey from 2003 through 2007 was nearly one billion dollars (an average of 178 million dollars a year; Idoine 1998); however, the actual economic value to the region was likely far greater in terms of the jobs, goods, and services associated with these fisheries. In 2007, commercial fisheries in New Jersey ranked eighth in value and tenth in landings in the U.S. (**Table 3-1**; **Figure 3-1**).

**Table 3-1. Top commercial fishing gears, landings (metric tons), and associated value ($US) for fisheries operating within or in the vicinity of the Study Area (State of New Jersey) from 2003 to 2007.**[2]

| Gear | Landings (mt) | Value ($) |
|---|---|---|
| Dredges (all types) | 165,388.0 | $465,770,895 |
| Trawls (all types) | 103,542.7 | $85,927,922 |
| Purse Seine | 39,701.5 | $7,269,516 |
| Hook-and-Line (all types) | 16,759.4 | $29,266,705 |
| Gillnets (all types) | 14,614.1 | $33,074,635 |
| Pots/Traps (all types) | 11,987.3 | $41,641,707 |
| **Total (All Gears)** | **372,499.8** | **$714,050,993** |

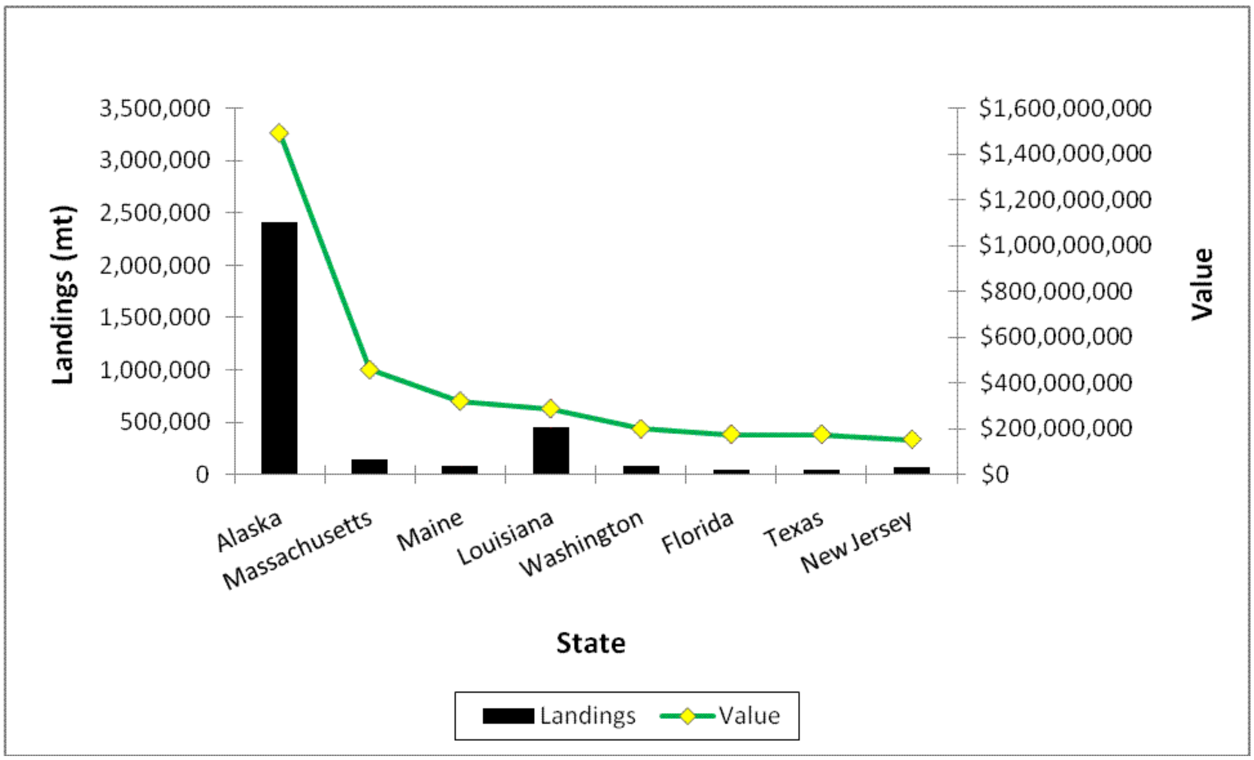


**Figure 3-1. Commercial fishing landings (metric tons) and value ($US) in 2007.**[2]

Commercial fisheries are generally referred to by the name of the species targeted or by the gear type utilized by fishermen. There are many types of fishing gears used off the coast of New Jersey and within or in the immediate vicinity of the Study Area, such as dredges, trawls, pound nets, gillnets, fixed nets (e.g., fyke nets and parallel nets) and hook-and-line; however, the primary gears utilized were dredges, trawls, purse seines, hook-and-line, gillnets, and pots/traps (**Table 3-1**) with the clam dredge, which was used to target Atlantic surfclam and ocean quahog (**Figures 3-2** and **3-3**), utilized the most. The total landings with clam dredge gear from 2003 through 2007 were 133,333 metric tons (mt; (146,666 tons [T]); clam dredge gear represented 50.5% of the total landings. Clam dredge landings ranged from a low of 22,612 mt (24,873 T) in 2005 to a high of 32,541 mt (35,794 T) in 2003 with a mean of 26,667 mt (29,334 T). The values of landings with clam dredge during this five year period was $159,612,233 which represented 43.8% of the total value. The fifth most valuable fishing gear was pots and traps, which ranged from $4,166,381 in 2003 to $6,110,242 in 2005. Overall, the northeast multispecies groundfish fishery (dredge and trawl gear) was the predominant fishery in terms of landings and number of active vessels (**Tables 3-1** and **3-2**).

The American lobster, Atlantic sea scallop (*Placopecten magellanicus*), and clam fisheries were also important fisheries within or near the vicinity of the Study Area. Some of these commercial fisheries have been established for more than a century. Another important fishery that operates within the vicinity of the Study Area is the pelagic longline fishery that targets offshore species such as tuna and swordfish. Recently, several commercial fisheries (e.g., skates [Rajidae], spiny dogfish shark [*Squalus acanthias*] and monkfish or goosefish [*Lophius americanus*]) have become more important as traditional fish stocks continue to decline. Furthermore, some fisheries, such as the herring (Clupeidae) fishery, have recently expanded the fishing grounds into other areas in hopes of increasing their landings. Depending on a species habitat requirements and behaviors, fishing operations target specific geographical areas at particular times.

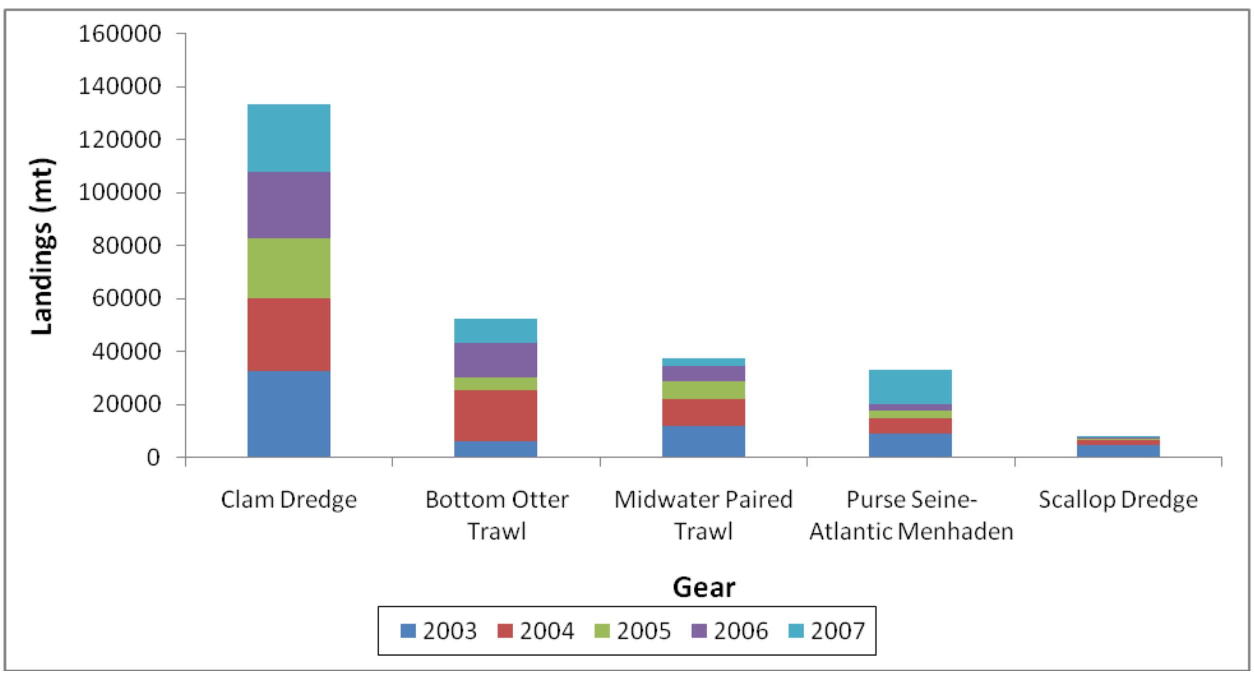


**Figure 3-2. The primary commercial fishing gears utilized off New Jersey by landings (metric tons [mt]) from 2003 to 2007.**[2]

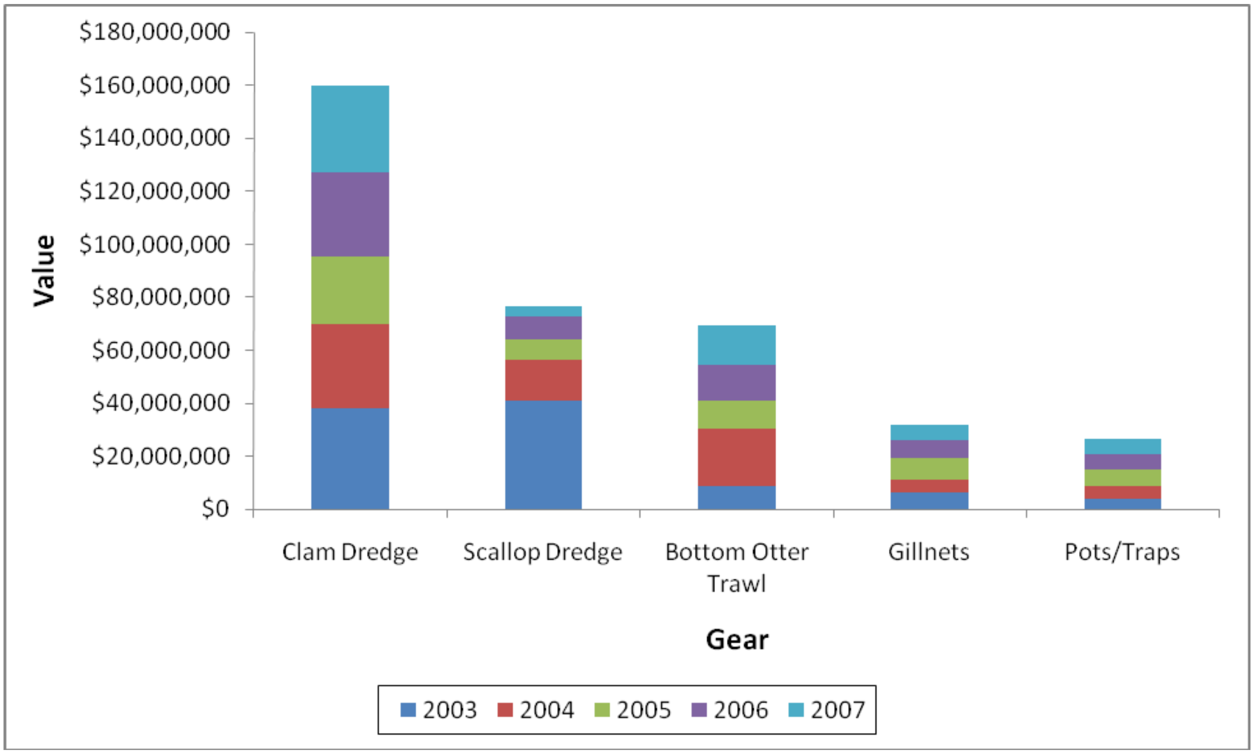


**Figure 3-3. The primary commercial fishing gears utilized off New Jersey by value ($US) from 2003 to 2007.[2]**

**Table 3-2. Major commercial fisheries, active season, and gear utilized within or in the vicinity of the Study Area (peak months/seasons given in parentheses).**

| Fishery | Season | Gear |
|---|---|---|
| Northeast groundfish | Year-round (seasonal by region) | Bottom trawls, bottom longlines, sink gillnets |
| Monkfish | Year-round (winter and summer) | Bottom trawls, scallop dredges, sink gillnets |
| Skates | Year-round (summer) | Bottom trawls, sink gillnets |
| Spiny dogfish | Year-round (seasonal by region) | Bottom trawls, sink gillnets |
| Atlantic sea scallop | Year-round (seasonal by region) | Scallop dredges, bottom trawls |
| Clams: Atlantic surfclam and Ocean quahog | Year-round (summer) | Hydraulic dredges, scallop dredges, bottom trawls |
| Atlantic herring | Year-round (seasonal by region) | Purse seines, mid-water trawls, pair trawls |
| American lobster | Year-round (May through December) | Traps, bottom trawls |
| Winter trawl | September through April | Bottom trawls, mid-water trawls |
| Highly migratory species | Year-round (seasonal by region, species, and gear type) | Bottom and pelagic longlines, sink and pelagic gillnets, purse seines, hand gear |

Sources: (NEFMC 1983; Ross; NEFMC 1993; Shepherd and Terceiro; NEFMC 1996; ASFMC 1997; Idoine 1998; NEFMC 1998a; MAFMC and NEFMC 1999; NEFMC 1999a; NMFS 1999a; Clark et al. 2000; Weinberg 2000; Idoine 2001; Weinberg 2001; NEFMC 2003b; NEFMC 2003a; NMFS 2008; NMFS 2009d).

Generic descriptions of the primary fishing gears used in the waters off New Jersey are described below:

- Dredges—rugged, steel frame supported box or bag-shaped device used to target benthic animals, such as bivalve mollusks. Dredges are towed behind a fishing vessel along the seafloor. Dredge gear primarily takes clams, oysters, scallops, and mussels. The number of Atlantic coast crab dredge licenses issued ranged from 205 to 228 during 1999 through 2004 (Chuenpagdee et al. 2003; Fullenkamp 2006). Average licenses sold from 2008 to 2009 was 217 with limited entry and no cap (pers. comm., Brandon Muffley, New Jersey Department of Fish and Wildlife, 4 June 2010)

- Trawls—large nets (bag-shape) constructed with natural fibers or synthetic materials that are rectangle or polygon shaped (mouth openings), which are towed behind a fishing vessel to target fish. Trawls are towed at different water depths (usually bottom and mid-water) depending on target species; trawls are used to target squid, Atlantic mackerel, summer flounder, black sea bass, scup, Atlantic croaker (*Micropogonias undulatus*), and winter flounder. The number of otter trawl licenses issued ranged from 75 to 98 during the period of 1999 through 2003; shrimp trawl licenses ranged from 309 to 334 (Chuenpagdee et al. 2003; Fullenkamp 2006). Average licenses sold from 2008 to 2009 was 80 (pers. comm., Brandon Muffley, New Jersey Department of Fish and Wildlife, 4 June 2010).

- Purse seines—nets constructed with natural fibers or synthetic materials that are used to encircle a school of fish. Once the net has captured a school of fish, it is then cinched; purse seines are used to target Atlantic menhaden and Atlantic herring (*Clupea harengus*). This gear is also used to target bluefish in nearshore waters. The number of purse seine permits issued during the period of 1999 through 2003 ranged from 31 to 47 (Fullenkamp 2006). Average licenses sold from 2008 to 2009 was 33 (pers. comm., Brandon Muffley, New Jersey Department of Fish and Wildlife, 4 June 2010).

- Longline/Hook-and-Line—a longline consists of a monofilament mainline that has baited hooks attached at regular predetermined intervals. Longline gear is set either at the surface (using floats and highflyers) or along the seafloor. Longlines either drift with the currents or are stationary. Longlines are used to target benthic (e.g., Atlantic cod, haddock [*Melanogrammus aeglefinus*], and sharks) and pelagic species (tuna, swordfish, or pelagic sharks (Chuenpagdee et al. 2003; Fullenkamp 2006). No longlines licenses are issued since it is not a gear type allowed in state waters (pers. comm., Brandon Muffley, New Jersey Department of Fish and Wildlife, 4 June 2010).

- Hook-and-Line gear—consists of monofilament line that is deployed and retrieved by a reel. The reel is attached to fiberglass or carbon fiber constructed rod that usually ranges in length from 1.85 to 2.78 m (6 to 9 ft). Hook and line gear is used by commercial and recreational anglers to target various nearshore and offshore species such as bluefish, summer flounder, tautog, weakfish, or Atlantic striped bass (Chuenpagdee et al. 2003; Fullenkamp 2006).Average permits sold from 2008 to 2009 was 29 with limited entry (pers. comm., Brandon Muffley, New Jersey Department of Fish and Wildlife, 4 June 2010).

- Gillnets—rectangular panels of net constructed of monofilament or synthetic materials that are used to target a variety of species (e.g., mackerel or sharks) at the surface, mid-water, or on the seafloor. Gillnets are used to target Atlantic menhaden, butterfish, northern kingfish, spot (*Leiostomus xanthurus*), and river herring (*Alosa* spp.). The number of gillnet mesh exemption permits issued ranged from 13 to 18 during the period of 1999 through 2004. Drift gillnets are used to target Atlantic bonito (*Sarda sarda*), weakfish, and bluefish. The number of licenses issued in New Jersey ranged from 544 to 679 during the period of 1999 through 2003. Anchor gillnets are used to target Atlantic croaker, Atlantic menhaden, butterfish, spot, northern kingfish, smooth dogfish (*Mustelus canis*), American shad, and black drum (*Pogonias cromis*). The number of licenses issued ranged from 2,648 to 3,305 during the period of 1999 through 2003. Stake gillnets are used to target Atlantic menhaden, Atlantic croaker, butterfish, spot, northern kingfish, bluefish, weakfish (*Cynoscion regalis*), smooth dogfish, American shad, and black drum. The state only issues a staked and anchored gillnet license (Chuenpagdee et al. 2003; Fullenkamp 2006). From 2008 to 2009, the average gillnet exemption permits issued was 19, the average drifting gillnet licenses was 593, and the average staked/

anchored gillnets was 2,834, all with limited entry (pers. comm., Brandon Muffley, New Jersey Department of Fish and Wildlife, 4 June 2010).

- Pot and traps—rectangle, square, or cylindrical devices usually set on the seafloor to target benthic fish and invertebrates. Pots and traps are usually set for an extended period; locations are marked at the surface with a buoy (float) that is attached to the pot or trap by a rope. Pots/traps are used to target lobsters, whelk (Buccinidae), and black sea bass. In general, pots/traps are often set in a string (a number of pots/traps connected by a groundline) near natural or artificial structure, especially to target fish (**Figure 3-4**).The number of licenses issued for lobster, fish, and whelk during the period of 1999 through 2003 ranged from 167 to 274. The number of crab pots licenses during the period of 1999 through 2003 ranged from 333 to 377. In 2004, the number of lobster permits issued was 165, which allowed 117,570 pots (Chuenpagdee et al. 2003; Fullenkamp 2006). From 2008 to 2009, the average number of commercial blue crab pot licenses issued was 309 and the average number of lobster permits was 108 both with limited entry (pers. comm., Brandon Muffley, New Jersey Department of Fish and Wildlife, 4 June 2010).

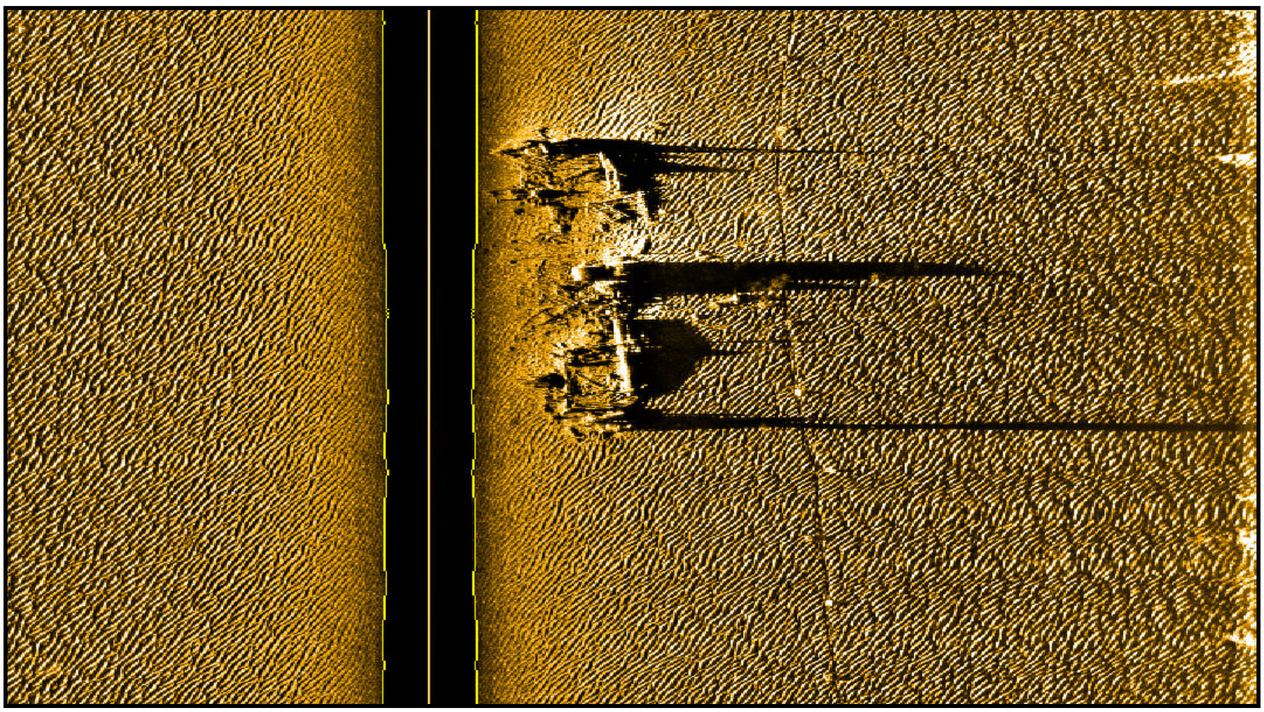

**Figure 3-4. A side-scan sonar image of a commercial fishing string of pots/traps and its association to bottom structure in the Study Area. The location of this bathymetric image was 39°26.3474′ North Latitude; 074°08.2308′ West Longitude.**

Commercial fishing effort within or in the vicinity of the Study Area varies spatially and temporally depending on the target species and weather conditions (storm fronts). The annual landings for New Jersey from 2003 through 2007 ranged from a high of 69,302 mt (76,232 T) in 2006 to 85,190 mt (93,709 T) in 2003 with a mean of 74,500 mt (81,950 T) (**Figure 3-5**). Most of the fishing landings generally occurred from March through August and most were in May and September. In terms of value, May ($77,690,018) and August ($74,658,970) were the most important months (**Figure 3-6**).

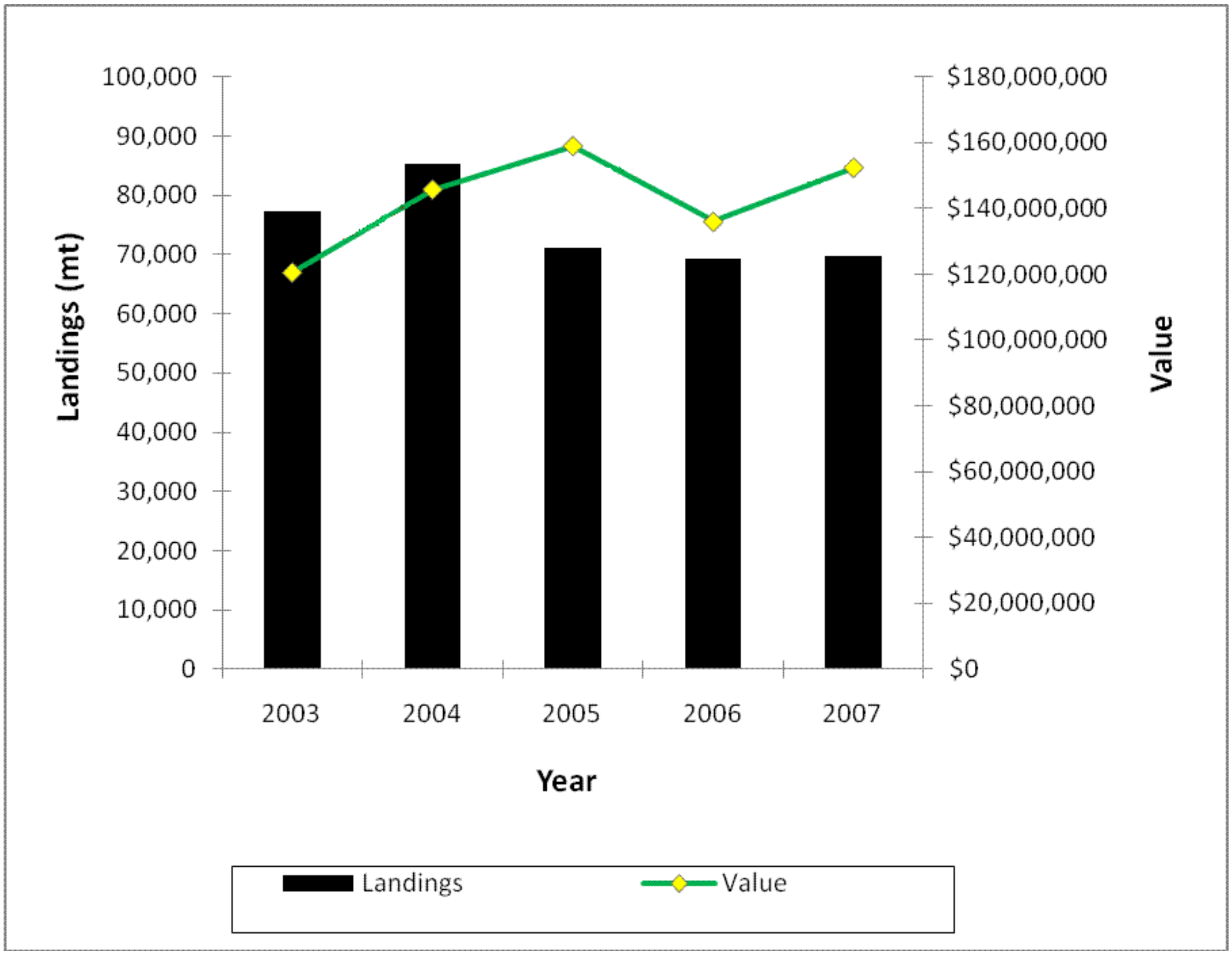


**Figure 3-5. Cumulative annual commercial fishing landings (metric tons) and value ($US) for New Jersey from 2003 to 2007. Source data: NMFS.[2]**

The top five species landed in New Jersey from 2003 through 2007 were Atlantic surfclam, sea scallop, ocean quahog, goosefish (monkfish), and summer flounder. Overall, Atlantic surfclam was the primary species landed in New Jersey (**Figure 3-7**). Atlantic surfclam landings from 2003 through 2007 ranged from a low of 17,676 mt (19,444 T) in 2005 to a high of 23,286 mt (25,615 T) in 2003 with a mean of 20,163 mt (22,179 T). The most valuable species landed in New Jersey was Atlantic sea scallop **(Figure 3-8**). Atlantic sea scallop value from 2003 through 2007 ranged from $43,506,985 in 2003 to $88,482,451 in 2005 with a mean of $66,856,061. It should be noted that although blue crab landings and economic value ranked fourth, the fishery is primarily conducted in the nearshore waters of Delaware Bay. The most valuable finfish landed in New Jersey was goosefish (monkfish). Goosefish value from 2003 through 2007 ranged from a low of $3,496,170 in 2004 to a high of $6,199,514 in 2003 with a mean of $7,675,132. In terms of landings, the most dominant fish species were Atlantic mackerel, Atlantic menhaden, goosefish, summer flounder, and Atlantic herring (**Figure 3-9**). Total landings for the primary fish species from 2003 through 2007 ranged from a low of 13,182 mt (14,500 T) in 2007 to a high of 40,724 mt (44,796 T) in 2003 with a mean of 27,389 mt (30,128 T). These data demonstrated that annual total landings for the primary fish species have decreased with time, which parallels the overall commercial landings trend in New Jersey.

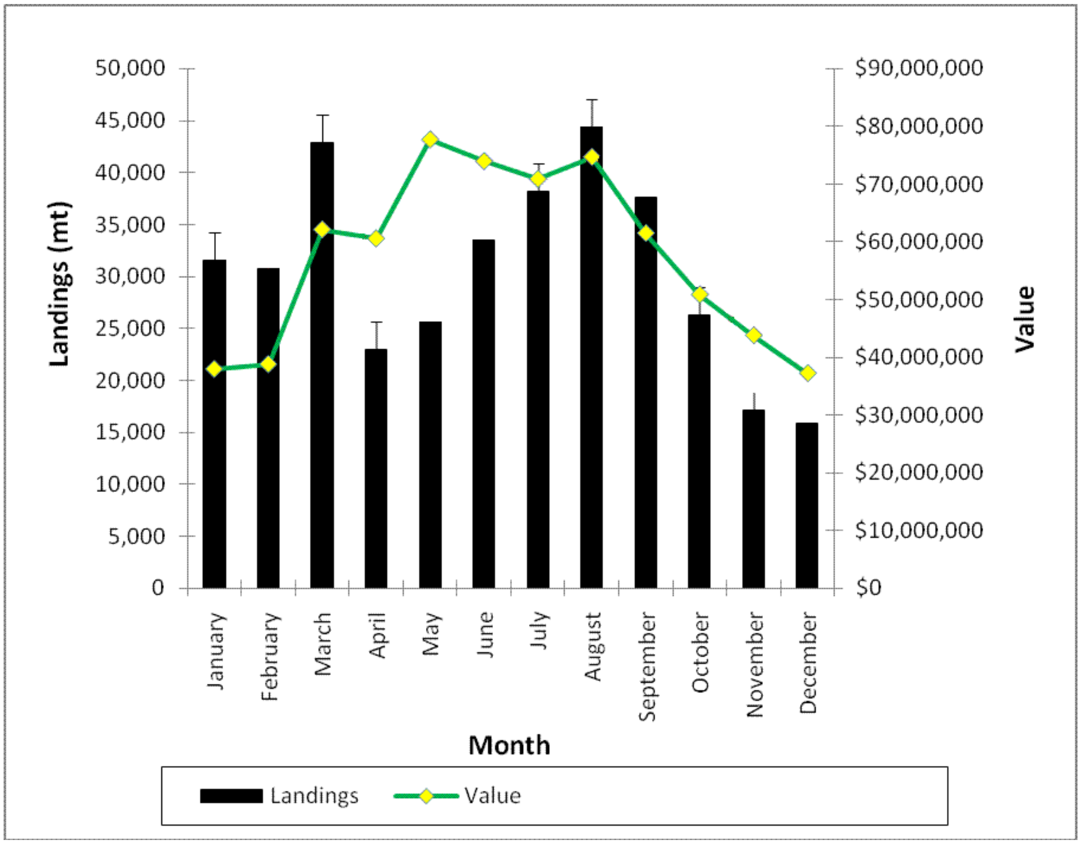


**Figure 3-6. Cumulative monthly commercial fishing landings (metric tons) and value ($US) for New Jersey from 2003 to 2007.[2]**

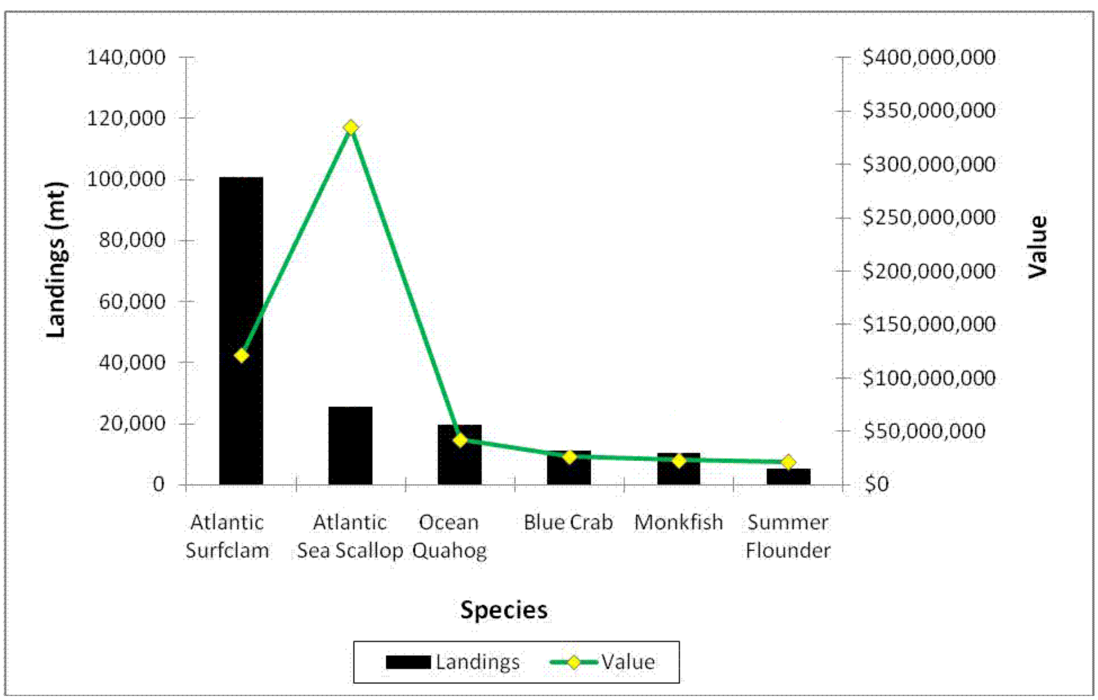


**Figure 3-7. The primary commercial species landed (metric tons) and value ($US) in New Jersey from 2003 to 2007.[2]**

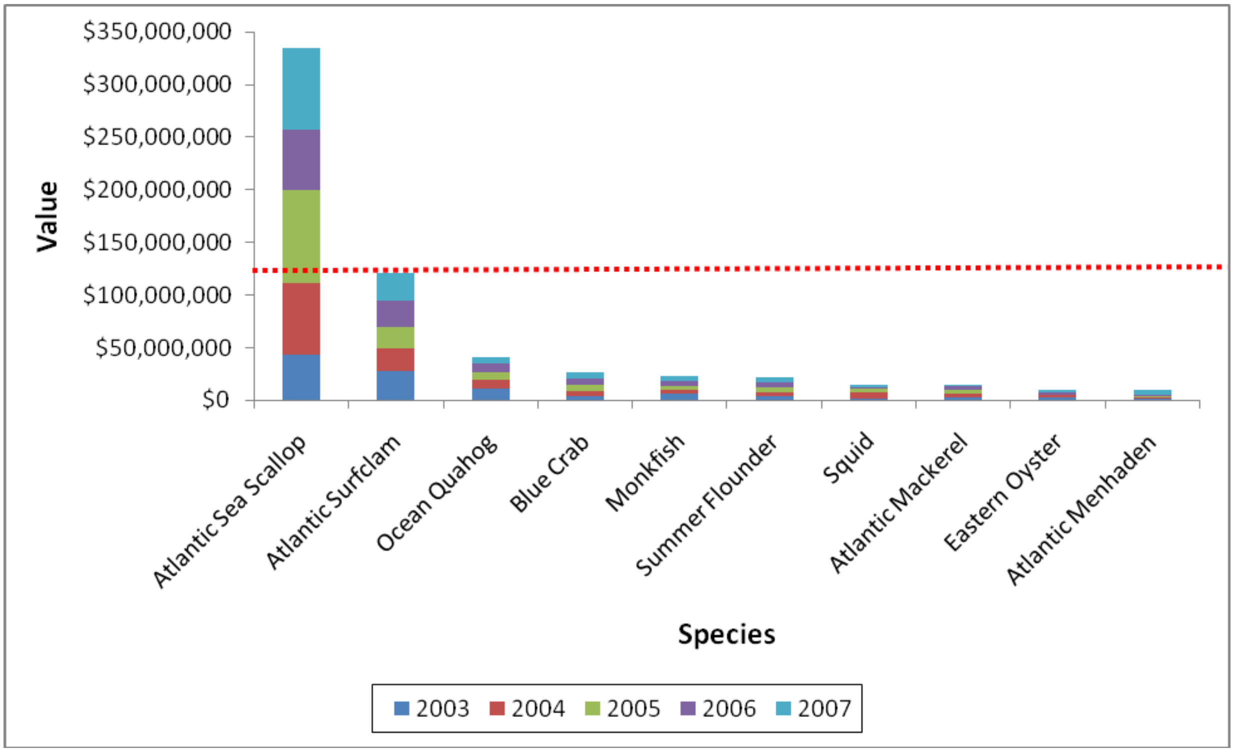


**Figure 3-8. The most valuable ($US) commercial species landed in New Jersey from 2003 to 2007. The dotted line depicts the mean overall value.[2]**

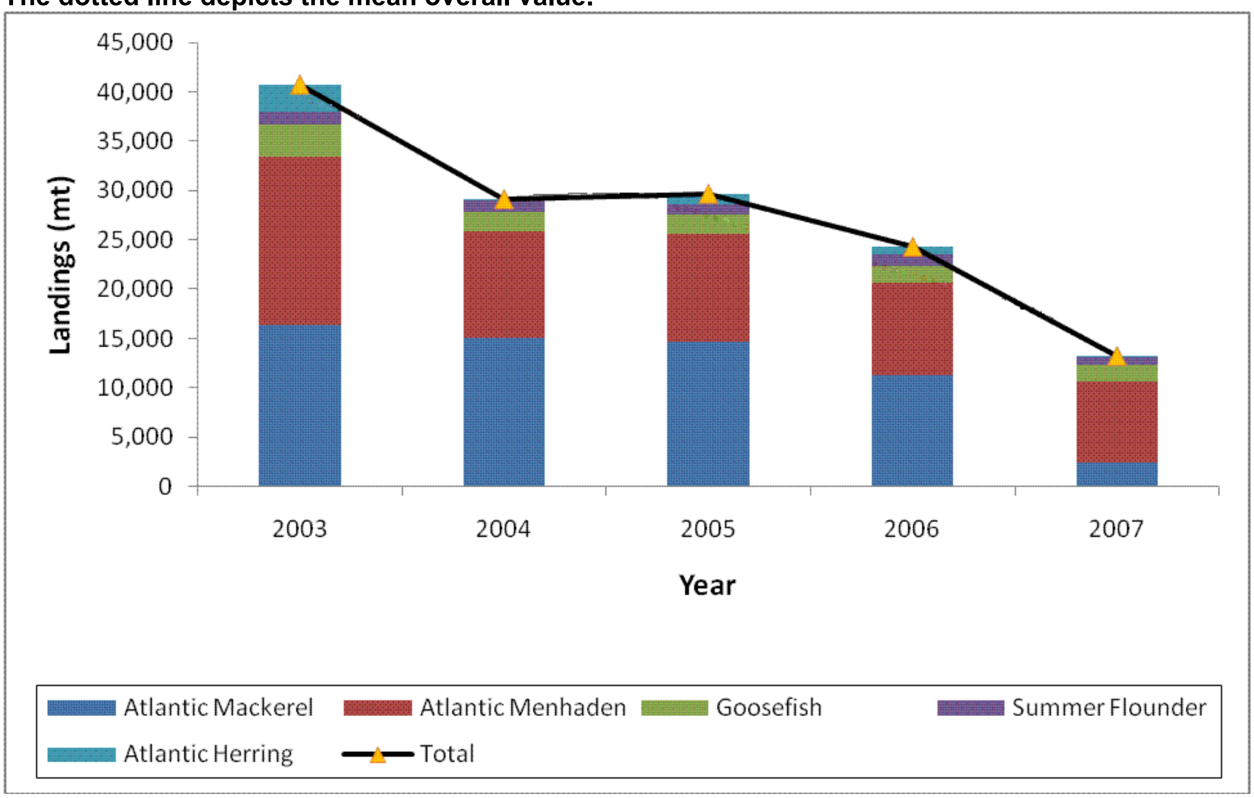


**Figure 3-9. The most numerically (metric tons) dominant commercial fish species landed (metric tons) in New Jersey from 2003 to 2007.[2]**

### *3.3.1 Northeast Multispecies Groundfish Fishery*

The Northeast multispecies groundfish fishery is a group of demersal finfish (i.e., groundfish) that are generally found and taken by commercial fishing gears in mixed assemblages (NEFMC 2004). The groundfish species found within or in the vicinity of the Study Area include: Atlantic cod, ocean pout (*Zoarces americanus*), red hake, silver hake (whiting), windowpane flounder, winter flounder, witch flounder, and yellowtail flounder.

Historically, Atlantic cod has been the primary species targeted in the offshore groundfish fishery, which also included haddock and yellowtail flounder. The primary commercial fishing gear utilized in the groundfish fishery is the bottom trawl (**Figure 3-10**); however, sink gillnets and bottom longlines are also utilized (**Figure 3-11**).

To protect and better manage some species, the NMFS designates several seasonal and year-round closed areas in this fishery. For various reasons, these areas are closed to bottom otter trawls, sink gillnets, and bottom longlines during designated times, but often remain open for other types of fishing gear, such as scallop dredges, pelagic (drift) gillnets, purse seines, pots and traps, shrimp trawls, mid-water trawls, and others (NEFMC 2004).

### *3.3.2 Winter Trawl Fishery*

The winter trawl fishery was traditionally a southern-based fishery (i.e., North Carolina), but it is active from Long Island, New York to Cape Lookout, North Carolina during September through April (Ross 1991). In general, the gear is deployed in coastal waters and dragged along the bottom at depth around 90 m (295 ft) (Ross and Moye 1989). The nearshore flounder fishery and deep-water trawl fishery (**Figure 3-10**) as well as the flynet (mid-water trawl) fishery are three sub-fishery components to this trawl fishery. Summer flounder dominates the nearshore and deep-water landings, while the weakfish, Atlantic croaker, and bluefish dominate the flynet (mid-water trawl) landings (Ross and Moye 1989).

### *3.3.3 Monkfish Fishery*

The monkfish (i.e., goosefish: *Lophius americanus*) fishery was the most valuable finfish species landed in New Jersey during 2003 through 2008. Monkfish landings in New Jersey ranged from a low of 1,675 mt (1,843 T) in 2008 to a high of 3,259 mt (3585 T) in 2003 with a mean of 2,042 mt (2,246 T; **Figure 3-11**). Since 2003, landings of monkfish in New Jersey have declined 51% (1,584 mt [1,742 T]; NEFMC, MAFMC, and NMFS 2004; NEFMC and MAFMC 2006). Monkfish range from the Grand Banks, Canada to Cape Hatteras, North Carolina. Monkfish are demersal and occur at depths to 900 m (2,952 ft) and greater. Females live longer (12 to 14 years) than males (about seven years) and reach maturity at five and four years, respectively. Based on genetics, there is one species; however, since there is a difference on how the northern (Gulf of Maine and northern Georges Bank) and southern (southern Georges Bank and Middle Atlantic) fisheries are conducted, the fishery is managed as two separate stocks (Haring and Maguire 2008; Richards et al. 2008).The monkfish fishery was established in the late 1970s through the 1980s as a result of high demand from foreign markets and the loss of major target fishery stocks, such as Atlantic cod and haddock. The monkfish fishery is a derivative of the multispecies groundfish and scallop dredge fisheries. In fact, less than a third of the landings result from vessels targeting monkfish directly (NEFMC 1998c; NEFMC 1998b). The primary fishing gears that take monkfish are bottom trawls (**Figure 3-10**), sink gillnets (**Figure 3-12**), and dredges (**Figures 3-13** and **3-14**). The trawl fishery takes a significant number of monkfish in the canyons and steep edges of the continental shelf break in the northern portion of the MAB. From 2003 through 2007, monkfish were mostly (80%) taken with bottom trawls, but in the southern fishery monkfish were mostly taken with gillnets (NEFMC and NMFS 2000; NEFMC and MAFMC 2006; MAFMC 2008). Fishing landings occur year-round, but New Jersey landings are generally seasonal (i.e., beginning in November and extending through February and peaking in May and June {NEFMC, MAFMC and NMFS 2004; NEFSC 2005; NEFMC and MAFMC 2006; MAFMC 2008). Based on the 2007 monkfish stock assessment (NDPSWG 2007), population models suggest that the species is not overfished in either the northern or southern stock management areas.

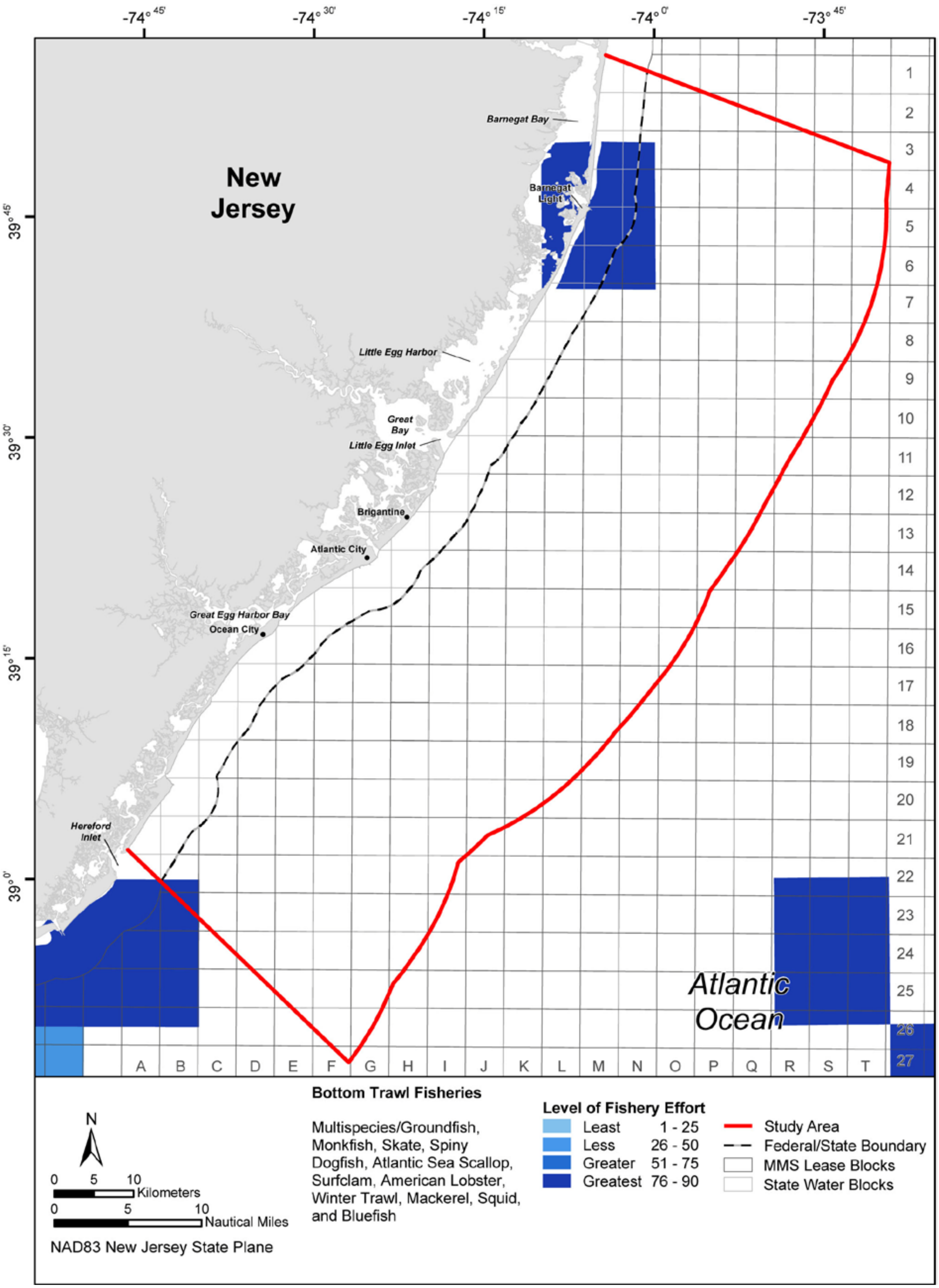


**Figure 3-10. Fishing effort distribution of bottom trawl fisheries in the Study Area and vicinity from 1995 to 2001. Source data: NMFS (2003a). Source information: NEFMC(2003a).**

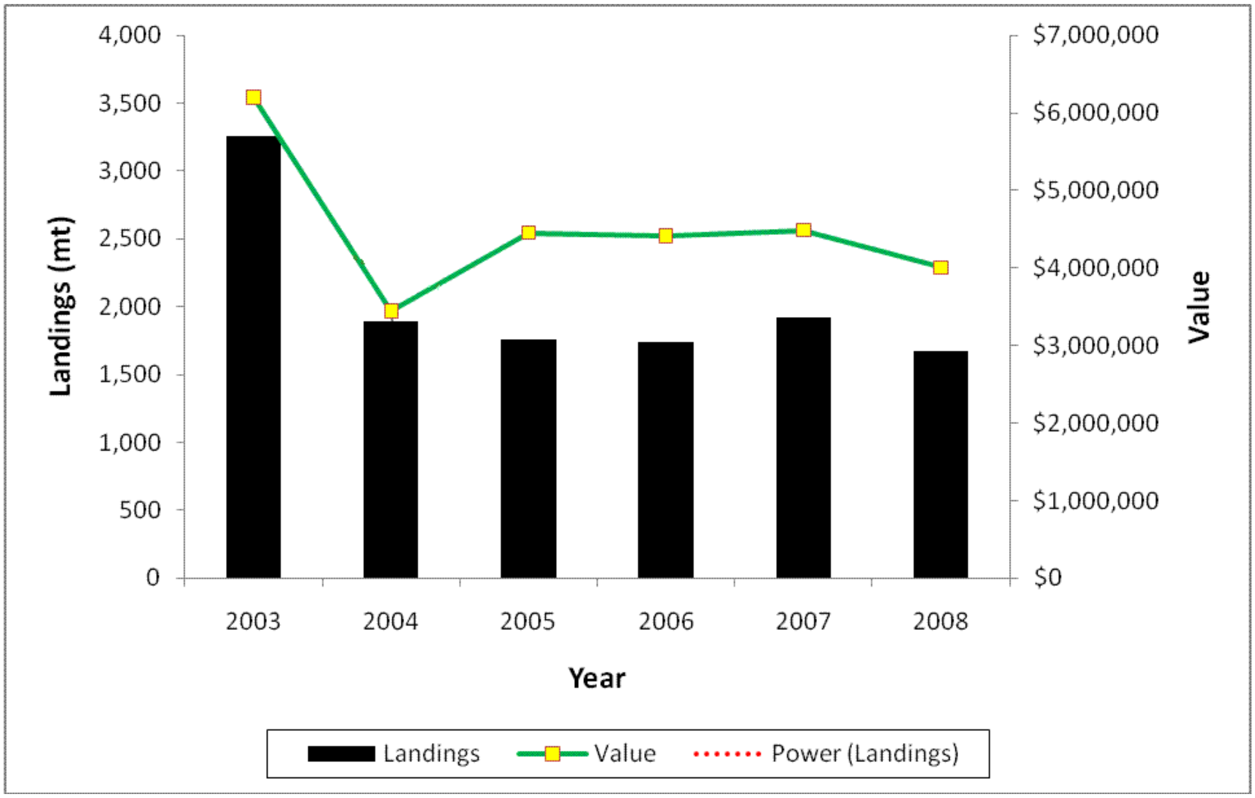


**Figure 3-11. Monkfish commercial landings (metric tons) and value ($US) in New Jersey from 2003 to 2007.**[2]

### *3.3.4 Skate Fishery*

The seven species in the Northeast Region (Maine to Virginia) skate complex are distributed along the Atlantic coast of the northeast U.S. from the tide line to depths exceeding 700 m (2,296 ft). The seven species are: little skate (*Leucoraja erinacea*), winter skate (*L. ocellata*), barndoor skate (*Dipturus laevis*), thorny skate (*Amblyraja radiata*), smooth skate (*Malacoraja senta*), clearnose skate (*Raja eglanteria*), and rosette skate (*L. garmani*) (Sosebee et al. 2009). Of the seven skate species off the northeastern U.S., both the smooth and thorny skates are in overfished condition, barndoor, winter, and little skates are low in biomass, and clearnose and rosette skates have high biomass (NEFMC 2009).[3]

Skates are harvested for bait and human consumption. The bait fishery primarily supplies bait for lobster traps and the "wing" (fin) fishery supplies restaurants with skate for human consumption. Sometimes wing meat is sold to fish markets and restaurants as "scallop". Similar to other fisheries within the Study Area, landings occur year-round, but peak landings primarily occur in summer. The directed "wing-meat" fishery is a relatively new, which was established during the 1990s after the decline of some primary groundfish species. Landings for the wing meat fishery mainly result from the bycatch in the groundfish, monkfish, and Atlantic sea scallop fisheries. Bottom trawls (**Figure 3-10**) are the main fish gear for skates (NEFMC 2003b), however, skates are also taken with sink gillnet gear (**Figure 3-12**).

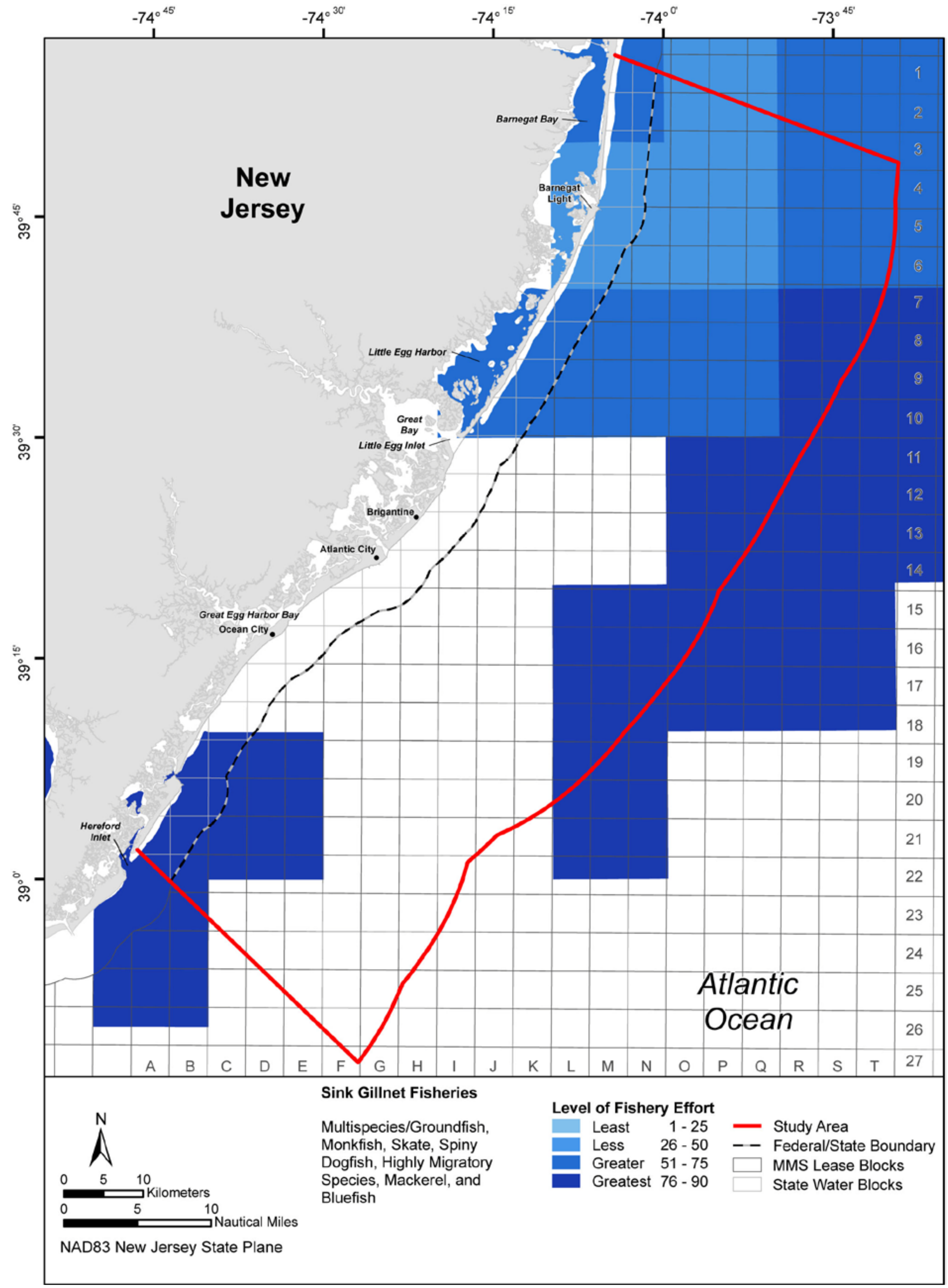


**Figure 3-12. Fishing effort distribution of sink gillnet fisheries in the Study Area and vicinity from 1995 to 2001. Source data: NMFS (2003a). Source information: NEFMC(2003a).**

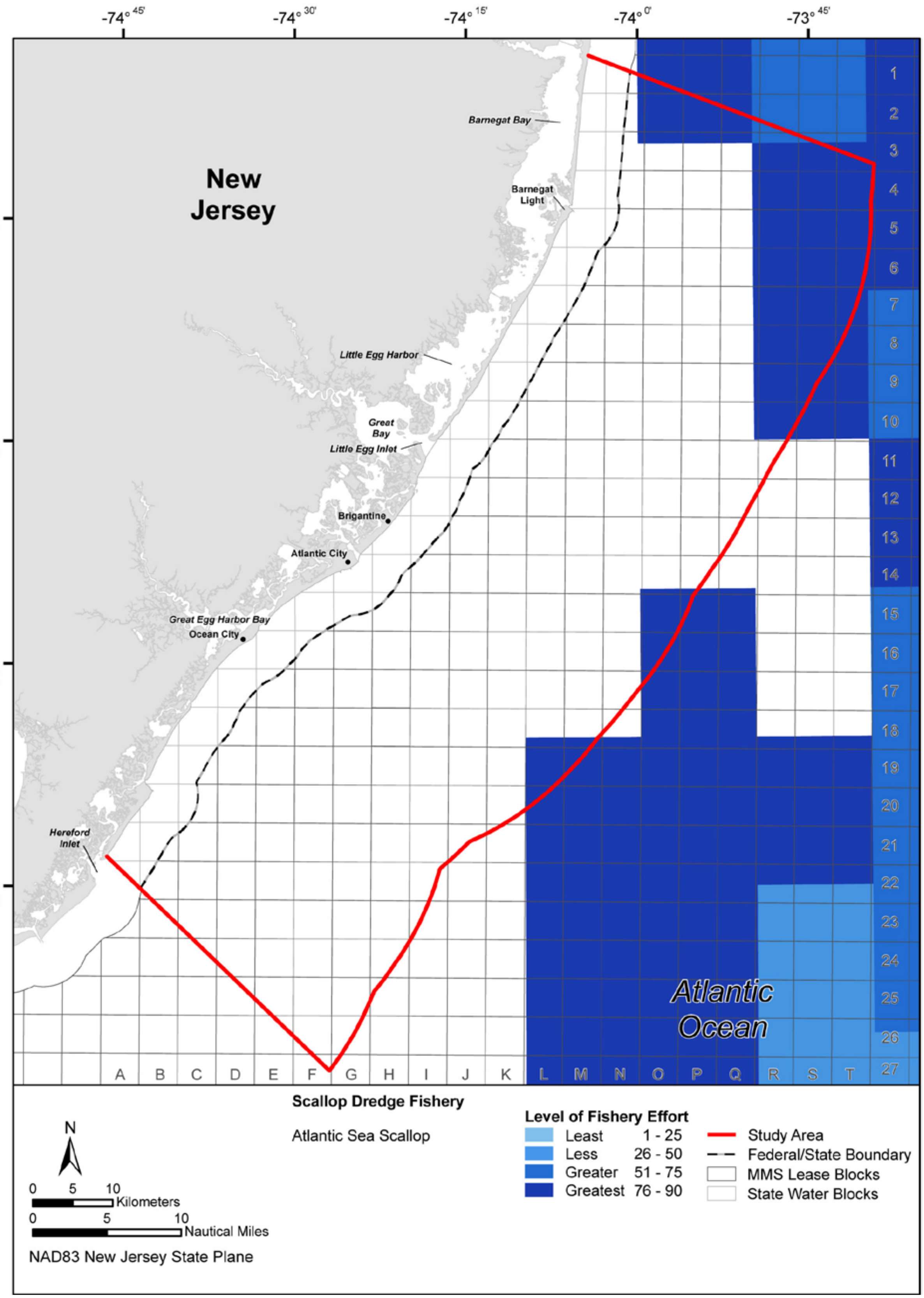


**Figure 3-13. Fishing effort distribution of scallop dredge (Atlantic sea scallop) fisheries in the Study Area from 1995 to 2001. Source data: NMFS (2003a). Source information: NEFMC(2003a).**

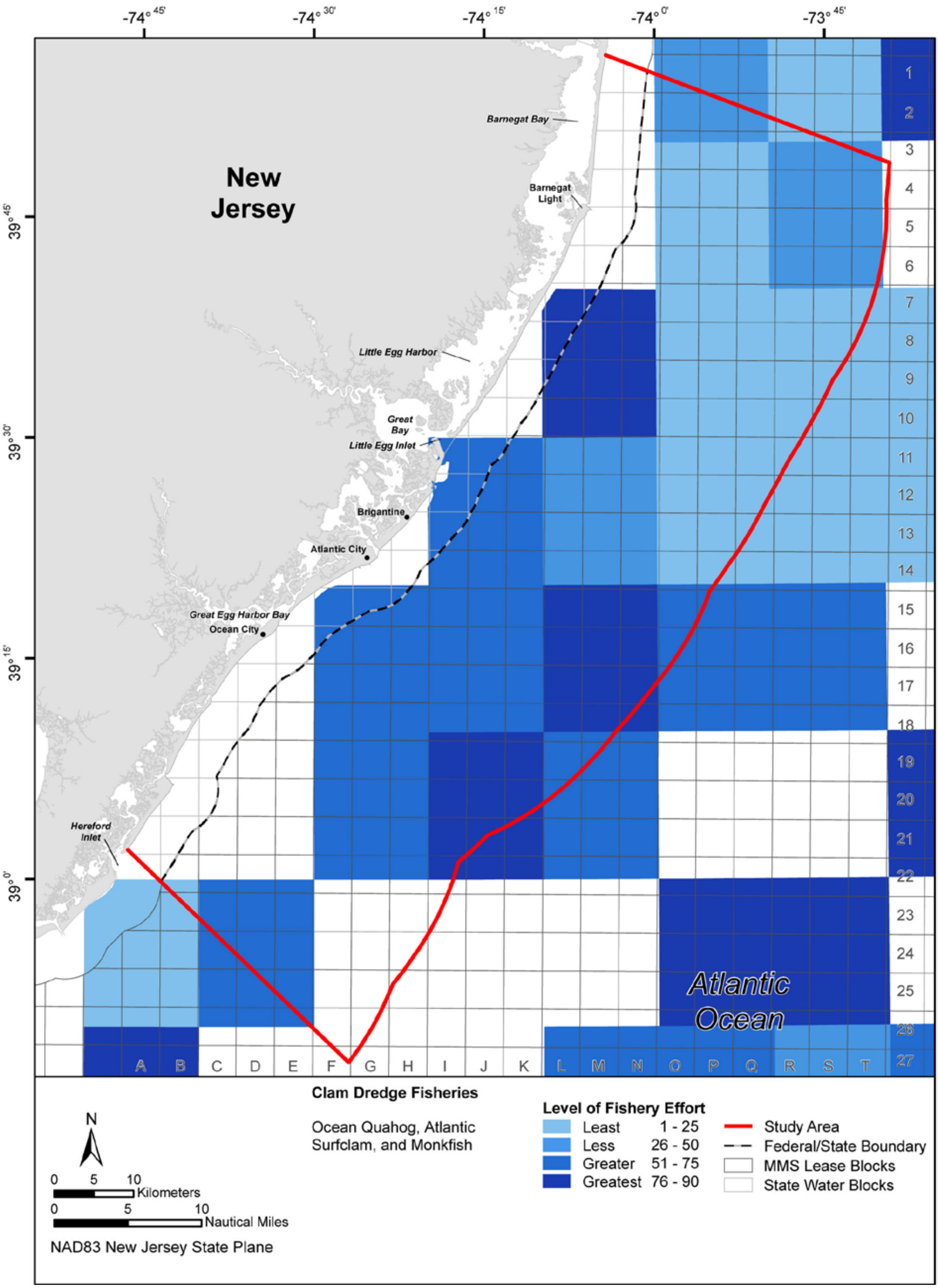


**Figure 3-14. Fishing effort distribution of clam dredge fisheries in the Study Area and vicinity from 1995 to 2001. Source data: NMFS (2003a). Source information: NEFMC(2003a).**

### *3.3.5 Spiny Dogfish Fishery*

Spiny dogfish (*Squalus acanthias*) are distributed in the western North Atlantic from Labrador to Florida and are considered to be a unit stock (Burgess 2002). During the spring and autumn, spiny dogfish can be found in coastal waters between North Carolina and Southern New England. In summer, dogfish migrate northward to the Gulf of Maine Georges Bank region and into Canadian waters and return southward in the autumn and winter (Jensen 1965). Atlantic stocks of spiny dogfish are not overfished, and have rebuilt to a level above the target spawning stock biomass (SSB; 167,000 mt [184,034 T]) based on an updated conducted by the Northeast Fisheries Science Center (NEFSC) in 2008 that estimates SSB to be 194,600 mt (214,449 T). The Technical Committee reviewed the assessment and agreed that SSB is at a value greater than $SSB_{target}$, but cautioned that the determination of rebuilt status is based on current levels of stock abundance and SSB is projected to decline sharply around 2017 due to a persistent trend of low recruitment that began in 1997 (Vonderweidt et al. 2009a).

The spiny dogfish fishery was established in the mid-1970s for the same reasons previously discussed for monkfish and skate fisheries, which was related to declining stocks of cod and other important species. Generally, spiny dogfish are a bycatch in multispecies groundfish fisheries. Fishing gears that take spiny dogfish include bottom trawls (**Figure 3-10**), sink gillnets (**Figure 3-12**), and bottom longlines (MAFMC 1999). In the MAB region, landings peak in the fall and winter months, while landings from Maine to New York, peak in the spring and summer (ASMFC 2002).

### *3.3.6 Atlantic Sea Scallop Fishery*

The Atlantic sea scallop (*Placopecten magellanicus*) fishery is among the most important and valuable fisheries in this region. In the MAB, scallops have been harvested since the 1800s (NEFMC 1993; NEFMC 2003a). Commercial vessels dredging with scallop rakes land the majority of Atlantic sea scallops (**Figure 3-13**), while a small percentage of the landings is attributed to vessels using bottom trawl gear (**Figure 3-10**) (NEFMC 1993). In addition, a significant percentage of landings are taken in the summer flounder and winter flounder fisheries. Depending on vessel size, fishing grounds, and weather conditions, fishing trips range in duration from a single day for small vessels to 22 days for large vessels (NEFMC 2003a). Atlantic sea scallops are mostly found in offshore waters in depths ranging from 9.3 to 247 m (30 to 800 ft) (Hart and Chute 2004). Fishing effort occurs year-round in the MAB, however, most landings are during April through September. The primary Atlantic sea scallop fishing ports are Cape May, New Jersey and Hampton, Virginia. Vessels from these ports are generally large and usually make extended trips to the scallop fishing grounds off New York and Virginia. Smaller inshore vessels range in length from 10 to 14 m (32.8 to 46.0 ft), while the larger vessels can exceed 30.5 m (100 ft) but are generally around 21 m (69 ft) long (NEFMC 2003a).

Biomass survey indices for both Georges Bank and Mid-Atlantic sea scallops were at or near their historical maximums in 2005. The combined survey index for 2005 was 7.8 kilograms (kg) per tow (17.2 lbs/tow). Well above the biomass target of 5.6 kg/tow (12.35 lbs/tow). Sea scallops were therefore not overfished in 2005. Fishing mortality has declined considerably from its peak in 1991. In 2005, fishing mortality was 0.22, slightly above the target fishing mortality rate of 0.2, but below the overfishing threshold 0f 0.24. Therefore, overfishing was not occurring in the sea scallop fishery in 2005 (Hart 2005).

### *3.3.7 Atlantic Surfclam Fishery*

In terms of landings, Atlantic surfclam (*Spisula solidissima*) is the primary species harvested in New Jersey waters (**Figure 3-14**). The Atlantic surfclam ranges from the southern Gulf of St. Lawrence to Cape Hatteras, North Carolina. The largest concentrations of Atlantic surfclams are found off New Jersey and at Georges Bank. As such, most (85 to 100%) of the landings occur from the MAB (NMFS-NEFSC 2010). The waters of Georges Bank are closed to Atlantic surfclam fishing because of the potential threat of paralytic shellfish poisoning (Weinberg 2000). In the Mid-Atlantic region, most surfclams are found from the intertidal zone to 60 m (197 ft), with much lower concentrations found at depths greater than 40 m (131 ft) (Cargnelli et al. 1999a). Atlantic surfclam is capable of living up to 30 years and can reproduce at year one; full maturity is achieved at 2 years of age. Most Atlantic surfclams taken by the fishery have a shell length between 10 and 12 centimeters (cm; 4 and 5 inches [in.]), which corresponds to an age of 5 years; however, recent information indicates that most of the surfclams landed were around 8 to 12 years old (NMFS-NEFSC 2010).The primary commercial fishing gear utilized to target Atlantic surfclam is the dredge. According to the current Atlantic surfclam stock assessment, the overall commercial landings from the EEZ during 1965 through 1983 ranged from a low of 6,000 mt (6,612 T) in 1970 to a high 34,000 mt (37,400 T) in 1974 with a mean of 17,000 mt (18,700 T) per year. Landings stabilized by 1983 due to quota management and varied between 19,000 and 25,000 mt (20,938 and 27,550 T) in later years. The recent Atlantic surfclam assessment indicates that the stock is not overfished nor is overfishing occurring. Atlantic surfclam biomass is moderately high and fishing mortality rates are relatively low. The stock was not overfished in 2008 because biomass 878,000 mt (967,556 T) exceeded the threshold level. As well, overfishing was not occurring during 2008 because the estimated fishing mortality rate (0.027) was less than the threshold level (NMFS-NEFSC 2010). Southern areas (Delmarva Peninsula and New Jersey) have experienced declines in biomass during recent years due primarily to poor recruitment and slow growth rates associated with warm water conditions (Weinberg 2005). Atlantic surfclam is managed as one stock despite the differences in biological characteristics, fishing effort, and population dynamics between regional areas (e.g., New England to southern Virginia) (NMFS-NEFSC 2010).

### *3.3.8 Ocean Quahog Fishery*

Another important commercial species that is harvested in New Jersey waters is the ocean quahog (*Arctica islandica*). In the northeast Atlantic, ocean quahog range from Newfoundland, Canada to Cape Hatteras, North Carolina. Ocean quahog are found in waters ranging in depth from 8 to 400 m (26 to 1,312 ft) with most found between 25 and 95 m (82 and 312 ft) (Cargnelli et al. 1999b). A significant number of ocean quahog landings occur off New Jersey, New York, and coastal southern New England; mostly in the EEZ. Ocean quahog has an interesting biology; it is among the longest lived marine animals in the world. It is estimated that ocean quahog can live up to 200 years (NMFS-NEFSC 2009). The average shell length is between 70 millimeters (mm) and 110 mm (2.8 and 4.3 in.). Reproductive information is mostly lacking, but available information for Icelandic waters indicates that the female ocean quahog is mature between 40 mm and 88 mm (1.5 in. and 3.5 in.) in size. Because quahog are slow growing, this size range (40 to 88 mm [1.5 to 3.5 in.]), corresponds to an age of 2 to 61 years (Weinberg, 2001). Similar to the Atlantic surfclam fishery, the primary fishing gear utilized to target ocean quahog is the hydraulic dredge which use jets of water to dislodge ocean quahogs from the sediments (**Figure 3-14**). According to the current ocean quahog stock assessment, ocean quahog has been commercially harvested since the 1940s. Overall, total landings never exceeded 2,000 mt (2,200 T) of shucked meats until 1976, afterwards landings increased to about 14,000 mt (15,428 T) in 1979, peaked at 22,000 mt (24,244 T) in 1992, declined to about 15,000 mt (16,530 T) during 2000, and have averaged about 16,000 mt (17,632 T) of meats since 2000**.** The recent NEFSC assessment suggests that ocean quahog biomass remains relatively high and fishing mortality rates are relatively low. The stock is not overfished nor is overfishing occurring (NMFS-NEFSC 2009). Fishing effort in recent years (1996 to present) has declined 38% and the number of commercial vessels in 2008 was the lowest ever recorded. Because commercial landings have declined at the historical fishing grounds (Delmarva Peninsula and New Jersey), fishing effort has shifted to the north (Long Island region). Today, it is estimated that only 22% of the total fishing effort occurs in Delmarva Peninsula and New Jersey. Similar to Atlantic surfclam, ocean quahog is managed as one stock even though there are regional differences in biological characteristics, fishing effort, and population dynamics. New information indicates that ocean quahog recruitment has declined 65% since 1993. Given this estimate and because of their life history characteristics, the recent assessment stresses that ocean quahog are vulnerable to overfishing (NMFS-NEFSC 2009).

### *3.3.9 Atlantic Herring Fishery*

Atlantic herring (*Clupea harengus*) are another important commercial species landed in New Jersey. In terms of New Jersey finfish landings, Atlantic herring ranked fifth during 2003 through 2007. Atlantic herring range from Labrador, Canada to Cape Hatteras, North Carolina. Although significant numbers of Atlantic herring are taken off New Jersey, more landings occur from northern waters (Georges Bank and Gulf of Maine). Atlantic herring range in age from two to seven years; most are two to three years old and the age of maturity is four years old (ASMFC 1999). Atlantic herring are primarily taken by purse seine and mid-water trawls, but in Maine and Canada, Atlantic herring are also taken with fixed gear (i.e., traps and weir gear; Stevenson and Scott 2005). Atlantic herring are used as fertilizer, lobster bait, fish meal, and human consumption (canned, pickled, filleted, and oils). In general, fishing trips are only one day long, but some larger vessels (with freezers) have extended fishing trips that last five to seven days. Commercial landings have significantly fluctuated from 470,000 mt (517,000 T) in 1968 to 36,000 mt (39,600 T) in 1983 (Stevenson and Scott 2005). Commercial landings gradually increased from the mid 1980s through the 1990s and peaked at 133,000 mt (146,300 T) in 2001. In 2007, commercial landings of Atlantic herring were 72,973 mt (80,270 T); landings in New Jersey represented 3.8% (2,739.5 mt [3,014 T]) of the total landings. In 2005, the stock size was estimated to be about 1.0 million mt (1.1 million T); it is estimated that the stock size is above the biomass maximum sustainable yield {629,000 mt [691,900 T]) (Stevenson and Scott 2005).

The current stock assessment indicates that Atlantic herring is not overfished nor is overfishing occurring. Overall, the stock has been recovering since the 1980s and today the estimated stock is about the size of the 1960s. Fishing mortality rates have remained well below the fishing mortality maximum sustainable yield ($F_{msy}$) (0.27) for over a decade with a high of 0.20 in 2001 and a low of 0.14 in 2008. Stock biomass (2+) increased steadily from about 105,000 mt (115,720 T) in 1982 to 562,000 (619,324 T) in 2008 (Vonderweidt et al. 2009b; NEFMC 2010).

### *3.3.10 American Lobster Fishery*

One example of a key pot/trap fishery for New Jersey is American lobster (*Homarus americanus*). American lobster ranges from Labrador, Canada to Cape Hatteras, North Carolina. American lobster is generally found in coastal nearshore waters at depths around 50 m (164 ft), but it can be found at deeper depths (~700 m [2,296 ft]). In nearshore waters, lobsters typically prefer rocky substrates for shelter; however, large concentrations of American lobster can also be found in mud substrates, which they use for burrowing. In offshore waters, lobsters are abundant along the continental shelf edge and near submarine canyons. American lobster has a complex life history, which consists of hatching from an egg, going through three planktonic larvae stages, metamorphosing into a juvenile, and reaching adult size around age five through eight (ASFMC 1997; Idoine 1998). The American lobster fishery is one of the most important and valuable commercial fisheries in the U.S. northeast. The U.S. lobster fishery is assessed and managed as three stocks: Gulf of Maine, Georges Bank, and Southern New England (ASMFC 2009b). Since its establishment in the 1940s and 1950s, it has greatly expanded and landings have increased from 10,522 mt (11,574 T) in 1950 to 40,281 mt (44,309 T) in 2008. In 2008, there were 287 mt (316 T) of American lobster landed in New Jersey, which represented 0.71% of the total landings. Most (79%) of the landings of American lobster occur in the State of Maine. Commercial fishing effort for American lobster has strong seasonality with most efforts in inshore shallow waters in summer and fall and away from inshore in spring and winter (Kerns et al. 2010). The offshore trap fishing grounds include areas on the continental shelf from Massachusetts to New Jersey and along the continental shelf break from Lydonia Canyon to Norfolk Canyon (NEFMC 1983). The nearshore fishery accounts for 80% of the landings while the offshore fishery accounts for remaining 20%. Fishing effort is year-round both offshore and inshore, with peak fishing occurring from May to December. The primary gear utilized to target American lobster is traps (i.e., lobster pots); however, some lobsters are also caught incidentally in bottom trawls (**Figure 3-15**).[2] Recent assessments suggest that the Southern New England stock is overfished but overfishing is not occurring. The rebuilding program was established in 2007 with the goal to have the stock rebuilt by 2022 (ASMFC 2010).[4]

### *3.3.11 Highly Migratory Species Fishery*

In terms of commercial landings (2003 to 2007), HMS accounted for only about 8% of the total landings in New Jersey; however, HMS commercial fisheries are among the most lucrative fisheries given that these species have among the highest dockside value (price per pound) of any fish group (NMFS 2006). Moreover, the HMS fishing grounds (i.e., canyons) are some of the most productive in the fishery. Despite the economic value, HMS fisheries have struggled with competition from imports and rising fuel costs. According to NMFS, the U.S. is only landing about 50% of its authorized quota in recent years even though the swordfish stock is considered rebuilt (Maguire et al. 2006). At one time, Barnegat Light was one the premier pelagic longline fishing ports on the east coast. Today, Barnegat Light, Atlantic City, and Cape May are still important fishing ports for pelagic longline vessels, but most have home ports in other states (e.g., New York, Rhode Island, and Massachusetts). As such, annual HMS commercial landings for New Jersey may not reflect the importance of these fishing grounds. Although HMS commercial fisheries are not specifically conducted within the Study Area, pelagic longline fishing vessels do set pelagic longline gear within the vicinity of the Study Area (~80 km or 50 mi). The primary species taken in the HMS fisheries include swordfish, five tuna species, and various species of pelagic sharks (e.g., shortfin mako shark [*Isurus oxyrinchus*]) and coastal sharks (e.g., blacktip shark [*Carcharhinus limbatus*]). Commercial landings of HMS (e.g., swordfish, yellowfin tuna [*Thunnus albacares*], and bigeye tuna [*T. obesus*]) from 2003 through 2007 ranged from 276 mt (304 T) in 2003 to 465 mt (512 T) in 2007. From 2007 to 2008, commercial landings of the yellowfin tuna decreased, while the bigeye tune remained constant (**Figure 3-16**). In general, landings for HMS during this period were stable.[2] The primary gear used to target HMS is pelagic longline gear, but bottom longlines, purse seines, handgear (handlines and harpoons), and gillnets (i.e., for sharks) also take HMS (NMFS 2010c). Fishing vessels set pelagic longline gear to target swordfish at sunset and retrieved gear around sunrise, while the opposite pattern is followed for tuna; gear is set at sunrise and retrieved in the afternoon before sunset. This longline fishery for tuna and swordfish is active year-round in the vicinity of the Study Area, but most of the commercial fishing effort is in the spring through fall. The fishing grounds are around 111.2 km (60 NM) or more from shore. The management of HMS is complicated and complex. In general, the NMFS HMS Management Division, in conjunction with its HMS Advisor Panel, implements the recommendations and resolutions made by the ICCAT based on the latest scientific and stock assessment information. In addition, NMFS also implements regulations to support various other international treaties and conventions associated with HMS issues. The NMFS HMS Management Division manages sharks as three separate groups: large coast sharks (LCS), small coastal sharks (SCS), and pelagic sharks (PS). Currently, there are 20 species of sharks that can be found within or in the vicinity of the Study Area. Of these, 12 are authorized to be landed and retained, while 6 are prohibited from being landed, traded, or sold (**Tables 3-3 and 3-4** Able 1992; NMFS 2010c).

### *3.3.12 Closed Areas*

One method that fishery resource managers use to control fishing effort or protect particular fishery habitats is designating closed areas. To notify the public, NMFS publishes these closed areas in the Federal Register and also mails, faxes, and emails interested parties a public notice announcing such closures. Some of these designated closed areas are either permanent (e.g., closed year-round), seasonal, or temporary (designated as a rolling closure). Permanent closed areas change over the years in response to the status of fishery stocks, whereas seasonal and rolling areas are closed at certain times of the year. Usually, rolling closures persist for a finite duration and are then de-designated, or sometimes these closures are moved to another location to fulfill similar conservation or management goals. Besides for fish conservation management reasons, fishery resource managers also use closed areas for marine mammal conservation or protection purposes. For specific closures and associated regulations and policy, information is discussed under each individual marine mammal Take Reduction Plan (TRP), such as the Bottlenose Dolphin TRP, Atlantic Large Whale, TRP, and the Mid-Atlantic Harbor Porpoise TRP.[5] Moreover, fishery managers also close specific areas to certain commercial fishing gear or methods to protect fish stocks. For example, the Northeastern U.S. Closed Area (39 degrees [°] to 40° North [N] latitude and 68° to 74° West [W] longitude) is prohibited to pelagic longline fishing vessels using pelagic longline gear during the month of June each year. The purpose of this particular fishery closure is to maintain and recover localized fish populations to harvestable and sustainable levels (NMFS 2010c). As with any federal regulation, NMFS abides by the public review and comment process as specified by the National Environmental Policy Act (NEPA) before designating any closed area. In general, closed areas change over the years in response to the status of fishery stocks or updated scientific information.

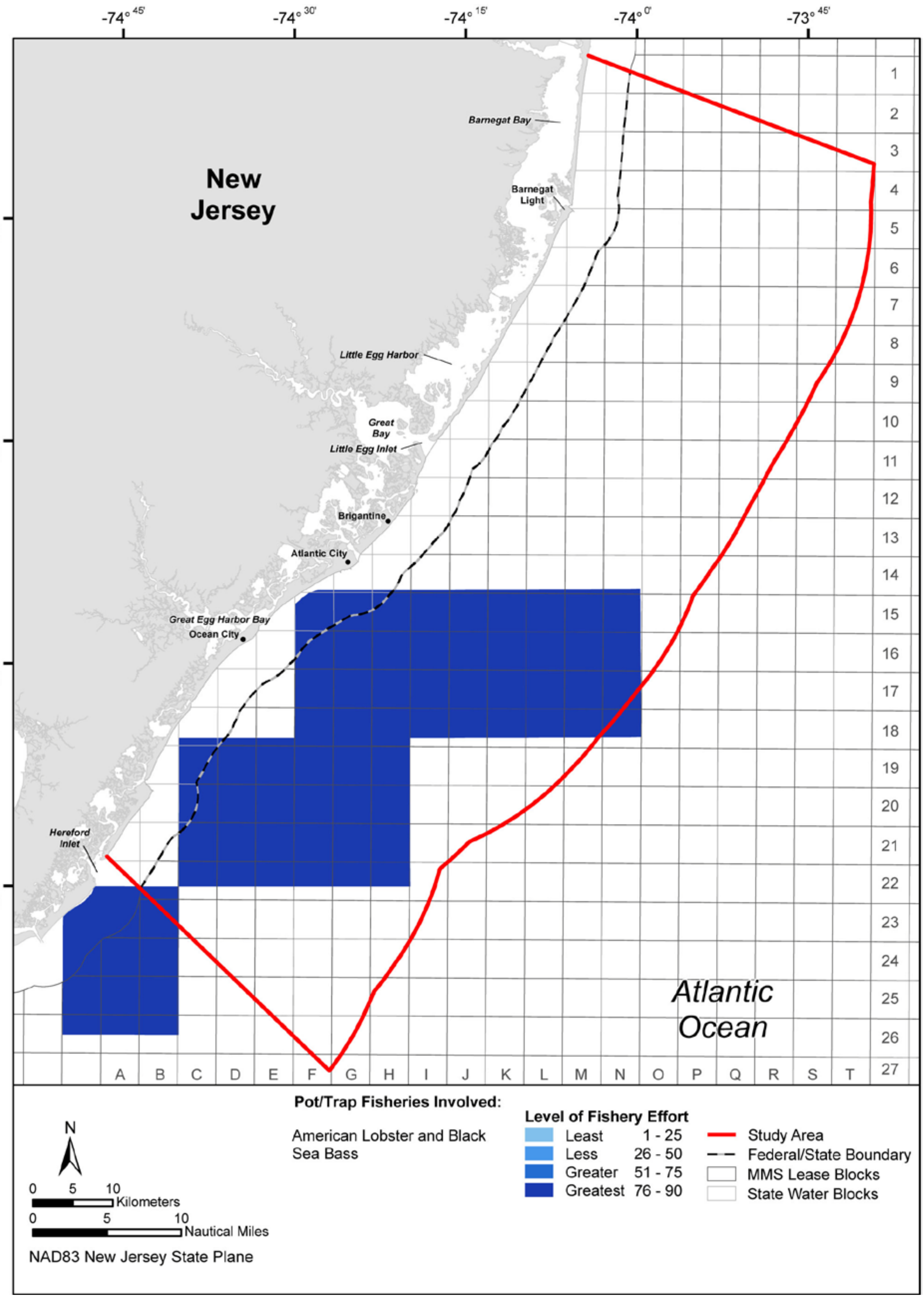


**Figure 3-15. Fishing effort distribution of pot and trap fisheries in the Study Area and vicinity from 1995 to 2001. Source data: NMFS (2003a). Source information: NEFMC(2003a).**

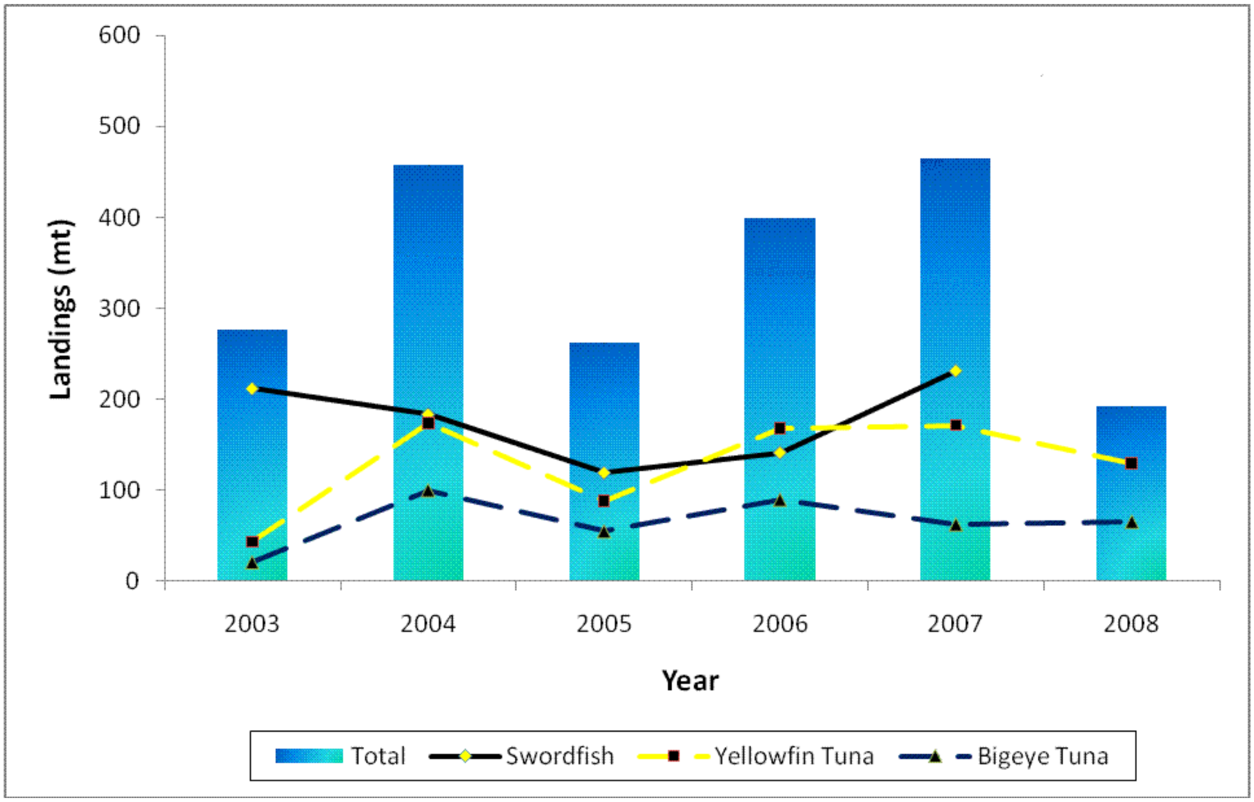


**Figure 3-16. Commercial landings (metric tons) of swordfish, yellowfin tuna, and bigeye tuna in New Jersey from 2003 to 2008.**[2]

**Table 3-3. NMFS authorized shark species within the Study Area.**

| NMFS Management Group | Common Name | Scientific Name |
|---|---|---|
| **Large Coastal Sharks (LCS)** | Blacktip shark | *Carcharhinus limbatus* |
| | Great hammerhead shark | *Sphyrna mokarran* |
| | Lemon shark | *Negaprion brevirostris* |
| | Scalloped hammerhead shark | *Sphyrna lewini* |
| | Silky shark | *Carcharhinus falciformis* |
| | Smooth hammerhead shark | *Sphyrna zygaena* |
| **Small Coastal Sharks (SCS)** | Atlantic sharpnose shark | *Rhizoprionodon terraenovae* |
| | Bonnethead shark | *Sphyrna tiburo* |
| **Pelagic Sharks (PS)** | Blue shark | *Prionace glauca* |
| | Common thresher shark | *Alopias vulpinus* |
| | Porbeagle shark | *Lamna nasus* |
| | Shortfin mako shark | *Isurus oxyrinchus* |

Source: (NMFS 2010c).

**Table 3-4. NMFS prohibited shark species within the Study Area.**

| Common Name | Scientific Name |
|---|---|
| Atlantic angel shark | *Squatina dumerili* |
| Basking shark | *Cetorhinus maximus* |
| Dusky shark | *Carcharhinus obscures* |
| Sand tiger shark | *Carcharius Taurus* |
| Sandbar shark | *Carcharhinus plumbeus* |
| White shark | *Carcharodon carcharias* |

Source: (NMFS 2010c)

### *3.3.13 Commercial Fishing Ports*

There are five primary commercial fishing ports (Belford, Point Pleasant, Barnegat Light, Atlantic City, and Cape May) on New Jersey's coastline and a number of smaller ports on the Delaware (Port Norris), Barnegat, and Raritan bays. Only Barnegat Light and Atlantic City are located within the Study Area (**see Figure 3-19**).[6] Belford and Point Pleasant and Cape May are located to the north and south of the Study Area, respectively. Cape May is the largest of New Jersey fishing ports and one of the biggest on the East Coast in terms of landings and value. It is also the center of fish processing and freezing in New Jersey.[7] Barnegat Light is one of New Jersey's largest commercial fishing ports and is home to the Blue Water Fishermen's Association, one of the largest and most influential fishing organizations. This port is home to various tilefish (*Lopholatilus chamaeleonticeps*), state-of-the art scallop, smaller inshore gillnet, and pelagic longline vessels. The commercial fishing fleet targets a variety of species including spiny dogfish, weakfish, monkfish, tunas (yellowfin and bigeye), and swordfish. Viking Village, one of Bargnet's Light's two commercial docks, is one of the largest suppliers of fish and seafood on the Eastern Seaboard. NMFS estimates that Viking Village unloads and sells about 1,814,000 kg (4 million lbs) of fish per year. Atlantic City is primarily the home port to some of the larger commercial fishing vessels that target ocean quahog and Atlantic surfclam. In fact, this port is one of the largest suppliers of minced clams and clam strips. Atlantic scallops and black sea bass are also unloaded and sold in the port of Atlantic City. In terms of value, ocean quahog and Atlantic surfclam sales in 2006 was around $22 million. Overall, there are about 24 to 37 commercial fishing vessels that utilize the port of Atlantic City.[8] One of the smaller ports located in the Study Area is Sea Isle City. This small commercial fishing port has a small offshore longline fishery for tuna and swordfish, pot fisheries targeting lobster, conch, and black sea bass, and gillnetting for monkfish (McCay and Cieri 2000).

### *3.3.14 Commercial Fishing Vessels and Traffic*

The waters off New Jersey and specifically the waters within the Study Area are active commercial fishing and vessel traffic areas; however, the number of fishing vessels that actively use the Study Area is unknown given that real time information is unavailable. Therefore, fishing vessel sightings within the Study Area were noted by scientific observers during shipboard marine mammal and seabird surveys between January 2008 and December 2009. Vessels within the Study Area were identified as fishing vessels according to the vessel type (e.g., trawler) and the gear onboard; however, because vessel sightings were only opportunistically noted during marine mammal and seabird surveys, scientific observers were unable to collect any additional information that would identify whether a vessel was traversing or actively fishing. In total, there were 549 fishing vessels sighted within the Study Area during 2008 through 2009. Overall, there were more ($n$ = 33) fishing vessels sighted in 2008 than in 2009; 291 fishing vessels were sighted in 2008 and 258 in 2009. The average number of fishing vessels sighted within the Study Area was 46 per month. The least number of fishing vessels sighted were in January and December, while the greatest number was sighted in March and August (**Figure 3-17**). Most of the fishing vessels were sighted in the spring through the summer and the fewest in the fall through the winter. The highest concentration of vessels sighted encompassed two-thirds of the Study Area from Atlantic City to the northern part of Barnegat Bay (**Figure 3-18**).

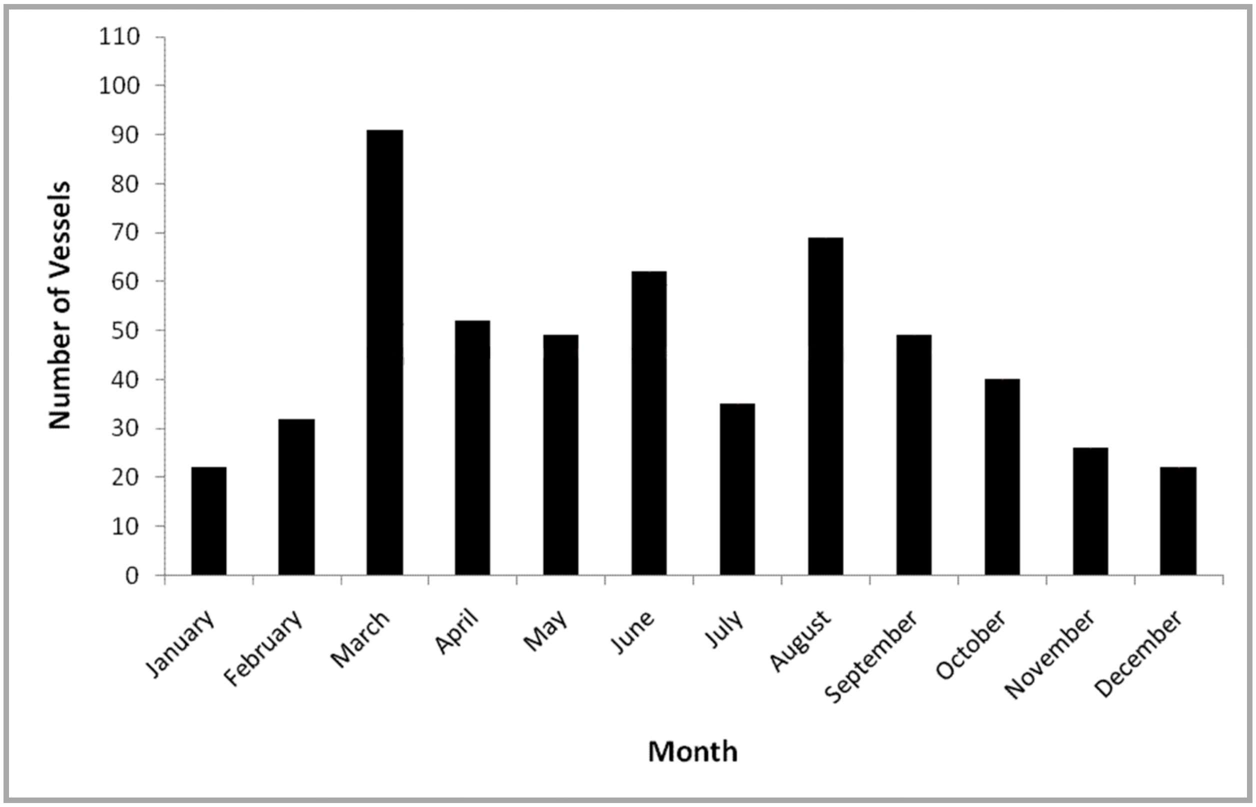


**Figure 3-17. The total number of fishing vessels opportunistically sighted within the Study Area from January 2008 to December 2009.**

3.4 RECREATIONAL FISHERIES

The goods and services associated with recreational fishing have an important economic impact to local and regional communities (Preble 2001). Recreational fishing within and in the vicinity of the Study Area is an important social and economic activity. According to the New Jersey Anglers Association (NJAA), the largest recreational fishing anglers association in the state, there are about 75 fishing clubs and around 30,000 active members in New Jersey (pers. comm., Bruce Smith, New Jersey Anglers Association, 5 February 2010). Currently, mandatory recreational angler reporting requirements were not imposed by state and federal agencies for any marine species accept for those anglers (non-tournament and tournament) targeting HMS in federal waters of the Atlantic, Gulf of Mexico, and U.S. Caribbean (NMFS 2010a). Most established recreational fishing programs (Marine Recreational Information Program [MRIP]) in the U.S. were only voluntary, however, under a new federal law, effective 1 January 2010, saltwater anglers will be required to register with the new NMFS National Saltwater Angler Registry. The National Saltwater Angler Registry is part of an improved data program of the MRIP to help protect the long-term sustainability of recreational fishing by conducting surveys of saltwater fishermen to determine how often they fish. [9]

The annual number of angler trips in New Jersey from 2003 through 2007 ranged from 6.5 million in 2004 to 7.4 million in 2007.[9] Besides private vessels, New Jersey's recreational fleet also consists of about 100 party and 300 charter boats, which are docked near all the major inlets and bays. In fact, the New Jersey charter and party vessel fishing fleet is the largest on the east coast providing employment and economic stimulus to local coastal communities (Giordano et al. 2008). Many charter and party vessel captains take anglers to fish throughout the Study Area on a regular basis. In general, charter outfitters offer fishing opportunities and professional services to those who do not own their own vessels or fishing equipment.

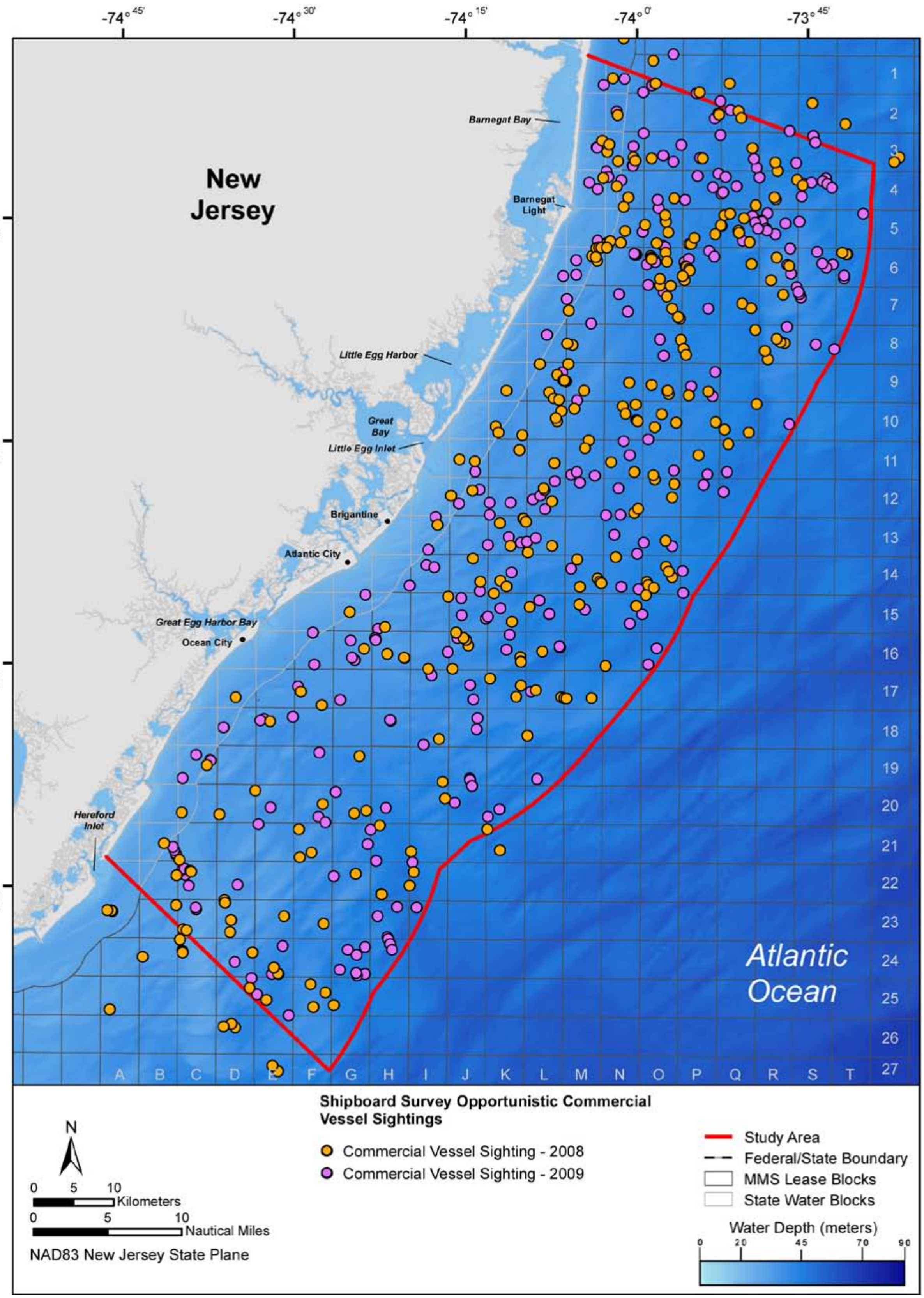


**Figure 3-18. The distribution of fishing vessels opportunistically sighted within the Study Area from January 2008 to December 2009.**

Depending on the weather, target species, and season, charter and party boats sail daily. Typically, a single group of anglers hires a captain of a charter boat on a per-trip basis (half or full-day), while party boats usually take anglers fishing at three regularly scheduled times (morning, afternoon, and evening). Party boat anglers pay a flat rate per person (~$45 per person for 4 to 6 hours of fishing), which is usually less than if they chartered a vessel ($900 to $1,000 per day). Party boats range in length from 18.2 m (59.7 ft) to 30.5 m (100 ft); some of these vessels are large enough to carry up to 150 anglers. Charter boats are typically smaller in size than party boats; vessels range in length from 7.6 m (25 ft) to 18.3 m (60 ft) and usually do not carry more than 6 to 8 anglers. Regardless of vessel type, the common fishing techniques are chumming, wreck/bottom fishing, drifting, and jigging. Because of size and the number of anglers, the technique of trolling is restricted to private and charter vessels (Levesque and Kerstetter 2007). Charter and party boats generally fish further offshore than many privately owned vessels, due to the high cost of owning and maintaining a larger personal fishing vessel.

### *3.4.1 Fishing Locations*

Among the most important strategies of recreational fishing is targeting specific species is identifying locations where targeted species are abundant. Target species are found in particular locations based on habitat, seasonal behaviors (e.g., spawning) and life history stages, and anglers generally have different favorite hotspot that reflect this. Information on hotspot locations is generally scare because most fisheries management data collection programs focus on the amount caught, size composition, and fishing effort (e.g., number caught per hour) for a species, not necessarily where fishing is taking place. Also, available studies suggest that identifying hotspots is often difficult because anglers are reluctant to divulge this valuable information; in Florida, for example, some fishing captains actually offer their hotspot locations for sale.

Given the voluntary status of recreational fishing information, most anglers prefer to remain anonymous and usually do not assist with submitting any additional information to researchers regarding specific fishing locations. Nonetheless, one method of identifying recreational fishing hotspots is to utilize historical fishing charts. Two such historical comprehensive fish charts for New Jersey were completed by Freeman and Walford (1974) and Long et al. (1982); however, some of this historical data may not be appropriate in quantifying the current spatial distribution of recreational fisheries. For that purpose, this historical data was incorporated with marine recreational fishing hotspots gathered from global positioning system (GPS) detailed fishing and dive charts (Saltwater Directions 2003a, 2003b, 2003c) and NJDEP Geographic Information System (GIS) websites (NJDEP 2008b).[10]

Within and adjacent to the Study Area (**Figure 3-19** and **Table 3-5**), fishing hotspots (143 in the Study Area and 14 adjacent to the Study Area) included areas with some type of structural feature, such as shoals, ridges, lumps, banks, ship wrecks, and reefs (artificial and natural: rocks). Each of these structural features provide prime fishing sites for anglers targeting specific species, such as Atlantic striped bass and bluefish around shoals; bluefish and flounder near ridges; black sea bass and tautog around shipwrecks/reefs (Saltwater Directions 2003a, 2003b, 2003c). Man-made fishing sites included piers, docks, rock and concrete jetties, and beach groins. Among the most popular fishing sites are artificial reefs. The New Jersey Artificial Reef Program is one of the largest on the east coast consisting of over 1,000 reefs and 100 vessels; the network consists of 15 ocean sites located from Sandy Hook to Cape May (NJDEP 1999; NJDEP 2000; NJDEP 2008a; NJDEP 2008b). Reefs are constructed from a variety of materials including ships and barges, concrete demolition debris, dredge rock, concrete-ballasted tire units, and other dense materials. In addition, because hydrographic features also concentrate fish, recreational anglers often target locations with strong currents that are rich with nutrients, which are sometimes associated with natural structures (Freeman and Walford 1974; Long et al. 1982).

### *3.4.2 Recreational Fishing Effort*

Recreational fishing off New Jersey consists of anglers targeting various species with certain fishing gears including, but not limited to, seines, pots/traps, and hook-and-line. Similar to most regions, hook-and-line is by the most common gear used by recreational anglers fishing off New Jersey (ASMFC 2008b). Recreational fishing effort can be classified as inshore or offshore activity. Inshore recreational

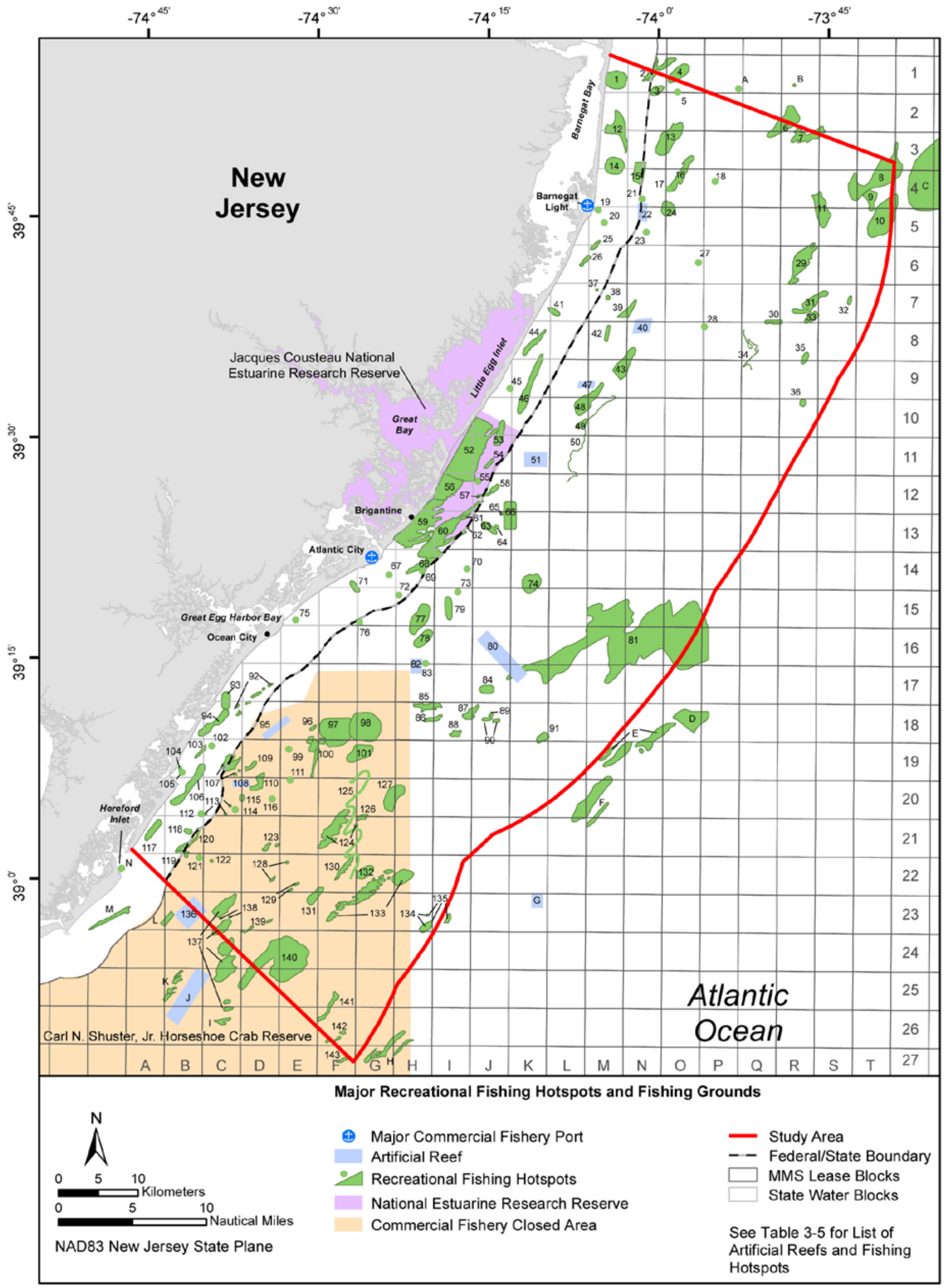


**Figure 3-19. Major commercial fishing ports and recreational fishing hotspots found in the Study Area and vicinity. Source information: NEFMC (2003a). Map adapted from: Freeman and Walford (1974), Long et al. (1982), Saltwater Directions (2003a; 2003b; 2003c), and NJDEP (2008b).[10]**

**Table 3-5. Major fishing hotspots found within or adjacent to the Study Area.**

| Fishing Hotspots in the Study Area | | | | | |
|---|---|---|---|---|---|
| 1 | Seaside Park | 2 | Big Wreck Lump | 3 | Ledges |
| 4 | Morris Treasy | 5 | Old Freighter | 6 | Tolten Lump |
| 7 | Tolten Hole South | 8 | Oles Lump | 9 | Ollie’s Hole |
| 10 | Ollie’s Lump | 11 | Range Buoy | 12 | Cedar Creek |
| 13 | Clam Beds | 14 | North Pounds | 15 | Clam Beds |
| 16 | Ralph’s Lump | 17 | Several Sunken Barges | 18 | Remains of Cornelius Hargraves and Vizcaya Wrecks |
| 19 | Several Sunken Barges | 20 | Barnegat Inlet Rough Water Entrance | 21 | Summer Wreck |
| 22 | Barnegat Light Reef Site | 23 | Bow of Former Tanker Gulftrade | 24 | Barnegat Ringe Buoy |
| 25 | Loveladies Lump | 26 | Sandy Island Lump | 27 | San Saba Wreck |
| 28 | Great Issac Wreck | 29 | Barnegat Ridge North | 30 | West Hole |
| 31 | Barnegat Ridge South | 32 | Cod Lump | 33 | South Hole |
| 34 | No Name | 35 | 11 Fathom Lump | 36 | J-Lump |
| 37 | Harvey Cedars Lump | 38 | Harvey Cedars Hole | 39 | Fingers |
| 40 | Garden State North Reef Site | 41 | Ship Bottom Sewer Line | 42 | Tires |
| 43 | Fingers | 44 | Brant Beach Lump | 45 | Beach Haven Lumps |
| 46 | Pound Piles | 47 | Garden State South Reef Site | 48 | Ceddies Ridge |
| 49 | Pinnacle | 50 | 60’ Edge | 51 | Little Egg Reef Site |
| 52 | Little Egg Inlet | 53 | No Name | 54 | Atomic Lump |
| 55 | “LE” Buoy | 56 | Wreck Inlet | 57 | South East Lump |
| 58 | D Buoy | 59 | Brigantine Hotel | 60 | Brigantine Shoal |
| 61 | Little Beach Lump | 62 | 4BS Lump | 63 | 2BS Lump |
| 64 | Carlson Wreck | 65 | Wreck Buoy | 66 | Wreck Buoy |
| 67 | Shoaling near Absecon Inlet | 68 | Black Buoy Slope | 69 | Long Narrow Shoal |
| 70 | Long Narrow Shoal | 71 | Atlantic City Sewer Line | 72 | Inshore Ridge |
| 73 | Pet Wreck | 74 | The Wall | 75 | Great Egg Harbor Inlet |
| 76 | Scattered Wreckage | 77 | South East Wreck | 78 | Dift Spot |
| 79 | No Name | 80 | Atlantic City Reef Site | 81 | Lobster Hole |
| 82 | Great Egg Reef Site | 83 | American Oil Wreck | 84 | Lobster Pots |
| 85 | Dog Lump | 86 | The Chicken | 87 | Hambone |
| 88 | The Ham | 89 | Teardrop | 90 | Triple Lumps |
| 91 | Atlantic City Bluefish Lump | 92 | Cuma Lumps | 93 | Corson Inlet |
| 94 | Deep Hole | 95 | Ocean City Reef Site | 96 | Coral Bottm |
| 97 | Inshore Stone Beds | 98 | Stone Beds | 99 | Bell Wreck |
| 100 | Breakfast Table | 101 | Mus R.?. | 102 | Shoaling Ridges off Sea Isle City |

**Table 3-5 (*continued*). Major fishing hotspots found within or adjacent to the Study Area.**

| Fishing Hotspots in the Study Area | | | | | |
|---|---|---|---|---|---|
| 103 | No Name | 104 | Seven Mile Beach | 105 | Townsends Inlet |
| 106 | Chinese Wreck | 107 | Sea Isle Lump | 108 | Townsends Inlet Reef |
| 109 | The Lump | 110 | Catalunya | 111 | Wreck |
| 112 | Wreck | 113 | Clear mar | 114 | Wrecked Barge Wayne |
| 115 | Sea Isle Shoal | 116 | Avalon Shoal | 117 | Stone Harbour |
| 118 | No Nmae | 119 | Coral.?. | 120 | Peacock Shoals |
| 121 | Sandy Lump | 122 | White P Boat | 123 | Shutes Shoal |
| 124 | 1st Jump | 125 | The Fingers | 126 | Tuna Lumps |
| 127 | Meat Grounds | 128 | M. Lump | 129 | Middle Grounds |
| 130 | 2nd Jump | 131 | No Name | 132 | Sylvester's |
| 133 | Sea Isle Ridge | 134 | High Bottom | 135 | Scallop Bottom |
| 136 | Wildwood Reef Site | 137 | Five Fathom Bank | 138 | No Name |
| 139 | Pep's Lump | 140 | Mussel and Coral Beds | 141 | North East Lump |
| 142 | Middle Lump | 143 | East Lump | | |
| **Fishing Hotspots adjacent to the Study Area** | | | | | |
| A | Old crane barge | B | Tolten Hole North | C | Mako Hole |
| D | Oyster Creek Spot | E | 120 Foot Hole | F | Atlantic City Ridge |
| G | Deepwater Reef Site | H | No Name | I | South Shoal |
| J | Cape May Reef Site | K | No Name | L | Coral Beds |
| M | Taylor Slough | N | Deepwater Reef | | |

Source: Freeman and Walford (1974); Long et al. (1982); Saltwater Directions (2003a; 2003b; 2003c); NJDEP (2008b) [10]

fishing (<4.8 km [3.0 mi]) involves fishing from boats, beaches, marshes, and man-made structures (e.g., jetties, docks, and piers), while offshore fishing (>4.8 km [3.0 mi]) involves using larger private boats, rental boats, charter or party boats. From 2003 through 2007, there were almost 35 million fishing trips conducted in New Jersey waters. Overall, most saltwater anglers fished from private or rental vessels (54%) followed by shore (37%) and party or charter (9%) vessels (**Figure 3-20**). Regardless of the fishing mode, most (90.5%) recreational fishing trips were within 4.8 km (3.0 mi) from shore and most were in the spring (75%) (**Figure 3-21**). While fishing occurs year-round in New Jersey, there is clearly much more activity in the warmer months (June through August) when more than 20 species are actively fished by recreational fishermen (St. Martin et al. 2005; Daetsch et al. 2006).

### *3.4.3 Recreational Catch Characteristics*

Recreational anglers target a variety of fish along its 193.2 km (120 mi) of coastline and offshore waters; the species that anglers target depend on the season, fishing location, and daily movement patterns. Some species, such as mackerel are found off New Jersey seasonally, while others (winter flounder) are found year-round. Although recreational fishing is a year-round activity, most anglers target specific species at certain times. In the spring, many anglers target Atlantic striped bass, bluefish, or summer flounder (fluke). Anglers also target tautog, black sea bass, and weakfish during spring (ASMFC 2008b). Just outside of the Study Area, there are several famous tuna fishing grounds, such as the Mud Hole. The Mud Hole is a deep trench that is located around 48.3 to 64.4 km (30 to 40 mi) offshore in 77.2 m (250 ft) of water. Offshore anglers fishing this area have been known to catch bluefin and yellowfin tunas as well as sharks. Another popular offshore location is Barnegat Ridge, which is located 25.8 km (16 mi) from shore. At this fishing spot, anglers have the opportunity to catch bluefin tuna, little tunny (*Euthynnus alletteratus*), Atlantic bonito, and dolphinfish (*Coryphaena* spp.; ASMFC 2008b). In general, these offshore areas are pursued by anglers during late summer. Anglers also target many inshore fish from shore such as Atlantic striped bass, weakfish, and winter flounder (ASMFC 1994). According to NMFS (MRIP), the primary species landed from 2003 to 2007 was summer flounder. Summer flounder landings represented 40.8% of the total landings, while bluefish and black sea bass represented 18.9% and 18.2%, respectively (**Figure 3-22**).

Most of the seasonal round of recreational fishing is based on regulations and ability to fish for certain species at certain times of the year (St. Martin et al. 2005). Regulations often change annually as is reflected in the proposed changes for the 2010 recreational harvest of summer flounder (fluke), winter flounder, weakfish, black sea bass, and coastal sharks. These new rules are implemented for New Jersey in compliance with the ASMFC's management plans for these species. They aimed at providing adequate protection to these fish stocks and may involve changes to the size, season, and/or possession limits.[11]

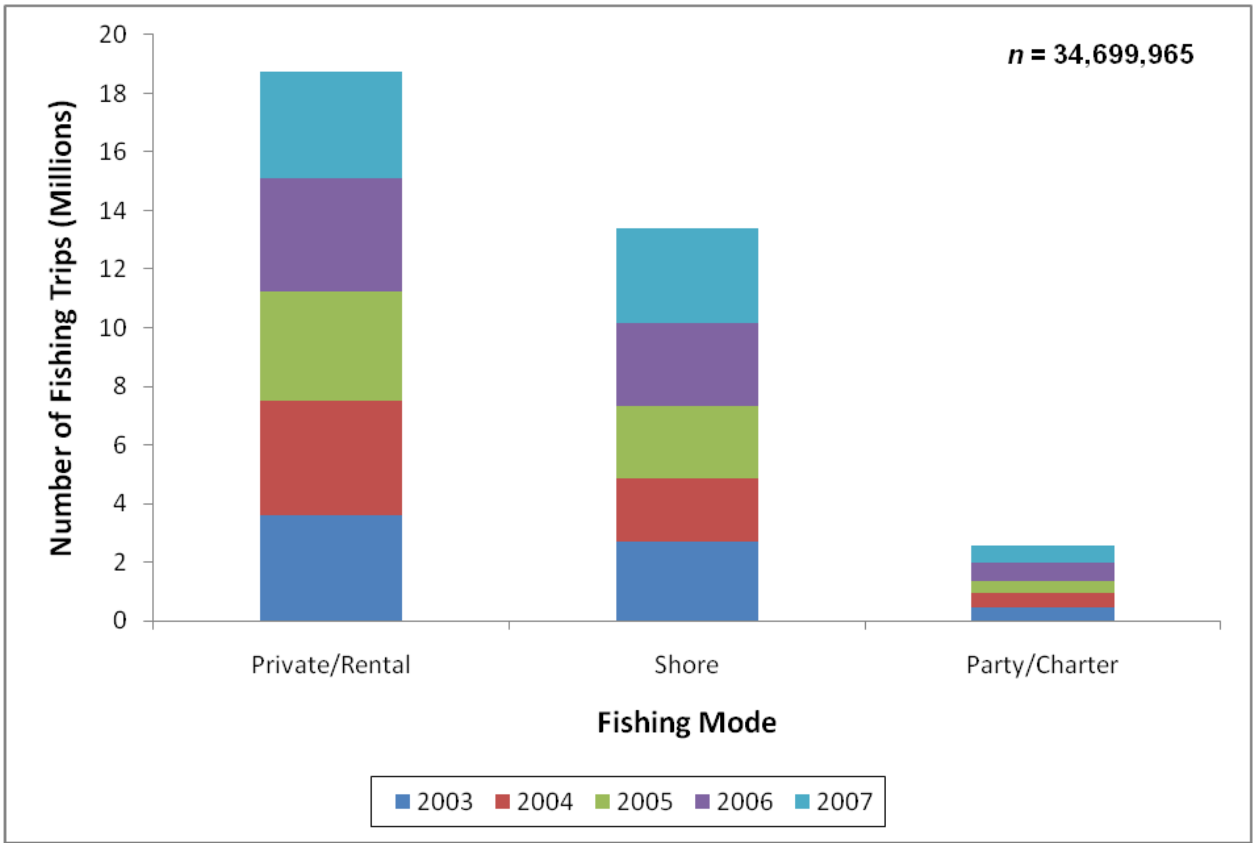


**Figure 3-20. The total number of recreational fishing trips off New Jersey from 2003 to 2007 according to fishing mode (private/rental, shore, and party/charter boat).**[9]

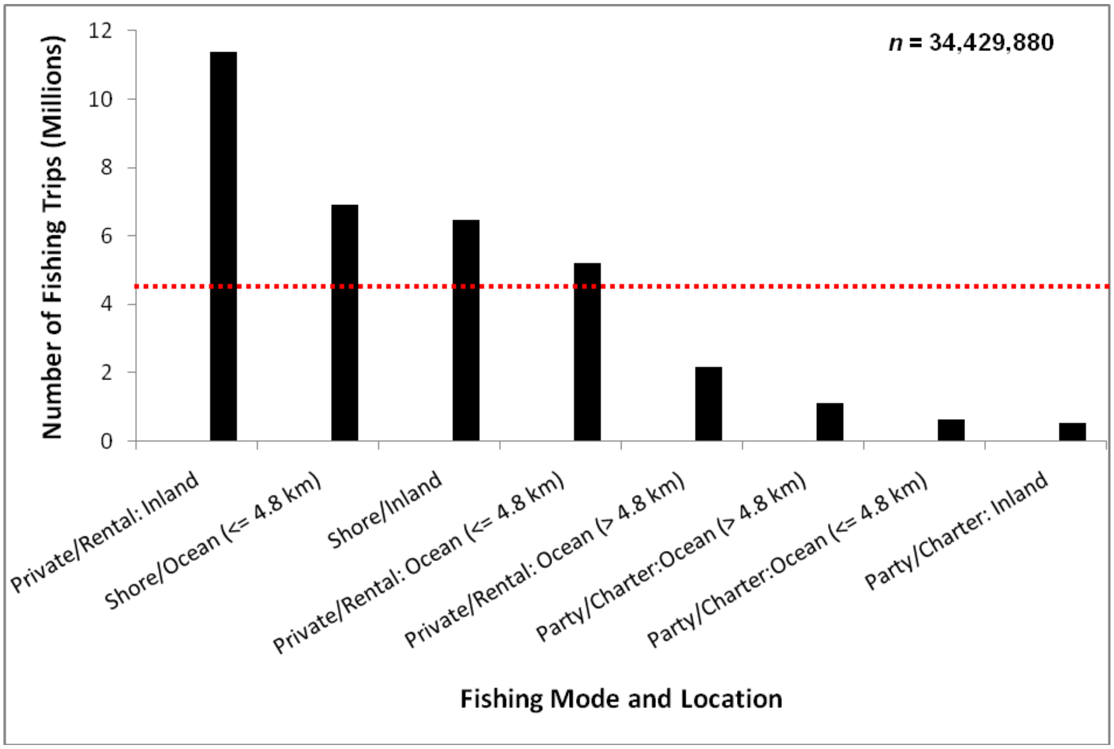


**Figure 3-21. The number of recreational fishing trips by the three modes (private/rental, shore, and party/charter boat) in the waters off New Jersey from 2003 to 2007. The dotted line depicts the annual mean total number of fishing trips.[9]**

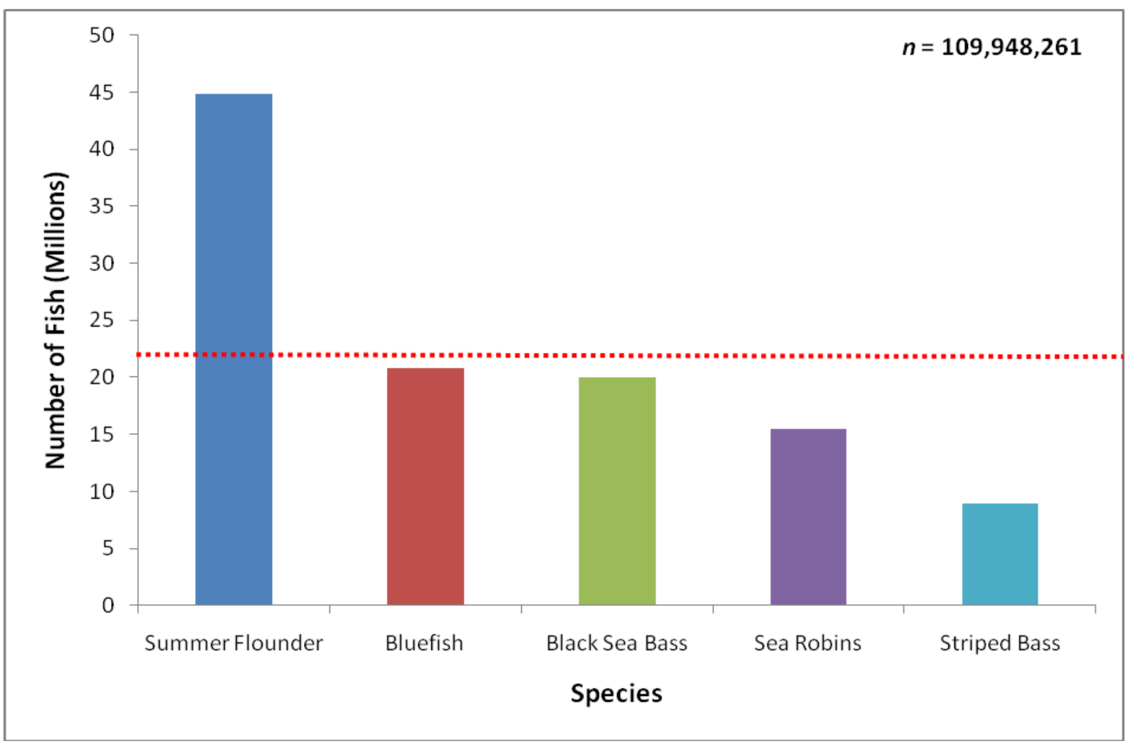


**Figure 3-22. Primary fish species caught by recreational anglers fishing in the waters off New Jersey from 2003 to 2007. The dotted line represents the annual mean total number of fish landed by anglers.[9]**

### *3.4.4 Fishing Tournaments*

Organized saltwater fishing tournaments are popular public events that take place in New Jersey waters within or in the vicinity of the Study Area. Given the inclement winter weather, most recreational saltwater fishing tournaments take place in summer; often on the weekends. Many fishing tournaments are economically important to local cities or towns. Anglers often travel from other locations to fish in these tournaments, requiring them to stay for duration of the event and contribute to local economies via utilization of hotels, eateries, gas, and marine supply and fishing outfitters. Aside from for the sport and trophies, many anglers participate in these tournaments because of the substantial prizes that are given to the winners; many are monetary (Levesque and Kerstetter 2007). Some of the most popular and economically valuable tournaments in the U.S. are specifically directed at HMS (e.g., billfish, swordfish, tuna, and sharks). In general, organizations and companies usually sponsor each fishing tournament and prizes are given for the largest and the greatest number of fish caught of a given species. Depending on the fishing tournament, participants either target inshore or offshore species. Generally, each fishing tournament has its own set of rules, which includes time limits and geographical boundaries. Based on these rules, anglers then choose fishing sites according to the species targeted, experience, and the extended weather forecast.

The number of fishing tournaments in a given area changes each year, even though some have an extensive history. It is difficult to estimate the overall economic importance of these tournaments to a given area considering fishing tournaments depend on many factors, such as the economy, sponsorship, and weather. Although most tournaments are annual events, the list of scheduled tournaments identified below is not static (**Table 3-6**). Each year, some fishing tournaments may be cancelled due to the lack of participation and support, or new tournaments may be organized. It should be noted that the exact dates and weigh-in locations of annual tournaments will vary slightly from year to year, but many take place at the same place and location every year. In addition, each fishing tournament may or may not set geographical boundaries; thus, even though an event's weigh-out is in a particular location this does not necessarily suggest that fishing cannot take place in another area away from the actual weigh-in location.

**Table 3-6. A list of selected New Jersey recreational saltwater fishing tournaments occurring within or in the vicinity of the Study Area in 2009.**[12, 13, 14]

| Event Date | Weigh-in Location | Event Name |
|---|---|---|
| May 1-2, 2009 | Cape May, New Jersey | 8$^{th}$ Annual South Jersey/ASA Spring Striper Tournament |
| May 8-9, 2009 | Sandy Hook, New Jersey | ASA Striper Tournament |
| June 6, 2009 | Atlantic City, New Jersey | Greater Atlantic Bluefish |
| June 11-14, 2009 | Cape May, New Jersey | 29$^{th}$ Annual South Jersey Shark, Mako, Blue, Thresher Tournament |
| June 13, 2009 | Forked River, New Jersey | Forked River Tuna Club Spring Shoot-Out Tuna |
| June 27-28, 2009 | Clark's Landing, New Jersey | Mako Mania |
| July 8-12, 2009 | Cape May, New Jersey | 20$^{th}$ Annual Ocean/Viking Marlin, Tuna, Wahoo |
| July 15-18, 2009 | Cape May, New Jersey | 8$^{th}$ Annual Mid-Atlantic Tuna Tournament |
| July 24-25, 2009 | Avalon, New Jersey | Jersey Shore Classic |

**Table 3-6 (*continued*). A list of selected New Jersey recreational saltwater fishing tournaments occurring within or in the vicinity of the Study Area in 2009.[12,13,14]**

| Event Date | Weigh-in Location | Event Name |
|---|---|---|
| August 15-23, 2009 | Forked River, New Jersey | Forked River Tuna Club Annual Tuna Tournament |
| August 16-21, 2009 | Cape May, New Jersey | 18th Annual Mid-Atlantic $500,000 Tuna, Wahoo Tournament |
| August 23-29, 2009 | Atlantic City, New Jersey | Tuna Stakes Invitational |
| October 4, 2009 | Island Beach State Park, New Jersey | Governor's Surf Fishing Bluefish, Blackfish Tournament |
| October 17-22, 2009 | Forked River, New Jersey | Forked River Tuna Club Striped Bass, Bluefish Tournament |
| November 6-7, 2009 | Cape May, New Jersey | 9th Annual South Jersey Marina's Big Striped Bass Open |

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# 4.0 NEW JERSEY FISHERIES INDEPENDENT MONITORING DATA

Fishery resource managers rely upon dependent (e.g., state or federally funded commercial fisheries sampling program [dock-side or sea sampling]) and independent (i.e., state or federally funded fisheries research sampling program) data to assess population trends in fish and fisheries. Because of limited equipment, staff, and funding, state and federal agencies often use dependent data (e.g., commercial landings or self-reporting logbook) to monitor commercial fisheries. In contrast to commercial fisheries, the regulatory framework for monitoring recreational fisheries has yet to be established so resource managers must frequently rely upon independent data (i.e., dock/boat ramp intercept or creel surveys), such as the Marine Recreational Fishery Statistics Survey (MRFSS), to monitor the dynamics of recreational fisheries. To better assess fish populations and make informed management decisions, many states have established various independent monitoring programs to supplement existing fishery information for local fish stocks. One of the oldest independent fisheries monitoring programs in the U.S. is the New Jersey Ocean Stock Assessment (OSA) program. The NJDEP, Division of Fish and Wildlife, established the OSA program in August 1988 to develop comprehensive baseline data for coastal recreational fishes and their forage items; develop a recruitment indices for recreational fishes and documentation of annual relative abundance of young-of-the-year (YOY) fish; provide a scientific basis to formulate or modify existing management plans for recreational fishes; and provide information to complement other state and federal data for estimating populations and developing predictive models for managing fish stocks (Byrne 2008).

## 4.1 STUDY AREA

The Study Area borders a barrier island chain along the New Jersey coastline and extends 37 km (20 nautical miles [NM]) perpendicular to shore (i.e., 125.8 km x 37 km [78.2 mi x 22.9 mi] in size; **Figure 4-1**). Overall, the Study Area encompasses approximately 2,516 square kilometers ($km^2$; 1,360 square nautical miles [$NM^2$]) and stretches from an area adjacent to Seaside Park in the north (approximate 39°55′56″N; 74°04′10″W) to Stone Harbor in the south (approximate 39°01′58″N; 74°46′11″W). Major rivers that have outflows into the region include the Toms River (north), Mullica River via Great Bay (central), and Great Egg Harbor River via Great Egg Harbor (south). For the purpose of these analyses, the New Jersey Environmental Baseline Study Area for this assessment was overlaid with the New Jersey OSA program's study area (**Figure 4-1**; Byrne 2008). As discussed below (**Section 4.1.1.2**), it should be noted that the individual strata (areas) within the New Jersey OSA program's study area were primarily based by depth profile isobaths. Given that these isobaths (i.e., depth profiles) were initially hand drawn using National Oceanic and Atmospheric Administration (NOAA) navigational charts when the state's program was developed, GPS coordinates were unavailable. Therefore, each individual New Jersey OSA sampling strata (area) was digitized using ArcView GIS software according to confirmed depth isobaths and pre-determined latitudinal coordinates defined by NMFS NEFSC Northwest Atlantic Groundfish Survey.

### *4.1.1 Methodology*

#### 4.1.1.1 Data

To evaluate trends in fish and invertebrate populations in the Study Area, ocean trawl data (New Jersey OSA survey program) from 2003 to 2008 were compiled and sorted into two separate groups according to landings (i.e., top 10 species numerically collected) and economic value (i.e., top 5 species [$US]). The top five species having economic value was based on an evaluation of the New Jersey commercial landings during 2003 through 2008 (see **Chapter 3.0**). The segregated data were summarized and evaluated according to the nine New Jersey OSA strata (areas 15 to 23) corresponding with the Study Area (**Figure 4-1**; Byrne 2008; NJDEP 2009).

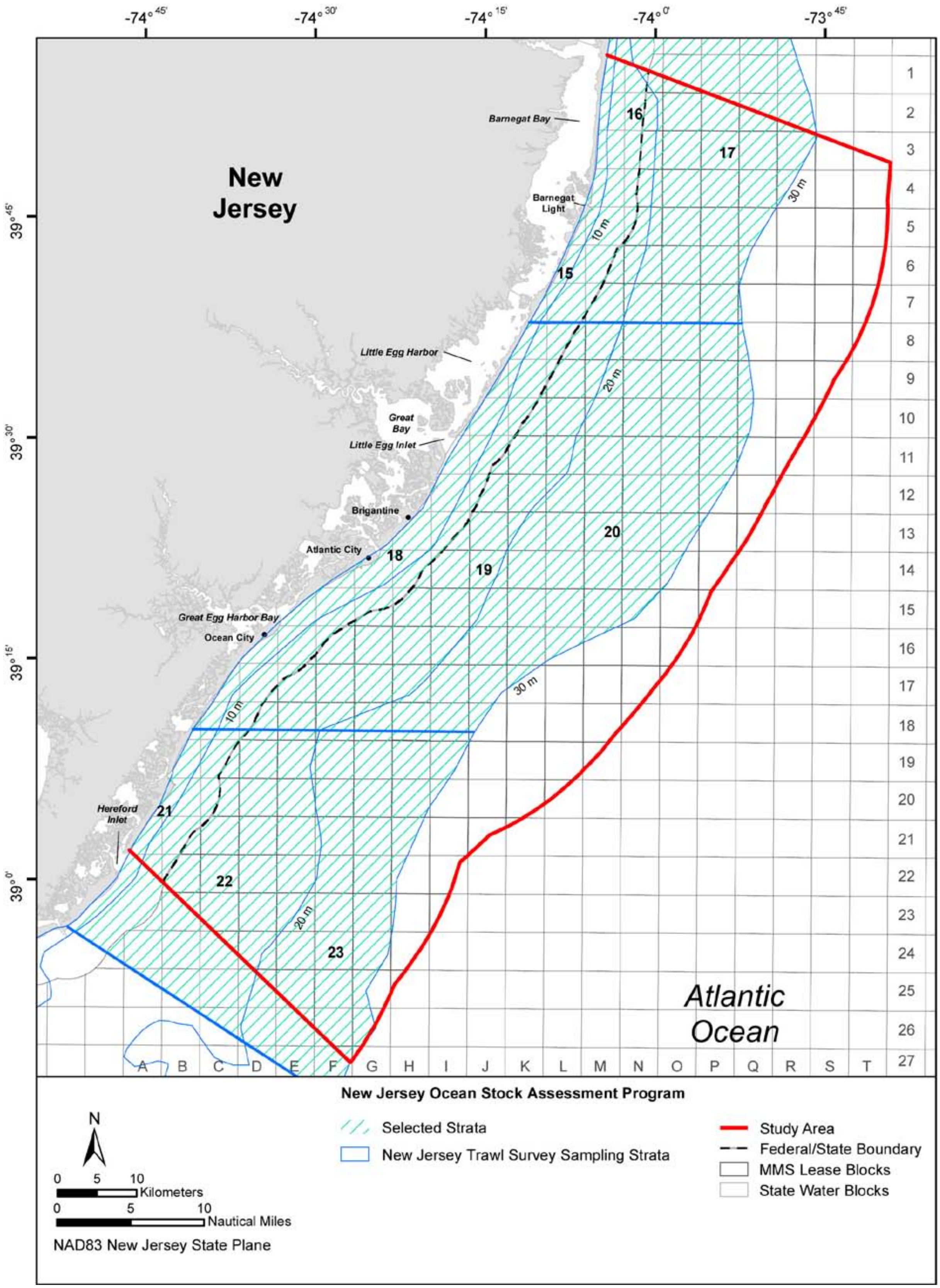


**Figure 4-1. The New Jersey Ocean Stock Assessment (OSA) Program sampling strata (areas 15 to 23) within the Study Area. Source information: NJDEP (2008b). Map adapted from: Byrne (2008).**

#### 4.1.1.2 New Jersey Open Stock Assessment Survey Design

The New Jersey OSA survey area encompasses about 2,898 $km^2$ (1,566 $NM^2$) consisting of the coastal waters from Ambrose Channel, New Jersey (i.e., the entrance to New York Harbor) to Cape Henlopen Channel, New Jersey (i.e., the entrance to Delaware Bay); it includes the waters from about the 5.5-m (18-ft) to the 27.4-m (90-ft) isobaths (ASMFC 1994). To evaluate spatial dynamics, the New Jersey OSA survey program divides the New Jersey coastline into 15 strata zones (areas 12 to 26) based on depth and location (latitude). To be consistent with established federal sampling programs, the OSA survey incorporates the latitudinal boundaries defined by NMFS NEFSC Northwest Atlantic Groundfish Survey. The exceptions are those strata at the northern and southern ends of the New Jersey coastline where NMFS extends its survey into New York or Delaware waters. The New Jersey OSA survey truncates the boundaries to exclude these northern and southern strata, confining the survey area to include only waters adjacent to the New Jersey coastline, except for the ocean waters off Delaware Bay. The longitudinal boundaries consist of the 9.1-m (30-ft), 18.3-m (60-ft), and 27.4-m (90-ft) isobaths where these bottom contours are irregular and the stratum boundaries are smoothed by eye (ASMFC 1994). In general, the longitudinal strata boundaries are similar, but not identical, to the corresponding NMFS boundaries of its Northwest Atlantic Groundfish Survey. To reduce sampling bias, each stratum is divided into smaller blocks that represent potential sampling sites; each block is identified by a number assigned sequentially within each stratum. Mid-shore (9.1 to 18.3 m [30 to 60 ft]) and offshore (18.3 to 27.4 m [60 to 90 ft]) blocks are 2.0 minutes (min) longitude by 2.5 min latitude, whereas inshore (5.5 to 9.1 m [18 to 30 ft]) blocks are 1.0 min longitude by 1.0 min latitude. Inshore block dimensions are smaller because inshore strata are narrower and encompass less area than the mid and offshore strata; the smaller block size permits a greater number of potential sampling sites than would be possible with larger dimensions. Blocks also truncated by stratum boundaries have less area than whole blocks and those reduced in area by more than one-half are generally not assigned a number (Byrne 2008).

#### 4.1.1.3 Survey Experimental Approach

Sampling surveys were conducted bi-monthly (once every two months: February, April, June, August, October, and December) from 1988 to 1990. Beginning in 1990, the December 1990 and February 1991 surveys were replaced by a single winter survey in January 1991. Today, this temporal sampling approach continues with only one winter survey in January, followed by surveys in April, June, August, and October for a total of five surveys per year (ASMFC 1994). Since August 1991, the sampling survey effort has consisted of 39 hauls (i.e., two samples from each strata plus one additional haul in each of the nine larger strata). The winter survey consists of two hauls for all strata. Before August 1991, the sampling survey effort varied because of high charter vessel costs, but generally followed the same approach with a minimum annual sampling survey effort of two hauls per stratum. Sampling stations (survey site location) were randomly selected. Because strata shapes were elongate and the sampling effort was limited, a station selection procedure was used to reduce any spatial distribution sampling bias. The station selection procedure consists of limiting the first station to the top half of the block numbers and the second station to the bottom half; however, if a third station was selected then no limitations were imposed. For instance, haul one would be selected from blocks 1 to 25 blocks, haul two from blocks 26 to 50, and haul three from blocks 1 to 50 for a stratum with 50 blocks. For each station, three additional alternate sites were also selected using the same procedures described above to account for fixed fishing gear, bottom obstructions, or other impediments that prevented sampling at the initial station (Byrne 2008).

#### 4.1.1.4 Survey Gear

Survey gear consisted of a two-seam, three-in-one otter trawl, which tapered from three-to-one. The trawl was constructed of polyethylene twine with forward netting (i.e., wings and belly) that had 12-cm (4.7-in) stretch mesh and 8-cm (3.1-in) stretch mesh rear netting. The otter trawl cod-end was 7.6-cm (3.0-in) stretch mesh and it was lined with a 6.4-mm (0.25-in) bar mesh liner. The otter trawl head rope was 25 m (82 ft) and the footrope 30.5 m (100 ft) long. The trawl bridle was 36.6 m (120 ft) long, the top leg consisted of a 1.27-cm (0.5-in) wire rope, and the bottom leg consisted of a 1.91-cm (0.75-in) wire rope covered with 6.03-cm (2.375-in) rubber cookies. The groundline length between the bridle and otter trawl doors was 18.3 m (60 ft) long; it was constructed of 1.91-cm (0.75-in) wire rope covered with 6.03-cm (2.375-in) rubber cookies. The trawl doors were wooden with steel shoes and were 2.44 m (8.0 in) x 1.27 m (4.83 in); each trawl door weighed approximately 453.5 kg (1,000 lbs; Byrne 2008).

All tows were performed during daylight defined as the hours between sunrise and sunset. The trawl tow duration was 20 min (i.e., the time the net was deployed to when the winch brakes were set to begin haul back) and the surface ground speed was maintained between 2.5 and 3.0 knots (kts; 2.9 and 3.5 miles per hour [mph]); one 20-min tow generally covered a distance of around 1.85 km (1.0 NM). Tow durations that were shortened because of hangs, bottom obstructions, fixed fishing gear, or other problems were considered an adequate sample provided the tow time was more than 15 min and there was no major damage to the net. For those tows that were less than 15 min, the tows were repeated unless there were extenuating circumstances (e.g., the bottom was known as a difficult area to sample). To standardize these shorter tow times (<20 min), extrapolation was applied under the assumption that there was a direct linear association between catch size and tow time. At each otter trawl deployment, 91.5 m (300 ft) of wire was released regardless of the depth to maintain a tow wire depth ratio of approximately 3:1 at the deepest sampling depth (27.4 m [90 ft]). This tow wire depth ratio was also selected to ensure that there was a sufficient distance between the vessel and the net when towing in shallow water (~9.1 m [30 ft]; Byrne 2008).

The New Jersey OSA program has used two different survey vessels for sampling the New Jersey coastline: the FIV Amy Diane (1988 to 1991) and the RJVARGO Maine (1991 to present). Both vessels were similar in size (24.4 m [80 ft] length, 78.7 m [24 ft] beam, and 3.1 m [10 ft] draft) and capabilities. Using SCANMAR equipment, the net's towing dimensions were generally similar under both vessels, but the vertical opening of the net with the RJVARGO Maine was greater than that of the FIV Amy Diane. The mean SCANMAR measurements for the FIV Amy Diane and RJVARGO Maine were: 39.6 m (130 ft) door spread, 11.6 m (38 ft) wing spread, 2.13 m (7 ft) vertical opening, and 39.6 m (130 ft) door spread, 11.9 m (39 ft) wing spread, and 3.4 m (11 ft) vertical opening, respectively (Byrne 2008).

#### 4.1.1.5 Field Collections

At each sampling station, and before the gear was deployed, environmental conditions were recorded. To measure salinity and dissolved oxygen at the surface and bottom, water samples were collected with 1.2 liter (L; 0.9317 gallons [gal]) Kemmerer bottle and conductance meter and Winkler titration methods were applied, respectively. Surface and bottom temperatures were measured with a thermistor.

Once the tow was completed the catch (fish and macroinvertebrates) was identified to species, enumerated, and sorted using plastic buckets and wire fish baskets. The total weight, or a representative sample (i.e., large catches), of each species was taken with a hanging metric scale and the length (fork or total) was measured to the nearest cm for fish and the disk width (cm) for stingrays (Dasyatidae). Depending on the macroinvertebrate species, various other measurements were recorded. For example, the carapace width (mm) was measured for crabs, the carapace length (mm) for lobsters, and mantle length (mm) for squids. Catches containing large numbers of relatively small specimens were sub-sampled, sorted, weighed, and individuals were measured. To determine the total catch, extrapolation was applied to the sub-sample under the assumption that there was direct association between the number and types of species in the sub-sample as in the total catch (Byrne 2008).

#### 4.1.1.6 Data Analysis

New Jersey OSA program data (2003 to 2008) were filtered and compiled into two separate datasets according to commercial and recreational importance of fish and invertebrates (i.e., state or federally managed species). This six year dataset (2003 to 2008) was aggregated according to collection (top 10 species numerically collected) and economic value (top 5 species collected). For each dataset, data were summarized, graphed, and various factors (i.e., numbers [cumulative and by individual species], relative abundance [density; numbers of fish per meter squared], and size by area, season, and year) were evaluated using standard statistical approaches. Prior to analyses, all datasets were tested for normality and homoscedacity (variance [equivalently standard deviation] are equal) using Kolmogorov-Smirnov and

Bartlett tests (Zar 1999), respectively. Datasets with a normal distribution were analyzed using parametric methods (Analysis of Variance [ANOVA]). Non-normal data were log-transformed [log (X+1)] to meet the underlying assumptions of normality (Zar 1999) and if after transformation the data still did not meet the assumptions of normality, then non-parametric methods (Kruskal-Wallis test) were applied. For all analyses, statistical significance was defined as $P<0.05$. A *post-hoc* multiple comparison test (i.e., Tukey or Nemenyi) was used to perform pairwise comparisons among those factors that were detected as significant (e.g., annual number of individuals collected among species). Chi-square goodness of fit was applied to length-frequency data to infer whether the population from which it came conforms to a specified theoretical distribution (Zar 1999). Length data were evaluated using either parametric or non-parametric methods. All analyses were conducted using Microsoft Excel® and Fortran (Version 10).

The catchability of sampling gear may differ among fish species, implying the species composition obtained from the survey may not be representative of actual fish community structure in the ecosystem; however, this may not affect spatial and temporal comparisons of fish assemblages, as long as the sampling catchability for a fish species is consistent throughout time and space.

## 4.2 RESULTS

### *4.2.1 Survey Effort*

The New Jersey OSA program completed a total of 1,120 tows off the coast of New Jersey within nine strata (areas 15 to 23) over a six-year period (2003 to 2008). The total survey area was around 2,202.1 $km^2$ (1,368.3 square miles [$mi^2$]). The mean number of tows per year was 187 and the total number of tows in each stratum (areas 15 to 23) ranged from 60 in area 15 to 87 in area 17. The average number of tows (2003 to 2008) in each area was 13 tows per year.

### *4.2.2 Trawl Species Composition*

A total of 2,639,040 individuals (fish and invertebrates) were collected by the New Jersey OSA program representing 11 groups of fish and macroinvertebrates (state [ASMFC] or federally [FMCs and NMFS: EFH] managed species) consisting of 32 species from 2003 to 2008 (**Table 4-1**). According to these data, 61% (*n* = 1,619,401) consisted of the top 10 (numerically; *n* = 1,430,061 or 88%) and top five (*n* = 351,985 or 22%) species having the most economical value (US $; **Figure 4-2**).

**Table 4-1. Groups of fish and macroinvertebrates collected and classified by the New Jersey Ocean Stock Assessment (OSA) Program from 2003 to 2008.**

| Fish/Macroinvertebrate Groups | Species |
|---|---|
| Anadromous | Alewife, Blueback Herring, American Shad, Atlantic Sturgeon, and Atlantic Striped Bass |
| Drums | Atlantic Croaker, Spot, and Weakfish |
| Flatfish | Summer Flounder, Winter Flounder, Witch Flounder, and Windowpane Flounder |
| Sharks and Skates | Little Skate, Winter Skate, Clearnose Skate, and Spiny Dogfish |
| Macroinvertebrates | American Lobster, Horseshoe Crab, and Squid |
| Cods and Hakes | Atlantic Cod, Red Hake, and Silver Hake |
| Anglerfish | Goosefish (Monkfish) |
| Eelpout | Ocean Pout |
| Schooling Fish | Atlantic Herring, Spanish Mackerel, Atlantic Menhaden, Butterfish, and Scup |
| Reef Fish | Black Sea Bass and Tautog |
| Coastal Pelagic | Bluefish |

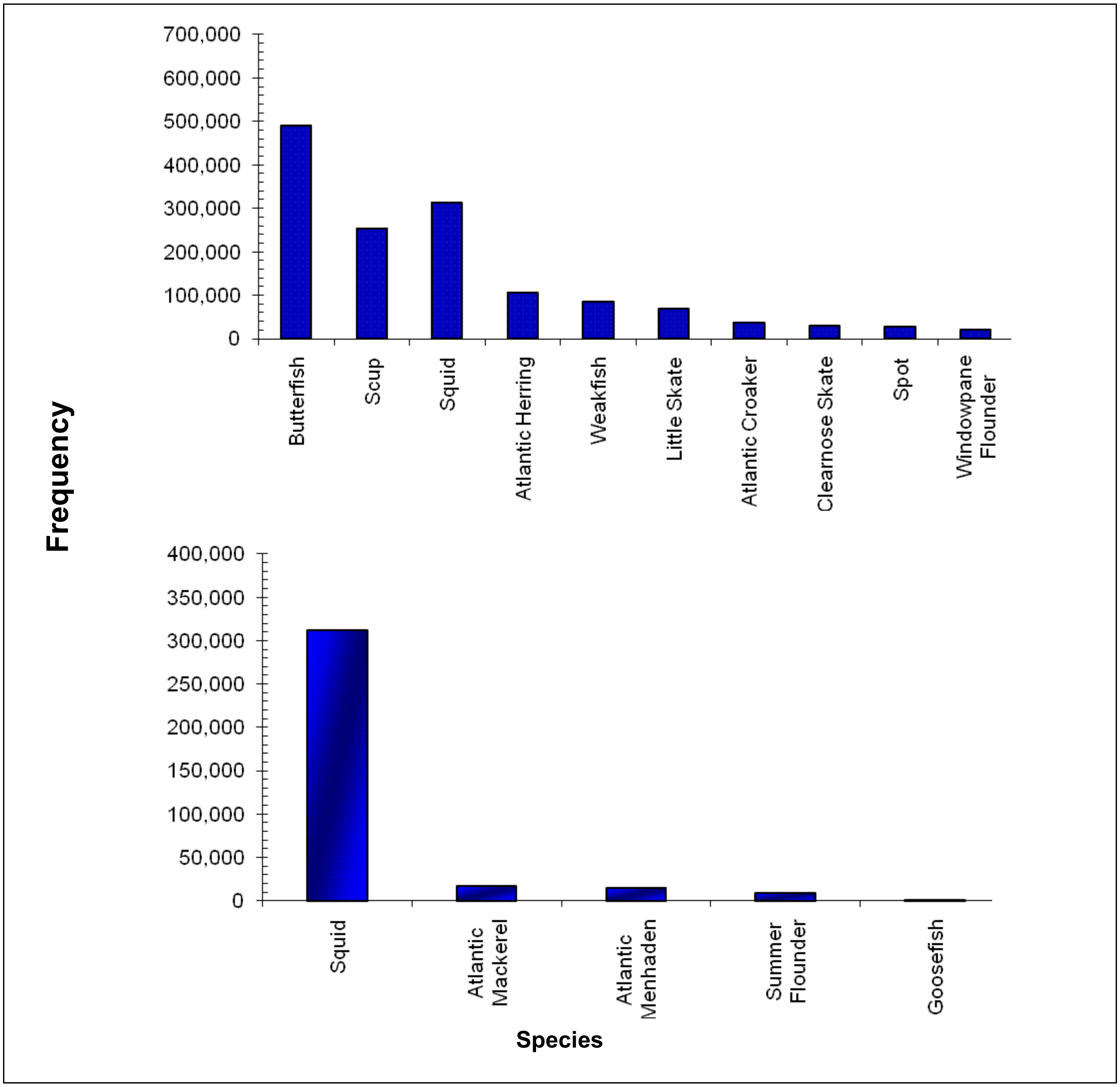


**Figure 4-2. The frequency distribution of the most dominant (Top Graph: top 10 species) and economically valuable species (Bottom Graph: top 5 species) collected by the New Jersey Ocean Stock Assessment (OSA) Program off the coast of New Jersey from 2003 to 2008.**

*4.2.3 Annual Dynamics*

The data demonstrated that there was annual variability in the total number of individuals (fish and vertebrates) collected from 2003 to 2008. Overall, the total number of individuals (fish and invertebrates) collected (top 10 species) ranged from 156,673 in 2007 to 353,250 in 2006 with a mean of 238,360 individuals (fish and macroinvertebrates) per year (**Figure 4-3**). The cumulative number of individuals collected from 2003 to 2008 was significantly different among species by year ($P$ = 0.001) and area ($P$ = 0.0448). The most dominant species collected was butterfish ($n$ = 489,376 or 34%). A *post-hoc* Tukey multiple comparison test demonstrated that there was a significant difference detected between the annual total number of butterfish collected and little skate, Atlantic croaker, clearnose skate, spot, and windowpane flounder ($P<0.05$); however, no significant difference was detected between the annual total number of butterfish collected and scup, squid, Atlantic herring, and weakfish ($P>0.05$). The total number of butterfish collected ranged from 26,213 in 2005 to 190,685 in 2008 with a mean of 81,563 butterfish per year.

The overall annual relative abundance for all species combined, expressed in density (number of fish per $m^2$), ranged from 0.006 fish/$m^2$ (0.000558 fish/$ft^2$) in 2003 to 0.04 fish/$m^2$ (0.003717 fish/$ft^2$) in 2004 with a mean of 0.01 fish/$m^2$ (0.000929 fish/$ft^2$) per year (**Figure 4-4**). A species specific evaluation showed that squid had the greatest (0.06/$m^2$ [0.005576/$ft^2$]) mean relative abundance and windowpane flounder the lowest (0.0041/$m^2$ [0.000381/$ft^2$]). The mean relative abundance of squid ranged from a low of 0.014/$m^2$ (0.001301/$ft^2$) in 2008 to a high of 0.257/$m^2$ (0.023885/$ft^2$) in 2004 with a mean of 0.256/$m^2$ (0.023792/$ft^2$) per year (**Figure 4-4**).

The total number of individuals (fish and invertebrates) collected (top 5 species) having economic value ranged from 31,812 in 2003 to 82,872 in 2008 with a mean of 58,664 individuals (fish and macroinvertebrates) per year (**Figure 4-3**). The overall number of individuals collected having economic value from 2003 to 2008 was significantly different among species by year ($P$ = 0.001).The most dominant species collected having economic value was squid ($n$ = 312,299 or 89%). A *post-hoc* Tukey multiple comparison test demonstrated that there was a significant difference detected between the annual total number of squid collected and the other five species, but no statistical difference was detected between the total number of summer flounder and Atlantic mackerel collected ($P>0.05$) or between the total number of Atlantic mackerel collected and Atlantic menhaden. In addition, there was no statistical difference detected between the total number of summer flounder collected and goosefish or Atlantic menhaden ($P>0.05$); the Tukey test showed that the total number of Atlantic menhaden and goosefish collected were also similar ($P>0.05$).The total number of squid collected ranged from 28,696 in 2003 to 80,693 in 2006 with a mean of 52,050 squid per year.

The overall annual relative abundance for all species combined ranged from 0.002 fish/$m^2$ (0.000186 fish/$ft^2$) in 2003 to 0.05 fish/$m^2$ (0.004647 fish/$ft^2$) in 2005 with a mean of 0.01 fish/$m^2$ (0.000929 fish/$ft^2$) per year (**Figure 4-4**). A species specific evaluation showed that squid had the greatest (0.06 squid/$m^2$ [0.005576 squid/$ft^2$]) mean relative abundance and goosefish the lowest (0.0 fish/$m^2$ [0.0 fish/$ft^2$]; **Figure 4-4**).

#### *4.2.4 Seasonal Dynamics*

The data demonstrated that there was seasonal variability in the total number of individuals (fish and vertebrates) collected from 2003 to 2008. Overall, the total number of individuals (fish and invertebrates) collected (top 10 species) ranged from 67,520 (4.5% of the total catch) in winter to 801,753 (52.9%) in summer with a mean of 379,066 individuals per season (**Figure 4-5**). In summer, the most numerically dominant species was butterfish ($n$ = 349,852 or 43.6%), while the least was Atlantic herring ($n$ = 104 or 0.01%). The mean relative abundance of butterfish in summer ranged from 0.005633/$m^2$ (0.005235/$ft^2$) in 2007 to 0.136614/$m^2$ (0.012696/$ft^2$) in 2008 with a mean of 0.046684/$m^2$ (0.004339/$ft^2$) per year (summer season). The most numerically dominant species in winter was Atlantic herring ($n$ = 47,521 or 70%) and the least was spot ($n$ = 1 or 0.001%). The mean relative abundance of Atlantic herring in winter ranged from 0.00467/$m^2$ (0.000434/$ft^2$) in 2005 to 0.20498/$m^2$ (0.019050/$ft^2$) in 2007 with a mean of 0.018254/$m^2$ (0.001696/$ft^2$) per year (winter season).

The total number of individuals (fish and invertebrates) collected (top 5 species) having economic value ranged from 7,765 (2.2%) in winter to 208,457 (59.2%) in summer with a mean of 140,794 individuals per season (**Figure 4-5**). In summer, the most numerically dominant species was squid ($n$ = 202,995 or 97%) and the least was goosefish ($n$ = 29 or 0.01%). The mean relative abundance of squid in summer ranged from 0.012830/$m^2$ (0.001192/$ft^2$) in 2003 to 0.057316/$m^2$ (0.005327/$ft^2$) in 2004 with a mean of 0.027025/$m^2$ (0.002512/$ft^2$) per year (summer season). Likewise, the most numerically dominant species collected in winter was squid ($n$ = 5,188 or 66.8%) and the least was goosefish ($n$ = 3 or 0.04%). The mean relative abundance of squid in winter ranged from 0.0/$m^2$ (0.0/$ft^2$) in 2004 to 0.11342/$m^2$ (0.010541/$ft^2$) in 2007 with a mean of 0.001977/$m^2$ (0.000184/$ft^2$) per year (winter season).

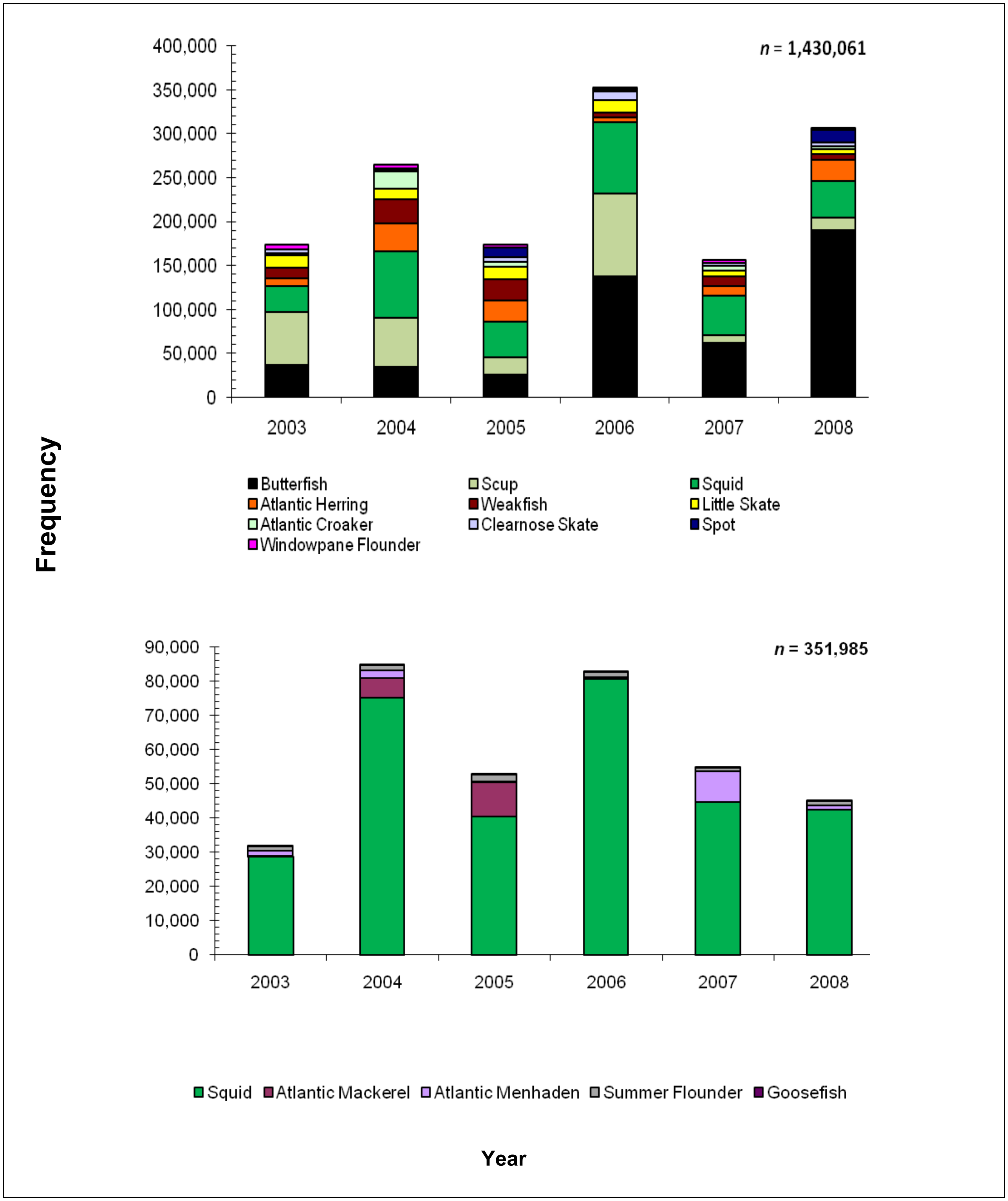


**Figure 4-3. The annual frequency distribution of the most dominant (Top Graph: top 10 species) and economically valuable species (Bottom Graph: top 5 species) collected by the New Jersey Ocean Stock Assessment (OSA) Program off the coast of New Jersey from 2003 to 2008.**

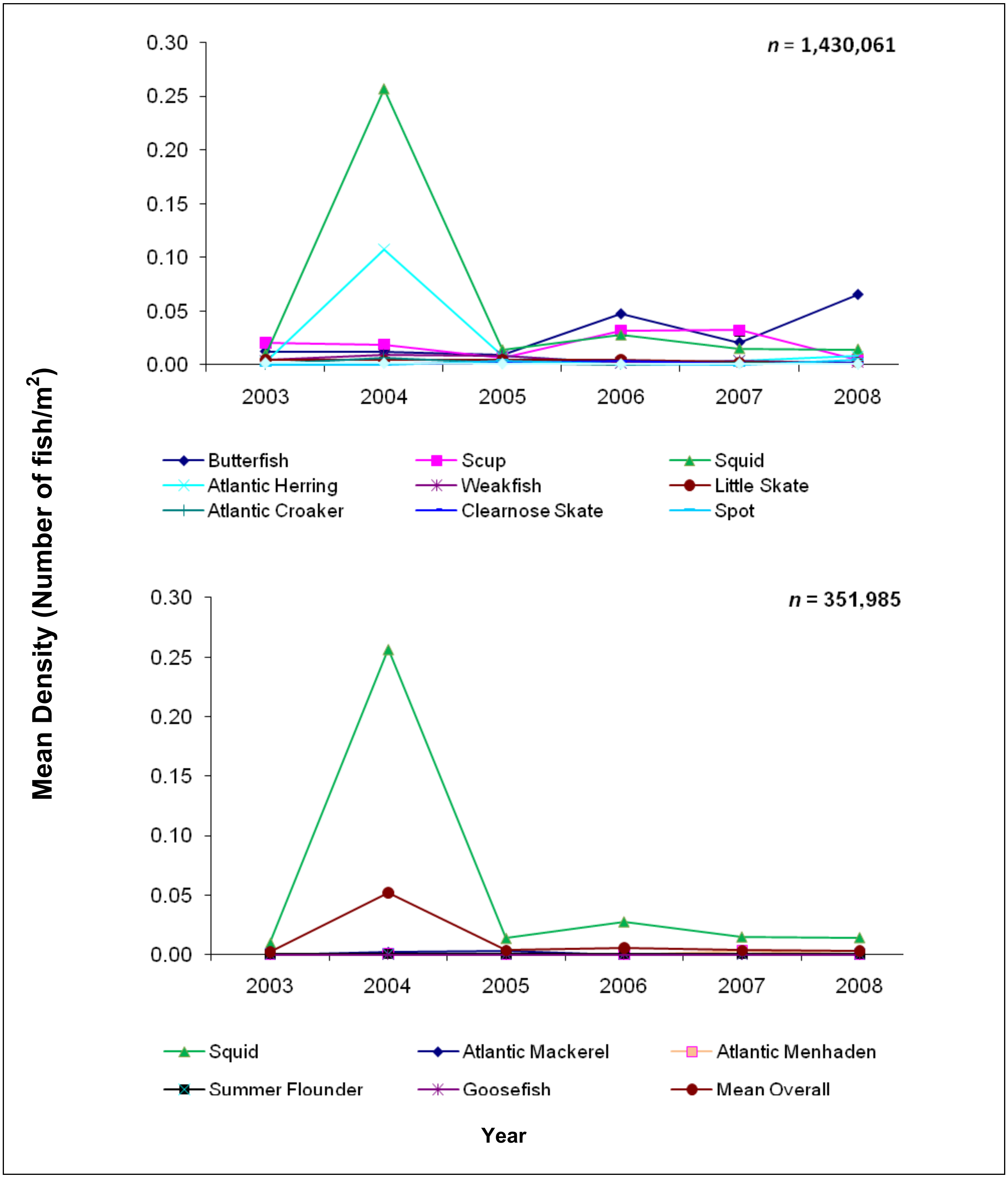


**Figure 4-4. The annual mean relative abundance (number of fish/m$^2$) of the most dominant (Top Graph: top 10 species) and economically valuable species (Bottom Graph: top 5 species) collected by the New Jersey Ocean Stock Assessment (OSA) Program off the coast of New Jersey from 2003 to 2008.**

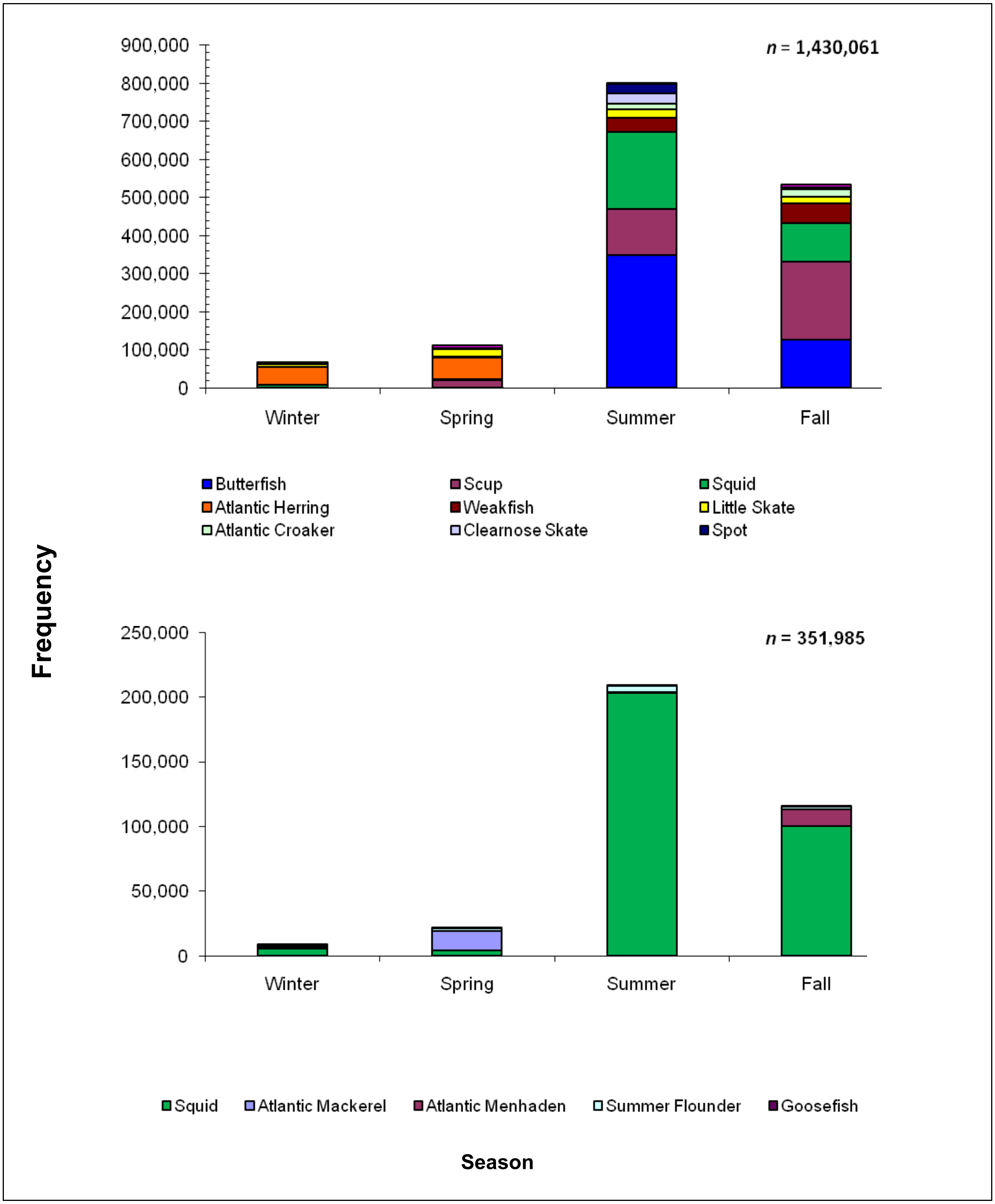


**Figure 4-5. The seasonal frequency distribution of the most dominant (Top Graph: top 10 species) and economically valuable species (Bottom Graph: top 5 species) collected by the New Jersey Ocean Stock Assessment (OSA) Program off the coast of New Jersey from 2003 to 2008.**

### *4.2.5 Spatial Dynamics*

The data demonstrated that there was no variability in the total number of individuals (fish and vertebrates) collected from 2003 to 2008 by sampling location, but there was a significant difference detected for the total number of individuals collected for a specific species by area. The total number of individuals collected (top 10 species) from 2003 to 2008 ranged from 85,225 (5.6%) in area 21 to 261,093 (17.2%) in area 16 (**Figures 4-6** and **4-8**). Overall, there was no significant difference detected in the cumulative numbers of individuals collected by area ($P$>0.05); however, there was a significant difference detected between the total number of individuals collected for a specific species by area ($P$<0.001). A species specific evaluation determined that the most numerically dominant species in area 21 was butterfish ($n$ = 19,253 or 23%), while the least was Atlantic herring ($n$ = 1,662 or 2%). In area 16, the most numerically dominant species was also butterfish ($n$ = 124,528 or 48%) and the least was spot ($n$ = 321 or 0.12%; **Table 4-2**).

The overall mean relative abundance for all species combined ranged from 0.005 fish/m$^2$ (0.000465 fish/ft$^2$) in area 23 to 0.012 fish/m$^2$ (0.001152 fish/ft$^2$) in area 16 with a mean of 0.0009 fish/m$^2$ (0.000084 fish/ft$^2$) per area (**Figure 4-7**). Overall, butterfish had the greatest (0.027/m$^2$ [0.002509/ft$^2$]) mean relative abundance and windowpane flounder the lowest (0.001/m$^2$ [0.000093/ft$^2$]). The mean relative abundance of butterfish ranged from 0.006/m$^2$ (0.000558/ft$^2$) in area 23 to 0.065/m$^2$ (0.006041/ft$^2$) in area 19 with a mean of 0.027/m$^2$ (0.002509/ft$^2$) per area (**Figure 4-7**).

The total number of individuals collected (top 5 species) having economical value ranged from 2,988 (0.2%) in area 21 to 64,397 (4.2%) individuals in area 15 (**Figures 4-6** and **4-8**). Overall, there was no significant difference detected in the cumulative numbers of individuals collected by area ($P$>0.05), or the interaction (two-way ANOVA) between area and year ($P$>0.05); however, there was a significant difference detected between the total number of individuals collected for a particular species by area ($P$<0.001). The most numerically dominant species in area 21 was squid ($n$ = 1,875 or 62.8%), while the least was goosefish ($n$ = 0). In area 15, the most and least numerically dominant species were squid ($n$ = 48,566 or 75%) and goosefish ($n$ = 0), respectively.

The overall mean relative abundance for all species combined ranged from 0.0003 fish/m$^2$ (0.000029 fish/ft$^2$) in area 18 to 0.006 fish/m$^2$ (0.000558 fish/ft$^2$) in area 15 with a mean of 0.004 fish/m$^2$ (0.000372 fish/ft$^2$) per area (**Figure 4-7**). Overall, squid had the greatest (0.017/m$^2$ [0.001579/ft$^2$]) mean relative abundance and goosefish the lowest (0.0/m$^2$ [0.0/ft$^2$]). The mean relative abundance of squid ranged from 0.0008/m$^2$ (0.00074/ft$^2$) in area 18 to 0.028/m$^2$ (0.002602/ft$^2$) in area 23 with a mean of 0.017/m$^2$ (0.001579/ft$^2$) per area (**Figure 4-7**).

### *4.2.6 Size Composition*

Butterfish was the most numerically abundant species collected by the New Jersey OSA program from 2003 to 2008. A total of 758,975 butterfish were collected and measured (2003 to 2008) ranging in length from 2 to 23 cm (0.78 to 9.1 in) fork length (FL) with a mean of 10.3 cm FL (4.1 in). The annual mean butterfish size ranged from a low of 9.90 cm (3.9 in) FL in 2006 and 2008 to a high of 11.12 cm (4.4 in) FL in 2003 (**Figure 4-9**). The most numerically abundant species collected by the New Jersey OSA program from 2003 to 2008 having economic value was squid. A total of 10,106 squid were collected and measured (2003 to 2008) ranging in length from 1 to 6.3 cm (0.04 to 2.5 in) with a mean of 1.2 cm (0.46 in). The mean annual squid mantel length ranged from 1.1 cm (0.49 in) in 2004 to 1.3 cm (0.5 in) in 2006 (**Figure 4-10**).

Overall, there was a significant difference detected in the annual mean butterfish size among years ($P$ = 0.0005). Moreover, a chi-square test of goodness-of-fit demonstrated that the length frequency distribution for butterfish was significantly different among years ($P$<0.001). Likewise, findings were similar for the annual mean size and length frequency distribution for the other primary species collected and measured (scup [$P$ = 0.0005; $P$<0.001, respectively], squid [$P$ = 0.0005; $P$<0.001, respectively], Atlantic herring [$P$ = 0.0005; $P$<0.001, respectively], weakfish [$P$ = 0.0005; $P$<0.001, respectively], and summer flounder [$P$ = 0.0001; $P$ = 0.0005, respectively]). In contrast, there was no significant difference detected in the annual mean size or frequency distribution for goosefish ($P$ = 0.75, $P$ = 0.9, respectively).

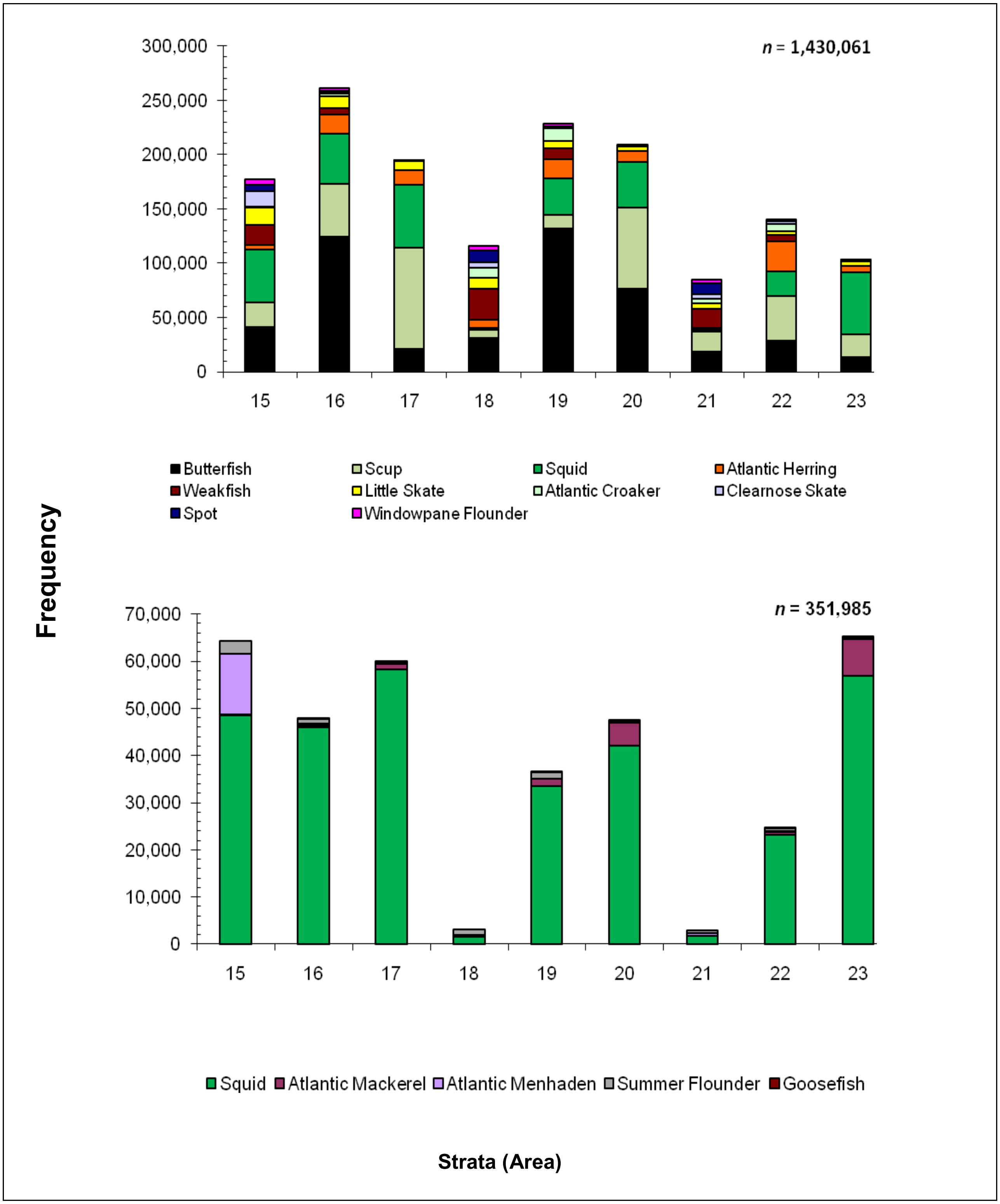


**Figure 4-6. The spatial frequency distribution of the most dominant (Top Graph: top 10 species) and economically valuable species (Bottom Graph: top 5 species) collected by the New Jersey Ocean Stock Assessment (OSA) Program off the coast of New Jersey from 2003 to 2008.**

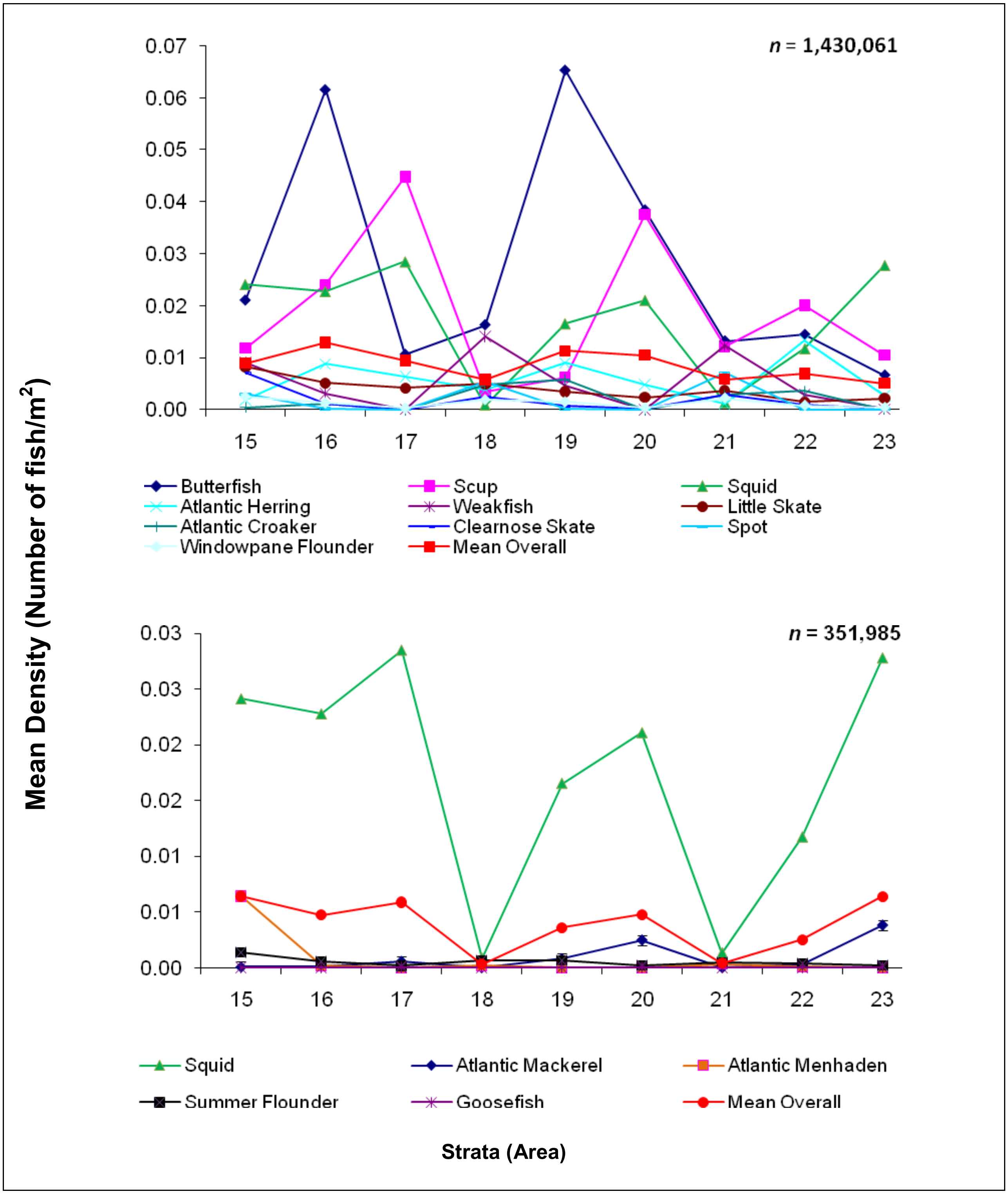


**Figure 4-7. The spatial mean relative abundance (number of fish/m$^2$) of the most dominant (Top Graph: top 10 species) and economically valuable species (Bottom Graph: top 5 species) collected by the New Jersey Ocean Stock Assessment (OSA) Program off the coast of New Jersey from 2003 to 2008.**

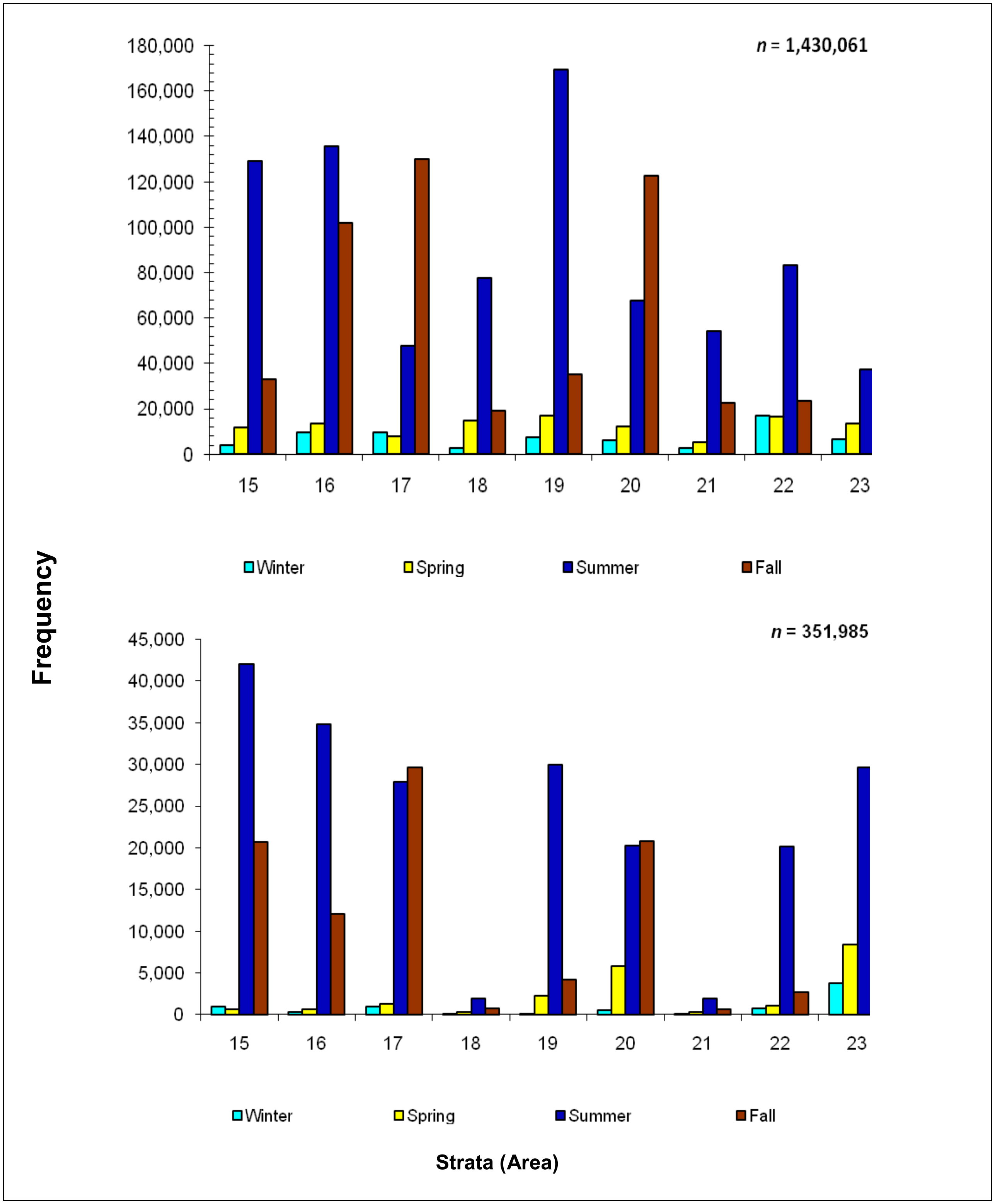


**Figure 4-8. The spatial and seasonal frequency distribution of the most dominant (Top Graph: top 10 species) and economically valuable species (Bottom Graph: top 5 species) collected by the New Jersey Ocean Stock Assessment Program off the coast of New Jersey from 2003 to 2008.**

**Table 4-2. The most dominant species (top 10 species) collected by the New Jersey Ocean Stock Assessment (OSA) Program from 2003 to 2008 in areas 15 to 23 (NJDEP 2009). The shaded cells depict the most numerically dominate species in each area.**

| Species | Areas | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** |
| **Butterfish** | 41,328 | 124,528 | 21,337 | 31,614 | 131,960 | 76,678 | 19,253 | 29,152 | 13,526 |
| **Scup** | 23,211 | 48,759 | 92,885 | 7,037 | 12,645 | 74,916 | 17,758 | 40,574 | 21,516 |
| **Squid** | 48,566 | 46,123 | 58,324 | 1,659 | 33,547 | 42,104 | 1,875 | 23,168 | 56,933 |
| **Atlantic Herring** | 3,724 | 17,791 | 13,120 | 7,694 | 18,129 | 9,656 | 1,662 | 27,793 | 5,484 |
| **Weakfish** | 18,478 | 6,139 | 62 | 28,562 | 9,444 | 20 | 17,549 | 5,737 | 244 |
| **Little Skate** | 16,333 | 10,380 | 8,547 | 9,872 | 6,960 | 4,666 | 5,267 | 2,953 | 4,472 |
| **Atlantic Croaker** | 821 | 2,343 | 14 | 9,879 | 11,769 | 13 | 4,032 | 7,214 | 73 |
| **Clearnose Skate** | 14,217 | 2,187 | 99 | 4,863 | 1,468 | 146 | 4,250 | 1,900 | 347 |
| **Spot** | 6,071 | 321 | 0 | 11,060 | 137 | 0 | 10,408 | 116 | 4 |
| **Windowpane Flounder** | 4,933 | 2,522 | 549 | 3,758 | 2,935 | 612 | 3,171 | 1,632 | 785 |
| **Total** | **177,682** | **261,093** | **194,937** | **115,998** | **228,994** | **208,811** | **85,225** | **140,239** | **103,384** |
| **Percent** | **11.7** | **17.2** | **12.9** | **7.7** | **15.1** | **13.8** | **5.6** | **9.2** | **6.8** |

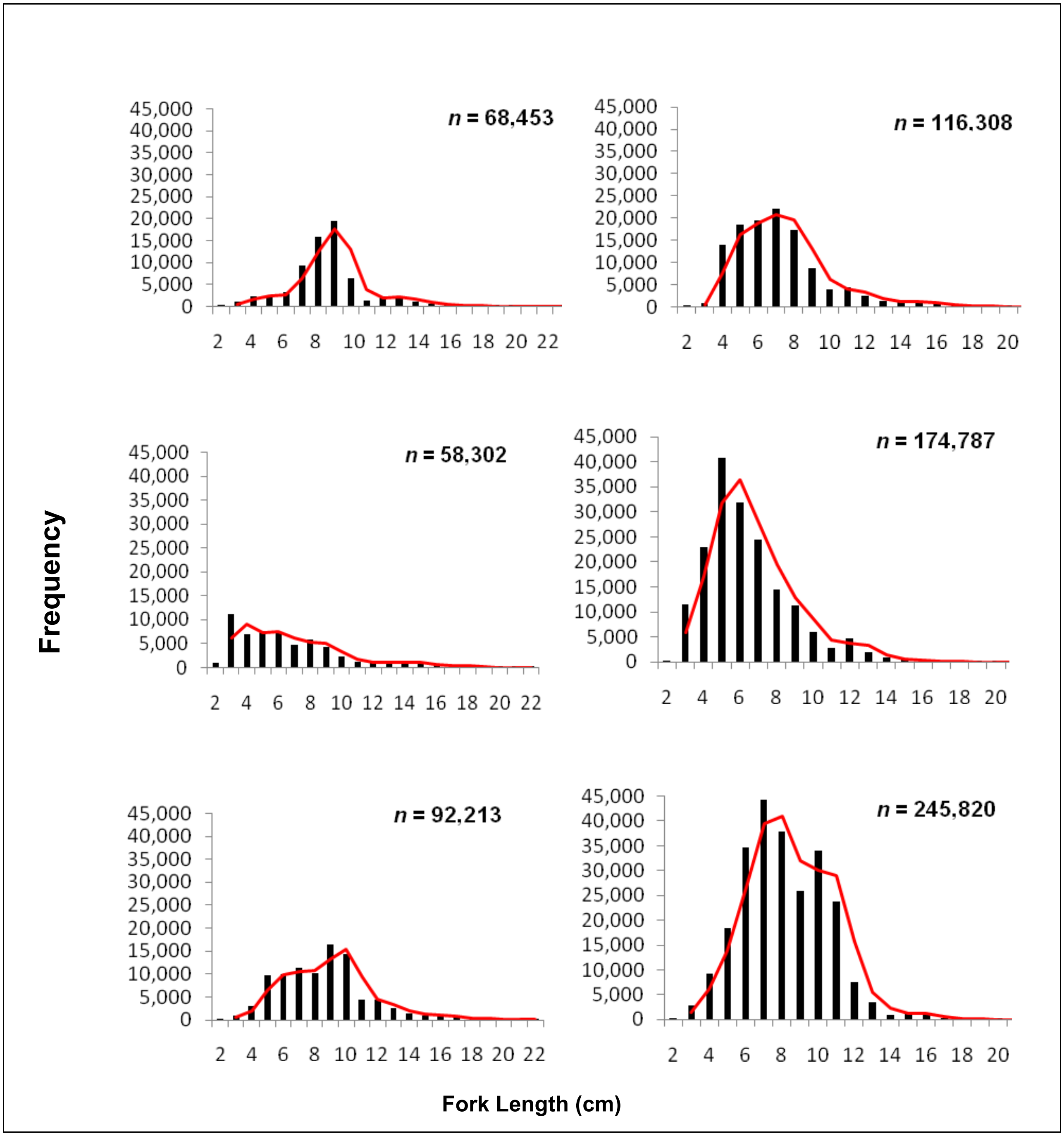


**Figure 4-9. The length-frequency distribution of butterfish collected and measured by New Jersey Ocean Stock Assessment (OSA) Program off the coast of New Jersey from 2003 (top left graph) to 2008 (bottom right graph). The solid line depicts the moving average.**

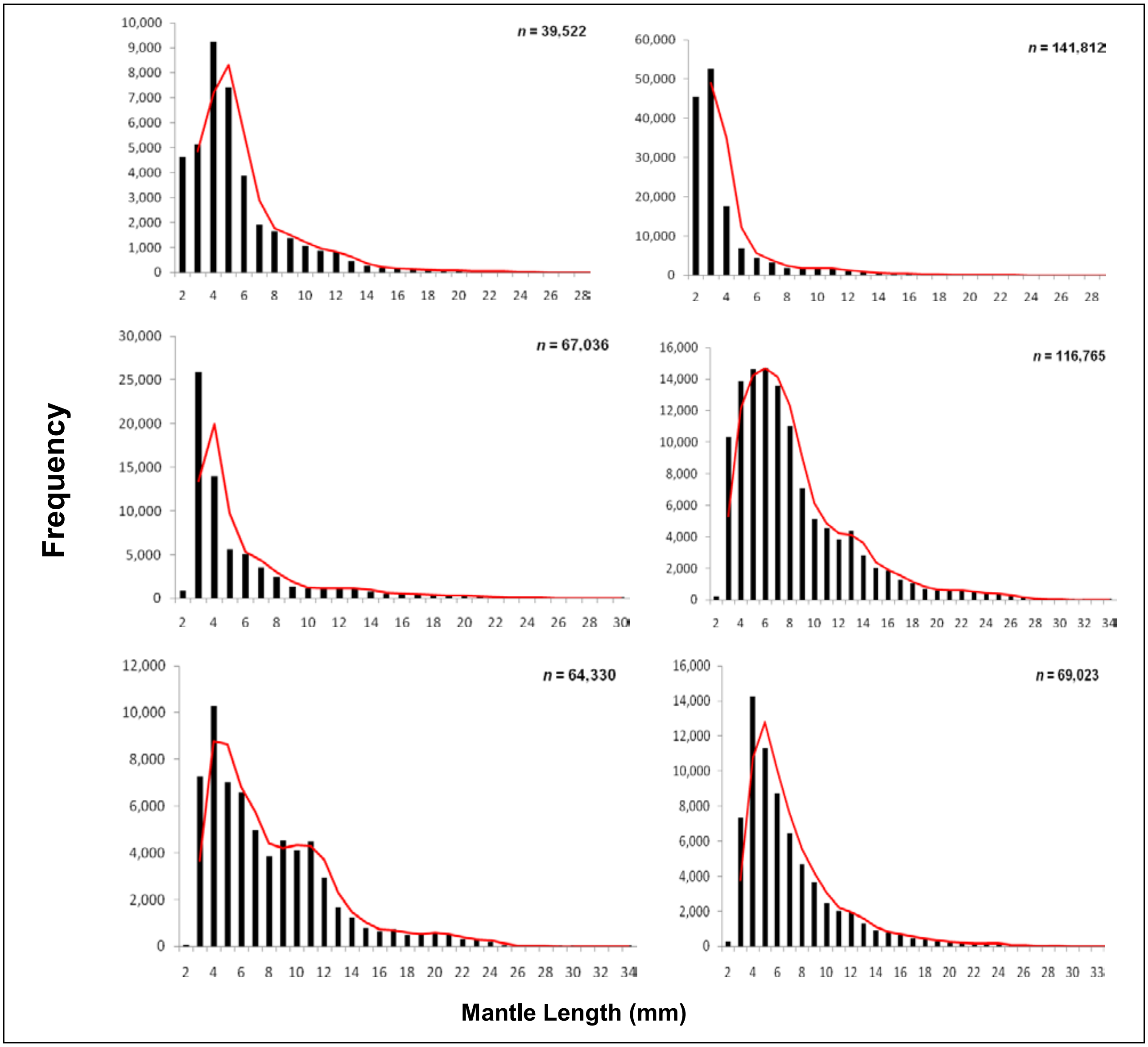


**Figure 4-10. The length-frequency distribution of squid collected and measured by New Jersey Ocean Stock Assessment (OSA) Program off the coast of New Jersey from 2003 (top left graph) to 2008 (bottom right graph). The solid line depicts the moving average.**

A *post-hoc* Tukey multiple comparison test for butterfish did not detect any significant difference in mean size among years 2003 to 2004, 2003 to 2005, 2003 to 2006, 2003 to 2007 or any other combination; however, the test did show there was a significant difference in mean squid size between the years 2003 and 2008.

## 4.3 DISCUSSION AND CONCLUSION

The New Jersey coastal waters consist of various nearshore (e.g., estuaries, bays, salt marshes, tidal creeks, and coastal beaches) and offshore environments (e.g., sand ridges, continental shelf, canyons, hard bottom, and artificial reefs [e.g., ship wrecks and man-made structures]) that provide critical habitats for many state and federally managed fish and invertebrates. Marine fish depend upon and utilize many types of habitats (e.g., seagrasses, salt marshes, solitary corals, and rocky intertidal areas) at different life stages. In general, the nearshore waters (estuaries, bays, and coastal beaches) are utilized by early life stages (larvae and juveniles), while the offshore waters provide habitat for sub-adult and adult life stages of various fish and invertebrates. Despite the importance of understanding how habitats and population dynamics are interrelated in this region, the relationship between these habitats to fish dynamics in the northeastern U.S. is not well understood or documented (Able et al. 2010).

Acknowledging that most fish studies conducted in this region have only evaluated the nearshore coastal habitats (<3-m [9.7-ft] depth contour; e.g., Hagan and Able 2003; Able et al. 2010), it is difficult to compare the findings of this present study to other investigations in this region given that this study specifically evaluated the fish assemblages found in the deeper nearshore coastal waters (9.1 to 27.4 m [30 to 90 ft]); the area between the surf zone and the offshore waters. In fact, very little information is available about this transition zone. Thus, the findings of this study not only contribute to our knowledge of the New Jersey coastal fish communities, but also support the notion that the nearshore coastal waters between the surf zone and offshore environments off New Jersey serve as habitats for various fish and invertebrates of commercial and recreational importance. Based on the findings of this study, the nearshore waters off New Jersey are equally important to butterfish, scup, Atlantic herring, and weakfish. The data also showed that although there were similarities in species composition over time, there was a significant difference among the abundance and size structure of individuals collected by year and area. In general, the findings revealed that the Study Area is dominated by a limited number of species, which is common for temperate fish assemblages.

Although the findings of this study demonstrate that there is a significant difference in the annual variability of fish abundance and mean size, it appears that the association between relative abundance and time is stable. The data revealed that there were not only annual differences in overall fish abundance, but there were seasonal differences in species composition and total numbers of individuals collected, which was probably related to localized spawning events or fluctuations in environmental (temperature) and oceanographic conditions (prevalent winds and currents transporting juveniles). Overall, summer and fall (52.9% and 35.2%, respectively) were the most important seasons in terms of relative fish abundance, while winter and spring (4.5% and 7.4%, respectively) the least. The findings revealed that specific species were more numerically dominant at certain times, which is probably associated with water temperature or daily movements. In summer, butterfish (44%) was the most abundant and Atlantic herring (0.01%) the least; however, in winter, Atlantic herring (70%) was the most abundant and spot (0.001%) the least. In spring and fall, the most abundant species were Atlantic herring (51%) and scup (38%), respectively. Evaluation of the spatial dynamics demonstrated that each area within the Study Area was just as important as the other in terms of overall annual abundance, but some areas were more important to specific species (**Table 4-2**). In general, butterfish were widely distributed and numerically dominated most of the areas (16 [48%], 18 [27%], 19 [58%], 20 [37%] and 21 [23%]). Squid was most abundant in areas 15 (27%) and 23 (55%), while scup was most abundant in areas 17 (48%) and 22 (29%). An evaluation of the seasonal abundance by area and species showed that butterfish abundance was highest in areas 16 and 19 in summer, while scup and squid abundance was highest in areas 17 and 23, respectively. In winter, Atlantic herring abundance was highest in area 22 and lowest in area 21. These numerically dominated species encompassed areas which contained substantial numbers of fishing hotspots/grounds within the Study Area (**Figure 4-11**).

In summary, this assessment of the coastal fishes off New Jersey demonstrates that the Study Area serves as important habitat to various commercially and recreationally valuable fish and invertebrate species. Overall, our findings indicated that although most collections (fish and invertebrates) occurred throughout the Study Area, most were in summer and fall (88.1%). The data showed that the total numbers of dominant species collected appeared to be evenly distributed across the entire Study Area by area and depth strata. The percentage of collections (fish and invertebrates) according to area ranged from a low of 5.6% in area 21 to a high of 15.1% in area 19. The percentage of collections (fish and invertebrates) according to depth strata ranged from a low of 25% (<10 m [32.8 ft]) to a high of 42% (10 to 20 m [32.8 to 65.6 ft]). These finding are expected given that many of these species are pelagic species, which tend to have extensive daily movement patterns; however, benthic species, such as clearnose skate and windowpane flounder, were more abundant in areas 15, 18, and 21, which corresponded to the areas having a depth profile less than 10 m (32.8 ft). As expected, this shows that benthic species are more closely associated with bottom depth than pelagic species (**Table 4-2**).

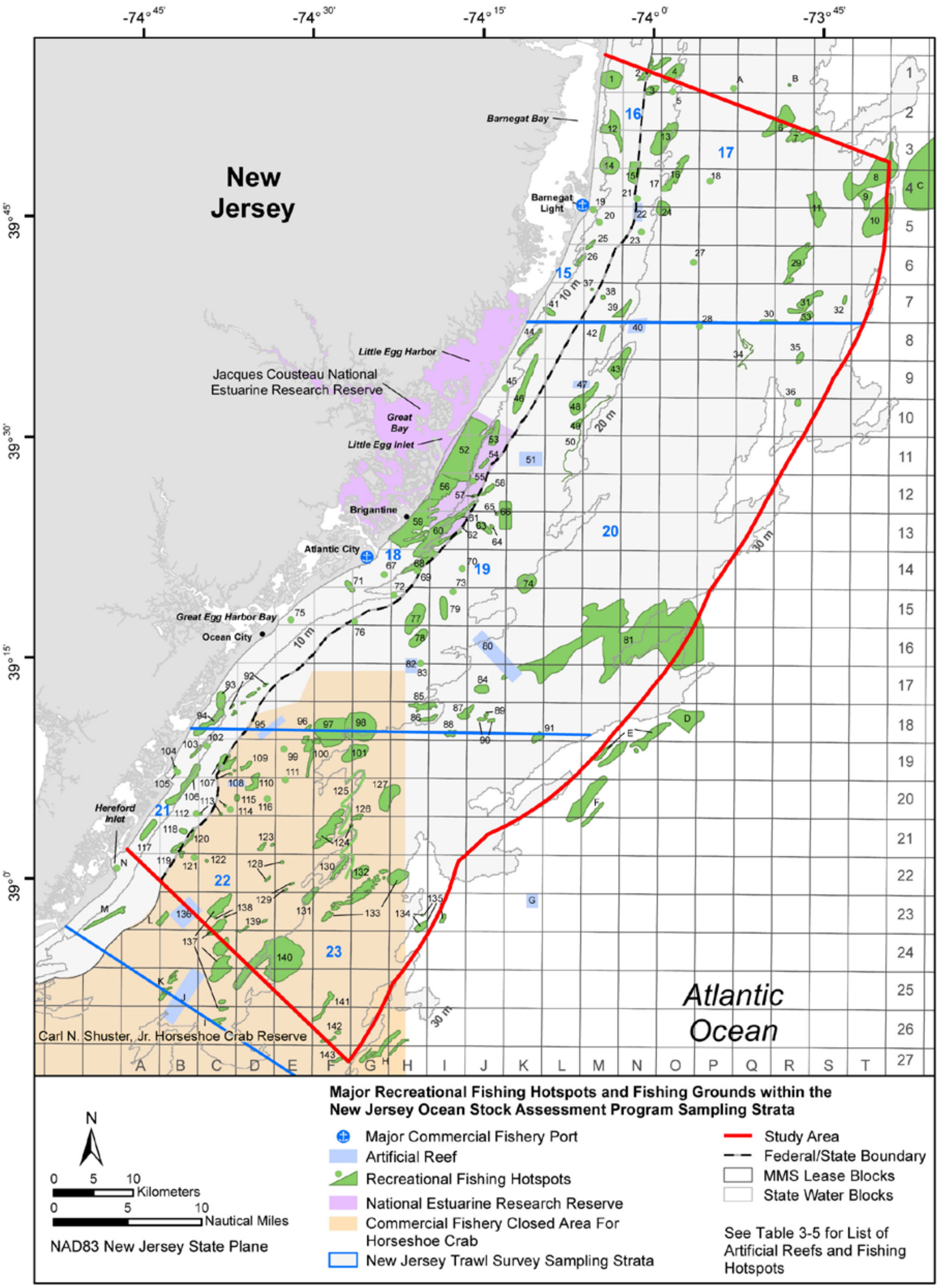


**Figure 4-11. Major recreational fishing hotspots and fishing grounds found within the New Jersey Ocean Stock Assessment (OSA) Program sampling strata (areas 15 to 23). Source Information: NEFMC (2003a). Map adapted from Freeman and Walford (1974); Long et al. (1982); Saltwater Directions (2003a; 2003b; 2003c); Byrne (2008); and NJDEP (2008b).[10]**

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# 5.0 ESSENTIAL FISH HABITAT MANAGED SPECIES

Fish and fisheries found within the Study Area are managed by various FMCs depending on the species and its range. The NEFMC, MAFMC, and SAFMC manage fisheries found within the Study Area. In addition, the Gulf of Mexico Fishery Management Council (GMFMC) and SAFMC co-manage the coastal migratory pelagic species (king mackerel [*Scomberomorus cavalla*], Spanish mackerel [*S.maculatus*], cobia [*Rachycentron canadum*], cero [*S.regalis*], and little tunny [*Euthynnus alletteratus*) with the SAFMC responsible for managing these species within the Study Area. In state waters, the ASMFC manages shared marine fishery resources. Through the Interstate Fishery Management Plan (IFMP), the ASMFC coordinates the conservation and management of 22 Atlantic coastal fish and invertebrate species and 2 species groups (shad/river herring and coastal sharks), which are found in the Study Area or vicinity.[4] Although most Atlantic HMS are usually found outside the Study Area and offshore (e.g., international waters), the NMFS is the only domestic agency that manages these species.

The MSFMCA, as amended by the SFA, requires that the NMFS, in conjunction with the FMCs, identifies and protects habitat essential for federal managed fish and invertebrate species. Each FMP should identify and describe the EFH, describe non-fishing and fishing threats, and suggest measures to conserve and enhance EFH. Both the FMCs and NMFS are also required to identify other important areas called HAPCs. Criteria for HAPC should demonstrate one or more of the following considerations: (a) importance of ecological function, (b) sensitivity to human-induced environmental degradation, (c) development activities stressing habitat type, or (d) rarity of habitat (NMFS 2002).

The FMC or NMFS may designate EFH and/or HAPC for federal management species outside their region of jurisdiction, whereas the ASMFC identifies all habitats and HAPC, but refrains from identifying EFH (Greene et al. 2009). Since descriptions of EFH are not currently included in the ASMFC's FMPs, the HAPC definition has been modified to include areas within the species' habitat that satisfy one or more of the aforementioned criteria. A HAPC is a subset of habitats the species is known to occupy, and could include spawning habitat, nursery habitat for larvae, juveniles, and sub-adults, and/or foraging habitat for mature adults. HAPC are geographical locations that are particularly critical to the survival of a species (Greene et al. 2009).

There are 40 fish and invertebrate species in the Study Area that have designated EFH and are hereinafter referred to as managed species (**Tables 5-1** and **5-2**). These managed species are grouped as temperate, subtropical-tropical, and HMS. Of the 40 managed species, 23 are temperate, 3 are subtropical-tropical, and 14 are HMS. For each managed species, the management, status, distribution (including range), habitat associations (substrate, depth, temperature, and salinity), life history (migration, movements, and spawning), forage species, and EFH lifestage designations are provided for the Study Area. In addition, there is an associated map figure that depicts the distribution of the designated EFH in the Study Area. It should be noted that although the status of a species may be different at a local scale (i.e., within the Study Area), stock refers to the entire population (stock) since state and federal agencies manage species based on the population stock (usually defined by genetic techniques) and not by localized populations. Management agencies use this approach because many fish species display seasonal movement patterns that cross various state and federal boundary jurisdictions.

In general, EFH within the Study Area may be characterized in the following habitat categories:

- <u>Benthic Habitat</u>: refers to seafloor habitats, which include the continental shelf and slope. These habitats consist of bottom substrate such as rocks, gravel, cobble, pebbles, sand, clay, mud, silt, shell fragments, and hard bottom. Benthic habitats are utilized by a variety species for spawning/nesting, development, dispersal, and feeding (SAFMC 1998; NMFS 1999a; NMFS 1999b; NMFS 2001).

- <u>Sediment Interface</u>: refers to habitat area between the seafloor and 1-m (3.28-ft) depth below the water-sediment interface. This habitat usually consisting of soft sediments and therefore is utilized by juvenile and adult bivalves (e.g., ocean quahog and Atlantic surfclam; Serchuk et al. 1982; Ma et al. 2006).

**Table 5-1. The fish and invertebrate species with essential fish habitat (EFH) designated in the Study Area. Taxonomy follows Nelson et al. (2004) for fish and Turgeon et al. (1998) for mollusks.**

| | | |
|---|---|---|
| **I. Temperate Water/Fish and Invertebrate Species (23)** | | |
| Atlantic cod | Goosefish/Monkfish | Spiny dogfish |
| Atlantic herring | Little skate | Summer flounder |
| Atlantic mackerel | Longfin inshore squid | Windowpane flounder |
| Atlantic surfclam | Ocean pout | Winter flounder |
| Black sea bass | Ocean quahog | Winter skate |
| Bluefish | Red hake | Witch flounder |
| Butterfish | Scup | Yellowtail flounder |
| Clearnose skate | Silver hake/Whiting | |
| **II. Subtropical-Tropical/Southeast Species (3)** | | |
| Cobia | King mackerel | Spanish mackerel |
| **III. Highly Migratory Species: Billfishes, Tunas, Swordfish, and Sharks (14)** | | |
| Albacore tuna | Longbill spearfish | Skipjack tuna |
| Atlantic angel shark | Sand tiger shark | Thresher shark |
| Bluefin tuna | Sandbar shark | Tiger shark |
| Blue shark | Scalloped hammerhead shark | White shark |
| Dusky shark | Shortfin mako shark | |

**Table 5-2. Management units (MUs) and managed species with designated essential fish habitat (EFH) and habitat areas of particular concern (HAPC) within the Study Area by management agency and lifestage (Egg, Larvae, Juvenile, Adult, Spawning Adult, and All). Taxonomy follows Nelson et al. (2004) for fish and Turgeon et al. (1998) for mollusks.**

| MANAGEMENT AGENCY, MANAGEMENT UNIT, AND MANAGED SPECIES | LIFESTAGE DESIGNATED FOR EFH AND HAPC WITHIN THE STUDY AREA |
|---|---|
| NEW ENGLAND FISHERY MANAGEMENT COUNCIL | |
| **Atlantic Herring MU** | |
| Atlantic herring (*Clupea harengus*) | Larvae, Juvenile, Adult, and Spawning Adult |
| **Northeast Multispecies MU** | |
| *Large Mesh* | |
| Atlantic cod (*Gadus morhua*) | Adult |
| Ocean pout (*Zoarces americanus)* | All Lifestages |
| Windowpane flounder (*Scophthalmus aquosus*) | All Lifestages |
| Winter flounder (*Pseudopleuronectes americanus*) | All Lifestages |
| Witch flounder (*Glyptocephalus cynoglossus*) | Egg and Larvae |
| Yellowtail flounder (*Limanda ferruginea*) | All Lifestages |
| *Small Mesh* | |
| Red hake (*Urophycis chuss*) | Egg, Larvae, and Juvenile |
| Silver hake/Whiting (*Merluccius bilinearis*) | All Lifestages |
| **Northeast Skate Complex MU** | |
| Clearnose skate (*Raja eglanteria*) | Juvenile and Adult |
| Little skate (*Leucoraja erinacea*) | Egg, Juvenile, and Adult |
| Winter skate (*Leucoraja ocellata*) | Juvenile and Adult |
| **Monkfish MU[1]** | |
| Goosefish/Monkfish (*Lophius americanus*) | Egg, Larvae, and Juvenile |

**Table 5-2 (*continued*). Management units (MUs) and managed species with designated essential fish habitat (EFH) and habitat areas of particular concern (HAPC) within the Study Area by management agency and lifestage (Egg, Larvae, Juvenile, Adult, Spawning Adult, and All). Taxonomy follows Nelson et al. (2004) for fish and Turgeon et al. (1998) for mollusks.**

| MANAGEMENT AGENCY, MANAGEMENT UNIT, AND MANAGED SPECIES | LIFESTAGE DESIGNATED FOR EFH AND HAPC WITHIN THE STUDY AREA |
|---|---|
| MID-ATLANTIC FISHERY MANAGEMENT COUNCIL | |
| **Atlantic Mackerel, Squid, and Butterfish MU** | |
| Atlantic mackerel (*Scomber scombrus*) | Juvenile and Adult |
| Butterfish (*Peprilus triacanthus*) | Larvae and Juvenile |
| Longfin inshore squid (*Loligo pealeii*) | All Lifestages |
| **Bluefish MU**[2] | |
| Bluefish (*Pomatomus saltarix*) | All Lifestages |
| **Spiny Dogfish MU**[3] | |
| Spiny dogfish (*Squalus acanthias*) | Juvenile and Adult |
| **Summer Flounder, Scup, and Black Sea Bass MU**[2] | |
| Black sea bass (*Centropristis striata*) | Larvae, Juvenile and Adult |
| Scup (*Stenotomus chrysops*) | Juvenile and Adult |
| Summer flounder (*Paralichthys dentatus*) | All Lifestages and HAPC |
| **Surfclam and Ocean Quahog MU** | |
| Atlantic surfclam (*Spisula solidissima*) | Juvenile and Adult |
| Ocean quahog (*Arctica islandica*) | Juvenile and Adult |
| SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL | |
| **Coastal Migratory Pelagics MU**[4] | |
| Cobia (*Rachycentron canadum)* | All Lifestages |
| King mackerel (*Scomberomorus cavalla)* | All Lifestages |
| Spanish mackerel (*Scomberomorus maculatus)* | All Lifestages |
| NATIONAL MARINE FISHERIES SERVICE (Highly Migratory Species Management Division) | |
| **Billfish MU** | |
| Longbill spearfish (*Tetrapturus pfluegeri*) | Juvenile/Subadult and Adult |
| **Tuna MU** | |
| Albacore tuna (*Thunnus alalunga*) | Adult |
| Bluefin tuna (*Thunnus thynnus*) | Juvenile |
| Skipjack tuna (*Katsuwonus pelamis*) | Juvenile/Subadult and Adult |
| **Large Coastal Shark MU** | |
| Sandbar shark (*Carcharhinus plumbeus*) | All Lifestages and HAPC |
| Scalloped hammerhead shark (*Sphyrna lewini*) | Juvenile and Adult |
| Tiger shark (*Galeocerdo cuvier*) | Juvenile and Adult |
| **Pelagic Shark MU** | |
| Blue shark (*Prionace glauca*) | Juvenile and Adult |
| Shortfin mako shark (*Isurus oxyrinchus*) | All Lifestages |
| Thresher shark (*Alopias vulpinus*) | All Lifestages |
| **Prohibited Species MU** | |
| Atlantic angel shark (*Squatina dumeril*) | Juvenile and Adult |
| Dusky shark (*Carcharhinus obscurus*) | All Lifestages |
| Sand tiger shark (*Carcharius taurus*) | All Lifestages |
| White shark (*Carcharodon carcharias*) | All Lifestages |

[1] Jointly managed by the NEFMC (lead) and the MAFMC;
[2] Jointly managed by the MAFMC and the ASMFC
[3] Jointly managed by the MAFMC (lead), the NEFMC, and the ASMFC
[4] Jointly managed by the SAFMC (lead) and the GMFMC

- Aquatic Macrophytes: refers to seagrass beds and macroalgae mats located in estuarine areas, especially in the nearshore bays of New Jersey. These areas are nursery areas and habitat for juvenile species, such as bluefish and sandbar shark (Sogard 1992; Szedlmayer and Able 1996; Rountree and Able 1997; McCandless et al. 2002).

- Structured Habitats: refers to man-made or natural structures that provide shelter for a variety of species; these habitats provide surface area for settlement, attachment, or colonization. Because of the variety of marine life associated with structures, these habitats often form their own community.

  - Artificial reefs and shipwrecks*:* Artificial habitat primarily used by adults, especially spawning adults (Musick and Mercer 1977; Eklund and Targett 1991; Steimle and Figley 1996).

  - Biogenic: Includes communities of sponges, mussel beds, hydroids, amphipod tubes, red algae, and bryozoans, which are used primarily by Atlantic sea scallop larvae (Hart and Chute 2004).

- Marine Water Column: refers to the vertical water column, which extends from the surface to the seafloor. Depending on the species, this designated habitat may only refer to part or the entire water column, such as surface or bottom waters. This habitat is important for a wide variety of species and their lifestages (NEFMC 1998a; SAFMC 1998; NMFS 2009c).

- Estuarine Water Column: refers to the vertical water column found in estuaries, bays and other inshore coastal waters. This habitat commonly includes the "mixing" (0.5 to 25 practical salinity units [psu]) and "seawater" (>25 psu) salinity zones as defined by the NOAA's Estuarine Living Marine Resources (ELMR) database. The estuarine water column habitat is important to all lifestages of many fishes (Buckel et al. 1999).

- Habitat Areas of Particular Concern: refers to designated habitat areas in the Study Area and its vicinity for two species (summer flounder and sandbar shark).

  - Juvenile and adult lifestages for the summer flounder: estuarine and bay areas and communities of macroalgae, seagrasses, and freshwater and tidal macrophytes within the designated EFH; these areas are all adjacent to the Study Area (MAFMC and ASMFC 1998a).

  - All lifestages for the sandbar shark: the shallow areas at the mouth of Great Bay, New Jersey; lower and middle Delaware Bay; lower Chesapeake Bay, Maryland; near the Outer Banks, North Carolina; and in areas of Pamlico Sound adjacent to Hatteras and Ocracoke Islands to just offshore of these barrier islands. A portion of the HAPC for Great Bay, New Jersey, extends within the boundaries of the Study Area, while HAPC for lower and middle Delaware Bay is south of the Study Area (McCandless et al. 2002; NMFS 2009c).

The FMCs classify EFH for temperate and subtropical-tropical managed species in terms of five basic lifestages: (1) eggs, (2) larvae, (3) juvenile, (4) adult, and (5) spawning adult (MAFMC 1998; MAFMC and ASMFC 1998a; MAFMC and ASMFC 1998b; NEFMC 1998a; NEFMC 1999b; NEFMC 2003b). Eggs represents the lifestage that has been spawned and formed, but has yet to hatch; this lifestage is completely dependent on its yolk for nutrition and survival. Larvae are individuals that have hatched and have the ability to obtain or capture food. Juveniles are those individuals that are not sexually mature, but are otherwise morphologically similar to adults. Adults are sexually mature individuals that are not necessarily in spawning condition stage. The last lifestage is spawning adults. This stage is represented by those individuals that are in spawning condition (Moyle and Cech 1988; MAFMC 1998; MAFMC and ASMFC 1998a; MAFMC and ASMFC 1998b; NEFMC 1998a; SAFMC 1998; NEFMC 1999b; NEFMC 2003b).

For HMS (e.g., tuna, swordfish, and billfish), the NMFS categorizes lifestages into three categories based on ecological groupings indicative of habitat usage: (1) spawning adults, eggs, and larvae, (2) juvenile and subadult, and (3) adult (NMFS 1999a; NMFS 1999b; NMFS 2006). The category of spawning adult, eggs, and larvae is dependent on spawning locations and circulation patterns (controlled by winds and currents) that control the distribution of this lifestage. The juvenile and subadult category is a cumulative group in which all lifestages between age one and maturity have been combined. Adults are characterized as sexually mature fish.

For sharks, the NMFS classifies EFH in terms of three combined lifestages, which are based on the general habitat shifts that accompany each developmental stage. Shark EFH is classified as: (1) neonate and early juvenile (including newborns and pups less than one year old), (2) late juvenile and subadult (age one to adult), and (3) adult (sexually mature sharks; NMFS 1999b). In 2003, Amendment 1 to the FMP for the Atlantic tunas, swordfish, and sharks, the first two lifestages were modified as follows: Neonate and early juvenile was renamed Neonate, which includes primarily neonates and small YOY sharks, and late juveniles and subadults category was renamed juveniles, which includes all immature sharks from young juveniles to older or late juveniles (NMFS 2003b; NMFS 2006).

The 40 federally managed species found within the Study Area are presented according to their grouping as temperate, subtropical-tropical, and HMS. In-depth descriptions with figures illustrating the distribution for all 40 EFH species are presented in **Appendix A**.

## 5.1 TEMPERATE WATER FISH AND INVERTEBRATE SPECIES

The temperate species found off the coast of New Jersey include principal groundfish species (Atlantic cod, silver hake, and red hake) and other groundfish species (goosefish/monkfish, silver hake, scup, black sea bass, and ocean pout), flounders (summer, yellowtail, witch, winter, and windowpane), principal pelagic species (Atlantic herring/Atlantic mackerel), other finfish (butterfish, bluefish, spiny dogfish, and skates), and invertebrates (e.g., squids, Atlantic surfclam, and ocean quahog). Twenty-three temperate fish and invertebrate managed species have designated EFH in the Study Area. Of the total number of managed species found within the Study Area, 11 are managed by the NEFMC, 7 are jointly managed by the MAFMC and ASMFC, and 5 are managed by the MAFMC. These temperate water fish and invertebrate species EFH descriptions are described in **Appendix A** and their distributions are illustrated in **Figures A-1** through **A-23**.

Currently, the NEFMC (2007) is proposing changes to the EFH components of the FMPs under its jurisdiction including the Northeast Multispecies (Amendment 14), Atlantic sea scallop (Amendment 14), Atlantic herring (Amendment 3), monkfish (Amendment 4 – joint with MAFMC), red deep-sea crab (*Geryon quinquedens*; Amendment 1), skates (Amendment 2), and Atlantic salmon (*Salmo salar;* Amendment 3). Approval of these updated EFH components may result in the change of the EFH designations for some of the current species and/or add new (i.e., juvenile Atlantic sea scallop) species in the Study Area. In addition, the MAFMC (2010) is also considering updating the textual descriptions and geographical identifications of EFH for all lifestages of the following four managed species: Atlantic mackerel, longfin inshore squid, northern shortfin squid (*Illex illecebrosus*), and butterfish. This also may result in changes to their EFH designation in the Study Area.

## 5.2 SUBTROPICAL-TROPICAL/SOUTHEAST FISH SPECIES

The collective distribution of subtropical-tropical species encompasses a portion of the marine and estuarine waters along the Atlantic coast from Cape Cod, Massachusetts through the Florida Straits; however, most species occupy only limited portions of this overall region. EFH designation for the subtropical-tropical managed species extends from the MAB through Florida under the management of the SAFMC (1998). Species that are managed by the SAFMC and for which EFH has been designated include the coastal migratory pelagic species complex. The GMFMC co-manages members of the coastal migratory pelagic species complex with the SAFMC but current EFH designations apply only to those habitats within the jurisdictional boundaries of either the SAFMC or GMFMC. Thus, EFH designations for this complex along the Atlantic coast are exclusively from the SAFMC.

Of the subtropical-tropical species and species-groups managed by the SAFMC, all three species of the coastal migratory pelagic complex have EFH designated and occur on the continental shelf in the Study Area: cobia, king mackerel, and Spanish mackerel. The EFH designations for these three species are based on the distribution of the resource (Hoff, T., MAFMC, pers. comm., 14 May 2004; Pugliese, R., SAFMC, pers. comm., 17 May 2004) and are described in **Appendix A** and illustrated in **Figure A-24.**

### 5.3 HIGHLY MIGRATORY SPECIES

Billfish, swordfish, members of the mackerel family (tuna), and many shark species are highly migratory fishes that are distributed over wide areas of the open ocean as well as over the neritic waters of the continental shelf and coastal waters. These species are capable of both horizontal and vertical movements; they move great horizontal distances as well as vertically in the water column. Seasonal migrations may involve north to south or inshore to offshore movements.

Identifying the habitat for highly migratory fish is complicated, as these fishes generally occur in the open ocean but may also frequent nearshore waters. HMS are not correlated with the areas or features that typify most fish habitat (bottom substrate or submerged vegetation) but rather are associated with physiographic and hydrographic features such as ocean fronts, current boundaries, the continental shelf margin, or seamounts. The distributions of the various lifestages of these highly mobile species are also constrained by temperature, salinity, and dissolved oxygen concentrations (NMFS 1999a; NMFS 1999b; NMFS 2003b; NMFS 2006; NMFS 2009c). The majority of the resulting habitat parameters are dynamic, changing both spatially and temporally and make habitat characterization for highly migratory fish species nearly impossible except in a broad context. The NMFS manages and designates EFH for all HMS. The 14 managed HMS occurring within the Study Area are described in **Appendix A** and the designated EFH locations are illustrated in **Figures A-25** through **A-38**.

## 6.0 ATLANTIC STATES MARINE FISHERIES COMMISSION MANAGED SPECIES

The ASMFC consists of 15 coastal states (Maine to Florida) that border the Atlantic Ocean. Similar to Regional Fishery Management Councils, the ASMFC serves as the primary marine resource management organization that coordinates the conservation and management of each state's shared nearshore fishery resources – marine, shell, and anadromous – for sustainable use. At this time, the ASMFC manages 22 Atlantic coastal fish and invertebrate species and 2 species groups (**Table 6-1**). Only two species, the northern shrimp (*Pandalus borealis*) and red drum (*Sciaenops ocellatus*) occur north and south of the Study Area (ASMFC 2009a). Eight of these species that are managed by the ASMFC in New Jersey state waters have EFH and/or HAPC designation under the MSFCMA and/or ASMFC and are discussed in length in **Appendix A.** Eleven species and the two species groups (spiny dogfish/coastal sharks and shad/river herring) that have HAPC designation by the ASMFC are listed in **Table 6-1**. Currently 40 species of coastal sharks (**Table 6-2**) are managed by ASMFC (ASMFC 2008a). Twenty shark species occur in New Jersey state waters. Ten shark species have EFH designation in the Study Area and have been discussed in detail in **Appendix A**; while the remaining 10 shark species are presented in **Table 6-3**.

More in-depth information about the 10 shark species presented in **Table 6-3** can be found in the Final Amendment 1 to the 2006 Consolidated HMS FMP for EFH (NMFS 2009c). Detailed information, including their HAPC designation in or adjacent to the Study Area, pertaining to the 12 ASMFC non-designated EFH species and the shad/river herring group have been described by the ESS Group, Inc. (2006), Greene et al. (2009), and in the managed species section of the ASMFC.[4]

**Table 6-1. Atlantic coastal fishes and invertebrates managed under ASMFC Interstate Fishery Management Plans (ISFMPs; ASMFC 2009a). Taxonomy follows Nelson et al. (2004) for fishes and McLaughlin et al. (2005) for invertebrates.**

| | |
|---|---|
| American eel (*Anguilla rsotrata*) | Shad and River herring |
| American lobster (*Homarus americanus*) | American shad (*Alosa sapidissima*) |
| Atlantic croaker (*Micropogonias undulatus*) | Hickory shad (*Alosa mediocris*) |
| Atlantic herring (*Clupea harengus*)[1] | Alewife (*Alosa pseudoharengus*) |
| Atlantic menhaden (*Brevoortia tyrannus*) | Blueback herring (*Alosa aestivalis*) |
| Atlantic striped bass (*Morone saxatilis*) | Spanish mackerel (*Scomberomorus maculates*) [1] |
| Atlantic sturgeon (*Acipenser oxyrhynchus*) | Spiny dogfish (*Squalus acanthias*) [1]/Coastal sharks[3] |
| Black sea bass (*Centropristis striata*)[1] | Spot (*Leiostomus xanthurus*) |
| Bluefish (*Pomatomus saltatrix*)[1] | Spotted seatrout (*Cynoscion nebulosus*) |
| Horseshoe crab (*Limulus polyphemus*) | Summer flounder (*Paralichthys dentatus*)[1] |
| Northern shrimp *(Pandalus borealis*)[2] | Tautog (*Tautog onitis*) |
| Red drum (*Sciaenops ocellatus*)[2] | Weakfish (*Cynoscion regalis*) |
| Scup (*Stenotomus chrysops*)[1] | Winter flounder (*Pseudopleuronectes americanus*)[1] |

[1] EFH species
[2] Not found in New Jersey state waters
[3] See **Table 6-2** for list of managed ISFMP Atlantic shark species

**Table 6-2. Atlantic coastal sharks managed under ASMFC Interstate Fishery Management Plan (ISFMPs; Able 1992; ASMFC 2008a). Taxonomy follows Nelson et al. (2004).**

Atlantic angel (*Squatina dumeril*)[1]
Atlantic sharpnose (*Rhizoprionodon terraenovae*)[2]
Basking (*Cetorhinus maximus*)[2]
Bigeye sand tiger (*Odontaspis noronhai*)
Bigeye sixgill (*Hexanchus nakamuri*)
Bigeye thresher (*Alopias supercilious*)
Bignose (*Carcharhinus altimus*)
Blacknose (*Carcharhinus acronotus*)
Blacktip (*Carcharhinus limbatus*)[2]
Blue (*Prionace glauca*)[1]
Bluntnose sixgill (*Hexanchus griseus*)
Bonnethead (*Sphyrna tiburo*)[2]
Bull (*Carcharhinus leucas*)[2]
Caribbean sharpnose (*Rhizoprionodon porosus*)
Common thresher (*Alopias vulpinus*)[1]
Dusky (*Carcharhinus obscurus*)[1]
Galapagos (*Carcharhinus galapagensis*)
Great hammerhead (*Sphyrna mokarran*)
Finetooth (*Carcharhinus isodon*)
Lemon (*Negaprion brevirostris*)[2]
Longfin mako (*Isurus paucus*)
Narrowtooth (*Carcharhinus brachyurus*)
Night (*Carcharhinus signatus*)
Nurse (*Ginglymostoma cirratum*)
Oceanic whitetip (*Carcharhinus longimanus*)
Porbeagle (*Lamna nasus*) [2]
Reef (*Carcarhinus perezii*)
Sand tiger (*Carcharias taurus*)[1]
Sandbar (*Carcarhinus plumbeus*)[1]
Scalloped hammerhead (*Shpyrna lewini*)[1]
Sharpnose sevengill (*Heptranchias perlo*)
Shortfin mako (*Isurus oxyrinchus*)[1]
Silky (*Carcarhinus falciformis*)[2]
Smalltail (*Carcharhinus porosus*)
Smooth dogfish (*Mustelus canis*)[2]
Smooth hammerhead (*Sphyrna zygaena*)[2]
Spinner (*Carcharhinus brevipinna*)
Tiger (*Galeocerdo cuvier*)[1]
Whale (*Rhincodon typus*)
White (*Carcharodon carcharias*)[1]

[1] Atlantic coastal sharks with EFH designation in the Study Area
[2] **Table 6-3** for Atlantic coastal sharks that have been reported in New Jersey waters

**Table 6-3. Atlantic coastal sharks managed under ASMFC Interstate Fishery Management Plan (ISFMP) that occur in New Jersey waters but do not have EFH designation in the Study Area (Able 1992; ASMFC 2008a; JCNEER 2009). Taxonomy follows Nelson et al. (2004).**

| Shark Species | Abundance | Occurrence |
|---|---|---|
| Atlantic sharpnose | Rare | Continental shelf from Cape May south |
| Basking | Rare | Outer continental shelf |
| Blacktip | Rare | Shallow coastal and offshore surface waters, mouth of Delaware Bay |
| Bonnethead | Rare | Shallow coastal waters, south of the Study Area |
| Bull | Rare | Shallow coastal waters and estuaries (Delaware Bay) |
| Lemon | Rare | Continental and insular shelves |
| Porbeagle | Rare | Deep, cold waters of outer continental shelf/slope |
| Silky | Rare | Outer continental shelf |
| Smooth dogfish[1] | Abundant | Resident on continental shelf, bays, and other inshore waters (Great Bay) |
| Smooth hammerhead | Rare | Continental shelf and inshore bays and estuaries (Great Bay and Delaware Bay) |

[1] Designated EFH species, management transferred to NMFS from ASMFC (NMFS 2010d)

## 7.0 FEDERAL AND STATE PROTECTED SPECIES

Within or near the vicinity of the Study Area, there are various fish species found that are either protected by the federal government (e.g., U.S. Fish and Wildlife Service [USFWS] and NMFS) and/or the State of New Jersey. These species warrant protection because population levels have declined to levels that could threaten or endanger the species existence throughout all or a significant portion of its range. Although the shortnose sturgeon (*Acipenser brevirostrum*) is the only fish species protected by the federal government under the Endangered Species Act (ESA; classified as endangered) that may be found in the vicinity of the Study Area (i.e., Delaware River), there are no records of shortnose sturgeon within the Study Area. At this time, there are also no known shortnose sturgeon populations in the riverine systems between the Hudson and Delaware rivers (NMFS 1998). This species is not known to make coastal migrations (Dadswell et al. 1984). In addition, there are five species of concern and one candidate species found within or in the vicinity of the Study Area. Species of concern are those species that NMFS has identified as potentially vulnerable to decline, but for which insufficient information is available to indicate a need to list the species under the ESA. Candidate species are species that are the subject of either a petition to list or status review, and for which NMFS or USFWS has determined that listing may be or is warranted jurisdiction.[15] Fish species classified as species of concern that may be found within or near the vicinity of the Study Area are the following: alewife, blueback herring, dusky shark, sand tiger shark, and barndoor skate (*Dipturus laevis*). One candidate species that may be found within or near the vicinity of the Study Area is the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). This migratory species commonly aggregates in shallow (10 to 50 m [32.8 to 164.1 ft]) nearshore areas along the New Jersey coast (Stein et al. 2004; Atlantic Sturgeon Status Review Team 2007). Currently, the NMFS is preparing a determination on whether listing this species or multiple distinct population segments (DPSs) as threatened or endangered is warranted (NMFS 2010b). The State of New Jersey also protects the shortnose sturgeon.[16]

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# 8.0 CLIMATE CHANGE

## 8.1 INTRODUCTION

Projected changes in the marine ecosystems off the northeastern U.S. as a result of climate-induced forcing includes alterations in water temperatures, salinity, wind stress, local precipitation patterns, and cloud cover, with potential ramifications for changes in water column structure and circulation. These, in turn, can affect many components of the marine ecosystem, beginning with the transport, production, and dynamics of planktonic communities and eventually extending through various parts of the food web. An increase in water temperatures predicted by climate change models will result in a poleward shift in the distribution of many subtropical-tropical and temperate water species in the northeast. This shift will include economically important fish and shellfish, changes in the productivity of these species, and possible increased uncertainty for the fishing industry and current resource management techniques during these periods of ecological transition (Fogarty et al. 2007).

## 8.2 FISH AND FISHERIES EFFECTS

Fish have complex life cycles, comprising several distinct life history stages (i.e., egg, larva, juvenile, and adult), each of which may be affected in different ways by climate change. In fish populations, climate-driven changes may result from four, often interlinked, mechanisms: (1) physiological response to changes in environmental parameters - sea surface temperature (SST), ocean circulation, and salinity patterns; (2) behavioral response - avoiding unfavorable conditions and moving into new suitable areas; (3) population dynamics - changes in the balance between rates of mortality, growth, and reproduction in combination with dispersal, which could result in the establishment of new populations in new areas, or abandonment of traditional sites; and (4) ecosystem - changes in habitat quantity and quality, productivity, and/or trophic interactions between competitors, predators, and pathogens (Lehodey et al. 2006; Rijnsdorp et al. 2009). The first three mechanisms would have a direct effect on fish populations, whereas the fourth mechanism would have an indirect effect (Brander 2010). Rijnsdorp et al. (2009) has suggested that early-life stages will be most sensitive to the effects of climate change, but the underlying mechanisms may differ among species or stocks and will depend on trophic position (Frank et al. 2007).

In addition, many other factors, including commercial fishing, biological interactions, and non-climatic environmental factors will also greatly affect the abundance and distribution of fish and may interact with the effects of climate change (Brander 2010). These changes in distributions and community structure of marine species affecting fishing activities may also have socioeconomic impacts on vulnerable coastal communities (Allison et al. 2009). Climate change will affect a range of abiotic variables that are tightly linked to the production and distribution of fish populations, while the climate-driven biotic changes will likely differ between the open ocean, shelf seas, and coastal waters (Walther et al. 2002; Lehodey et al. 2006).

Empirical and theoretical studies show that marine fish and invertebrates tend to shift their distributions according to the changing climate in a direction that is generally towards higher latitude and deeper water, with observed and projected rates of a range shift of around 30 to 130 km (16.2 to 70.2 NM) decade$^{-1}$ towards the pole and a 3.5 m (11.5 ft) decade$^{-1}$ to deeper waters (Perry et al. 2005; Cheung et al. 2008a; Dulvy et al. 2008; Mueter and Litzow 2008). In addition, changes in patterns of species richness may disrupt marine biodiversity and ecosystems and impact commercial fisheries (Roessig et al. 2004; Worm et al. 2006; Cheung et al. 2008b; Hiddink and Hofstede 2008). Cheung et al. (2010) projected changes in global catch potential for 1,066 species of exploited marine fish (836 spp.) and invertebrates (230 spp.) from 2005 to 2055. This study showed that climate change may lead to large-scale redistribution of global catch potential, with an average of 30 to 70% increase in high-latitude regions and a drop of up to 40% in the tropics.

## 8.3 NORTHEAST U.S. CONTINENTAL SHELF LARGE MARINE ECOSYSTEM

The Northeast (NE) U.S. Continental Shelf Large Marine Ecosystem (LME), a dynamic, highly productive system, has undergone sustained perturbations due to environmental and anthropogenic impacts over the last four decades, resulting in fundamental changes in its structure (Ecosystem Assessment Program 2009). Climate change may have particular impacts on the North Atlantic, because of dependence on north-south oceanic heat transfer and how any changes in SST, salinities, and ocean currents may affect both the fish and fisheries (Rose 2005). Groups of species may be expected to react differently to climate change, with species that spawn in shallow, relatively low salinity waters being most affected, while species that inhabit deeper, hydrographically more stable waters, less so. In addition, seasonal migrants that feed in the North Atlantic but spawn further south (e.g., bluefin tuna), may undergo migration shifts (Rose 2005).

In the NE LME, thermal conditions are changing due to warming of shelf and coastal waters and cooling in the northern end of the range. As a result, there has been a constriction of thermal habitats in the ecosystem with a northward shift in some fish species distributions (i.e., red hake) and shift to a warmer-water fish community (e.g., Narragansett Bay and Rhode Island Sound). The direct/indirect effects of species-selective harvesting patterns have also contributed to shifts from a demersal-dominated fish community to one now dominated by small pelagic fishes (Atlantic herring and Atlantic mackerel) and elasmobranchs (skates and small sharks) of low relative economic value. Notable changes are also evident within the benthic community with the increased abundance of the Atlantic sea scallops and American lobster and declining populations of ocean quahog and Atlantic surf clam (Weinberg 2005; Fogarty et al. 2007; Ecosystem Assessment Program 2009).

The potential importance of temperature regime and climate on fish stocks, especially those that are economically important, has been studied on relatively short temporal and spatial scales in the northwest Atlantic (Frank et al. 1990; Murawski 1993; Drinkwater et al. 2003; Hare and Able 2007). Nye et al. (2009) analyzed temporal trends of 36 fish stocks on the northeast continental shelf from 1968 to 2007 and reported that many stocks (17 of 36 or 47%) spanning several taxonomic groups, life-history strategies, and rates of fishing exhibited a poleward shift in their center of biomass, most with a simultaneous increase in depth, and a few with a concomitant expansion of their northern range. Most notable fish exhibiting a poleward shift were the alewife, American shad, and all southern populations of the silver hake, red hake, and yellowtail founder. These poleward shifts in the center of biomass and increases in depth distribution were consistent with the predicted responses to climate change that had been documented in many ecosystems (Southward et al. 1995; Parmesan and Yohe 2003; Rosenzweig et al. 2008) and in marine fishes (Holbrook et al. 1997; Perry et al. 2005; Dulvy et al. 2008). In addition, increased fishing pressure may also intensify the effects of climate change (Hsieh et al. 2008; Planque et al. 2010), especially at the southern extent of a species' range. On the eastern Scotian shelf, commercial fishing and decadal variability in water temperature appear to have shifted the fish community from a demersal- to a pelagic-dominated state (Choi et al. 2004).

With waters continuing to warm on a global scale, it is thought that the major western boundary current, the Gulf Stream, may weaken (Frank et al. 1990), resulting in fewer juvenile warm-water fishes being transported northward to temperate areas. It is also thought that the general fish assemblages of temperate estuaries may shift from more vertebrate (fish) to more invertebrate (crabs) species with increasing water temperatures (Wood et al. 2009). Collie et al. (2008) reported from 1959 to 2005 in Narragansett Bay and Rhode Island Sound that the coastal nekton community shifted progressively from vertebrates to invertebrates, and especially since 1980 from benthic to pelagic species. Demersal species (i.e., winter flounder, silver hake, and red hake) declined, while warm-water fishes (butterfish and scup) and invertebrates (American lobster, longfin inshore squid, and Atlantic rock and Jonah (*Cancer borealis*) crabs) increased with time. Triggered primarily by rising temperatures, a 1.6°C (2.9°F) increase over a 47-year period altered the trophic structure of the nekton community, resulting in a shift from benthic to pelagic consumers.

If species composition is largely driven by environmental forcing (e.g., SST and North Atlantic Oscillation [NAO]) and coastal temperatures continue to increase, it is likely that the fish community will continue to shift toward a more warm-water and pelagic community resembling those of more southern estuaries such as Chesapeake Bay and Delaware Bay, both south of Study Area (Collie et al. 2008). Rising water temperatures would favor a subtropical-tropical fauna over a temperate/boreal fauna (Oviatt 2004). Climate change-induced range shifts have been documented in the U.S. (Parker and Dixon 1998; Fodrie et al. 2010; Najjar et al. 2010) and in the northeastern Atlantic (Greenstreet and Hall 1996; Stebbing et al. 2002; Beare et al. 2004).

In conclusion, climate change has been implicated a major causes of fluctuations in marine fish diversity and abundance in both pelagic and demersal assemblages. Long-term changes in climate have also been related to changes in recruitment, growth, migration phenology, and depth and latitudinal distributions all of which will continue to be instrumental in affecting present and future fish populations and fisheries within the Study Area (Genner et al. 2010).

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# 9.0 SUMMARY OF RESULTS

This chapter provides a summary of the most relevant fish and fisheries resources within the Study Area. Important topics covered include commercial fisheries, recreational fishing, New Jersey Fisheries Independent Monitoring Data, EFH, and federally protected species.

## 9.1 COMMERCIAL FISHERIES

Fish and fisheries are among the most important and economically valuable natural resources to the State of New Jersey. In terms of economic value, the total value of commercial fisheries landed in New Jersey from 2003 through 2007 was nearly one billion dollars; however, the actual value to the region is likely far greater in terms of the jobs, goods, and services associated with these fisheries. In 2007, commercial fisheries in New Jersey ranked eighth in value and tenth in landings in the U.S.[2] The top five commercial species landed in New Jersey during this five year period were Atlantic surfclam, Atlantic sea scallop, ocean quahog, goosefish (monkfish), and summer flounder. Within the Study Area, the clam dredge, targeting Atlantic surfclam and ocean quahog, is the primary commercial fishing gear utilized in terms of value and landings (43%). The Atlantic surfclam is the primary landed commercial species, whereas the Atlantic sea scallop is the most economically valuable species.[2]

## 9.2 RECREATIONAL FISHING LOCATIONS

Recreational fishing within and adjacent to the Study Area is an important social and economic activity. The annual number of angler trips in New Jersey from 2003 through 2007 ranged from 6.5 million in 2004 to 7.4 million in 2007. According to NMFS (MRIP), the primary species landed from 2003 to 2007 was summer flounder. Summer flounder represented 40.8% of the total landings, while bluefish and black sea bass represented 18.9 and 18.2%, respectively.[9] There are numerous fishing hotspots (143 – see **Figure 3-19**) with 57% of these located in the southern half of the Study Area. These areas consist of structural features, such as shoals, ridges, lumps, banks, ship wrecks, and reefs (artificial and natural: rocks). Each of these structural features provides prime fishing sites for anglers targeting specific species, such as Atlantic striped bass and bluefish around shoals; bluefish and flounder near ridges; and black sea bass and tautog around shipwrecks/reefs (Saltwater Directions 2003a, 2003b, 2003c). In addition, the New Jersey Artificial Reef Program is one of the largest on the East Coast consisting of over 1,000 reefs and 100 vessels dispersed among 15 ocean sites of which 9 sites are located within the Study Area (NJDEP 2008b). Organized fishing tournaments are popular public events that take place within or in the vicinity of the Study Area.[12, 13, 14]

## 9.3 NEW JERSEY FISHERIES INDEPENDENT MONITORING DATA

The Study Area also provides important habitats to many juvenile fish and invertebrates having economic and ecological importance. Trends in these juvenile fish and invertebrate populations were analyzed by utilizing the ocean trawl data (New Jersey OSA survey program) from 2003 to 2008. New Jersey Fisheries independent monitoring program provided information on the spatial and temporal variability of the fish community in the Study Area (NJDEP 2009). Data was compiled and sorted into two separate groups according to landings (i.e., top 10 species numerically collected) and economic value (i.e., top 5 species [$US]). According to the New Jersey OSA defined strata (areas 15 to 23: see **Figure 4-1**), it was demonstrated that the coastal fishery landings within the Study Area that the juvenile butterfish, scup, squid, and Atlantic herring were numerically abundant and the squid was most economically valuable. Numerically, scup was the dominant fishery in 2003, squid in 2004 and 2005, and butterfish from 2006 to 2008. Economically, squid was dominant from 2003 to 2008. Summer and fall were the most important seasons in terms of relative juvenile fish abundance, while winter and spring the least important. Summer was dominated numerically by butterfish, spring and fall by Atlantic herring and scup, and winter by Atlantic herring, with squid economically dominating both summer and fall. Juvenile butterfish abundance was widely distributed and numerically dominant in 56% of OSA defined areas. In summer, butterfish abundance was highest in areas 16 and 19 and scup and squid abundance highest in areas 17 and 23, respectively. Atlantic herring abundance was highest in area 22. Economically, the squid abundance was highest in all areas in the summer except areas 18 and 21, which were the most diverse areas within the

Study Area (NJDEP 2009). These numerically dominated species encompassed locations which contained a large number of recreational fishing hotspots within the Study Area (see **Figure 4-11**).

### 9.4 ESSENTIAL FISH HABITAT

Marine resources (fish and invertebrates) that are found within the Study Area are managed through an elaborate process that includes the State of New Jersey, FMCs, ASMFC, and NMFS. The MSFMCA, as amended by the SFA, requires the identification and description of EFH in the FMPs and the consideration of actions to ensure the conservation and enhancement of such habitat. The EFH regulatory guidelines (50 Code of Federal Regulations [CFR] 600.815) state that NMFS should periodically review and revise EFH, as warranted, based on available information.

On June 12, 2009, NMFS announced the availability of a final integrated environmental impact statement (EIS) and Amendment 1 to the 2006 Consolidated Atlantic HMS FMP pursuant to the National Environmental Protection Act (NEPA) that amended the existing EFH identifications and descriptions for 44 managed (NMFS 2009a). Currently, 14 managed HMS species occur within the Study Area. Updated EFH descriptions and maps for all 14 species are described in **Appendix A** and illustrated in **Figures A-25** through **A-38**.

In addition to the updated EFH for the Atlantic HMS managed by NMFS, both the NEFMC and the MAFMC are also in the process of proposing changes to the EFH components of the FMPs under their jurisdiction (NEFMC 2007; MAFMC 2010). Approval of the updated textual descriptions and geographical identifications of EFH may result in changes to the EFH designations for some of the current species and/or add new (i.e., juvenile Atlantic sea scallop) species in the Study Area.

### 9.5 FEDERAL PROTECTED SPECIES

Within or near the vicinity of the Study Area, there are various fish species found that are either protected by the federal government (e.g., USFWS and NMFS) and/or State of New Jersey.[15,16] Although the endangered shortnose sturgeon is the only federally listed fish species that may be found in the vicinity of the Study Area (i.e., Delaware River), there are also no known shortnose sturgeon populations in the rivers between the Hudson and Delaware rivers (NMFS 1998). This species is not known to make coastal migrations (Dadswell et al. 1984). In addition, there are five species of concern and one candidate species found within or in the vicinity of the Study Area. The migratory Atlantic sturgeon, a candidate species, commonly aggregates in shallow (10 to 50 m [32.8 to 164.1 ft]) near shore areas within the Study Area (Stein et al. 2004; Atlantic Sturgeon Status Review Team 2007). NMFS is currently preparing a determination on whether listing the species or multiple DPSs of the Atlantic sturgeon as threatened or endangered is warranted (NMFS 2010b).

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# APPENDICES

## FISH AND FISHERIES STUDIES

# APPENDIX A

## ESSENTIAL FISH HABITAT DESCRIPTIONS AND FIGURES

The 40 federally managed species (23 temperate, 3 subtropical-tropical, and 14 highly migratory species [HMS]) and their designated Essential Fish Habitat (EFH) and/or Habitat Areas of Particular Concern (HAPC) found within the Study Area are described below. Specific EFH lifestages and/or HAPC found within the Study Area are highlighted in bold.

*Temperate Water Fish and Invertebrate Species*

- **Atlantic Cod (*Gadus morhua*)**

***Management***—Atlantic cod EFH is designated under Final Amendment #11 to the Northeast Multispecies Fisheries Management Plan (FMP) (NEFMC 1998). The Atlantic cod is managed as two separate stocks (Georges Bank and Gulf of Maine stocks) in U.S. waters (NEFMC 1998). The Georges Bank stock, whose southern distributional extent ranges into the Mid-Atlantic Bight (MAB), is the only stock that occurs within the Study Area (Mayo and O'Brien 2000).

***Status***—Both the Georges Bank and Gulf of Maine cod stocks are classified as overfished and overfishing is occurring (NMFS 2009d). The 2009 International Union for Conservation of Nature and Natural Resources (IUCN) Red List classifies Atlantic cod as vulnerable or facing a high risk of extinction.[1]

***Distribution***—The range of Atlantic cod extends to both sides of the northern Atlantic Ocean. In the western North Atlantic Ocean, this species is distributed from Greenland to Cape Hatteras, North Carolina (Fahay et al. 1999a).

***Habitat Associations***—Cod are a demersal (usually found within 2 m [6.6 ft] of the bottom) temperate species, which are found in waters ranging from 10 to 150 m (32.8 to 492.2 ft) off the northeastern U.S. coast. Cod prefer cobble or gravel shoals and water temperatures between 0°C and 10°C (32°F and 50°F) (NEFMC 1998; Klein-MacPhee 2002b). Adult cod are commonly found in deeper waters (600 m [1,968.6 ft]) (Cohen et al. 1990). Eggs are pelagic and larvae are found near the water surface moving to deeper waters with maturity (Fahay et al. 1999a; Klein-MacPhee 2002b; Lough 2004).

***Life History***—In the Study Area, cod are mostly non-migratory, but do undertake minor seasonal movements as water temperatures fluctuate. Cod typically move to the northern parts of their range as water temperatures warm in the summer and early fall (Cohen et al. 1990). Older fish also display vertical movements while searching for food (Klein-MacPhee 2002b). Spawning occurs on Georges Bank, in the Gulf of Maine, and over the inner half of the continental shelf off southern New England at night. Spawning occurs from November to April in waters with temperatures ranging from 0° to 12°C (32.0° to 53.6°F) and with depths of less than 50 m (164 ft) (Cohen et al. 1990; Fahay et al. 1999a).

***Forage Species***—Atlantic cod larvae feed on copepods, juveniles on crustaceans (sevenspine bay shrimp [*Crangon septemspinsoa*]), and adults primarily on fishes but also consume crustaceans and mollusks. Adult prey include: herring, sand lance (*Ammodytes* spp.), Atlantic mackerel, Atlantic rock crab (*Cancer irroratus*), longfin inshore squid, and northern shortfin squid (*Illex illecebrosus*) (Klein-MacPhee 2002b).

***EFH Designations***—(NEFMC 1998) (**Figure A-1**)

- Eggs—Designated EFH includes surface waters around the perimeter of the Gulf of Maine, Georges Bank, the eastern portion of the MAB continental shelf south to Long Island, New York, and within New England estuaries and embayments.

- Larvae—Designated EFH includes pelagic waters of the Gulf of Maine, Georges Bank, the eastern portion of the continental shelf off southern New England, and within southern New England estuaries and embayments.

- Juveniles—Designated EFH includes pelagic waters and bottom habitats with substrate of cobble or gravel in the Gulf of Maine, Georges Bank, MAB south to Long Island, New York, and within New England estuaries and embayments .

- **Adults**—Designated EFH includes bottom habitats with a substrate of rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, MAB south to the Delaware Bay, and within New England estuaries and embayments.

- Spawning Adults—Designated EFH includes bottom habitats with a substrate of smooth sand, rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, MAB south to the Delaware Bay, and within New England estuaries and embayments.

***HAPC Designations***—Areas designated as HAPC for this species are located north of the Study Area on the northern flank of Georges Bank (NEFMC 1998).

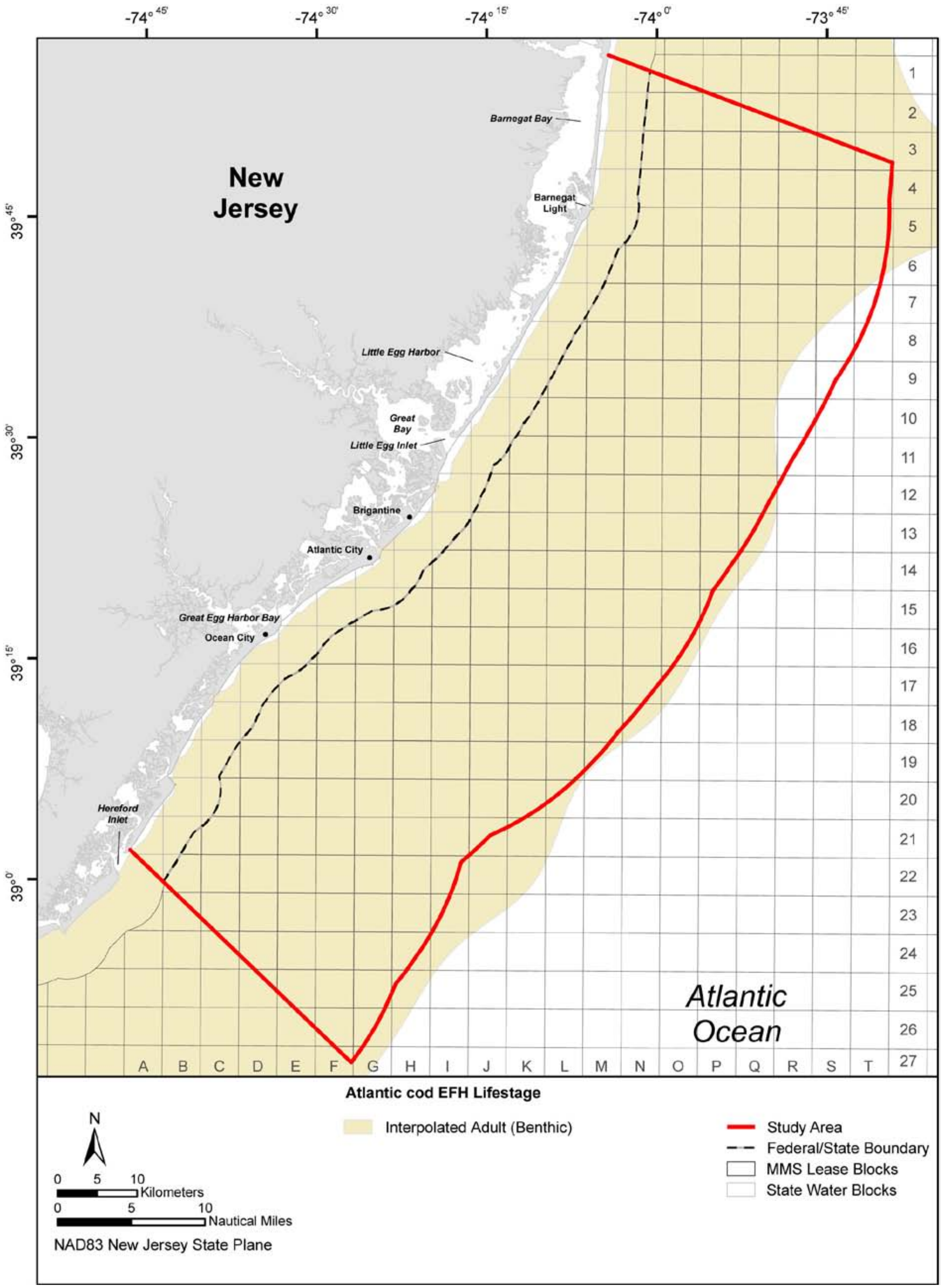


**Figure A-1. Essential fish habitat designated in the New Jersey Study Area for adult lifestage of Atlantic cod. Source map (scanned): NEFMC (1998).**

- **Atlantic Herring (*Clupea harengus*)**

***Management***—Atlantic herring EFH is designated by the New England Fishery Management Council (NEFMC) under the Atlantic Herring FMP (NEFMC 1998).

***Status***—Clupeids are among the most abundant and commercially important of the world's fishes. The Atlantic herring supports one the oldest and most important fisheries in the northwestern Atlantic (Overholtz 2000b). Atlantic herring are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Atlantic herring inhabits both sides of the North Atlantic Ocean in temperate and boreal waters (below 5°C [41°F]) (Munroe 2002). In the western North Atlantic Ocean, this species ranges from Labrador, Canada to Cape Hatteras, North Carolina (Overholtz 2000b).

***Habitat Associations***—Atlantic herring are a pelagic schooling species found at various depths depending on lifestage, season, and location. Eggs are demersal, adhesive, and deposited on a variety of benthic habitats including boulders, rocks, gravel, shell fragments, and on aquatic macrophytes typically in water depths ranging from 20 to 80 m (65.6 to 262.5 ft). Larvae are pelagic and either remain at or near spawning sites for extended periods (months) or are dispersed by local currents (Reid et al. 1999). Larvae prefer waters with temperatures ranging from 6° to 16°C (42.8° to 60.8°F), salinities of 32 practical salinity units (psu), and depths of 50 to 90 m (164 to 295 ft) (Reid et al. 1999). Juveniles have a preference for water temperatures below 10°C (50°F), a salinity range of 26 to 32 psu and depths of 15 to 135 m (49 to 443 ft). Adults typically are found in waters with temperatures below 10°C (50°F), depths of 20 to 130 m (65.6 to 426.5 ft), and salinities above 28 psu (NEFMC 1998; Stevenson and Scott 2005).

***Life History***—Atlantic herring spawn in well-mixed waters with tidal currents ranging from 2.8 to 5.6 kilometers per hour (kph; 1.7 to 3.5 miles per hour [mph]), temperatures below 15°C (59°F), depths of 20 to 90 m (66 to 295 ft), and a salinity range of 32 to 33 psu. Atlantic herring spawn over a variety of substrates including rocks, shells, pebbles, gravel, and clay (Reid et al. 1999; Munroe 2002). Spawning occurs from July to November in relatively shallow waters. Known spawning locations are southwestern Nova Scotia, Georges Bank/Nantucket Shoals, and the Gulf of Maine (Reid et al. 1999). Adult and juvenile herring undergo complex and extensive north-south and inshore-offshore migrations to spawn, feed, or overwinter. In addition, herring undertake diel vertical migrations in response to light intensity (Reid et al. 1999; Munroe 2002).

***Forage Species***—Atlantic herring are opportunistic filter feeders with larvae and juveniles preying primarily on zooplankton (copepods, cladocerns, and protozoans) and adults preying on crustaceans (euphausiids), mollusks, and chaetognaths (*Sagitta elegans*). This species feeds in the upper layers of the water with peak feeding activity occurring at dusk and dawn (Munroe 2002; Stevenson and Scott 2005).

***EFH Designations***—(NEFMC 1998) (**Figure A-2**)

- Eggs—Designated EFH includes bottom habitats with substrates of gravel, sand, cobble, and shell as well as aquatic macrophytes in the Gulf of Maine, Georges Bank, and New England estuaries and embayments.

- **Larvae**—Designated EFH includes pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, MAB south to New Jersey (approximately 40°N), and New England and mid-Atlantic estuaries and embayments.

- **Juveniles**—Designated EFH includes pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, MAB south to Cape Hatteras, North Carolina, and New England and mid-Atlantic estuaries and embayments including Barnegat Bay adjacent to the Study Area.

- **Adults**—Designated EFH includes the pelagic waters and bottom habitats from the Gulf of Maine, Georges Bank, MAB south to Cape Hatteras, North Carolina, and New England and mid-Atlantic estuaries and embayments including Barnegat Bay adjacent to the Study Area.

- **Spawning Adults**—Designated EFH includes bottom habitats with substrate consisting of gravel, sand, cobble, and shell fragments as well as aquatic macrophytes located in the Gulf of Maine, Georges Bank, MAB south to Cape Hatteras, North Carolina, and New England estuaries and embayments.

***HAPC Designations***—There are no HAPC identified for this species by the NEFMC. The Atlantic States Marine Fisheries Commission (ASMFC) has identified HAPC to include estuaries and embayments as important nursery grounds for juveniles.[2]

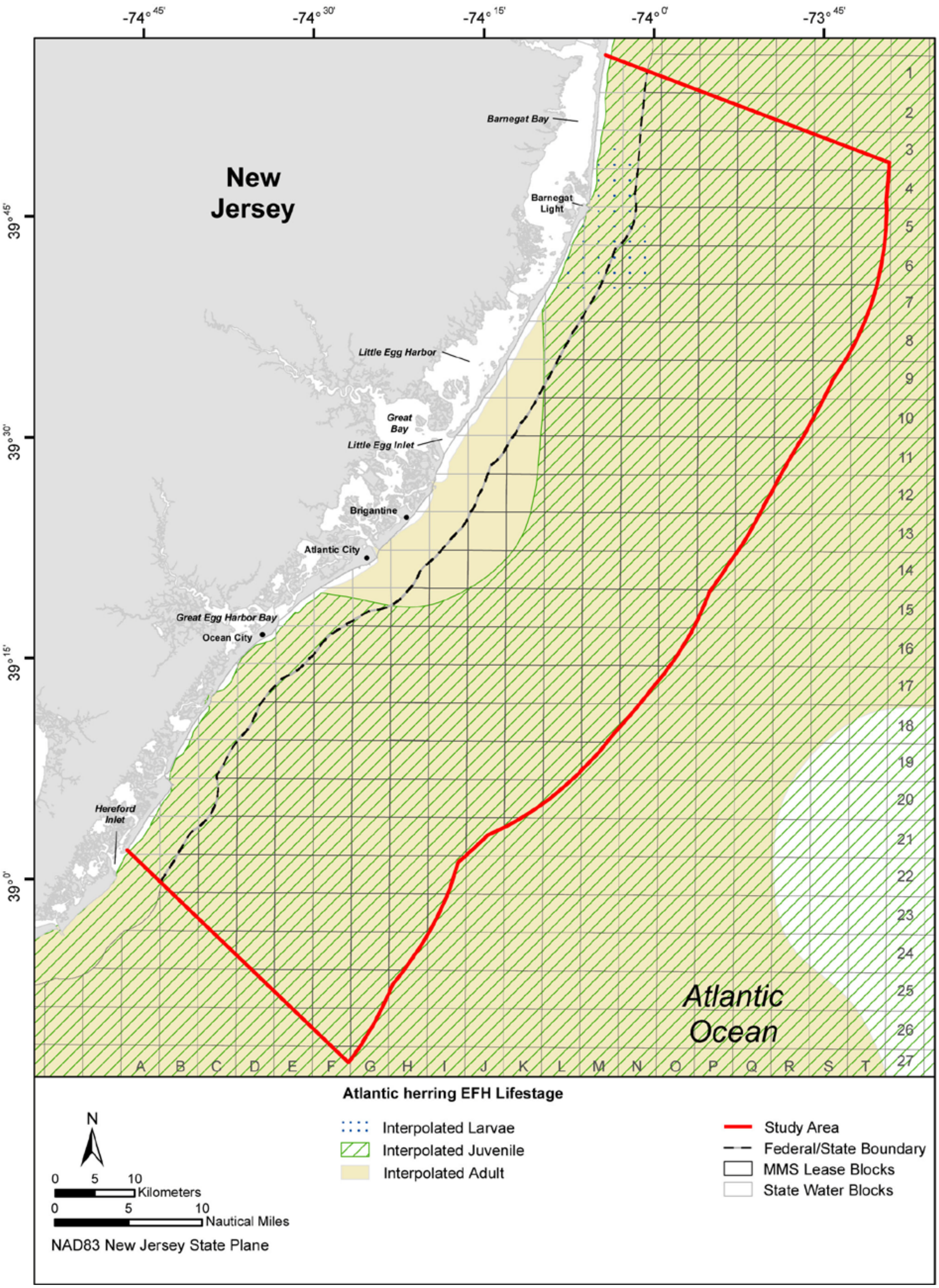


**Figure A-2. Essential fish habitat designated in the New Jersey Study Area for all lifestages of Atlantic herring. Source map (scanned): NEFMC (1998).**

- **Atlantic Mackerel *(Scomber scombrus)***

***Management***—The Middle Atlantic Fishery Management Council (MAFMC) designates EFH for the Atlantic mackerel through Amendment 8 to the Atlantic Mackerel, Squid, and Butterfish FMP (MAFMC 1998b).

***Status***—Atlantic mackerel are not classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Atlantic mackerel inhabits the North Atlantic Ocean, including the Baltic, Black, and Mediterranean seas. In the western North Atlantic Ocean, their distribution ranges from Black Island, Labrador, Canada to Cape Lookout, North Carolina (Collette 2002).

***Habitat Associations***—Atlantic mackerel are fast-swimming, pelagic schooling fish primarily found in the open sea but rarely occur beyond the continental shelf. Eggs are pelagic and have been collected from shore to a depth of 15 m (49.2 ft) in water temperatures between 5°C and 23°C (41.0°F and 73.4°F). Larvae are found at depths between 10 m and 130 m (49.0 ft and 426.5 ft) in water temperatures between 6°C and 22°C (42.8°F and 71.6°F). Atlantic mackerel juveniles are generally found from shore to a depth of 320 m (1,049.9 ft) and in water temperatures between 4°C and 22°C (39.2°F and 71.6°F). Adults inhabit waters from shore to 381 m (1,250 ft) and have a temperature preference range 4° to 16°C (39.2°F to 60.8°F) (Studholme et al. 1999). This species primarily inhabits open waters and does not depend directly on the coastline or bottom waters during any of its lifestages (Collette 2002). Adults overwinter in deeper waters between 70 m and 200 m (229.7 ft and 656.2 ft) (Collette 2002).

***Life History***—Atlantic mackerel are serial spawners (spawning in bursts or pulses more than once in a spawning season) and utilize inshore areas to spawn (Collette 2002). Spawning occurs from April to July, peaking in mid-April off the Chesapeake Bay and in May off New Jersey and Long Island, when water temperatures begin to warm and are between 9°C and 14°C (48.2°F and 57.2°F) (Studholme et al. 1999; Collette 2002). In the southern Gulf of St. Lawrence, spawning occurs from the end of May to mid-August (Overholtz 2000a; Collette 2002).

***Forage Species***—Atlantic mackerel are opportunistic feeders that prey upon small fauna such as copepods and ichthyoplankton as larvae, small crustaceans (amphipods, mysid shrimp, decapod larvae, and euphausiids) as juveniles, and shrimp and fishes (silver hake, sand lance, herring, hake [*Urophycis* and *Merluccius* spp], and sculpin [Cottidae]) as adults (Studholme et al. 1999; Collette 2002).

***EFH Designations***—(MAFMC 1998b) (**Figure A-3**)

- <u>Eggs</u>—Designated EFH includes the pelagic waters found over the continental shelf in areas that comprise the highest 75% of the catch where Atlantic mackerel eggs were collected during the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) ichthyoplankton surveys from the Gulf of Maine to Cape Hatteras, North Carolina. EFH is also designated within New England and mid-Atlantic estuaries and embayments.

- **<u>Larvae</u>**—Designated EFH includes the pelagic waters found over the continental shelf in areas that comprise the highest 75% of the catch where Atlantic mackerel larvae were collected in the MARMAP ichthyoplankton surveys from the Gulf of Maine to Cape Hatteras, North Carolina. EFH is also designated within New England and mid-Atlantic estuaries and embayments.

- <u>Juveniles</u>—Designated EFH includes the pelagic waters found over the continental shelf in areas that comprise the highest 75% of the catch where juvenile Atlantic mackerel were collected in the Northeastern Fisheries Science Center (NEFSC) trawl surveys, from the Gulf of Maine through Cape Hatteras, North Carolina. EFH is also designated within New England and mid-Atlantic estuaries and embayments.

- **<u>Adults</u>**—Designated EFH includes the pelagic waters found over the continental shelf; in areas that comprise the highest 75% of the catch where adult Atlantic mackerel were collected in NEFSC trawl surveys, from the Gulf of Maine to Cape Hatteras, North Carolina. EFH is also designated within New England and mid-Atlantic estuaries and embayments.

***HAPC Designations***—There are no HAPC identified for this species.

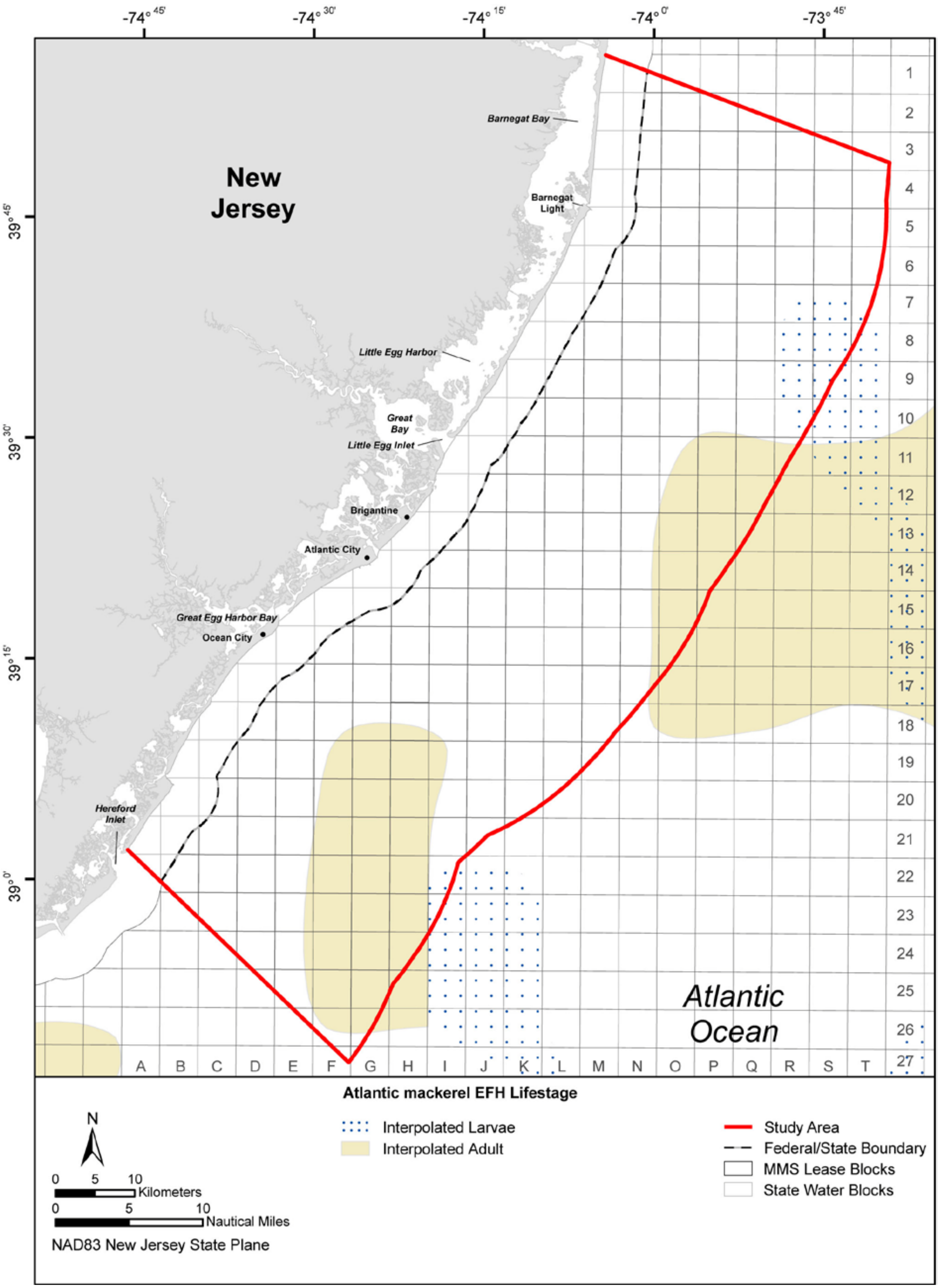


**Figure A-3. Essential fish habitat designated in the New Jersey Study Area for larval and adult lifestages of Atlantic mackerel. Source map (scanned): MAFMC (1998b).**

- **Atlantic Surfclam (*Spisula solidissima*)**

***Management***—Atlantic surfclam EFH is designated by the MAFMC under Amendment 12 to the Atlantic Surfclam and Ocean Quahog FMP of the MAFMC (1998a).

***Status***—Atlantic surfclam are not classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution—***Atlantic surfclam is distributed in the northwestern North Atlantic Ocean continental shelf waters from the southern Gulf of St. Lawrence, Canada to Cape Hatteras, North Carolina (Cargnelli et al. 1999b). Aggregations of this species are found on Georges Bank, south of Cape Cod, Massachusetts, off Long Island, New York, and southern New Jersey, and off the Delmarva Peninsula (Delaware Bay to the Chesapeake Bay) (Cargnelli et al. 1999b).

***Habitat Associations***—Eggs and larvae are dispersed by currents and settlement corresponds with the relaxation of upwelling events (Cargnelli et al. 1999b). Off New Jersey, high concentrations of Atlantic surfclam larvae is characterized by the initial arrival of warmer water during the episodic summer upwelling/downwelling events (Ma 2005; Ma et al. 2006b). Juvenile and adult lifestages are benthic and are found in sandy substrates at depths from 8 to 66 m (26.0 to 216.5 ft) (Cargnelli et al. 1999b).

***Life History***—Atlantic surfclams spawn inshore in late June and July and offshore in early fall usually in waters with temperatures warmer than 15°C (59°F) (Cargnelli et al. 1999b; Ma et al. 2006a). In Virginia, spawning occurs from May to the end in July (Cargnelli et al. 1999b). Atlantic surfclams are sedentary and do not migrate or exhibit seasonal movements (Ropes et al. 1982).

***Forage Species***—Atlantic surfclams are opportunistic filter feeders that as juveniles and adults feed upon plankton as small as four microns (μm; 157.5 microinches [μ in.]) in diameter (ciliates and diatoms) (Cargnelli et al. 1999b).

***EFH Designations***—(MAFMC 1998a) (**Figure A-4**)

- **Juveniles and Adults**—Designated EFH includes substrates (to a depth of 1 m [3.3 ft] below the water-sediment interface) that encompass the highest 90% of catch during the NEFSC surflclam dredge surveys, from the eastern edge of Georges Bank and Gulf of Maine through Cape Hatteras, North Carolina.

***HAPC Designations***—There are no HAPC identified for this species.

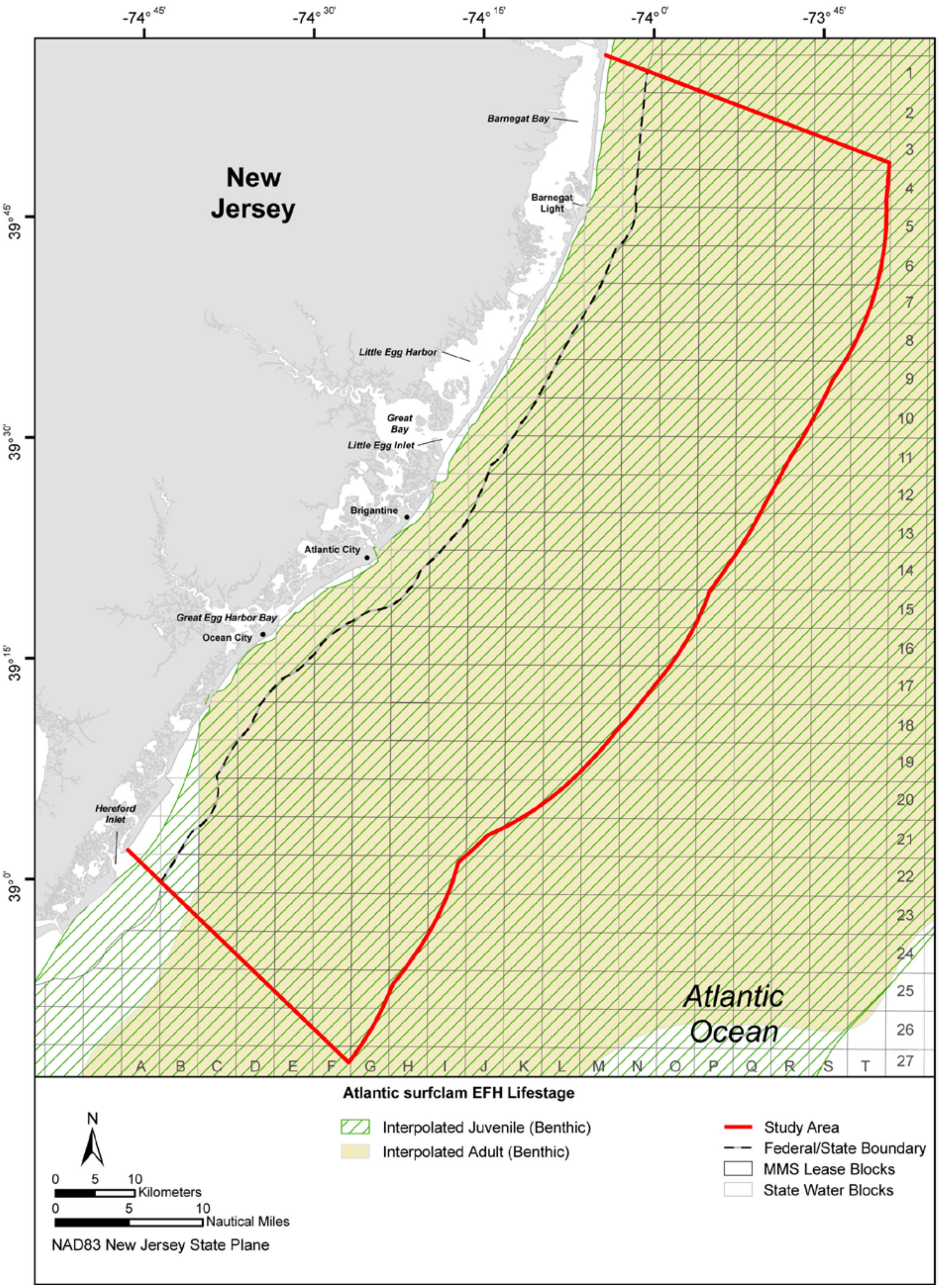


**Figure A-4. Essential fish habitat designated in the New Jersey Study Area for all lifestages of the Atlantic surfclam. Source map (scanned): MAFMC (1998a).**

- **Black Sea Bass (*Centropristis striata*)**

***Management***—Atlantic black sea bass are managed as two separate stocks divided north and south of Cape Hatteras, North Carolina. The northern stock has EFH designated by the MAFMC under Amendment 12 to the Summer Flounder, Scup, and Black Sea Bass FMP (MAFMC and ASMFC 1998b). The southern black sea bass stock, which occurs between Cape Hatteras, North Carolina and Cape Kennedy, Florida, is managed by the South Atlantic Fishery Management Council (SAFMC) and does not have EFH designated in the Study Area (SAFMC 1998).

***Status***—The northern black sea bass stock is not classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Black sea bass are found from southern Nova Scotia and Bay of Fundy, Canada to Cape Canaveral, Florida, and in the Gulf of Mexico (Steimle et al. 1999c; Klein-MacPhee 2002f).

***Habitat Associations***—Black sea bass are usually found in deeper waters (up to 165 m [541 ft]) associated with structured habitats such as artificial reefs and shipwrecks on the continental shelf (Musick and Mercer 1977; Steimle et al. 1999c; Klein-MacPhee 2002f). Black sea bass also associate with multispecies fish assemblage that include scup and summer flounder (Steimle et al. 1999c; Klein-MacPhee 2002f). Adults and juveniles are common in estuaries with salinities greater than 12 psu (Klein-MacPhee 2002f). When inshore, black sea bass prefer hard bottom habitats around wrecks, while offshore they prefer ledges, banks, rocks, and coral habitats (Klein-MacPhee 2002f). Eggs are buoyant and found on the continental shelf from May to October, while larvae move to estuarine habitat, between New York and Virginia, to metamorphosize into juveniles. Larvae are initially benthic, but then become demersal and utilize structured inshore habitats such as sponge beds (MAFMC and ASMFC 1998b). Juveniles and adults usually prefer waters warmer than 6°C (42.8°F) (MAFMC and ASMFC 1998b; Drohan et al. 2007).

***Life History***—Black sea bass from the northern stock seasonally migrate from inshore to offshore, typically traveling in small schools depending on water temperatures (Klein-MacPhee 2002f). As coastal waters cool below 14°C (57.2°F) in the fall, black sea bass migrate south and offshore to overwintering areas in deeper waters between central New Jersey and North Carolina (Musick and Mercer 1977; Moser and Shepherd 2009). In the spring, as bottom waters warm above 7°C (44.6°F), black sea bass then migrate inshore into coastal shallow areas and bays in the MAB (Drohan et al. 2007). The southern stock of black sea bass is not known to make an extensive migration but may move away from shallow coastal areas during cold winters, especially in the Carolinas (Steimle et al. 1999c; Klein-MacPhee 2002f). The northern stock spawns on the continental shelf from May through October, peaking in June at depths from 18 to 45 m (59 to 148 ft), while the southern stock spawns in April and May (Musick and Mercer 1977; Klein-MacPhee 2002f).

***Forage Species***—Black sea bass larvae prey upon zooplankton, juveniles on crustaceans (lobster and crabs), and adults on mollusks (clams), worms, and small fishes (anchovy [Engraulidae], herring [Clupeidae], seahorse, pipefish [Syngnathidae], cusk-eel [Ophidiidae], scup, sand lance, and windowpane flounder) (Steimle et al. 1999c; Klein-MacPhee 2002f). Feeding activities increase after periods of spawning (Steimle et al. 1999c).

***EFH Designations***—(MAFMC and ASMFC 1998b) (**Figure A-5**)

- <u>Eggs</u>—Designated EFH includes mid-Atlantic estuaries.

- **<u>Larvae</u>**—Designated EFH includes the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) in areas that encompass the highest 90% of the area where black sea bass larvae were collected in MARMAP surveys (Gulf of Maine to Cape Hatteras, North Carolina). EFH is also designated within New England and mid-Atlantic estuaries.

- **Juveniles**—Designated EFH includes the demersal waters over the continental shelf (from the coast out to the limits of the EEZ) in areas that encompass the highest 90% of the area where black sea bass juveniles were collected by the NEFSC surveys (Gulf of Maine to Cape Hatteras, North Carolina). EFH is also designated within New England and mid-Atlantic estuaries including, Barnegat Bay and the New Jersey Inland Bays adjacent to the Study Area.

- **Adults**—Designated EFH includes the demersal waters over the continental shelf (from the coast out to the limits of the EEZ) in areas that encompass the highest 90% of all the area where black sea bass adults were collected by NEFSC surveys (Gulf of Maine to Cape Hatteras, North Carolina). EFH is also designated within New England and mid-Atlantic estuaries including Barnegat Bay and the New Jersey Inland Bays adjacent to the Study Area.

***HAPC Designations***—There are no HAPC identified for this species.

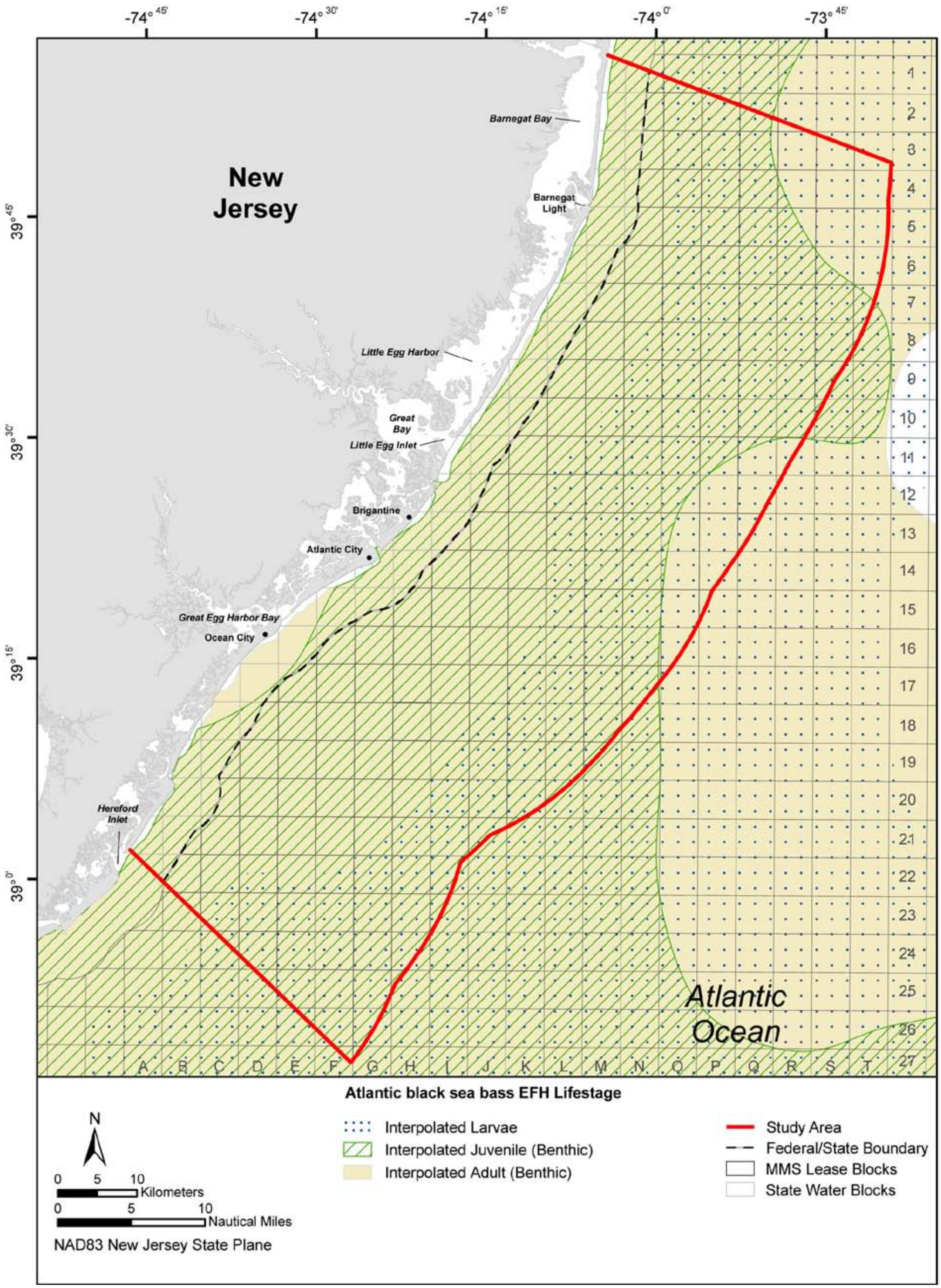


**Figure A-5. Essential fish habitat designated in the New Jersey Study Area for all lifestages of black sea bass. Source map (scanned): MAFMC and ASMFC (1998a).**

- **Bluefish (*Pomatomus saltatrix*)**

***Management***—East coast bluefish are managed as a single stock, with EFH designated under Amendment 1 to the Bluefish FMP developed by the MAFMC and the ASMFC (1998a).

***Status***—Bluefish are not classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Bluefish are a schooling species found in most oceans of the world, except the eastern Pacific Ocean. This species lives in the waters over the continental shelf but may be found in brackish estuaries and nearshore waters (Klein-MacPhee 2002g). In the western Atlantic, bluefish range from Nova Scotia and Bermuda to Argentina, but is considered rare between southern Florida and northern South America (Fahay et al. 1999b).

***Habitat Associations***—Bluefish are a warm-water pelagic species that rarely are found in temperatures below 14°C (57.2°F). The species is found inshore in bays, beaches, and coastal habitats as well as offshore (Klein-MacPhee 2002g). Bluefish eggs and larvae are pelagic and are typically found in waters with temperatures above 18°C (64.4°F) and salinities greater than 30 psu between April and August (MAFMC and ASMFC 1998a). Similar to other offshore spawning species, larvae are transported from spawning grounds to nursery habitats via the Gulf Stream Current (Hare and Cowen 1996). Juveniles utilize estuarine habitat in the MAB in two distinct episodes: spring-spawned cohort (late May to June) and summer-spawned cohort (July to October) (Shepherd et al. 2006). There is recent evidence that select cohorts may exclusively use alternative habitats, such as ocean beaches, during the juvenile stage (Able et al. 2003; Wilber et al. 2003) and that at least two cohorts of presumably summer-spawned fish (larvae and juveniles) may not recruit to estuaries (Taylor et al. 2007). Adult bluefish utilize offshore and estuarine habitats with water temperatures above 16°C (60.8°F) (Fahay et al. 1999b). Adults are typically found in MAB estuaries from April to October (MAFMC and ASMFC 1998a; Shepherd and Packer 2006).

***Life History***—Adult bluefish are known to seasonally migrate generally following one of three patterns: north-south (between northern MAB and Florida and within MAB) and inshore-offshore (Florida) (Shepherd et al. 2006). Bluefish move north during the spring through summer and southward and offshore during the fall and winter, when their highest abundance is found off New York and coastal southern New England (Klein-MacPhee 2002g). Bluefish overwinter in the South Atlantic Bight (SAB), between Florida and the Gulf Stream or at the edge of the continental shelf in the MAB (Shepherd et al. 2006). Fluctuations in light levels and water temperature are the primary triggers for migrational movements, but offshore and inshore migrations occur because of prey availability (Klein-MacPhee 2002g). There are two discrete spawning events for western Atlantic bluefish: 1) a spring spawning event occurs near the edge of the continental shelf in the SAB during March through May and 2) a summer spawning event occurs over the mid-continental shelf in the MAB between June and August in waters with temperatures between 18°C and 25°C (64.4°F and 77°F) and salinities from 25 to 31 psu (Fahay et al. 1999b; Klein-MacPhee 2002g).

***Forage Species***—Bluefish are piscivorous with juveniles and adults feeding on a variety of fish species including Atlantic menhaden (*Brevoortia tyrannus*), herring, alewife (*Alosa pseudoharengus*), anchovy, eel (Anguilliformes), sculpin, killifish (Cyprinodontiforms), silverside (Atherinopsidae), croaker (Sciaenidae), scup, goby (Gobiidae), sand lance, butterfish, and mackerel (Scombridae). This species also feeds on invertebrates (shrimp, squid, crabs, polychaetes, and worms) (Fahay et al. 1999b; Klein-MacPhee 2002g).

***EFH Designations***—(MAFMC and ASMFC 1998a) (**Figure A-6**)

- **Eggs**—Designated EFH includes the pelagic waters located within the mid-shelf depths of the continental shelf (from the coast out to the limits of the EEZ) in areas that encompass the highest 90% of the area where bluefish eggs were collected by MARMAP surveys (Montauk Point, New York, south to Cape Hatteras, North Carolina). Designated EFH also includes the pelagic waters between Cape Hatteras, North Carolina, and Key West, Florida.

- **Larvae**—Designated EFH includes the pelagic waters (most commonly above 15 m [49.2 ft]) over the continental shelf (from the coast out to the limits of the EEZ) that encompass the highest 90% of the area where bluefish larvae were collected by MARMAP surveys (Montauk Point, New York, south to Cape Hatteras, North Carolina). Designated EFH also includes the “Slope Sea” (oceanic area located between the continental shelf and north wall of the Gulf Stream) and Gulf Stream Current between latitudes 29°N and 40°N to the limits of the U.S. EEZ. Additional EFH includes the waters south of Cape Hatteras, North Carolina, to Key West, Florida.

- **Juveniles**—Designated EFH includes the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) in areas that encompass the highest 90% of the area where bluefish juveniles were collected by NEFSC trawl surveys (from Nantucket Island, Massachusetts, south to Cape Hatteras, North Carolina). Designated EFH also includes the “Slope Sea” (oceanic area located between the continental shelf and north wall of the Gulf Stream) and the Gulf Stream Current between latitudes 29°N and 40°N to the U.S. Additional designated EFH includes the waters south of Cape Hatteras, North Carolina, to Key West, Florida as well as all north Atlantic, mid-Atlantic, and southeast Atlantic estuaries.

- **Adults**—Designated EFH includes the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) in areas that encompass the highest 90% of all the area where bluefish adults were collected by the NEFSC trawl surveys (from Cape Cod Bay, Massachusetts, south to Cape Hatteras, North Carolina). Additional designated EFH includes the waters from Cape Hatteras, North Carolina to Key West, Florida as well as all north Atlantic, mid-Atlantic, and southeast Atlantic estuaries.

***HAPC Designations***—There are no HAPC identified for this species by the MAFMC. The ASMFC has identified HAPC to include inshore areas and estuaries as important habitats for larvae and juveniles.[2]

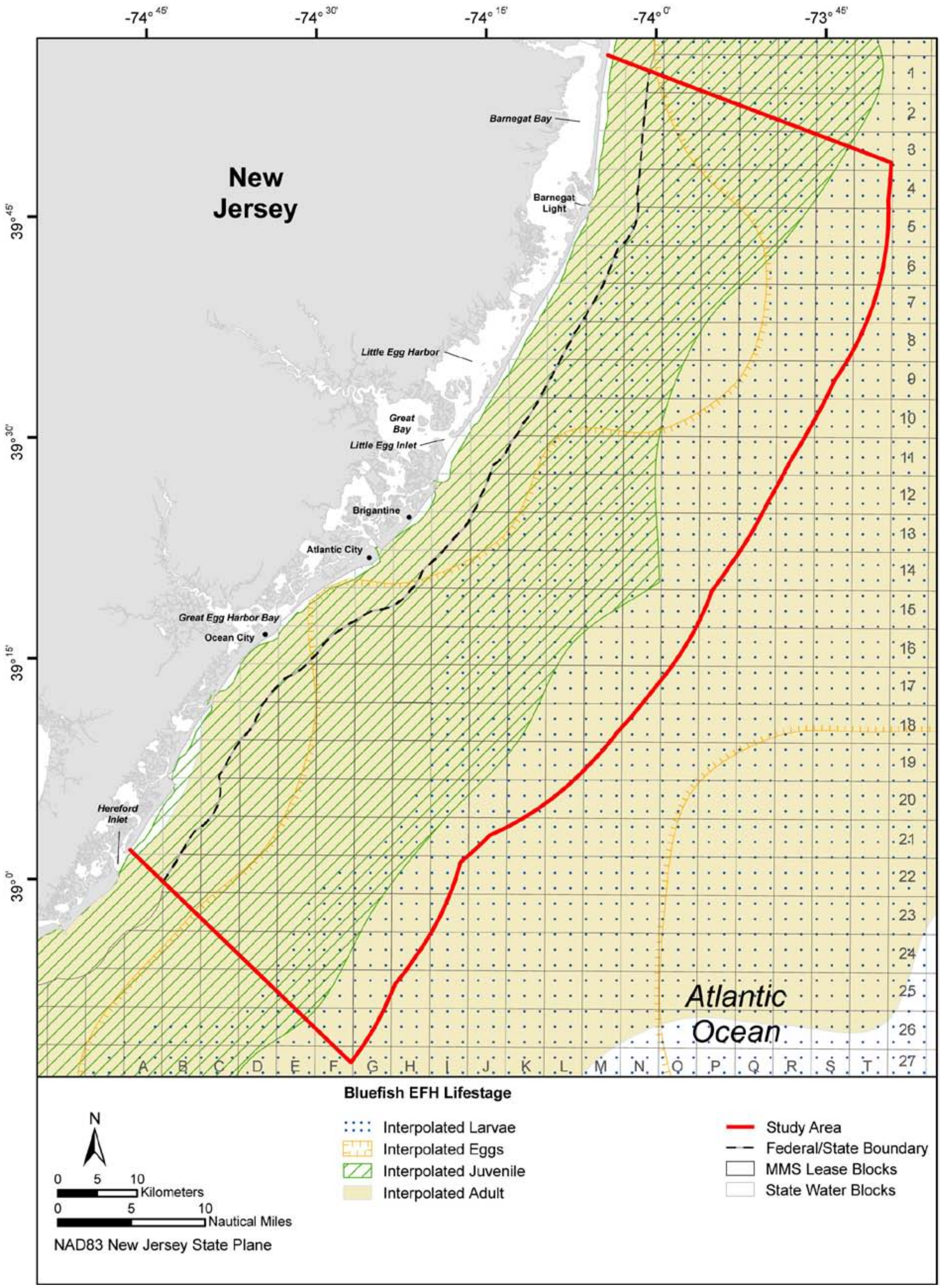


**Figure A-6. Essential fish habitat designated in the New Jersey Study Area for all lifestages of bluefish. Source map (scanned): MAFMC and ASMFC (1998b).**

♦ **Butterfish (*Peprilus triacanthus*)**

***Management***—Butterfish have EFH designated under Amendment 8 to the Atlantic Mackerel, Squid, and Butterfish FMP by the MAFMC (1998b).

***Status***—Butterfish are classified as overfished; however, overfishing is not occurring (NMFS 2009d).[3]

**Distribution**—In the western North Atlantic Ocean, butterfish range from the Gulf of St. Lawrence and the southern coast of Newfoundland, Canada to deeper waters off Florida. The species is common between Nova Scotia, Canada, and Cape Hatteras, North Carolina (Colton 1972; Klein-MacPhee 2002h).

***Habitat Associations***—All lifestages of the butterfish are common from the outer continental shelf to the lower, high salinity portions of bays and estuaries. Butterfish eggs are buoyant and pelagic and found throughout June and August (Waring and Murawski 1982; Klein-MacPhee 2002h). Eggs are generally found in surface waters with temperatures ranging from 6° to 26°C (42.8° to 78.8°F), salinities of 25 to 33 psu, and depths of 10 to 1,250 m (33 to 4,101 ft; most common in water of <200 m [656 ft]) (Cross et al. 1999). As larval butterfish develop, they become more nektonic (i.e., able to actively swim) than planktonic (i.e., passively floating) (Cross et al. 1999). Larval butterfish are often associated with large jellyfish and *Sargassum* and other flotsam (Waring and Murawski 1982; Cross et al. 1999; Klein-MacPhee 2002h). Larvae are found from April to December at temperatures between 4.4°C and 27.9°C (40°F and 82°F), salinities of 6.4 to 37.4 psu, and depths of 10 to 1,750 m (33.0 to 5,741.2 ft); most found in water <120 m [394 ft]) (Waring and Murawski 1982; Cross et al. 1999). As juveniles, butterfish depart shelters and begin schooling (Klein-MacPhee 2002h). They are found in a variety of areas, habitats, and conditions over sandy and muddy substrates, temperatures from 4.4° to 29.7°C (40.0° to 85.5°F), salinities from 3 to 37.4 psu, and depths from 10 to 330 m (33 to 1,083 ft; most often found in <120 m [394 ft]) (Cross et al. 1999). Adult schools are found throughout the water column from surface waters to deep waters (420 m [1,378 ft]). They are found in a variety of benthic bottoms including sand, sand-silt, and mud substrates (Cross et al. 1999). They are eurythermal and euryhaline, tolerating temperatures from 4.4° to 29.7°C (40.0° to 85.5°F) and salinities from 3.8 to 33 psu (Cross et al. 1999; Klein-MacPhee 2002h).

***Life History***—Butterfish are broadcast spawners (Klein-MacPhee 2002h). Spawning occurs in nearshore waters of the MAB and SAB annually from late January to July (Rotunno and Cowen 1997). Butterfish are sensitive to temperature; spawning does not occur in waters less than 15°C (59°F) (Colton 1972). Butterfish north of Cape Hatteras, North Carolina, undergo seasonal migrations when water temperature changes with the season. In general, butterfish move northward and inshore in the summer and southward and offshore during the winter (Klein-MacPhee 2002h).

***Forage Species***—Butterfish juveniles and adults feed on a variety of invertebrates but primarily on tunicates, sea squirts, salps, and sea angels as well as small fish (Cross et al. 1999; Klein-MacPhee 2002h).

***EFH Designations***—(MAFMC 1998b) (**Figure A-7**)

- Eggs—Designated EFH includes the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) in areas that encompass the highest 75% of the area where butterfish eggs were collected by the MARMAP surveys (from the Gulf of Maine through Cape Hatteras, North Carolina). EFH is also designated within New England and mid-Atlantic estuaries.

- Larvae—Designated EFH includes the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) in areas that encompass the highest 75% of the area where butterfish larvae were collected by the NEFSC trawl surveys (from the Gulf of Maine through Cape Hatteras, North Carolina). EFH is also designated within New England and mid-Atlantic estuaries.

- **Juveniles**—Designated EFH includes the pelagic waters found over the continental shelf (from the coast out to the limits of EEZ) in areas that encompass the highest 75% of the area where butterfish juveniles were collected by NEFSC trawl surveys (shelf from the Gulf of Maine through Cape Hatteras, North Carolina). EFH is also designated in New England and mid-Atlantic estuaries including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- Adults—Designated EFH includes the pelagic waters found over the continental shelf (from the coast out to limits of EEZ) in areas that encompass the highest 75% of the area where butterfish adults were collected by the NEFSC trawl surveys (from the Gulf of Maine through Cape Hatteras, North Carolina). EFH is also designated within New England and mid-Atlantic.

***HAPC Designations***—There are no HAPC identified for this species.

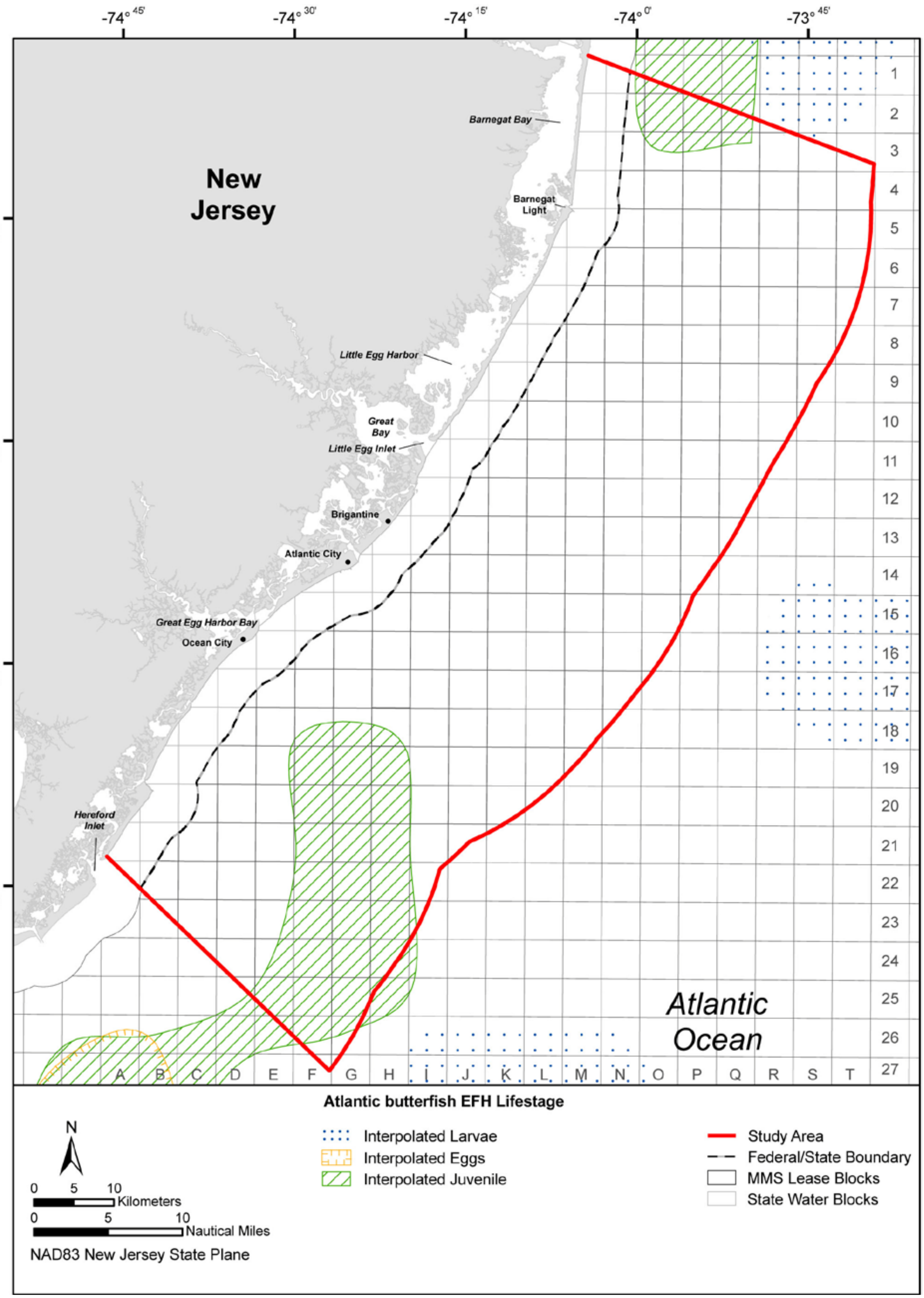


**Figure A-7. Essential fish habitat designated in the New Jersey Study Area for larvae and juvenile lifestages of butterfish. Source map (scanned): MAFMC (1998b).**

- **Clearnose Skate (*Raja eglanteria*)**

***Management***—Clearnose skate have EFH designated under the NEFMC Final FMP for the Northeast (NE) Skate Complex (NEFMC 2003a).

***Status***—Clearnose skate are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Clearnose skate are found along the eastern U.S. coast from the Nova Scotia Shelf to northeastern Florida; including the northern Gulf of Mexico (northwestern Florida to Texas) (McEachran and Musick 1975). In the western North Atlantic Ocean, clearnose skate are mostly found south of Cape Hatteras, North Carolina, but can also be found north of Cape Hatteras, North Carolina, during warmer months (McEachran and Musick 1975).

***Habitat Associations***—Clearnose skate are a demersal species that prefers mud and sand substrates along the continental shelf, but can also be found on rocky or gravel bottoms (Packer et al. 2003a). The species is found from shallow inshore waters out to depths of 330 m (1,049.9 ft); however, it is most abundant at depths less than 111 m (364 ft) (McEachran and Musick 1975; McEachran 2002). Juveniles and adults inhabit waters with temperatures ranging from 9° to 30°C (48.2° to 86.0°F) (Packer et al. 2003a).

***Life History***—Limited information is available regarding the species' spawning habitat; however, in Delaware Bay, incubation time for the egg capsules (known as "mermaid's purses") had been reported to be approximately three months, with spawning occurring in the spring (McEachran 2002; Packer et al. 2003a). As water temperatures begin to cool, individuals north of Cape Hatteras, North Carolina, move offshore and southward, while those south of Cape Hatteras do not usually move to deeper waters during the winter since water temperatures do not significantly fluctuate (McEachran and Musick 1975).

***Forage Species***—Clearnose skate juveniles and adults feed on a variety of invertebrate (shrimp, amphipods, mollusks, and squid) and fish species (anchovy, croaker, spot [*Leiostomus xanthurus*], tonguefish [*Symphurus* spp.], weakfish [*Cynoscion regalis*], and butterfish), with crabs being the primary component of their diet (McEachran 2002; Packer et al. 2003a).

***EFH Designations***—(NEFMC 2003a) (**Figure A-8**)

- Eggs—There is no information available on the offshore habitat association or distributions of the egg stage for this species. The following embayments and estuaries are designated as EFH for this lifestage: Hudson River/Raritan Bay and the Chesapeake Bay north and south of the Study Area.

- Larvae—No larval stage exists for this species. Upon hatching, they are fully developed juveniles.

- **Juveniles**—Designated EFH includes bottom habitats with substrates consisting of soft bottom along the continental shelf and rock or gravel bottom from the Gulf of Maine south along the continental shelf to Cape Hatteras, North Carolina. The following embayments and estuaries are designated as EFH: Hudson River/Raritan Bay and the Chesapeake Bay north and south of the Study Area.

- **Adults**—Designated EFH includes bottom habitats with a substrate of soft bottom along the continental shelf and rock or gravel bottom from the Gulf of Maine south along the continental shelf to Cape Hatteras, North Carolina. Various mid-Atlantic embayments and estuaries are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- Spawning A dults—Designated EFH includes the following estuaries and embayments: the Hudson River and Raritan Bay north of the Study Area.

***HAPC Designations***—There are no HAPC identified for this species.

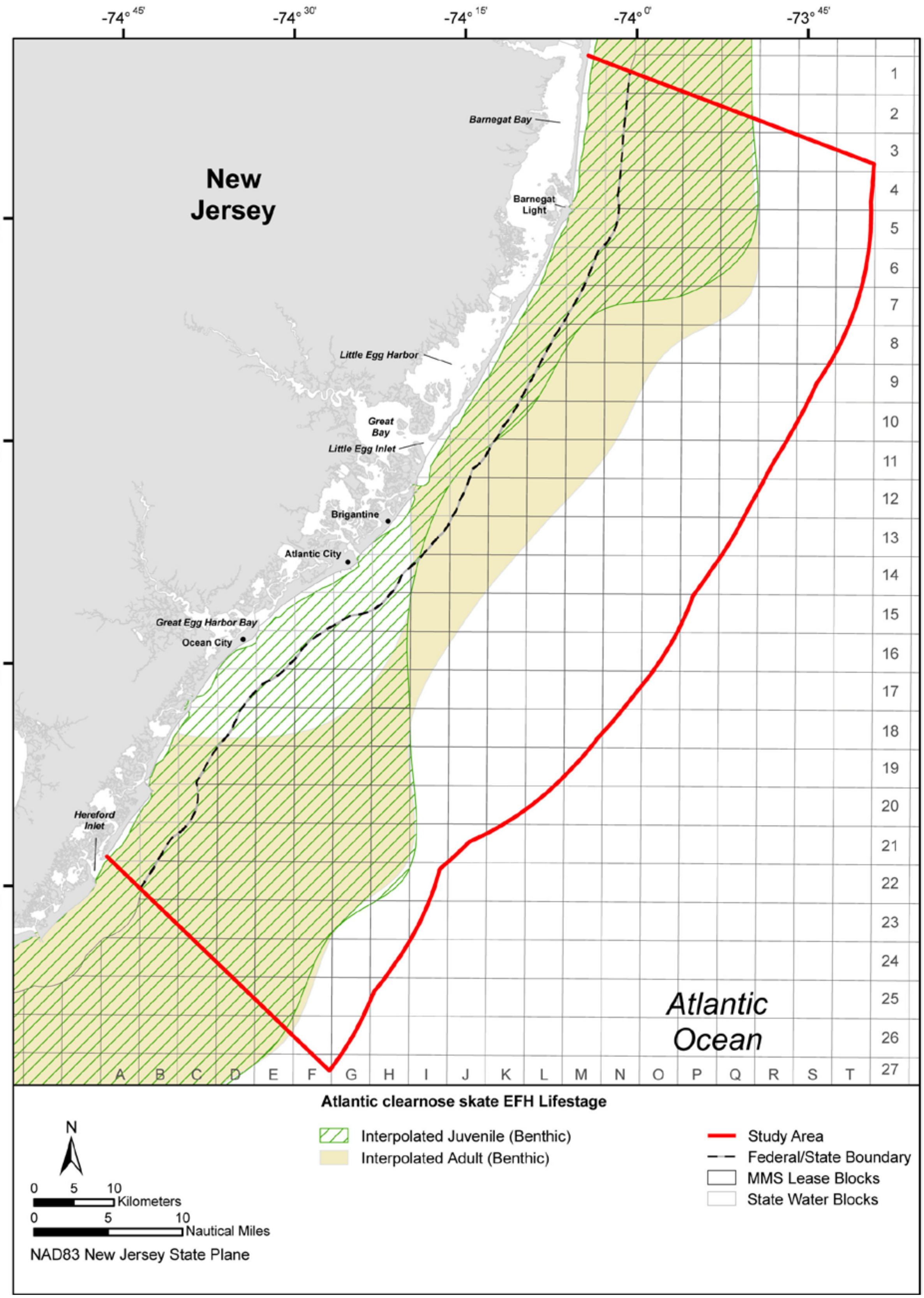


**Figure A-8. Essential fish habitat designated in the New Jersey Study Area for all lifestages of clearnose skate. Source map (scanned): NEFMC (2003a).**

♦ **Goosefish/Monkfish (*Lophius americanus*)**

***Management***—Goosefish currently have EFH designated under Amendment 1 to the Monkfish FMP and are separated into two stocks for management purposes (NEFMC 1998). The northern stock inhabits the Gulf of Maine and the northern Georges Bank. The southern stock ranges from southern Georges Bank to Cape Hatteras, North Carolina (Almeida et al. 1995; Richards 2000).

***Status***—Goosefish stock is neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Goosefish range from the Gulf of St. Lawrence and Newfoundland, Canada to the east coast of Florida; however, they are uncommon south of Cape Hatteras, North Carolina (Wood 1982; Caruso 2002).

***Habitat Associations***—Goosefish release their eggs in long mucous veils that float at the surface exposing them to currents, wind, and waves (Wood 1982; Steimle et al. 1999a; Caruso 2002). Eggs are found inshore and offshore on the continental shelf from March to September in waters with temperatures ranging from 4° to 18°C (39.2° to 64.4°F) (Wood 1982; Steimle et al. 1999a). Larval goosefish are pelagic and found across the continental shelf at water temperatures ranging from 10° to 16°C (50.0° to 60.8°F) and depths of 30 to 90 m (98.5 to 295.0 ft) (Steimle et al. 1999a). After transition from larval to juvenile, goosefish become benthic. Juveniles are found in bottom habitats at temperatures of 3° to 19°C (37.4° to 66.2°F), salinities of 32.6 to 33.9 psu, and at depths of 25 to 182 m (82 to 597 ft) (Steimle et al. 1999a). Adult goosefish prefer hard sand, gravel and broken shell, pebble, and soft mud substrates at depths from just below the tide line to at least 900 m (2,952.9 ft), although large adults rarely occur below 400 m (1,312 ft) (Markle and Musick 1974; Almeida et al. 1995; Caruso 2002). They also prefer temperatures ranging from 0° to 24°C (32.0° to 75.2°F) and salinities of 30 to 36 psu (Almeida et al. 1995; Steimle et al. 1999a).

***Life History***—Goosefish spawn between spring and early fall, depending on latitude (Wood 1982). Spawning occurs from March to May off North Carolina, between May and June in the Gulf of Maine, and as late as September off Maine and in Canadian waters (Steimle et al. 1999a; Caruso 2002). Spawning occurs across the continental shelf throughout its range (Caruso 2002). Goosefish migrate inshore and offshore seasonally depending on the water temperatures. Larger goosefish (>20 cm [7.87 in.]) in the Gulf of Maine move offshore in the winter and spring to avoid cold coastal conditions, and return inshore as the coastal waters warm in the summer and fall (Steimle et al. 1999a). Conversely, smaller goosefish (<20 cm [7.87 in.]) in the Gulf of Maine and along the MAB remain inshore during the winter and spring and then move offshore during the summer and fall, presumably to avoid overly warm summer conditions (Wood 1982; Almeida et al. 1995; Steimle et al. 1999a). Richards et al. (2008) recently described an apparent northward or deep-water (>365 m [1,197.6 ft]) excursion from the southern MAB in mid-spring which had not been reported previously.

***Forage Species***—Goosefish larvae feed on zooplankton and juveniles on zooplankton, mollusks, and fish. Adults consume benthic prey, such as bony fishes (silver hake, red hake, American plaice [*Hippoglossaides platessoides*], little skate, sand lance, and herring species), cephalopods (squid), and elasmobranchs. They have also been recorded to feed on various seabird species (Bowman et al. 2000). This species uses its angling apparatus (modified first dorsal spine) to lure small fishes (Caruso 2002).

***EFH Designations***—(NEFMC 1998) (**Figure A-9**)

- **Eggs**—Designated EFH includes the surface waters from the Gulf of Maine, Georges Bank, and MAB south to Cape Hatteras, North Carolina.

- **Larvae**—Designated EFH includes the pelagic waters from the Gulf of Maine, Georges Bank, and MAB south to Cape Hatteras, North Carolina.

- **Juveniles**—Designated EFH includes bottom habitats that are a sand-shell mix, algae-covered rocks, hard sand, pebbly gravel, or mud from the outer continental shelf of the MAB south to Cape Hatteras, North Carolina, and all bottom areas of the Gulf of Maine.

- Adults—Designated EFH includes bottom habitats that are a sand-shell mix, algae-covered rocks, hard sand, pebbly gravel, or mud from the outer continental shelf of the MAB south to Cape Hatteras, North Carolina. It also consists of the outer perimeter of Georges Bank and all benthic areas of the Gulf of Maine.

- Spawning Adults—Designated EFH includes bottom habitats that are a sand-shell mix, algae-covered rocks, hard sand, pebbly gravel, or mud from the outer continental shelf of the MAB, the outer perimeter of Georges Bank, and all benthic areas of Gulf of Maine.

***HAPC Designations***—There are no HAPC identified for this species.

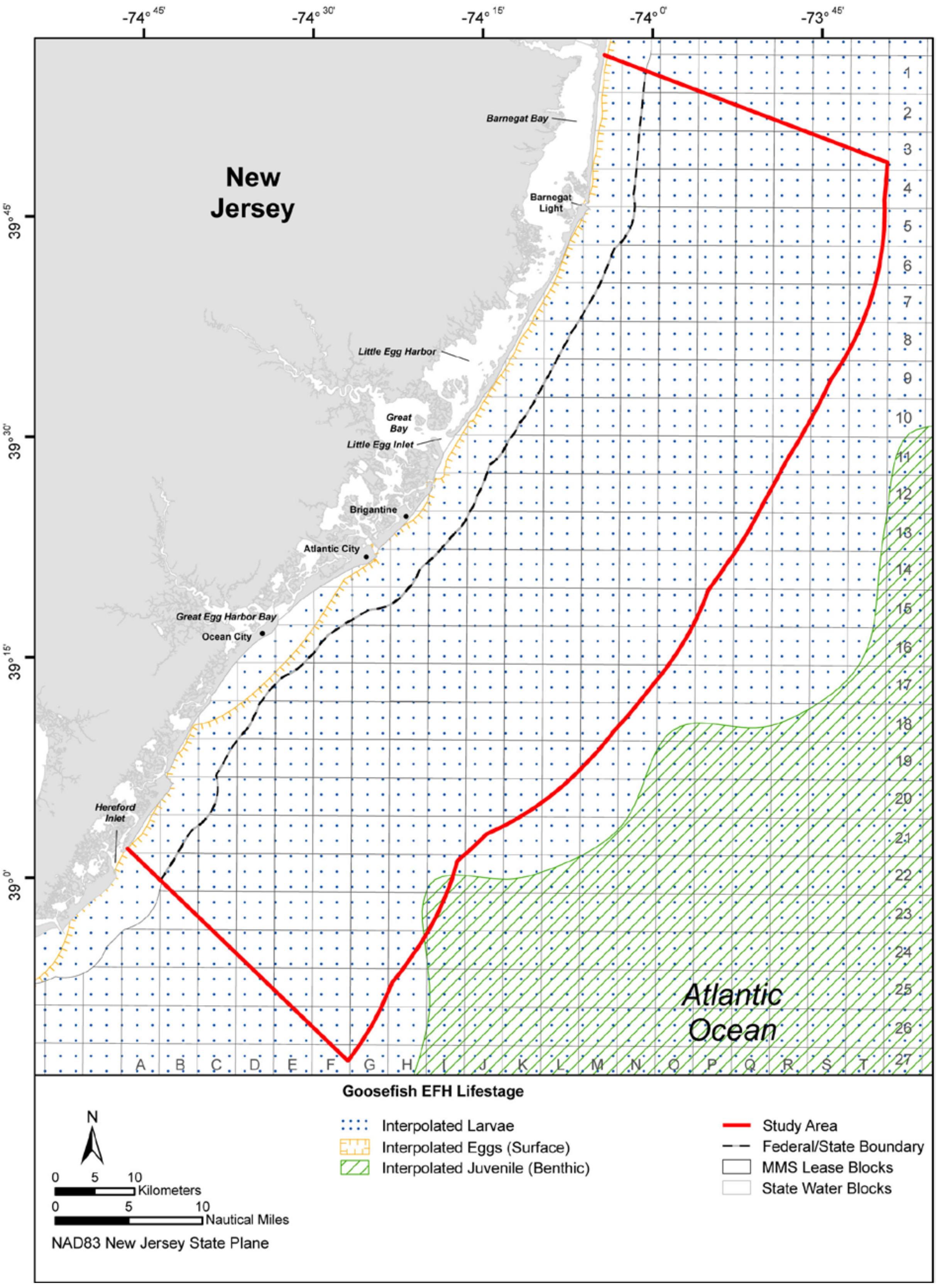


**Figure A-9. Essential fish habitat designated in the New Jersey Study Area for eggs, larvae, and juvenile lifestages of goosefish. Source mapped (scanned): NEFMC (1998).**

- **Little Skate (*Leucoraja erinacea*)**

***Management***—Little skate EFH is designated under the NEFMC Final FMP for the NE Skate Complex (NEFMC 2003a).

***Status—***Little skate is neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—The little skate ranges from Nova Scotia to Cape Hatteras, North Carolina with its center of abundance occurring on Georges Bank and in coastal waters south to the mouth of the Chesapeake Bay (McEachran 2002; Packer et al. 2003c).

***Habitat Associations***—Little skate juveniles and adults typically utilize sand, gravel, or mud substrates (McEachran and Musick 1975; Packer et al. 2003c). They have been associated with microhabitat features including biogenic depressions and flats and during the day with their abundances increasing in the spring and fall (Packer et al. 2003c). Little skate are found at deep depths (384 m [1,260 ft]), but are most common at depths less than 111 m [364 ft], especially in the northern section of the MAB (McEachran and Musick 1975). Little skate eggs are found in waters with temperatures warmer than 7°C (44.6°F) and depths less than 27 m (88.6 ft), while juveniles prefer temperatures between 4°C and 15°C (39.2°F and 59.0°F) and depths from shore to 137 m (449 ft) deep (NEFMC 2003a).

***Life History***—Egg cases, known as a "mermaid's purse," are found partially to fully developed year-round, but are most abundant from late October to January and from June to July (McEachran 2002; Packer et al. 2003c). Little skates do not undertake extensive seasonal migrations, but instead move inshore and offshore, along with north-south movements along the southern end of its range, in response to seasonal temperature changes (McEachran and Musick 1975). Little skate typically moves to deep waters in December and January and migrates to shallow waters in April and May (McEachran 2002).

***Forage Species***—Little skate juveniles and adults prey upon benthic invertebrates (shrimp, crabs, and worms) and fishes (herring, alewife, tomcod [*Microgadus tomcod*], silver hake, sculpin, silverside, Atlantic wolffish [*Anarhichas lupus*], sand lance, cunner [*Tautogolabrus adspersus*], winter flounder, and yellowtail flounder) (McEachran 2002; Packer et al. 2003c).

***EFH Designations***—(NEFMC 2003a) (**Figure A-10**)

- **Eggs**—Designated EFH includes bottom habitats with a sandy substrate from Georges Bank and MAB south to Cape Hatteras, North Carolina. Southern New England and mid-Atlantic embayments and estuaries are designated EFH.
- Larvae—No larval stage exists for this species. Upon hatching, they are fully developed juveniles.
- **Juveniles**—Designated EFH includes bottom habitats with a sand or gravel substrate from Georges Bank through the MAB to Cape Hatteras, North Carolina that encompass the highest 90% where this species was collected during NMFS trawl surveys. Southern New England and mid-Atlantic embayments and estuaries are designated EFH.
- **Adults**—Designated EFH includes bottom habitats with a sand, gravel, or mud substrate. It ranges from Georges Bank through the MAB to Cape Hatteras, North Carolina that encompass the highest 90% where this species was collected during NMFS trawl surveys. Southern New England and mid-Atlantic embayments and estuaries are designated EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.
- Spawning Adults—Designated EFH includes the following southern New England and mid-Atlantic embayments and estuaries: Buzzards Bay, Narragansett Bay, Long Island Sound, and Hudson River/Raritan Bay north of the Study Area.

***HAPC Designations***—There are no HAPC identified for this species.

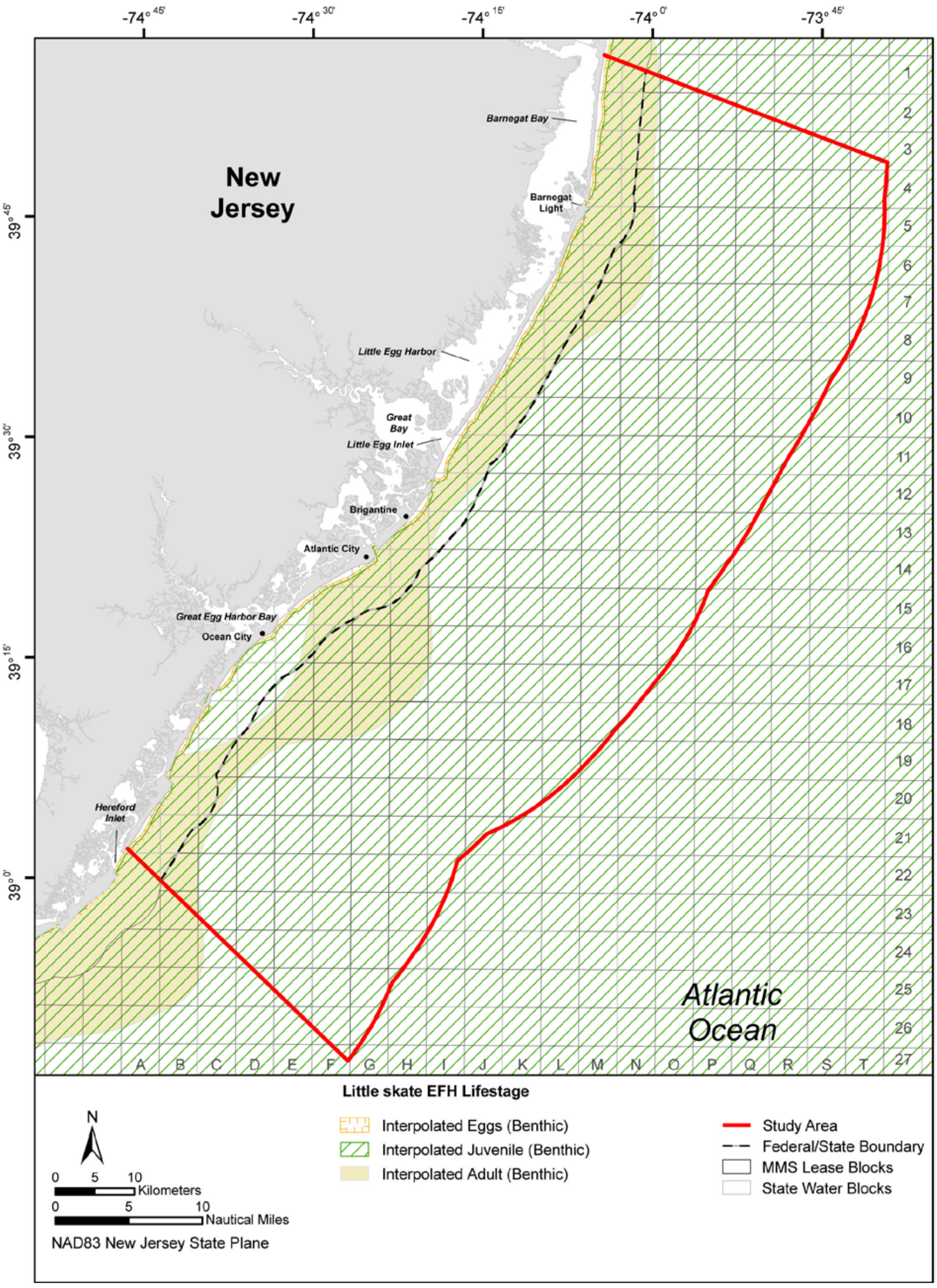


**Figure A-10. Essential fish habitat designated in the New Jersey Study Area for all lifestages of little skate. Source map (scanned): NEFMC (2003a).**

♦ **Longfin Inshore Squid (*Loligo pealei*)**

***Management***—The population of longfin inshore squid from southern Georges Bank to Cape Hatteras, North Carolina have EFH designated by MAFMC under Amendment 8 to the Atlantic Mackerel, Squid, and Butterfish FMP (MAFMC 1998b).

***Status***—Longfin inshore squid are neither classified as overfished, nor subject to overfishing (NMFS 2009d).

***Distribution***—This pelagic, schooling species is found across the continental shelf and slope from Newfoundland, Canada to the Gulf of Venezuela, South America. It is abundant from Georges Bank to Cape Hatteras, North Carolina (Lange 1982; Cargnelli et al. 1999c).

***Habitat Associations***— Longfin inshore squid are found on mud or sand/mud substrate in waters with temperatures warmer than 8°C (46.4°F) (Lange and Sissenwine 1980; Cargnelli et al. 1999c; Jacobson 2005). Demersal egg masses are commonly found attached to rocks and small boulders on sandy-muddy bottom and on aquatic vegetation in waters with temperatures colder than 8°C (46.4°F) (Cargnelli et al. 1999c). Larvae are pelagic and are found near the surface at temperatures between 10°C and 26°C (50.0°F and 78.8°F) (Vecchione 1981). Juveniles are usually found in the upper 10 m (33 ft) of the water column over water 50 to 100 m (164 to 328 ft) deep and prefer water temperatures ranging from 10° to 26°C (50.0° to 78.8°F) (Cargnelli et al. 1999c). Adults are found in waters over the continental shelf and upper continental slope to depths of 400 m (1,312 ft) (Cargnelli et al. 1999c). This species displays a diel migration pattern. It is typically demersal during the day and utilizes the water column at night (Vecchione 1981).

***Life History***—Longfin inshore squid seasonally migrate inshore and offshore as temperatures change; squid move offshore during late fall to overwinter along the edge of the continental shelf and moving inshore during the spring and early summer to spawn (Lange 1982; MAFMC 1998b). During winter and early spring when inshore waters are coldest, longfin inshore squid are most common along the outer edge of the continental shelf where waters are 9° to 13°C (48.2° to 55.4°F). The inshore movement to the shelf region begins when water temperatures start warming (MAFMC 1998b; Cargnelli et al. 1999c). Longfin inshore squid spawn from April to November (Cargnelli et al. 1999c) with peak spawning in May. Most eggs hatch during the summer around July (Lange and Sissenwine 1980).

***Forage Species***—Longfin squid juveniles feed on crustaceans (crabs, worms, and shrimp), while adults prey upon small fishes (silver hake, sand lance, anchovy, weakfish, silversides, mackerel, herring, and Atlantic menhaden) and squids. Longfin inshore squid have also been recorded engaged in cannibalism. While inshore, they prey primarily on fish, and when offshore, they feed upon fishes, squid, and crustaceans (Cargnelli et al. 1999c).

***EFH Designations***—(MAFMC 1998b; MAFMC 2008) (**Figure A-11**)

- **Eggs**—Designated EFH includes coastal and offshore bottom habitats from Georges Bank southward to Cape Hatteras, North Carolina.
- **Juveniles** (±8 cm [3.1 in.])—Designated EFH includes the pelagic waters found over the continental shelf in areas that comprise the highest 75% of the catch where juvenile longfin inshore squid were collected by the NEFSC trawl surveys (from the Gulf of Maine to Cape Hatteras, North Carolina).
- **Adults** (>8 cm [3.1 in.])—Designated EFH includes the pelagic waters found over the continental shelf in areas that comprise the highest 75% of the catch where recruited adult longfin inshore squid were collected by the NEFSC trawl surveys (from the Gulf of Maine to Cape Hatteras, North Carolina).

***HAPC Designations***—There are no HAPC identified for this species.

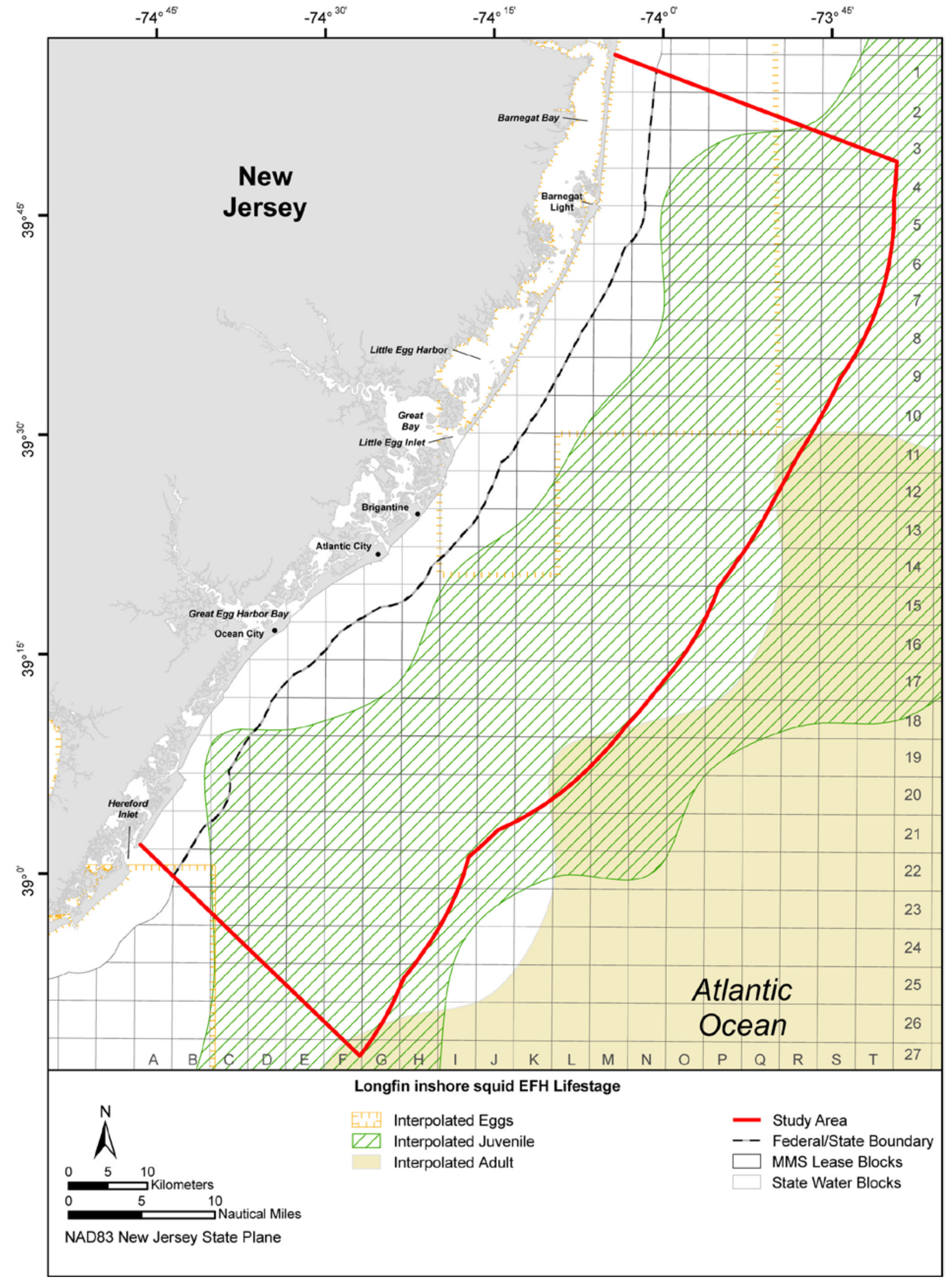


**Figure A-11. Essential fish habitat designated in the New Jersey Study Area for all lifestages of longfin inshore squid. Source map (scanned): MAFMC (1998b, 2008).**

♦ **Ocean Pout (*Zoarces americanus*)**

***Management***—EFH for the ocean pout is designated by the NEFMC under Final Amendment 11 to the Northeast Multispecies FMP (NEFMC 1998). Two separate stocks have been suggested based on stock identification studies. The first stock is found within the region of the Bay of Fundy and the northern Gulf of Maine, while the second stock ranges from Cape Cod Bay, Massachusetts south to Delaware (Wigley 2000).

***Status***—Ocean pout are classified as overfished; however, overfishing is not occurring (NMFS 2009d).[3]

***Distribution***—Ocean pout commonly are found from Labrador and the southern Grand Banks, Canada to Maryland (Dunaway 2001), but can also be found in the deeper, cooler waters south of Cape Hatteras, North Carolina (Steimle et al. 1999d).

***Habitat Associations***—Ocean pout lay demersal eggs in gelatinous clumps in sheltered areas where they are guarded and protected by either one or both sexes (Steimle et al. 1999d; Wigley 2000). Once the eggs hatch, larvae remain near the sheltered area throughout the duration of the transition stage. As juveniles, ocean pout disperse along the shallow, coastal waters. They are typically found in association with rocks and attached algae (Klein-MacPhee and Collette 2002). Adults are commonly found in deep, cooler waters (3° to 14°C [37.4° to 57.2°F]) of the continental shelf and the upper continental slope (Clark and Livingstone 1982; Steimle et al. 1999d).

***Life History***—Ocean pout spawning occurs in late summer through early winter. Peak spawning occurs in September and October and earlier (August through October) in the southern part of their range. Ocean pout spawn on hard bottom, sheltered areas (Klein-MacPhee and Collette 2002), including rock crevices, artificial reefs, and shipwrecks, at depths of less than 50 m (164 ft) and temperatures of 10°C (50°F) or colder (Clark and Livingstone 1982; Steimle et al. 1999d). Although ocean pout move seasonally within a region, this species is considered non-migratory (Klein-MacPhee and Collette 2002) and seasonal inshore/offshore movements are not extensive (Wigley 2000).

***Forage Species***—Ocean pout juveniles and adults prey primarily on mollusks, crustaceans (crabs), echinoderms (sand dollars, brittle stars, and sea urchins), and other invertebrates (polychaetes), and less commonly, on fishes and fish eggs (Steimle et al. 1999d). This species feeds primarily near the bottom during the daytime (Klein-MacPhee and Collette 2002).

***EFH Designations***—(NEFMC 1998) (**Figure A-12**)

- **Eggs, Larvae, and Adults**—Designated EFH includes primarily hard bottom habitats, on the continental shelf from the Gulf of Maine, Georges Bank, and MAB south to Delaware Bay. Southern New England estuaries and embayments are designated as EFH.

- **Juveniles**—Designated EFH includes bottom habitats consisting of smooth bottom near rocks or algae from the Gulf of Maine, Georges Bank, and MAB south to Delaware Bay. Southern New England estuaries and embayments are designated as EFH.

- **Spawning Adults**—Designated EFH includes bottom habitats with a hard bottom substrate including artificial reefs and shipwrecks from the Gulf of Maine, Georges Banks, and MAB south to Delaware Bay. Southern New England estuaries and embayments are designated as EFH.

***HAPC Designations***—There are no HAPC identified for this species.

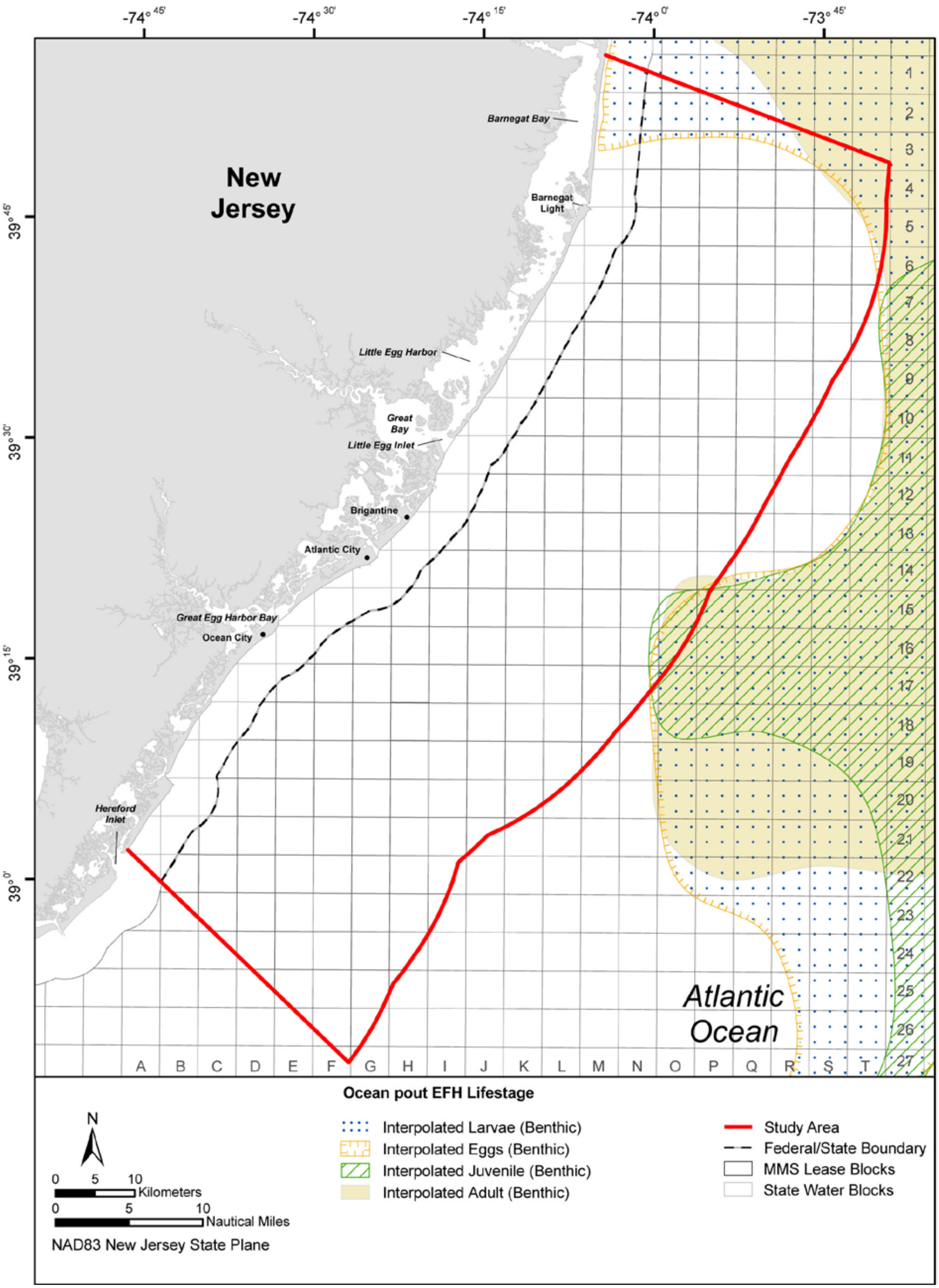


**Figure A-12. Essential fish habitat designated in the New Jersey Study Area for all lifestages of ocean pout. Source map (scanned): NEFMC (1998).**

- **Ocean Quahog (*Arctica islandica*)**

***Management***—Ocean quahog EFH is designated under Amendment 12 to the Atlantic Surfclam and Ocean Quahog FMP of the MAFMC (1998a).

***Status***—Ocean quahog is neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—The ocean quahog is found in temperate and boreal waters occurring on both sides of the north Atlantic (Serchuk et al. 1982). In the northwestern Atlantic Ocean, ocean quahog are found on the continental shelf from Newfoundland, Canada to Cape Hatteras, North Carolina (Mann 1982; Weinberg 2001).

***Habitat Associations***—Ocean quahog egg and larval stages are planktonic and are subject to dispersal by currents (Cargnelli et al. 1999a). Following metamorphosis, juveniles settle to the bottom, displaying a preference for sand substrates in offshore waters, but also inhabit mud intertidal environments (Cargnelli et al. 1999a). Ocean quahog are generally found in waters with salinities ranging from 32 to 34 psu at depths between 45 m and 75 m (148 ft and 246 ft). Adults typically congregate in dense beds, just below the sediment surface. Ocean quahog prefer silty or fine to medium grade sand substrates as habitat (Serchuk et al. 1982; Cargnelli et al. 1999a).

***Life History***—Ocean quahog spawning is protracted. Spawning begins in the spring and ends in the fall. Ocean quahog display multiple spawning events which occur at the individual and population level (Mann 1982; Cargnelli et al. 1999a). The spawning season begins in late spring or early summer when water temperatures reach 13.5°C (56.3°F). Peak ocean quahog spawning occurs from August to early October (Serchuk et al. 1982). Adult quahogs do not exhibit seasonal movements (Serchuk et al. 1982).

***Forage Species***—Ocean quahogs are filter feeders that primarily consume phytoplankton (Cargnelli et al. 1999a).

***EFH Designations***—(MAFMC 1998a) (**Figure A-13**)

- **Juveniles and Adults**—Designated EFH includes bottom substrates (to a depth of 1 m [3.3 ft] below the water-sediment interface in areas) that encompass the top 90% of the NEFSC surfclam and ocean quahog dredge surveys (from the eastern edge of Georges Bank and the Gulf of Maine) throughout the Atlantic U.S. EEZ.

***HAPC Designations***—There are no HAPC identified for this species.

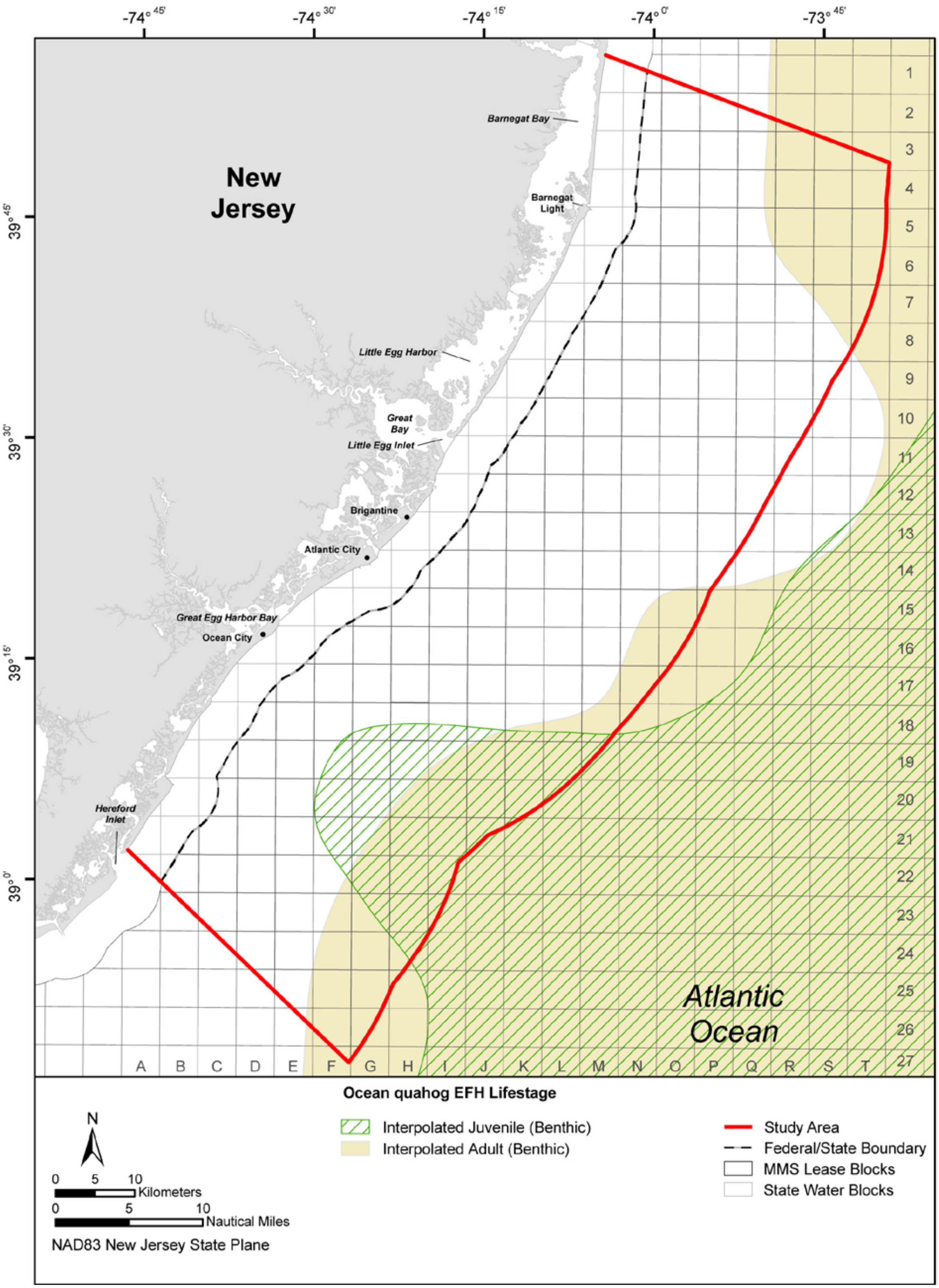


**Figure A-13. Essential fish habitat designated in the New Jersey Study Area for all lifestages of the ocean quahog. Source map (scanned): MAFMC (1998a).**

♦ **Red Hake (*Urophycis chuss*)**

***Management***—Red hake EFH is designated by the NEFMC under Final Amendment 11 to the Northeast Multispecies FMP (NEFMC 1998). The red hake is divided into two separate stocks (northern and southern separated by the central axis of Georges Bank) in U.S. waters (NEFMC 1999).

***Status***—Red hake (southern Georges Bank/mid-Atlantic) are not classified as overfished; however, it is undefined whether or not overfishing is occurring (NMFS 2009d).

***Distribution***—Red hake are found in the coastal waters off southern Newfoundland, Canada to North Carolina, with peak abundance occurring along Georges Bank, in the Gulf of Maine off Cape Cod, and in the northern MAB off Long Island, New York. In addition, all lifestages of red hake are also found in estuaries from southern Maine to the Chesapeake Bay (Steimle et al. 1999b).

***Habitat Associations***—Red hake eggs are pelagic and buoyant and are most common off Georges Bank, Canada, and southern New England coast during May and June (Klein-MacPhee 2002e). Larvae are found from May to December on Georges Bank and southern New England, but are most numerous during September and October (Klein-MacPhee 2002e). In the MAB, larvae are found in waters with temperatures ranging from 8° to 23°C (46.4° to 73.4°F) and at depths between 10 m and 200 m (32.8 ft and 656.0 ft) (Steimle et al. 1999b). Both eggs and larvae drift with the prevailing currents (Anderson 1982). Upon recruitment from the plankton to the benthos, juvenile red hake are commonly found in close association with benthic debris (e.g., shells, sponges, and rocks), which serve as shelters at depths of 40 to 50 m (131 to 164 ft) (Klein-MacPhee 2002e). Juvenile red hake prefer water temperatures between 4.2°C and 7.5°C (39.6°F and 45.5°F) and salinities of 31 to 32.8 psu. Adults prefer water temperatures ranging from 5° to 12°C (41.0° to 53.6°F) and salinities of 33 or 34 psu. Red hake prefer soft sediments and wide ranging depths between 35 m and 980 m (115.0 ft and 3,215.4 ft) (Steimle et al. 1999b; Klein-MacPhee 2002e).

***Life History***—Red hake spawning grounds include the southwest portion of Georges Bank, the continental shelf off southern New England, and eastern Long Island, New York. Spawning adults are commonly found in coastal bays between Narragansett Bay and Massachusetts Bay, but are uncommon to the north or the south of this range (Steimle et al. 1999b). Spawning occurs from April through November at water temperatures around 5° and 10°C (41° and 50°F) (Steimle et al. 1999b). Red hake undergo extensive seasonal migrations; they are found in coastal waters, typically less than 100 m (328 ft), during the warmer months and migrate further offshore (>100 m [328 ft]) during the colder months (Steimle et al. 1999b).

***Forage Species***—Red hake larvae prey upon copepods and other micro-crustaceans. Both juveniles and adults feed primarily on crustaceans (crab and shrimp) and other invertebrates (bivalves, squid, and worms) and secondarily on fishes (haddock (*Melanogrammus aeglefinus*), silver hake, sand lance, searobins [Triglidae], and mackerel) (Klein-MacPhee 2002e).

***EFH Designations***—(NEFMC 1998) (**Figure A-14**)

- **Eggs**—Designated EFH includes the surface waters from the Gulf of Maine, Georges Bank, and the continental shelf of the MAB south to Cape Hatteras, North Carolina.
- **Larvae**—Designated EFH includes the surface waters from the Gulf of Maine, Georges Bank, and the continental shelf of the MAB south to Cape Hatteras, North Carolina. New England and northern mid-Atlantic estuaries and embayments are designated as EFH.
- **Juveniles**—Designated EFH includes bottom habitats with substrates consisting of shell fragments, including areas with an abundance of live scallops from the Gulf of Maine, Georges Bank, and the continental shelf of the MAB south to Cape Hatteras, North Carolina. New England and mid-Atlantic estuaries and embayments are designated as EFH.

- Adults—Designated EFH includes bottom habitats in depressions with substrates consisting of sand and mud from the Gulf of Maine, Georges Bank, and the continental shelf of the MAB south to Cape Hatteras, North Carolina. New England and mid-Atlantic estuaries and embayments are designated as EFH.

- Spawning Adults—Designated EFH includes bottom habitats in depressions with a substrates consisting of sand and mud from the Gulf of Maine, the southern edge of Georges Bank, and the continental shelf of the MAB south to Cape Hatteras, New England and northern mid-Atlantic estuaries and embayments are designated as EFH.

***HAPC Designations***—There are no HAPC identified for this species.

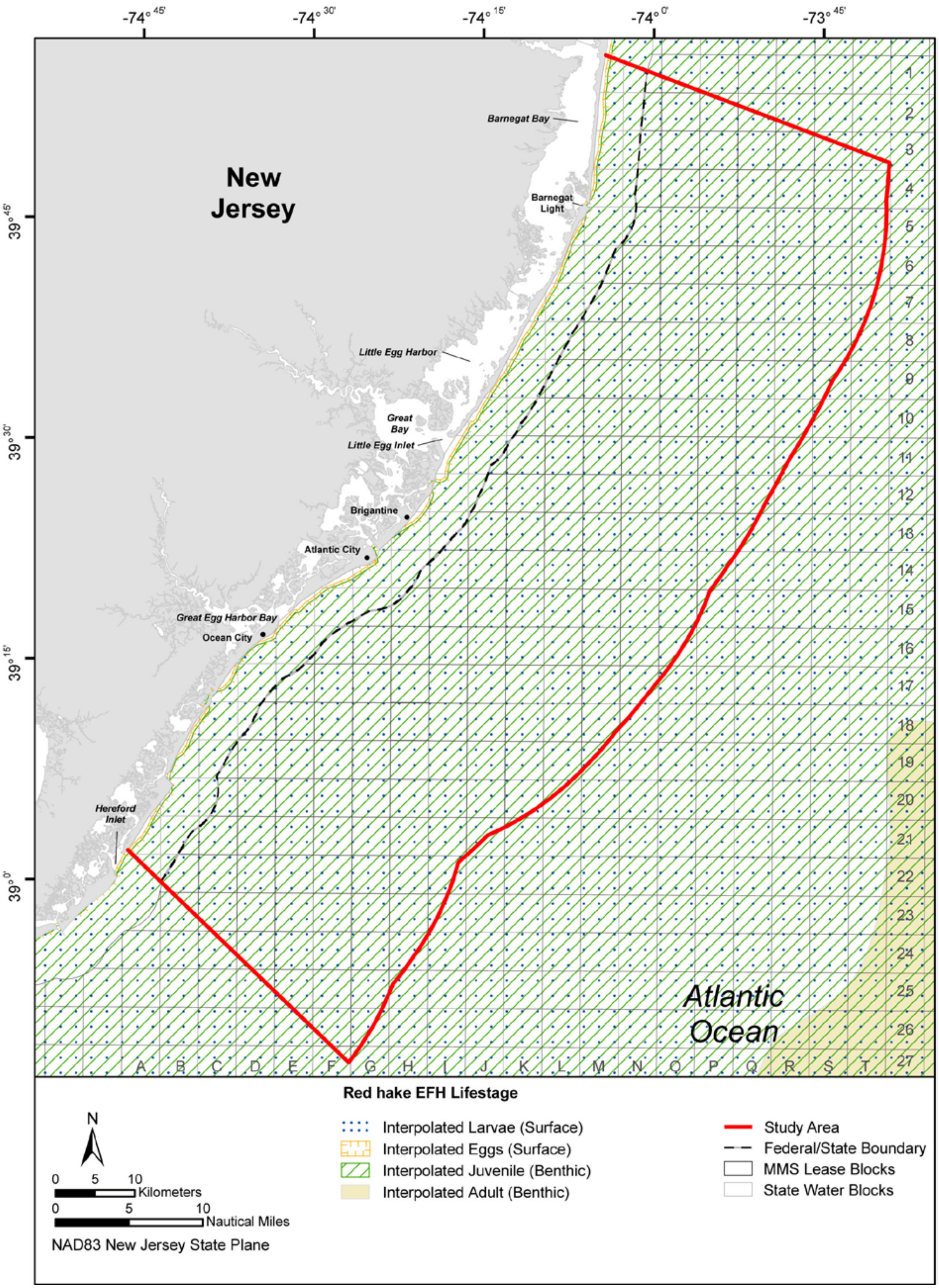


**Figure A-14. Essential fish habitat designated in the New Jersey Study Area for egg, larval, and juvenile lifestages of red hake. Source map (scanned): NEFMC (1999b).**

- **Scup (*Stenotomus chrysops*)**

***Management***—The scup fishery has EFH designated jointly by the MAFMC and the ASMFC under Amendment 12 to the Summer Flounder, Scup, and Black Sea Bass FMP (MAFMC and ASMFC 1998b).

***Status***—Scup are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Scup are a continental shelf species found in the western North Atlantic Ocean that occurs primarily from Cape Cod, Massachusetts to Cape Hatteras, North Carolina (Morse 1982). Scup have been reported as far north as the Bay of Fundy and Sable Island Bank, Nova Scotia (Steimle et al. 1999e; Klein-MacPhee 2002i) and as far south as Florida (Manooch III 1988).

***Habitat Associations***—During May through August, scup pelagic eggs are found in coastal waters of southern New England, including bays and sounds (Morse 1982; Steimle et al. 1999e). Larval scup are also pelagic and are found from May to September in coastal waters at temperatures ranging from 14° to 22°C (57.2° to 71.6°F). Both eggs and larvae are typically found in waters of less than 50 m (164 ft) in depth (Steimle et al. 1999e). During the transition of larvae into juveniles, the scup abandons the pelagic stage in favor of bottom habitats (Morse 1982). Juvenile scup prefer intertidal and subtidal habitats. During summer and fall, these areas include sand bottoms, mud bottoms, mussel beds, and eelgrass beds, while during winter and spring, juvenile scup are found on the continental shelf over habitats ranging from flat, open, sandy-silty bottoms to the heads of submarine canyons. Adult scup are commonly associated euryhaline waters with soft, sandy bottoms on or near structures including rock ledges, mussel beds, artificial reefs, and wrecks. Both juveniles and adults prefer waters with temperatures ranging between 5°C and 27°C (41.0°F and 80.6°F) (Steimle et al. 1999e).

***Life History***—In the MAB, scup spawn once a year during the daytime and typically close to shore from May to August, with peaks occurring in June and July (Morse 1982; Steimle et al. 1999e; Klein-MacPhee 2002i). Migration times and overwintering localities vary from year to year depending on water temperatures. Scup migrate out of the inshore waters to the warmer, deeper waters of the outer continental shelf ranging in depth from 70 to 180 m (230 to 591 ft) south of Hudson Canyon off New Jersey and along the coast from south of Long Island, New York to North Carolina (Terceiro 2001; Klein-MacPhee 2002i). Scup return to the inshore waters once the water temperatures begin to rise again in the spring (Steimle et al. 1999e). During the summer, scup are most common in most large estuaries and coastal areas (Klein-MacPhee 2002i).

***Forage Species***—Scup larvae prey upon zooplankton. Both juveniles and adults feed on benthic invertebrates (mollusks, crab, shrimp, squid, crustaceans, and worms) and small fishes but rarely feed any higher in the water column (Steimle et al. 1999e; Klein-MacPhee 2002i).

***EFH Designations***—(MAFMC and ASMFC 1998b) (**Figure A-15**)

- <u>Eggs and Larvae</u>—Designated EFH includes southern New England and mid-Atlantic estuaries and embayments.

- **<u>Juveniles</u>**—Designated EFH includes bottom waters from the coast out to the limits of the U.S. EEZ in areas that encompass the highest 90% of where juvenile scup were collected by the NEFSC trawl surveys (Gulf of Maine to Cape Hatteras, North Carolina). Southern New England and mid-Atlantic estuaries and embayments are designated EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- **<u>Adults</u>**—Designated EFH includes bottom waters from the coast out to the limits of the U.S. EEZ in areas that encompass the highest 90% of where juvenile scup were collected by the NEFSC trawl surveys (Gulf of Maine to Cape Hatteras, North Carolina). Southern New England and mid-

Atlantic estuaries and embayments are designated EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

***HAPC Designations***—There are no HAPC identified for this species by the MAFMC. The ASMFC has identified HAPC to include sandy and weedy areas and structured habitats as important fishery nursery areas for juveniles.[2]

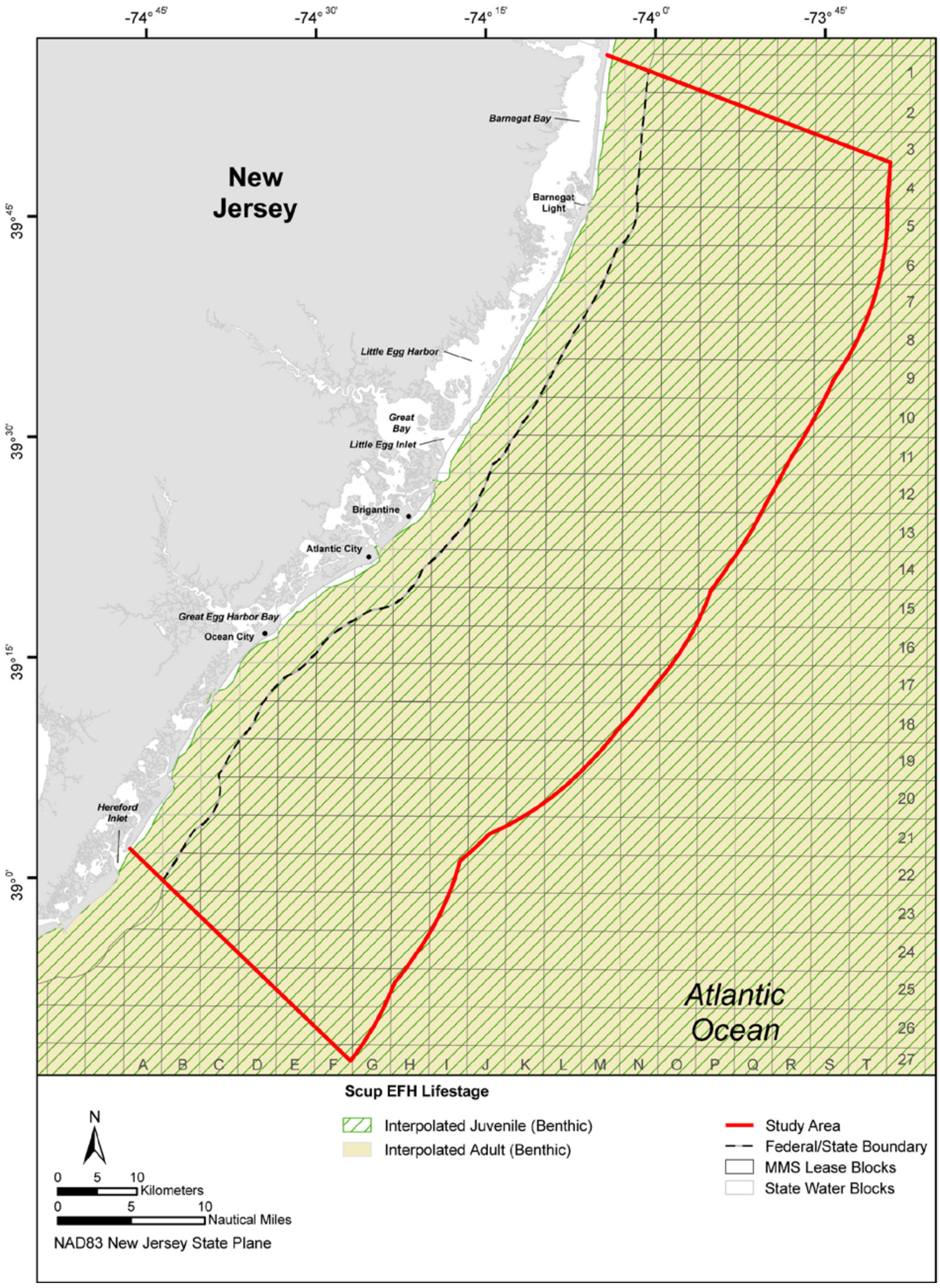


**Figure A-15. Essential fish habitat designated in the New Jersey Study Area for juvenile and adult lifestages of scup. Source map (scanned): MAFMC and ASMFC (1998a).**

- **Silver Hake/Whiting (*Merluccius bilinearis*)**

***Management***—Two main stocks are recognized in U.S. coastal waters: a northern stock within waters of the Gulf of Maine and the northern portion of Georges Bank and a southern stock inhabiting the southern portion of Georges Bank to the MAB (Helser 1996; Brodziak 2001). Both stocks have EFH designated by the NEFMC under Final Amendment 11 to the Northeast Multispecies FMP (NEFMC 1998).

***Status***—Silver hake are neither overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Silver hake are found in the northwestern Atlantic from the southern edge of the Grand Banks off Newfoundland, Canada, and the Gulf of St. Lawrence south to Cape Fear, North Carolina, along the continental shelf (Klein-MacPhee 2002d). They are most commonly found in the waters of the Gulf of Maine, the Scotian Shelf, Georges Bank, off Long Island, New York, and the southern edge of the Grand Banks (Morse et al. 1999).

***Habitat Associations***—Silver hake eggs are pelagic and drift with the prevailing currents. Eggs are typically observed at temperatures between 5 °C and 21°C (41.0°F and 69.8°F) and over bottom depths of 10 to 1,250 m (33.0 to 4,101.2 ft) over the continental shelf but are most abundant at depths of 50 to 150 m (164 to 492 ft) (Lock and Packer 2004). The pelagic larval stage inhabits waters over the continental shelf between temperatures of 5°C and 16°C (41.0°F and 60.8°F) and at depths of 10 to 1,250 m (33.0 to 4,101.2 ft), although they are most common in depths of 50 to 130 m (164.0 to 426.5 ft) (Lock and Packer 2004). During the transition between larvae and juveniles, silver hake drop out of the plankton and settle into the benthic habitat (Steves and Cowen 2000; Lock and Packer 2004). While juvenile silver hake are found over a wide range of temperatures and depths on the continental shelf (Lock and Packer 2004), they display a preference for bottom temperatures between 8°C and 10°C (46.4°F and 50.0°F) and depths of 60 to 100 m (197 to 328 ft) (Steves and Cowen 2000). Adults have been observed in waters ranging from 3° to 18°C (37.4° to 64.4°F) in temperature, although they are most common between 7°C to 17°C (44.6°F and 62.6°F). Silver hake are nocturnal hunters, and during the day they are believed to rest on the bottom, on sand or pebbly bottom or on mud, but seldom over rocks. During the night, silver hake can be found throughout the water column in pursuit of prey with no limits to their vertical movements (Klein-MacPhee 2002d; Lock and Packer 2004).

***Life History***—During feeding and spawning, silver hake are often found in dense schools. Spawning extends throughout the year and peaks between May and August (Brodziak 2001; Klein-MacPhee 2002d). Primary spawning activity occurs along the southeastern and southern slopes of Georges Bank, around Nantucket Shoals, and south of Martha's Vineyard to Cape Hatteras, North Carolina (Klein-MacPhee 2002d). Silver hake migrate in response to seasonal changes in water temperatures. During the spring, silver hake migrate into shallow water where spawning takes place throughout late spring and early summer. When autumn arrives, the fish move back into the deeper waters of the Gulf of Maine and the outer continental shelf and slope waters (Brodziak 2001).

***Forage Species***—Silver hake feed on copepod larvae and younger copepodites. Both juveniles and adults prey upon crustaceans, fishes (anchovy, herring, lanternfish [Myctophidae], mackerel, sand lance, and butterfish), and squid (Klein-MacPhee 2002d; Lock and Packer 2004).

- ***EFH Designations***—(NEFMC 1998) (**Figure A-16**)

- **Eggs and Larvae**—Designated EFH includes the surface waters from the Gulf of Maine, Georges Bank, and the continental shelf of the MAB south to Cape Hatteras, North Carolina. Southern New England estuaries and embayments are designated as EFH.

- **Juveniles, Adults, and Spawning Adults**—Designated EFH includes bottom habitats off all substrates from the Gulf of Maine, on Georges Bank, and the continental shelf of the MAB south to Cape Hatteras, North Carolina. Southern New England estuaries and embayments are designated as EFH.

***HAPC Designations***—There are no HAPC identified for this species.

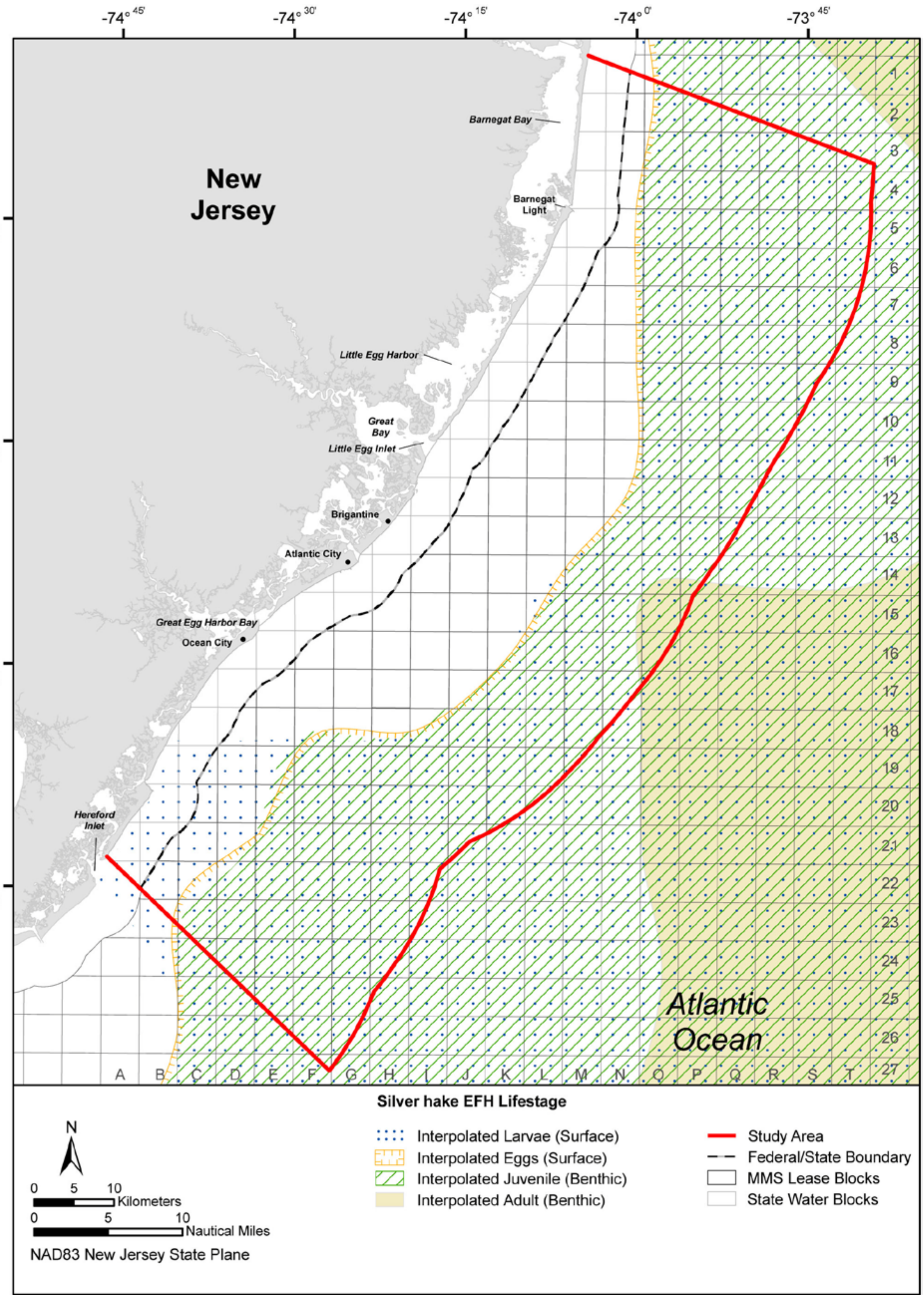


**Figure A-16. Essential fish habitat designated in the New Jersey Study Area for all lifestages of silver hake. Source map (scanned): NEFMC (1999b).**

- **Spiny Dogfish (*Squalus acanthias*)**

***Management***—Spiny dogfish have EFH designated under the joint management of the MAFMC and the NEFMC through the Spiny Dogfish FMP (MAFMC and NEFMC 1999).

***Status***—Spiny dogfish are neither classified as overfished, nor is overfishing occurring (NMFS 2009d). According to the 2009 IUCN Red List, spiny dogfish (Northwest Atlantic subpopulation) is classified as endangered.[4]

***Distribution***—In the western North Atlantic Ocean, the spiny dogfish ranges from Greenland to southern Florida and Cuba, but is most abundant between Newfoundland, Canada, and Georgia (Nammack et al. 1985).

***Habitat Associations***—Spiny dogfish are ovoviviparous and eggs develop internally (Burgess 2002). The offspring, known as pups, are born live as fully developed juveniles following a gestation period of two years (Cohen 1982). Both juvenile and adult spiny dogfish are epibenthic, but move throughout the water column. They inhabit nearshore shallow waters out to depths of 900 m (2,952.9 ft) along the inshore and offshore continental shelf (Burgess 2002; Stehlik 2007).

***Life History***—Spiny dogfish spawn in the winter in offshore waters (Cohen 1982; Burgess 2002). Parturition occurs between November and January in offshore wintering grounds but can occur as late as May in areas of colder temperatures (Nammack et al. 1985; McMillan and Morse 1999; Burgess 2002). Spiny dogfish migrate north in the spring and summer, typically north of Cape Cod, Massachusetts and return south again in the fall and winter, usually off of the North Carolina coast (McMillan and Morse 1999). Seasonal inshore-offshore migrations are also common for this species and are related to water temperature. Spiny dogfish overwinter in deeper offshore waters and move into the nearshore shallow waters during the summer (McMillan and Morse 1999; Burgess 2002).

***Forage Species***—Spiny dogfish are very aggressive piscivores that feed primarily on fishes, such as mackerel, herring, Atlantic menhaden, sand lance, capelin (*Mallotus villosus*), Atlantic wolffish, flatfish species, Atlantic cod, and haddock (Stehlik 2007). They also consume mollusks, crustaceans, and other invertebrates (Burgess 2002).

***EFH Designations***—(MAFMC and NEFMC 1999) (**Figure A-17**)

- **Juveniles**—Designated EFH includes the waters off the continental shelf in areas that encompass the highest 90% of the area where juvenile dogfish were collected by the NEFSC trawl surveys (Gulf of Maine through Cape Hatteras, North Carolina). New England estuaries and embayments are designated as EFH. Additional EFH is designated in waters with depths to 390 m (1,280 ft) south of Cape Hatteras, North Carolina, to Cape Canaveral, Florida.

- **Adults**—Designated EFH includes the waters over the continental shelf in areas that encompass the highest 90% of the area where adult dogfish were collected by the NEFSC trawl surveys (Gulf of Maine through Cape Hatteras, North Carolina). New England estuaries and embayments are designated as EFH. Additional EFH is designated in waters with depths to 450 m (1,476 ft) south of Cape Hatteras, North Carolina, to Cape Canaveral, Florida.

***HAPC Designations***—There are no HAPC identified for this species by the MAFMC and the NEFMC. The ASMFC has identified HAPC to include ocean bottom habitat and estuarine areas for refuge, foraging, or both.[2]

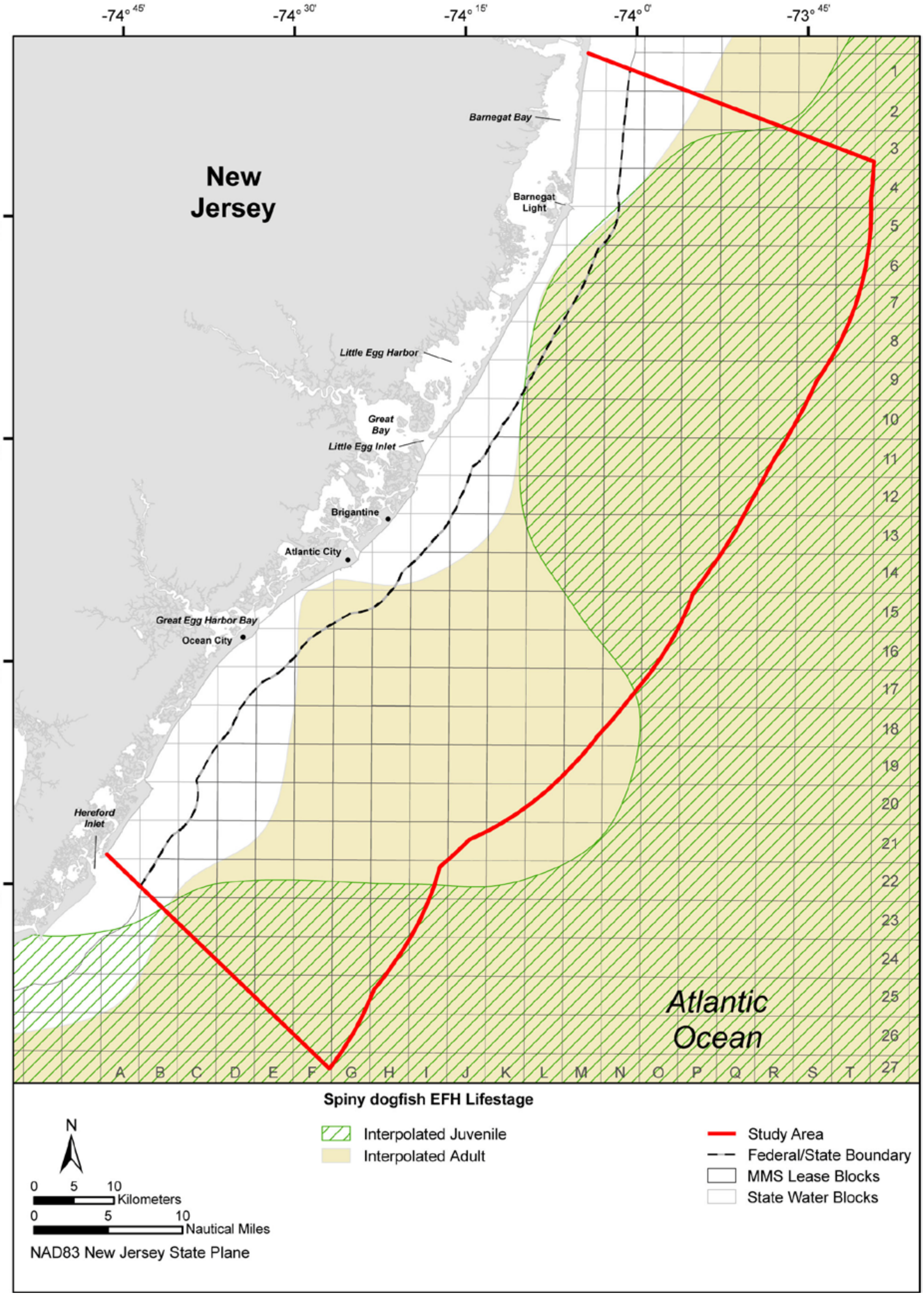


**Figure A-17. Essential fish habitat designated in the New Jersey Study Area for all lifestages of spiny dogfish. Source map (scanned): MAFMC and NEFMC (1999).**

- **Summer Flounder (*Paralichthys dentatus*)**

***Management***—The summer flounder stock has EFH jointly designated by the MAFMC and the ASMFC under Amendment 12 to the Summer Flounder, Scup, and Black Sea Bass FMP (MAFMC and ASMFC 1998b).

***Status***—Summer flounder are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Summer flounder range from Nova Scotia, Canada to Florida, but their occurrence north of Cape Cod, Massachusetts, and south of Cape Hatteras, North Carolina, is rare (Byrne and Azarovitz 1982; Klein-MacPhee 2002c).

***Habitat Associations***—Summer flounder eggs are pelagic and occur over the continental shelf in waters with temperatures ranging from 9° to 23°C (48.2° to 73.4°F), although the majority of eggs have been observed between 12°C to 19°C (53.6°F to 66.2°F). Eggs are most common in the MAB between Long Island, New York, and Cape Hatteras, North Carolina, within 46 km (24.8 NM) of shore (Byrne and Azarovitz 1982). The larvae are also pelagic and found primarily over the continental shelf. Larvae thrive in waters with temperatures between 0°C and 23°C (32.0°F and 73.4°F) but appear with the most frequency in waters between 9°C and 18°C (48.2°F and 64.4°F) (Byrne and Azarovitz 1982). Following the metamorphosis into juveniles, the summer flounder seek out inshore demersal habitats (Byrne and Azarovitz 1982). They display a preference for portions of estuaries containing sandy substrates or where there is a transition from fine sand to silt and clay, and water temperatures ranging between 3°C and 27°C (37.4°F and 80.6°F) (Packer et al. 1999). Adults share the same temperature preferences as the juveniles, but upon reaching maturity, move out of the estuaries and onto the continental shelf (Byrne and Azarovitz 1982; Packer et al. 1999).

***Life History***—Summer flounder have two distinct annual spawning periods. The first is also the most intense and occurs over the southern New England and mid-Atlantic regions during autumn and winter. The second spawning period occurs in the southern part of the Mid-Atlantic region in the spring (Berrien and Sibunka 1999). Female summer flounder continually produce egg batches throughout the spawning period (Klein-MacPhee 2002c). Summer flounder begin moving into the inshore waters of southern New England in April continue through July or August. Those fish that move inshore from the Chesapeake Bay north move offshore again in the fall. This offshore migration begins in September and by October or November, most of the summer flounder have left the northern part of their range (Klein-MacPhee 2002c).

***Forage Species***—Summer flounder's diet for larvae includes polychaete tentacles, harpactacoid copepods, and clams. Juveniles prey upon crustaceans, polychaetes, and invertebrate parts. Adults consume bony fish (sand lance, anchovy, herring, silver hake, and flatfish species), crustaceans, and squid (Packer et al. 1999; Klein-MacPhee 2002c). Summer flounder feed on benthos as well as throughout the water column to the surface (Klein-MacPhee 2002c).

***EFH Designations***—(MAFMC and ASMFC 1998b) (**Figure A-18**)

- **Eggs**—Designated EFH includes the pelagic waters found over the continental shelf in the highest 90% of the area where summer flounder eggs were collected during the MARMAP survey (Gulf of Maine to Cape Hatteras, North Carolina). Additional designated EFH is south of Cape Hatteras, North Carolina, to Cape Canaveral, Florida in waters over the continental shelf (from the coast to the limits of the EEZ) to depths of 110 m (361 ft).

- **Larvae**—Designated EFH includes the pelagic waters found over the continental shelf in the highest 90% of the area where summer flounder larvae were collected during the MARMAP survey (Gulf of Maine to Cape Hatteras, North Carolina). Southern New England, mid-Atlantic, and southeast Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area. Additional designated EFH is nearshore waters (to 81.5 km [44 NM] from shore) of the continental shelf (from the coast to the limits of EEZ) south of Cape Hatteras, North Carolina, to Cape Canaveral, Florida.

- **Juveniles**—Designated EFH includes the demersal waters over the continental shelf in the highest 90% of the area where juvenile summer flounder were collected by the NEFSC trawl survey (Gulf of Maine to Cape Hatteras, North Carolina). Southern New England, mid-Atlantic, and southeast Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area. Additional designated EFH is waters over the continental shelf (from the coast to the limits of the EEZ) to depths of 152 m (498.7 ft) south of Cape Hatteras, North Carolina, to Cape Canaveral, Florida.

- **Adults**—Designated EFH includes the demersal waters over the continental shelf in the highest 90% of the area where adult summer flounder were collected by the NEFSC trawl survey (Gulf of Maine to Cape Hatteras, North Carolina). Southern New England, mid-Atlantic, and southeast Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area. Additional designated EFH for this lifestage is waters over the continental shelf (from the coast to the limits of the EEZ) to depths of 152 m (498.7 ft) from Cape Hatteras, North Carolina, to Cape Canaveral, Florida.

***HAPC Designations***—For juvenile and adult lifestages, HAPC is considered to include all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes, whether found as small aggregations or in beds, located within the adult and juvenile summer flounder EFH. Areas designated as HAPC for this species are adjacent to the Study Area (MAFMC and ASMFC 1998b). The ASMFC has identified HAPC as estuaries, bays, and harbors east and south of Cape Cod, Massachusetts as important juvenile habitat. In addition, there are other areas designated by the ASMFC north (Massachusetts) and south (North Carolina) of the Study Area.[2]

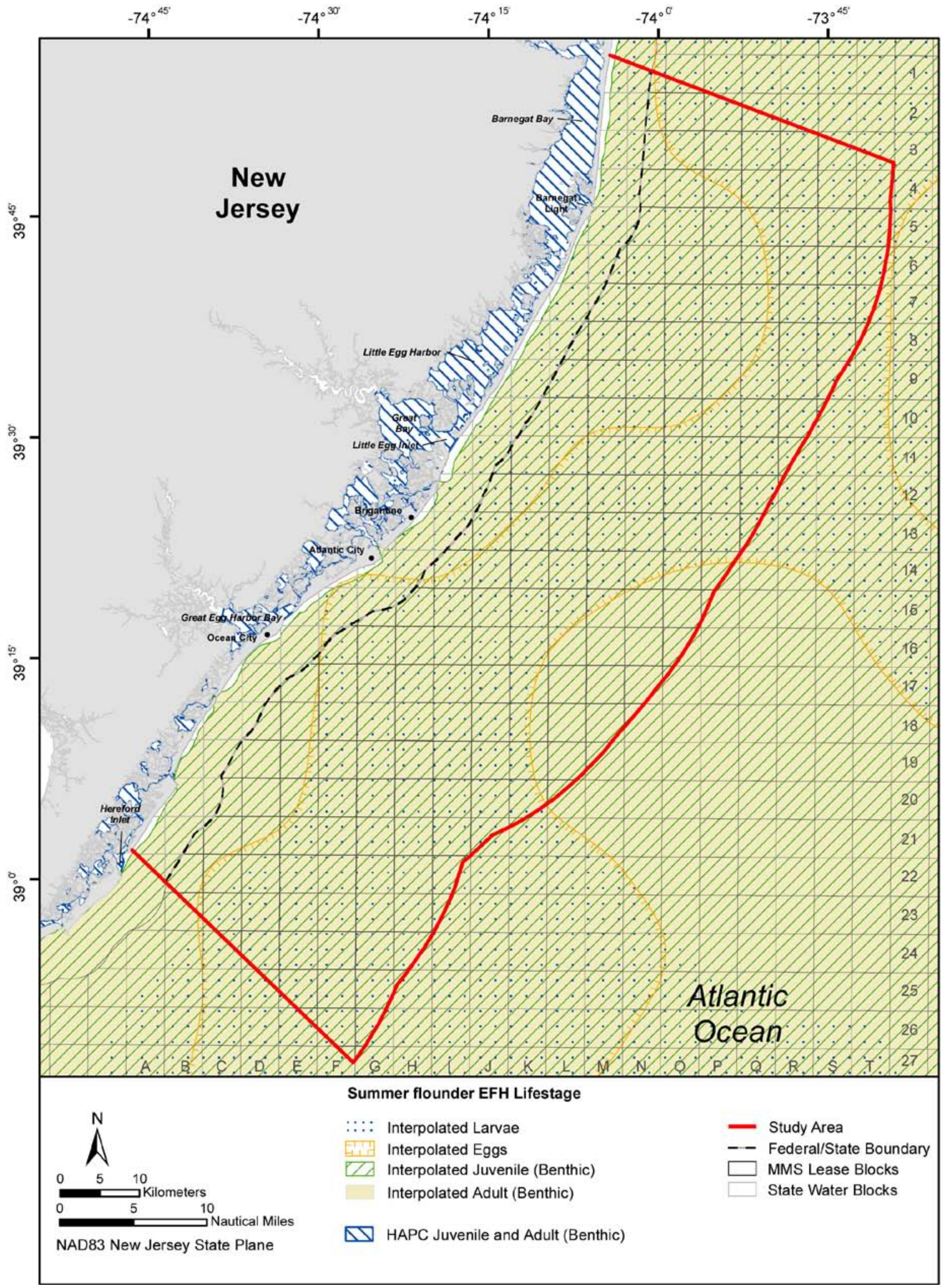


**Figure A-18. Essential fish habitat and habitat areas of particular concern (HAPC) designated in the New Jersey Study Area for all lifestages of summer flounder. Source map (scanned): MAFMC and ASMFC (1998a).**

♦ **Windowpane Flounder (*Scophthalmus aquosus*)**

***Management***—Windowpane flounder currently have EFH designated by the NEFMC through the Final Amendment 11 to the Northeast Multispecies FMP (NEFMC 1998). This species is managed as two stocks: a northern stock, located in the Gulf of Maine and Georges Bank region, and a southern stock, located in the MAB region (NEFMC 1998; NEFMC 2004)).

***Status***—Windowpane flounder (southern New England/mid-Atlantic stock) is classified as overfished; however, overfishing is not occurring (NMFS 2009d).[3]

***Distribution***—Windowpane flounder range throughout the western North Atlantic Ocean from the Gulf of St. Lawrence to Florida, but primarily is found between Georges Bank and the Chesapeake Bay (Morse and Able 1995).

***Habitat Associations***—Windowpane flounder eggs are primarily found throughout the high salinity areas of estuaries and the inner continental shelf in waters between 5°C to 20°C (41°F and 68°F) in temperature and less than 70 m (230 ft) in depth (Chang et al. 1999). Larval windowpane flounder start off as pelagic but settle to the bottom at approximately 10 mm (0.4 in.). They are found primarily in estuaries and on the nearshore continental shelf in waters with temperatures ranging from 3° to 19°C (37.4° to 66.2°F) and at depths of less than 70 m (230 ft) (Morse and Able 1995; Chang et al. 1999). Juveniles and adults are found in estuaries and throughout much of the continental shelf between depths of 5 m and 207 m (16.4 ft and 679.0 ft; most common in waters <50 m [164 ft]) and temperatures of 0° to 27°C (50.0° to 80.6°F) (Morse and Able 1995; Chang et al. 1999; Klein-MacPhee 2002a). Adults are euryhaline and can tolerate salinity ranges of 5.5 to 36.0 psu (Chang et al. 1999; Klein-MacPhee 2002a). Adult windowpane flounder prefer sandy substrates off southern New England and in the MAB but are also frequently observed on mud grounds in the Gulf of Maine (Chang et al. 1999).

***Life History***—Spawning occurs in the inner shelf waters between New Jersey and Cape Hatteras, North Carolina, in February or March. By April, spawning has expanded into the deeper waters and on to Georges Bank. The peak spawning period is between May and October (Klein-MacPhee 2002a) and spawning is completed by January (Morse and Able 1995). Spawning typically occurs in waters with temperatures of 6° to 17°C (42.8° to 62.6°F) (Klein-MacPhee 2002a). Windowpane flounder display limited seasonal movement (Morse and Able 1995). Based on trawl surveys, they are concentrated in shoal waters during the summer and early fall and migrate offshore for the winter and early spring as water temperatures decline (Dery and Livingstone 1982).

***Forage Species***—The main prey of the juvenile and adult windowpane flounder's diet are opossum shrimp (*Neomysis americana*), sevenspine bay shrimp, bony fishes (anchovy, snake eel, silver hake, tomcod, cusk-eel, killifish, silverside, pipefish, blackbelly rosefish [*Helicolenus dactylopterus*], sculpin, Atlantic striped bass (*Morone saxatilis*), sand lance, and flatfish species) and fish larvae (Chang et al. 1999; Klein-MacPhee 2002a). They have also been reported to feed on various other invertebrates, including squids, mollusks, worms, isopods, krill, and salps (Klein-MacPhee 2002a).

***EFH Designations***—(NEFMC 1998) (**Figure A-19**)

- **Eggs**—Designated EFH includes the surface waters around the perimeter of the Gulf of Maine, Georges Bank, and the MAB south to Cape Hatteras, North Carolina. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- **Larvae**—Designated EFH includes the pelagic waters around the perimeter of the Gulf of Maine, Georges Bank, and the MAB south to Cape Hatteras, North Carolina. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- **Juveniles**—Designated EFH includes bottom habitats consisting of mud or fine-grained sand around the perimeter of the Gulf of Maine, Georges Bank, and the MAB south to Cape Hatteras, North Carolina. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- **Adults and Spawning Adults**—Designated EFH includes bottom habitats consisting of substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, Georges Bank, and the MAB south to the Virginia-North Carolina border. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

***HAPC Designations***—There are no HAPC identified for this species.

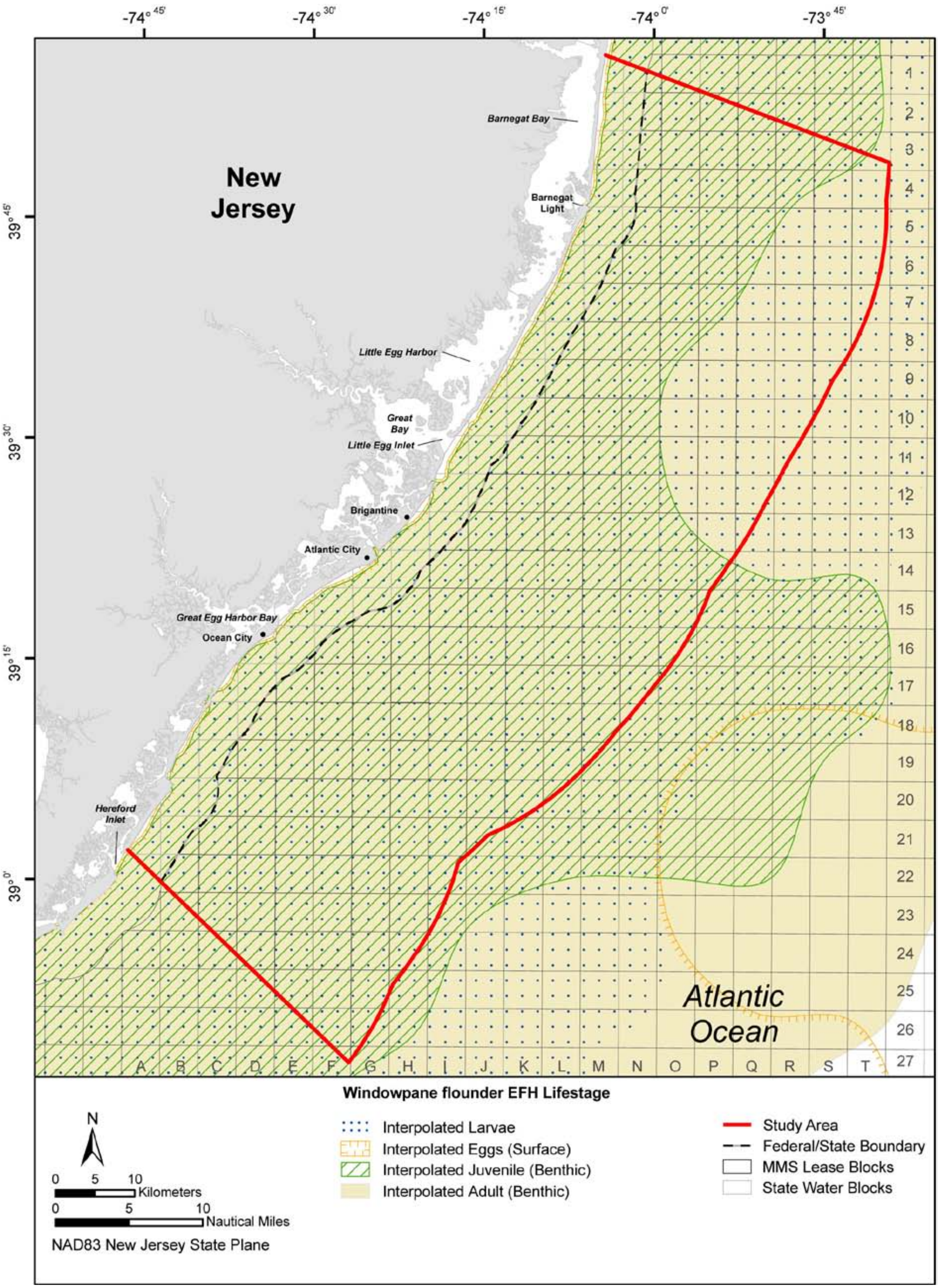


**Figure A-19. Essential fish habitat designated in the New Jersey Study Area for all lifestages of windowpane flounder. Source map (scanned): NEFMC (1998).**

- **Winter Flounder (*Pseudopleuronectes americanus*)**

***Management***—Winter flounder EFH is designated by the NEFMC under the Final Amendment 11 to the Northeast Multispecies FMP (NEFMC 1998).

***Status***—Winter flounder (southern New England/mid-Atlantic stock) are classified as overfished and overfishing is occurring (NMFS 2009d).[3]

***Distribution***—Winter flounder are distributed in the northwestern Atlantic from as far north as Labrador south to Georgia (McCracken 1963) with highest population densities are found between the Gulf of St. Lawrence and the Chesapeake Bay (Klein-MacPhee 2002c).

***Habitat Associations***—Winter flounder eggs are demersal and stick together in clusters. They are laid in estuaries, coves, and inlets in less than 5 m (16.4 ft) of water, at temperatures of 10°C (50°F) or less and salinities of 10 to 30 psu. Eggs occur on a variety of substrates including sand, muddy sand, mud, and gravel (Pereira et al. 1999). Larval winter flounder are negatively buoyant and sink when not swimming (Klein-MacPhee 2002c). They occur inshore, with the exception of Georges Bank and Nantucket Shoals, in waters ranging from 2.0° to 19.5°C (35.6° to 67.1°F) in temperature, salinities of 6 to 26 psu, and depths of 2 to 70 m (6.6 to 230.0 ft) depending on location (Pereira et al. 1999). Newly settled juvenile winter flounders are found in temperature ranges of 4° to 15°C (39.2° to 59.0°F) and are the most densely congregated over muddy substrates or fine-grained substrates. Older juveniles are found to a lesser extent in a variety of habitats, including mud-shell litter, marsh creeks, macroalgae, and eelgrass (Pereira et al. 1999; Klein-MacPhee 2002c). Adult winter flounder prefer water temperatures of 2.0° to 19.5°C (35.6° to 66.2°F) and salinities of 15 psu or greater (McCracken 1963; Pereira et al. 1999). They are found in a variety of habitats ranging from muddy sand, sand, clay, pebbles, and gravel inshore to hard bottom on the offshore banks (Klein-MacPhee 2002c).

***Life History—***Winter flounder are batch spawners, which spawn on sandy bottoms in shallow waters, estuaries, and coastal ponds (Pereira et al. 1999; Klein-MacPhee 2002c). Spawning occurs between January and May off southern New England and during November to April in the southern part of their range, from Delaware south (Klein-MacPhee 2002c). Winter flounder migrate out of the bays and the shore zone during the summer months south of Cape Cod, Massachusetts. North of Cape Cod, this movement pattern is not uniform in all areas. This migration has been correlated with an increase in temperature in excess of 15°C (59°F) in the inshore waters (McCracken 1963). In early fall, winter flounder reappear within the bays and estuaries once temperatures return to the preferred range (McCracken 1963).

***Forage Species***—Winter flounder juvenile and adults are opportunistic feeders, feeding primarily on benthic invertebrates (hydroids, shrimp, amphipods, mollusks, and worms) during the daytime. They have also been recorded to eat sand lances and fish eggs (Pereira et al. 1999; Klein-MacPhee 2002c).

***EFH Designations***—(NEFMC 1998) (**Figure A-20**)

- **Eggs**—Designated EFH includes bottom habitats consisting of sand, muddy sand, mud, and gravel on Georges Bank, inshore areas of the Gulf of Maine, and the MAB south to Delaware Bay. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- **Larvae**—Designated EFH includes the pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, and the MAB south to Delaware Bay. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- **Juveniles**—Designated EFH includes bottom habitats with mud or fine-grained sand located on Georges Bank, the inshore areas of the Gulf of Maine, and the MAB south to Delaware Bay. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- **Adults**—Designated EFH includes bottom habitats including estuaries with substrates consisting of mud, sand, and gravel on Georges Bank, inshore areas of the Gulf of Maine, and the MAB south to Delaware Bay. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area.

- **Spawning Adults**—Designated EFH includes bottom habitats including estuaries with substrates consisting of sand, muddy sand, mud, and gravel on Georges Bank, inshore areas of the Gulf of Maine, and the MAB south to Delaware Bay. New England and mid-Atlantic estuaries and embayments are designated as EFH including Barnegat Bay and New Jersey Inland Bays adjacent to the Study Area

***HAPC Designations***—There are no HAPC identified for this species by the NEFMC. The ASMFC has identified HAPC to include spawning habitats (shallow areas <5 m [16.4 ft]) in the upper estuary, suitable coves, and river mouths; nursery habitats (in or near spawning and settlement areas), and estuaries important as foraging areas for adults.[2]

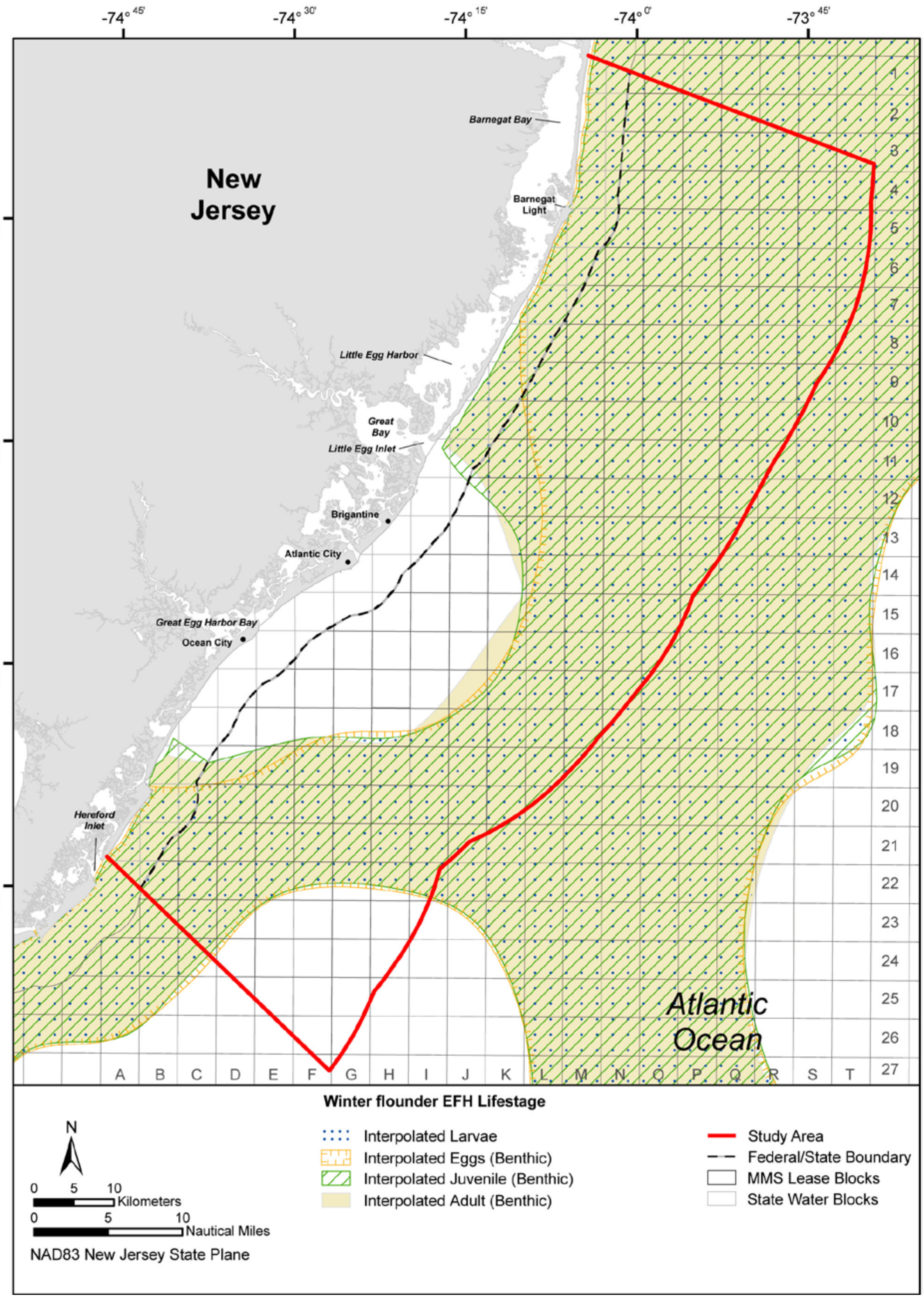


**Figure A-20. Essential fish habitat designated in the New Jersey Study Area for all lifestages of winter flounder. Source map (scanned): NEFMC (1998).**

- **Winter Skate (*Leucoraja ocellata*)**

***Management***—Winter skate has EFH designated by the NEFMC through the Final FMP for the NE Skate Complex (NEFMC 2003b).

***Status***—Winter skate are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Winter skates are found from southern Newfoundland and the southern Gulf of St. Lawrence to Cape Hatteras, North Carolina (McEachran and Musick 1975; McEachran 2002; Packer et al. 2003b).

***Habitat Associations***—Winter skates lay their eggs in capsules on the bottom (McEachran 2002; Packer et al. 2003b). Upon hatching, the skates are already fully developed juveniles (NEFMC 2003b). During the spring, the juvenile winter skates are most common in waters with temperatures of 4° to 5°C (39.2° to 41.0°F), salinities of 32 to 33 psu, and depths of 11 to 70 m (26 to 230 ft). In the fall, juveniles are typically observed in waters with temperatures of 7° to 16°C (44.6° to 60.8°F; peaks between 13°C and 15°C [55.4°F and 59.0°F]), salinities between 32 psu and 33 psu, and depths ranging from 21 to 80 m (69 to 262 ft) (Packer et al. 2003b). In spring, adult winter skates are most abundant in waters ranging from 4° to 6°C (39.2° to 42.8°F) in temperature, salinities of 33 psu, and depths of 31 to 60 m (102 to 197 ft), while during the fall, adults are most commonly distributed in waters with temperatures ranging from 11° to 15°C (51.8° to 59.0°F), salinities of 32 psu, and depths of 31 to 50 m (102 to 164 ft) (Packer et al. 2003b). Winter skates are most frequently found in habitats containing sandy to gravelly bottoms (McEachran 2002).

***Life History***—Female winter skates carrying fully formed egg capsules are present throughout the year but are most common during the summer and fall (McEachran 2002). Winter skates undergo seasonal movements in the southern portion of its range (McEachran and Musick 1975). Only during the winter months are winter skates abundant south of Delaware. In addition, they are more abundant during the winter than the rest of the year in inshore waters near Woods Hole, Massachusetts and in Massachusetts Bay (McEachran 2002).

***Forage Species***—Winter skate juveniles and adults prey primarily on benthic invertebrates, including squid, worms, crabs, krill, shrimp, bivalves, amphipods, echinoderms, and fishes (skates [Rajiidae], eels, herring, alewife, Atlantic menhaden, silver hake, red hake, tomcod, cod, smelt [*Osmerus mordax*], sculpins, redfish [*Sebastes* spp.], sand lance, cunner, butterfish, mackerel, summer flounder, and yellowtail flounder) (McEachran 2002; Packer et al. 2003b).

***EFH Designations***—(NEFMC 2003b) (**Figure A-21**)

- Eggs—Designated EFH includes southern New England and mid-Atlantic estuaries and embayments.
- Larvae—No larval stage exists for this species. Upon hatching, they are fully developed juveniles.
- **Juveniles**—Designated EFH includes bottom habitats consisting of sand and gravel or mud in Cape Cod Bay, on Georges Bank, and through the MAB to North Carolina. Southern New England and mid-Atlantic estuaries and embayments are designated EFH.
- **Adults**—Designated EFH includes bottom habitats consisting of sand and gravel or mud in Cape Cod Bay, on Georges Bank, and through the MAB to North Carolina. Southern New England and mid-Atlantic estuaries and embayments are designated EFH including Barnegat Bay and New Jersey inland bays adjacent to the Study Area.
- Spawning Adults— Designated EFH includes southern New England and mid-Atlantic estuaries and embayments.

***HAPC Designations***—There are no HAPC identified for this species.

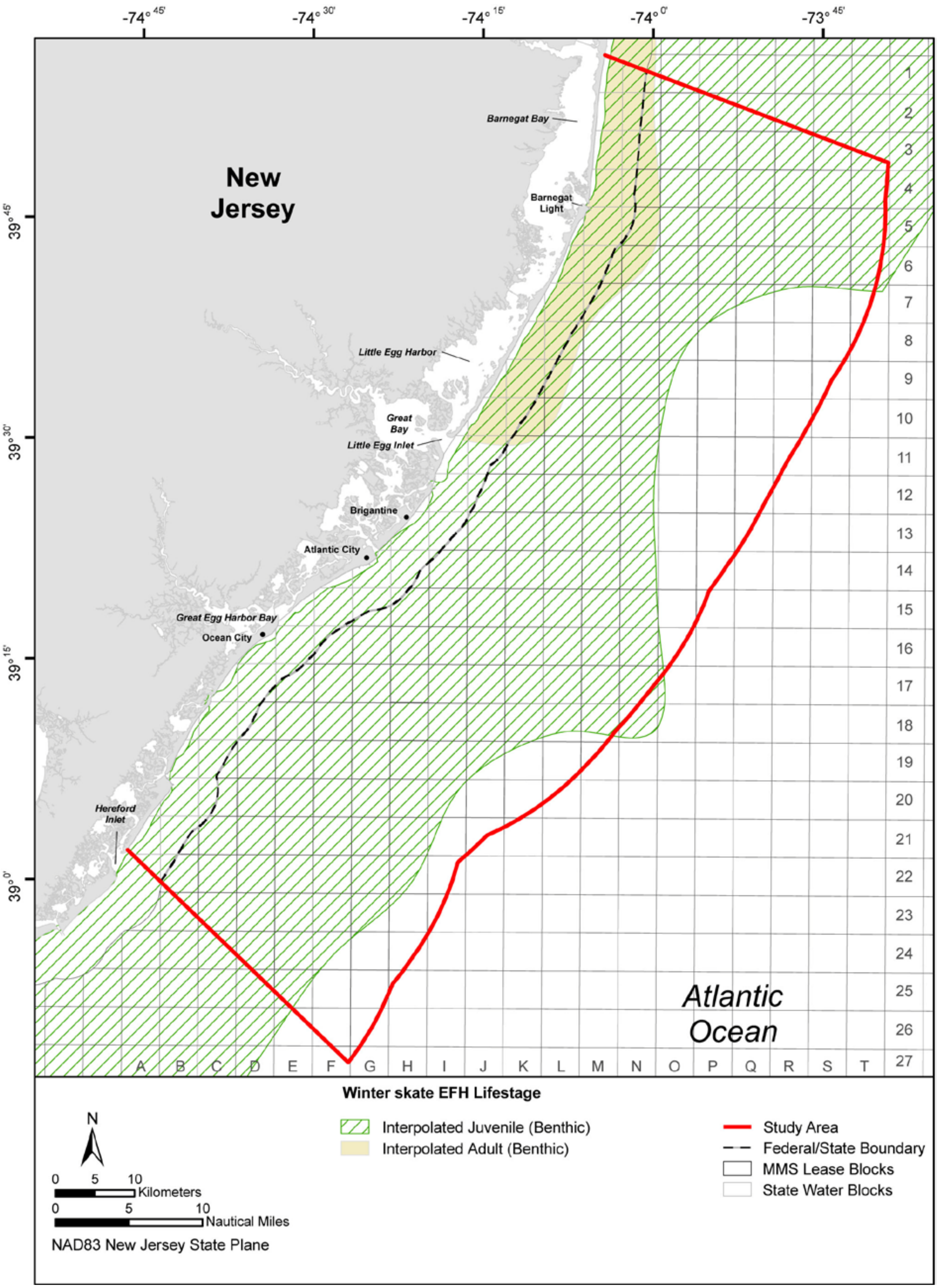


**Figure A-21. Essential fish habitat designated in the New Jersey Study Area for all lifestages of winter skate. Source map (scanned): NEFMC (2003a).**

♦ **Witch Flounder (*Glyptocephalus cynoglossus*)**

***Management***—Witch flounder EFH is designated by the NEFMC through the Final Amendment 11 to the Northeast Multispecies FMP (NEFMC 1998).

***Status***—Witch flounder are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***— Witch flounder occur on both sides of the Atlantic Ocean. In U.S. waters, this species occurs on or adjacent to Georges Bank and along the continental shelf edge and upper slope south to Cape Hatteras, North Carolina (Cargnelli et al. 1999d).

***Habitat Associations***—Witch flounder are benthic species exhibiting a preference for deep water (Cargnelli et al. 1999d). Juveniles and adults are found at depths of 20 to 1,565 m (65.6 ft to 5,134.8 ft), although the highest concentrations occur between 90 m and 300 m (295 ft and 984 ft) (Klein-MacPhee 2002c). Juvenile witch flounder tend to inhabit deeper waters than their adult counterparts (Cargnelli et al. 1999d). Both juveniles and adults prefer temperatures of 0° to 15°C (32° to 59°F) (Klein-MacPhee 2002c) and salinities of 31 to 36 psu (Cargnelli et al. 1999d). Substrate preferences for the species include mud, silt, clay, and muddy sand (Cargnelli et al. 1999d).

***Life History***—Spawning occurs from March to November and generally begins earlier in the southern portion of the range. The peak spawning period takes place between May and August (Brander and Hurley 1992). During spawning, witch flounder form dense aggregations that are concentrated around areas of cold water, typically in the range of 0° to 10°C (32° to 50°F) (Cargnelli et al. 1999d).

***Forage Species***—Witch flounder juveniles and adults feed primarily on polychaete worms but also consume echinoderms, squid, mollusks, amphipods, and isopods (Cargnelli et al. 1999d; Klein-MacPhee 2002c).

***EFH Designations***—(NEFMC 1998) (**Figure A-22**)

- **Eggs**—Designated EFH includes the surface waters of the Gulf of Maine, Georges Bank, and the MAB south to Cape Hatteras, North Carolina.

- **Larvae**—Designated EFH includes the surface waters to 250 m (820 ft) from the Gulf of Maine, Georges Bank, and the MAB south to Cape Hatteras, North Carolina.

- Juveniles—Designated EFH includes fine-grained substrates in the Gulf of Maine and along the shelf break region from Georges Bank south to Cape Hatteras, North Carolina.

- Adults and Spawning Adults—Designated EFH includes fine-grained substrates in the Gulf of Maine and along the shelf break region from Georges Bank south to the Chesapeake Bay.

***HAPC Designations***—There are no HAPC identified for this species.

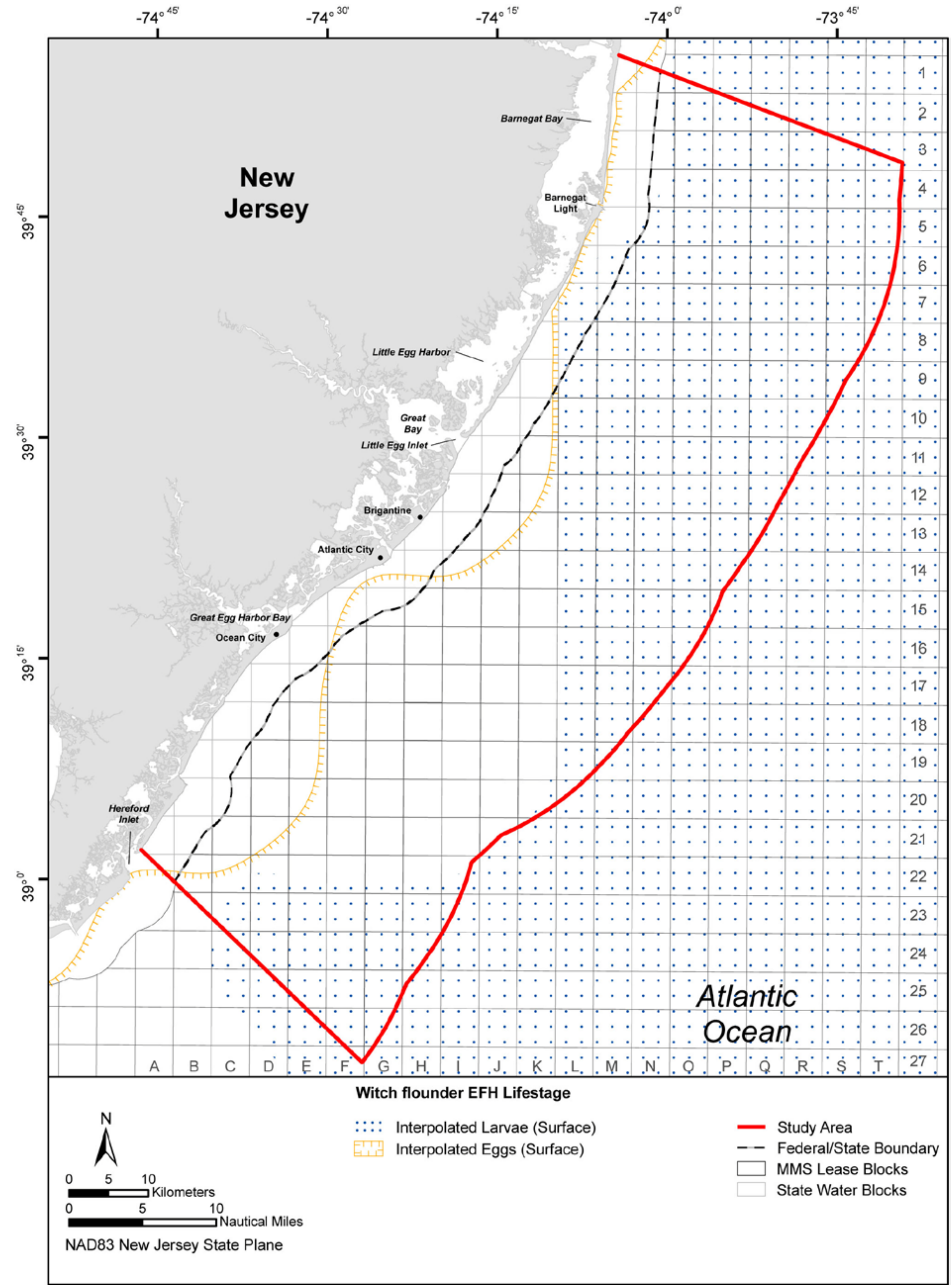


**Figure A-22. Essential fish habitat designated in the New Jersey Study Area for egg and larval lifestages of witch flounder. Source map (scanned): NEFMC (1998).**

♦ **Yellowtail Flounder (*Limanda ferruginea*)**

***Management***—Yellowtail flounder are managed by the NEFMC as five separate stocks (Nova Scotia, Georges Bank, southern New England, Cape Cod, Massachusetts, and the MAB) and have EFH designated under the Final Amendment 11 to the Northeast Multispecies FMP (NEFMC 1998).

***Status***—Yellowtail Flounder (southern New England/mid-Atlantic stock) are classified as overfished and overfishing is occurring (NMFS 2009d).[3] The 2009 IUCN Red List classifies yellowtail flounder as vulnerable, or facing a risk of extinction in the wild.[5]

***Distribution***—Yellowtail flounder are found between the south coast of Labrador and the Chesapeake Bay and occur with greatest frequency between southern New England and Georges Bank, on the Grand Bank, and around Sable Island off the Nova Scotia coast (Lux and Livingstone 1982).

***Habitat Associations***—Yellowtail flounder eggs are buoyant and remain suspended near the surface until hatching (Lux and Livingstone 1982; Johnson et al. 1999). They are found in waters with temperatures of 2° to 15°C (35.6° to 59.0°F) and depths of 10 to 750 m (33 to 2,461 ft; most common from 30 to 90 m [98 to 295 ft]) between February and September (Johnson et al. 1999). Eggs are found on the continental shelf off New Jersey and Long Island, New York, on Browns Bank, on Georges Bank, northwest of Cape Cod, Massachusetts, and in some years as far south as the Chesapeake Bay (Lux and Livingstone 1982; Johnson et al. 1999). Larval yellowtail flounder are pelagic and found during April through August in 5° to 17°C (41.0° to 62.6°F) water temperatures and between 10 m and 1,250 m (33.0 ft and 4,101.3 ft); most abundant between 10 m and 90 m (33 ft and 295 ft) (Lux and Livingstone 1982; Johnson et al. 1999). Juvenile yellowtail flounder prefer benthic habitats and are most commonly found in water temperatures of 2° to 17°C (35.6° to 62.6°F) and between 5 m and 125 m (16.4 ft and 410.0 ft) in depth (Johnson et al. 1999). Adult yellowtail flounder prefer sand and gravel substrates in waters ranging from 2° to 15°C (35.6° to 59.0°F) in temperature and depths of 10 to 100 m (33 to 328 ft) (Johnson et al. 1999; Klein-MacPhee 2002c).

***Life History***—Yellowtail flounder are batch spawners, spawning once a year primarily between March and July, with a peak around mid-May (Lux and Livingstone 1982; Klein-MacPhee 2002c). Little migration occurs between the five relatively distinct stocks of yellowtail flounder and each stock remains primarily within its fishing grounds (Johnson et al. 1999); however, there is evidence to suggest that some yellowtail flounder move considerable distances (Klein-MacPhee 2002c).

***Forage Species***—Amphipods, particularly *Erichthonius rubricornis*, are the primary component of the adult yellowtail flounder's diet. Juveniles prey on the sevenspine bay shrimp. They also consume other invertebrates (crustaceans) and small fishes (Johnson et al. 1999; Klein-MacPhee 2002c).

***EFH Designations***—(NEFMC 1998) (**Figure A-23**)

- **Eggs**—Designated EFH includes the surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the MAB south to Delaware Bay. New England estuaries and embayments are designated EFH.

- **Larvae**—Designated EFH includes the surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the MAB south to Chesapeake Bay. New England estuaries and embayments are designated EFH.

- **Juveniles and Adults**—Designated EFH includes bottom habitats consisting of sand or a combination of sand and mud on Georges Bank, the Gulf of Maine, and the MAB south to Delaware Bay. New England estuaries and embayments are designated EFH.

- **Spawning Adults**—Designated EFH includes bottom habitats consisting of sand or a combination of sand and mud on Georges Bank, the Gulf of Maine, and the MAB south to Delaware Bay. Some New England estuaries and embayments are designated EFH.

***HAPC Designations***—There are no HAPC identified for this species.

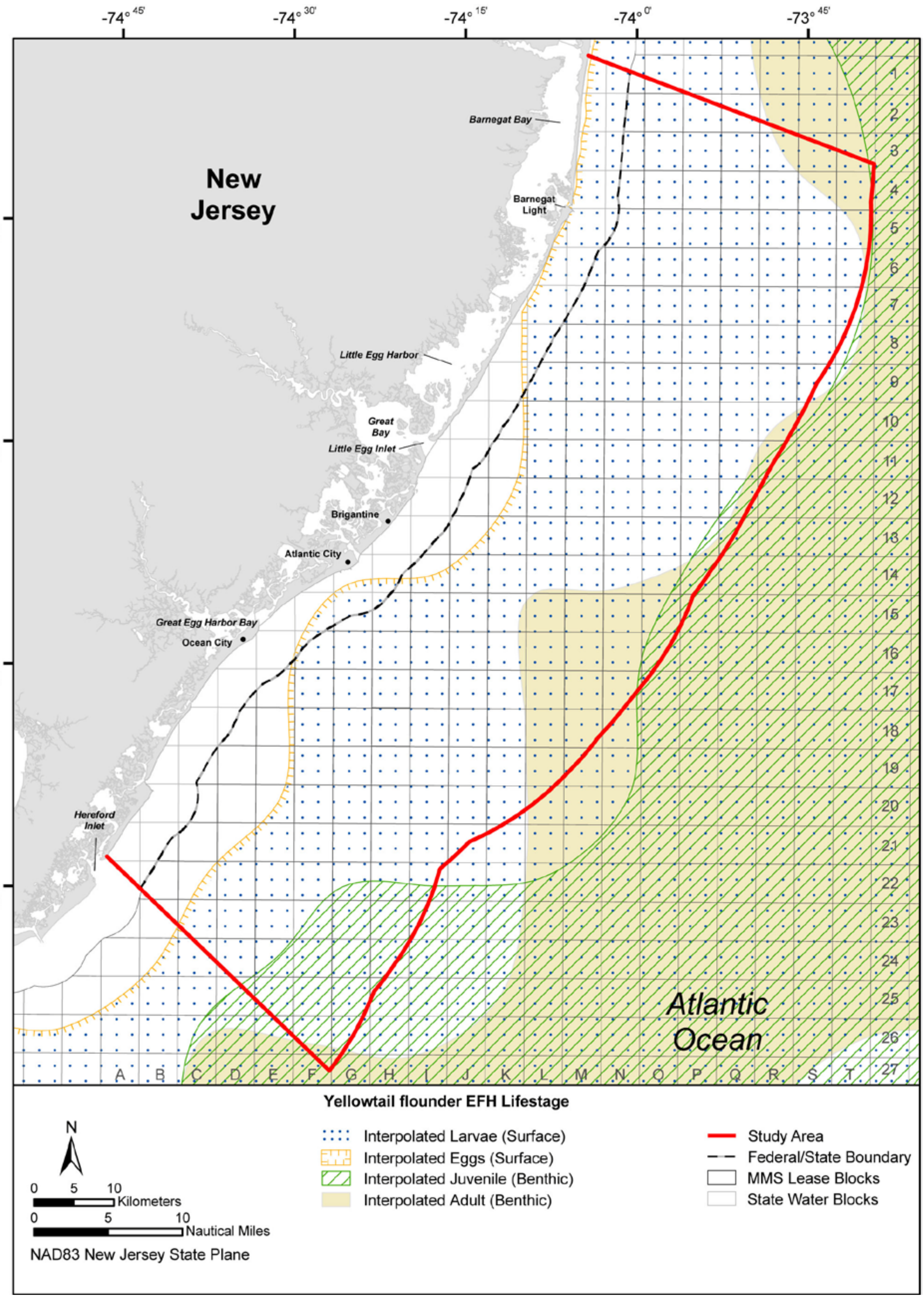


**Figure A-23. Essential fish habitat designated in the New Jersey Study Area for all lifestages of yellowtail flounder. Source map (scanned): NEFMC (1998).**

*Subtropical-Tropical/Southeast Fish Species*

- **Cobia (*Rachycentron canadum*)**

***Management***—Cobia off the southeast coast of the U.S. are managed jointly by the SAFMC and Gulf of Mexico Fishery Management Council (GMFMC); however, EFH in the Study Area is only designated by the SAFMC through the Final Habitat Plan for the South Atlantic Region (SAFMC 1998).

***Status***—Cobia are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Cobia are distributed world-wide throughout tropical, subtropical, and warm-temperate waters, with the exception of the eastern Pacific (Williams 2001). In the western Atlantic, cobia range from Massachusetts and Bermuda to Argentina but are most common along the U.S. coast south of Virginia and in the northern Gulf of Mexico (Franks et al. 1999; FMRI 2003).

***Habitat Associations***—Cobia eggs and larvae are pelagic and found at the surface within the upper meter of water (Ditty and Shaw 1992). Eggs occur between May and August and larvae are found from May to September across the continental shelf from the Gulf Stream to inshore inlets and bays (GMFMC and SAFMC 1985; Ditty and Shaw 1992; Franks et al. 1999). Eggs are found in surface water exceeding 20°C (68°F) in temperature and between 19 psu and 35 psu in salinity (Ditty and Shaw 1992). Developing larvae occupy waters with temperatures of 24.2° to 32.0°C (75.6° to 89.6°F), salinities between 18.9 psu and 37.7 psu, and depths of less than 100 m (328 ft) (Ditty and Shaw 1992). Juvenile and adult cobia are found in coastal bays and inlets and across the continental shelf. Juveniles occur at temperatures between 16.8°C and 25.2°C (62.2°F and 77.4°F) and at salinities of 30.0 to 36.4 psu. Adults prefer temperatures of 19.6° to 28.0°C (67.3° to 82.4°F), salinities ranging from 24.6 to 36.4 psu, and waters ranging in depth from nearshore shallows out to 70 m (230 ft) (GMFMC 1998). They are closely associated with any type of structure including artificial reefs, pilings, platforms, anchored boats, *Sargassum*, and flotsam (Bester 1999b; Williams 2001).

***Life History***—Spawning occurs in the daylight hours between April and September in estuarine or shelf waters (Ditty and Shaw 1992; CBP 2004). Cobia are batch spawners and form large aggregations during spawning (Bester 1999b; Williams 2001). Cobia undergo seasonal migrations. Following the spawning season, cobia migrate south to warmer offshore waters of the Florida Keys during the autumn and winter (CBP 2004). In the spring, they begin their migration north to the polyhaline/mesohaline waters of coastal Virginia and the Carolinas for the summer and to spawn (Williams 2001).

***Forage Species***—Cobia larvae mostly feed on copepods, while juveniles and adults prey upon demersal organisms, particularly crustaceans. Shrimp (i.e., mantis and penaeid), eels, and squid are consumed with the highest frequency. Several fish species have also been observed in the stomachs of cobia, including Spanish mackerel (GMFMC and SAFMC 1985). Cobia also are commonly seen in schools following sharks, turtles, and large rays as they feed, to scavenge food from the other animals (Williams 2001; CBP 2004).

***EFH Designations***—(SAFMC 1998) (**Figure A-24**)

- Larvae—The Gulf Stream is designated as EFH for this lifestage because it provides a mechanism for dispersal.

- **All Lifestages**—In the MAB and the SAB, designated EFH includes sandy shoals of capes and offshore bars, high profile rock bottoms, and barrier island (ocean side) waters from the surf zone to the shelf break but only from the edge of the Gulf Stream shoreward. In addition, high salinity bays, estuaries, seagrass habitat, and coastal inlets are also considered as EFH.

***HAPC Designations***—Areas designated as HAPC for this species are located south of the Study Area (SAFMC 1998).

- **King Mackerel (*Scomberomorous cavalla*)**

***Management***—King Mackerel are managed by the GMFMC and SAFMC. In the Study Area, King mackerel EFH is designated by the SAFMC under the Final Habitat Plan for the South Atlantic Region (SAFMC 1998).

***Status***—King mackerel are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—King mackerel are commonly found along the continental shelf in the warmer waters of the western North Atlantic Ocean from North Carolina to Brazil, but occasionally reported as far north as Massachusetts (Collette 2002; Gold et al. 2002). This species is not usually found further offshore than the shelf break (GMFMC and SAFMC 1985).

***Habitat Associations***—King mackerel eggs are pelagic and occur in waters over depths of 35 to 180 m (115 to 591 ft) during the spring and summer (GMFMC 1998). Larvae occur over the middle and outer continental shelf off the eastern coast of the U.S. from May to November in waters ranging from 22° to 28°C (71.6° to 82.4°F) in temperature, salinities between 30 psu and 37 psu, and over bottom depths of 35 to 180 m (115 to 591 ft) (GMFMC and SAFMC 1985; Godcharles and Murphy 1986; GMFMC 1998). Juvenile and adult king mackerel can be found ranging from inshore waters to the shelf break, but are commonly found at depths of less than 80 m (262 ft). They prefer areas of temperatures greater than 20°C (68°F) and salinities between 32 psu and 36 psu. As adults, king mackerel rarely enter estuaries but feed upon estuarine dependent species (GMFMC 1998).

***Life History***—King mackerel are highly fecund serial spawners (Gledhill and Lyczdowski-Shultz 2000). They have a protracted spawning season that runs from May to October (Godcharles and Murphy 1986). King mackerel exhibit seasonal movements; during the summer, they migrate north and occur in the waters off Virginia and the Carolinas through fall. As the waters become cooler in the winter, they migrate south again to Florida (Godcharles and Murphy 1986; Schaefer and Fable 1994).

***Forage Species***—King mackerel (larvae, juveniles, and adults) feed on a variety of fish species including sardines (Clupeidae), Atlantic thread herring (*Opisthonema oglinum*), Atlantic menhaden, scads and jacks (Carangidae), snappers (Lutjanidae), mackerels, and grunts (Haemulidae). Invertebrate species such as shrimp and squid also make up a large portion of their diet (GMFMC and SAFMC 1985; Collette 2002).

***EFH Designations***—(SAFMC 1998) (**Figure A-24**)

- <u>Larvae</u>—The Gulf Stream is designated as EFH for this lifestage because it provides a mechanism for dispersal.
- **<u>All Lifestages</u>**—In the MAB and the SAB, designated EFH includes sandy shoals of capes and offshore bars, high profile rock bottoms and barrier island ocean side waters from surf zone to the shelf break but only in the region from the wall of the Gulf Stream shoreward. Additionally, all coastal inlets are designated as EFH.

***HAPC Designations***—Areas designated as HAPC for this species are located south of the Study Area (SAFMC 1998).

- **Spanish Mackerel (*Scomberomorous maculatus*)**

***Management***—Spanish mackerel are managed jointly by the SAFMC and the GMFMC. In the Study Area, Spanish mackerel EFH is only designated by the SAFMC under the Final Habitat Plan for the South Atlantic Region (SAFMC 1998).

***Status***—Spanish mackerel are neither classified as overfished, nor is overfishing occurring (NMFS 2009d).

***Distribution***—Spanish mackerel are abundant from the Chesapeake Bay south to the Gulf of Mexico; however, they occasionally occur as far north as the southern coast of New England (Collette 2002).

***Habitat Associations***—Spanish mackerel eggs are pelagic and usually occur over depths of less than 50 m (164 ft) along the inner continental shelf during the spring and summer (Godcharles and Murphy 1986; GMFMC 1998). Larvae occur in coastal waters with temperatures ranging from 20° to 32°C (68.0° to 89.6°F), salinities between 28 psu to 37 psu, and over depths of 9 to 84 m (29.5 to 276.0 ft; most abundant in waters < 50 m [164 ft]) (Godcharles and Murphy 1986; GMFMC 1998). They occur between May and September off the southeast U.S. coast (GMFMC and SAFMC 1985). Juvenile Spanish mackerel utilize a variety of habitats from low salinity estuaries to high salinity nearshore waters as nursery grounds (Godcharles and Murphy 1986). They prefer water temperatures greater than 25°C (77°F) and tolerate a wide range of salinities, typically greater than 10 psu (GMFMC 1998). Adults are surface feeders that form large schools of similar sized fish and often frequent nearshore coastal waters. They also frequently enter tidal estuaries, bays, and lagoons (GMFMC and SAFMC 1985). They are found in waters exceeding 20°C (68°F) and at depths of less than 75 m (246 ft) (GMFMC 1998).

***Life History***—Spanish mackerel have a protracted spawning season, which runs from April to September (GMFMC and SAFMC 1985; Godcharles and Murphy 1986). The onset of spawning progresses from south to north and occurs over the inner continental shelf in waters 12 to 34 m (39.0 to 111.5 ft) deep. Spawning starts in April off the Carolinas, in mid-June in the Chesapeake Bay, and from late August to September off the coasts of New Jersey and New York (Godcharles and Murphy 1986; Collette 2002). Spanish mackerel make seasonal migrations along the Atlantic coast. They are found off Florida during the winter and migrate north as the waters warm. They occur off the Carolinas in April, off Virginia by May, and as far north as Narragansett Bay by July, in some years. They remain in the cooler northern waters until September before beginning their migration south again (GMFMC and SAFMC 1985).

***Forage Species***—Spanish mackerel (larvae, juveniles, and adults) feed primarily on small fishes, including round herring (*Etrumeus teres*), Atlantic menhaden, alewife, anchovies, false pilchard (*Harengula clupeola*), and mullets (*Mugil* spp.). This species also preys upon shrimp, crabs, and squid (GMFMC and SAFMC 1985; Collette 2002).

***EFH Designations***—(SAFMC 1998) (**Figure A-24**)

- Larvae—The Gulf Stream is designated as EFH for this lifestage as it provides a mechanism for dispersal.

- **All Lifestages**—In the MAB and the SAB, designated EFH includes sandy shoals of capes and offshore bars, high profile rock bottom, and barrier island (ocean side) waters from the surf zone to the shelf break but only from the Gulf Stream wall shoreward. Additionally, all coastal inlets are designated as EFH.

***HAPC Designations***—Areas designated as HAPC for this species are located south of the Study Area (SAFMC 1998). The ASMFC has identified HAPC to include spawning grounds and areas where eggs and larvae develop, and estuaries as important habitat and nursery areas, respectively.[2]

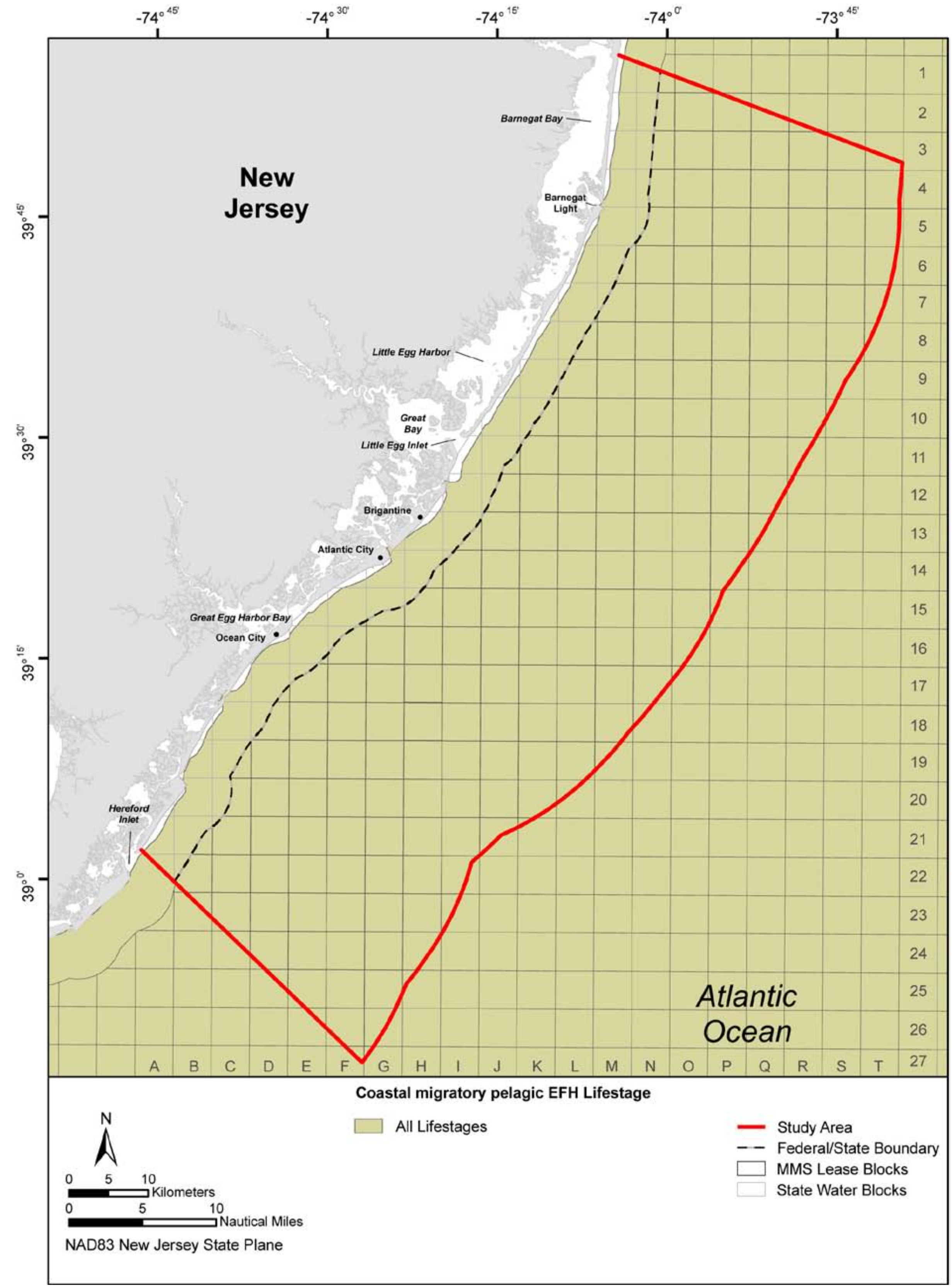


**Figure A-24. Essential fish habitat designated in the New Jersey Study Area for all lifestages of coastal migratory pelagic species. Map adapted from: SAFMC (1998).**

*Highly Migratory Species*

- **Albacore Tuna (*Thunnus alalunga*)**

***Management***—The albacore tuna is managed under the Tuna Management Unit (MU) through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—This species consists of three separate stocks, the north and south Atlantic stocks and a Mediterranean stock (NMFS 2003). The Atlantic stocks are separated at 5° N with no evidence of mixing occurring between the two stocks (NMFS 1999b). According to the current NMFS stock assessment and fishery evaluation reports (NMFS 2009d), the north Atlantic stock is overfished with overfishing occurring; whereas the south Atlantic stock is not overfished and overfishing is not occurring.[3] The north Atlantic stock is listed by the 2009 IUCN Red List as vulnerable or facing a high risk of extinction in the wild,[6] however, the south Atlantic stock is classified as critically endangered or facing an extremely high risk of extinction in the wild.[7]

***Distribution***—Albacore tuna are distributed worldwide in temperate and subtropical waters of the Atlantic, Indian, and Pacific oceans (Gusey 1981; Collette and Nauen 1983). In the western Atlantic Ocean, this species occurs from New England to southern Brazil. Although widespread in the Caribbean Sea and off the coast of Venezuela, this species is absent from the Gulf of Mexico and the Straits of Florida. In the western Atlantic Ocean, the albacore ranges from 40°N to 45°N, to 40°S (Santiago and Arrizabalaga 2005).

***Habitat Associations***—The albacore tuna is an epipelagic and mesopelagic species that is typically found in waters with a temperature range of 15.6° to 19.4°C and in areas around thermal discontinuities, such as ocean fronts (NMFS 2006a). In the Atlantic Ocean, typically larger albacore tuna are found in cooler, deeper waters (up to 600 m) and can tolerate a wider temperature range (13.5° to 25.2°C) than younger, smaller individuals. Schools typically associate with other tuna species (skipjack, yellowfin, and bluefin) and floating objects, including *Sargassum* mats (Collette and Nauen 1983; NMFS 1999b; NMFS 2006a).

***Life History***—Albacore tuna undergo extensive seasonal horizontal movements (north to south and transoceanic migrations). In the western Atlantic Ocean, populations above 25°N migrate north starting in November, while those south of this region remain throughout the fall and winter in the warm waters of the eastern Caribbean and western tropical Atlantic (Gusey 1981). Albacore tuna also tend to aggregate near temperature discontinuities and migrate with water masses; however, they do not seem to cross temperature and oxygen gradient boundaries (Gusey 1981; Collette and Nauen 1983; NMFS 1999b; NMFS 2006a). This species spawns in the spring and summer in the western tropical Atlantic (NMFS 1999b; NMFS 2006a). They are assumed to spawn in waters around the Sargasso Sea and adjacent waters (Santiago and Arrizabalaga 2005).

***Forage Species***—Albacore tuna, as other tuna, are considered opportunistic feeders that prey on a diversity of fishes and invertebrates (NMFS 1999b; NMFS 2006a). Consoli et al. (2008) assessed feeding habits of the albacore tuna in the Mediterranean and found that this species was a top pelagic predator that consumed primarily medium-sized fish and secondarily cephalopods.

***EFH Designations*** (NMFS 2009a; NMFS 2009b)[8] (**Figure A-25**)

- <u>Spawning, eggs, and larvae</u>—Currently, available information is insufficient for the identification of EFH for this lifestage within the U.S. EEZ.

- <u>Juveniles</u> (<90 cm [35.4 in.] fork length [FL])—EFH is designated as offshore waters along the Atlantic east coast from north of Cape Hatteras, North Carolina to Cape Cod, Massachusetts and along the mid-east coast of Florida.

- **Adults** (≥90 cm [35.4 in.] FL)—EFH is designated as offshore waters along the Atlantic east coast from North Carolina, south of Cape Hatteras to Cape Cod, Massachusetts, mid-east coast of Florida, central Gulf of Mexico, and Puerto Rico.

***HAPC Designations***—No HAPC are identified for this species.

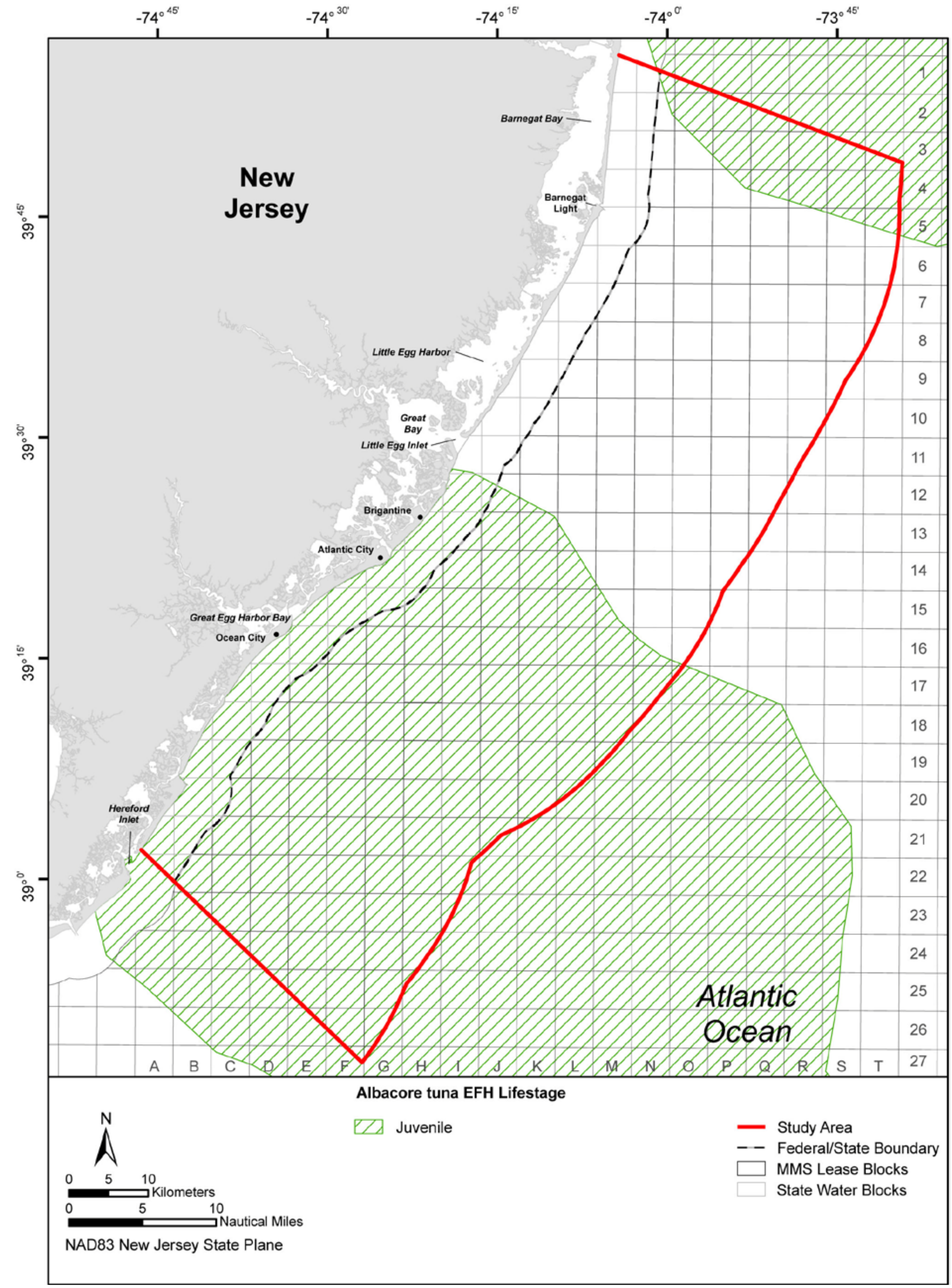


**Figure A-25. Essential fish habitat designated in the New Jersey Study Area for juvenile lifestage of albacore tuna. Source data: NMFS (2009i).[8]**

- **Atlantic Angel Shark (*Squatina dumeril*)**

***Management***—Atlantic angel shark is managed under the Prohibited Species MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—The NMFS (1999b; 2006a) prohibits possession of this species as a precautionary measure due to the lack of biological data and its high susceptibly to exploitation. The 2009 IUCN Red List designates the Atlantic angel shark as data deficient to properly assess the population (Heupel and Carlson 2006).[9]

***Distribution***—Atlantic angel sharks inhabit temperate and subtropical waters in the northwestern Atlantic from Massachusetts to Florida Keys, the Gulf of Mexico, and the Caribbean Sea. It is common in the MAB from southern New England to the Maryland coast (Castro 1983).

***Habitat Associations***—This demersal shark species buries itself in the sand or mud in shallow waters of the northern part of its range, while in the southern part of its range, it inhabits deeper waters (up to 1,390 m [4,560.6 ft]) off the continental shelf (Castro 1983; Compagno 1984a).

***Life History***—This shark appears seasonally in shallow water, moving inshore in the spring and summer. Its winter grounds are not known as it disappears from shallow waters, presumably retreating to deeper water for the duration of winter (Castro 1983). It gives birth to live young (up to 16 pups in 1 litter) in the spring or early summer (Castro 1983). This species has a biennial reproductive cycle with gestation period of approximately 10 months (Baremore and Carlson 2004).

***Forage Species***—Atlantic angel shark is a demersal feeder, which often feeds on fishes, crustaceans, and bivalves (Compagno 1984a). Baremore et al. (2010) reported teleost fishes, especially Atlantic croaker (*Micropogonias undulates*), butterfish, and goatfishes (Mullidae) were most important prey items along with *Loligo* squid, mantis shrimp (*Lysosquilla* sp.), brown rock shrimp (*Sicyonia brevirostris*), and portunid crabs (Portunidae).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-26**)

- Neonate/Young-of-the-Year (YOY) (≤31 cm [12.2 in.] Total Length [TL])— Currently, insufficient data is available to determine EFH for this lifestage.

- **Juveniles and Adults**—EFH is designated along the Atlantic coast from Cape Lookout, North Carolina to the mid-coast of New Jersey, localized areas off of eastern Louisiana, and from Mississippi to the Florida Panhandle in the Gulf of Mexico.

***HAPC Designations***—There are no HAPC identified for this species.

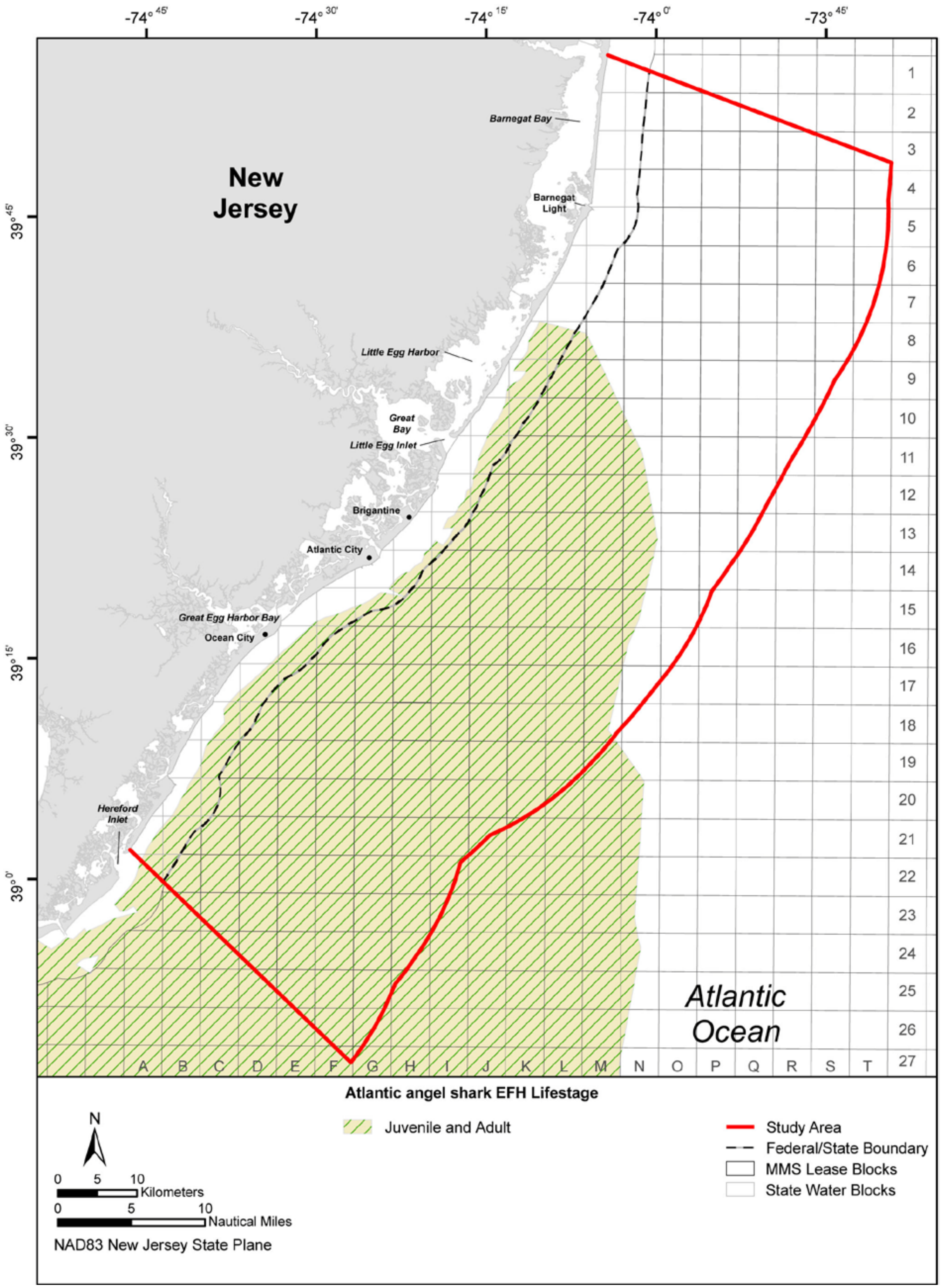


**Figure A-26. Essential fish habitat designated in the New Jersey Study Area for juvenile and adult lifestages of Atlantic angel sharks. Source data: NMFS (2009).[8]**

- **Blue Shark (*Prionace glauca*)**

***Management***—Blue shark is managed under the Pelagic Shark MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—Currently, it is unknown whether blue shark is overfished or if overfishing is occurring (NMFS 2009d). Numerically, the blue shark is the top non-target species captured by the U.S. Atlantic pelagic longline fleet which may make it more vulnerable to overfishing (Beerkircher et al. 2002). Catch rate information from the North Atlantic suggests that this species may be declining (Campana et al. 2006; Aires-da-Silva et al. 2008). The 2009 IUCN Red List designates blue shark as lower risk/near threatened or likely to qualify for a threatened future in the near future.[10]

***Distribution***—Blue sharks have a world-wide distribution and are considered the widest-ranging shark species (Compagno 1984b). Even though its range extends into the tropics, it is commonly found in deeper, more temperate waters (Ferrari and Ferrari 2002). In the northwestern Atlantic, this shark is found from Newfoundland, Canada south to Argentina, South America (Compagno 1984b). There are no records of this shark in the Gulf of Mexico (Castro 1983).

***Habitat Associations***—Blue sharks inhabit waters from the surface to depths up to 600 m (1, 969 ft) (Nakano and Stevens 2008) and although this species is oceanic, it occasionally occurs close to shore at night or in areas where the continental shelf is narrow (Castro 1983; Compagno 1984b; Cooper 1999). This shark is also epipelagic being found in large aggregations close to the surface in temperate waters. It prefers relatively cool water, from 7° to 16°C (44.6° to 60.8°F) but can tolerate water as warm as 21°C (69.8°F) (Cooper 1999; NMFS 1999b; NMFS 2006a).

***Life History***—Little is known about the reproductive locations of this species in the Atlantic, but mating is believed to occur in late May and early June on the continental shelf off New England (Branstetter and Burgess 2002b). This species has a gestation period of 12 months producing a litter of 28 to 54 pups (Pratt 1979). Blue shark nurseries are believed to occur in the open oceanic waters of higher latitudes of their range (NMFS 1999b; NMFS 2006a). Blue sharks have complex migratory patterns related to reproduction and the distribution of prey that generally encompasses great distances. Castro (1983) reported a population of northwest Atlantic blue sharks migrating to northeastern South America, whereas Queiroz et al. (2005) found that 82% of tagged blue sharks in the northeast Atlantic traveled less than 1,000 km (539.6 NM) while the remaining 18 percent traveled longer distances to northwest Africa, central Atlantic, and the Bay of Biscay. In addition, its north-south movements seemed to be related to seasonal sea surface temperature (SST) variation. Kohler and Turner (2008) also reported that tagging studies demonstrated extensive movements in the Atlantic with numerous trans-Atlantic migrations, which were probably accomplished by swimming more slowly and utilizing the major current systems.

***Forage Species***—Blue sharks feed on small pelagic fishes (herrings, sardines, skates, lancetfish [*Alepisaurus* spp.], cod, bluefish, scup, butterfish, mackerel, and yellowtail flounder), invertebrates (squid, cuttlefish, and octopus), and seabirds, as well as scavenging on cetaceans (possibly as carrion) (Cooper 1999; Nakano and Stevens 2008). In the mid-Atlantic, squid are the primary component of the blue shark's diet (Branstetter and Burgess 2002b).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-27**)

- Neonate (≤90 cm [35.4 in.] TL)—Designated EFH includes areas in the Atlantic Ocean off of New Jersey through Cape Cod, Massachusetts.

- **Juveniles** (91 to 220 cm [35.8 to 86.6 in.] TL)—Designated EFH includes localized areas in the Atlantic Ocean off the mid-coast of Florida, South Carolina, and the Gulf of Maine, and from Cape Hatteras, North Carolina to New England.

- **<u>Adults</u>** (≥221 cm [87 in.] TL)—Designated EFH includes localized areas in the Atlantic Ocean off Florida and Georgia and from South Carolina to the Gulf of Maine as well as localized areas off Puerto Rico and the U.S. Virgin Islands.

***HAPC Designations***—There are no HAPC identified for this species.

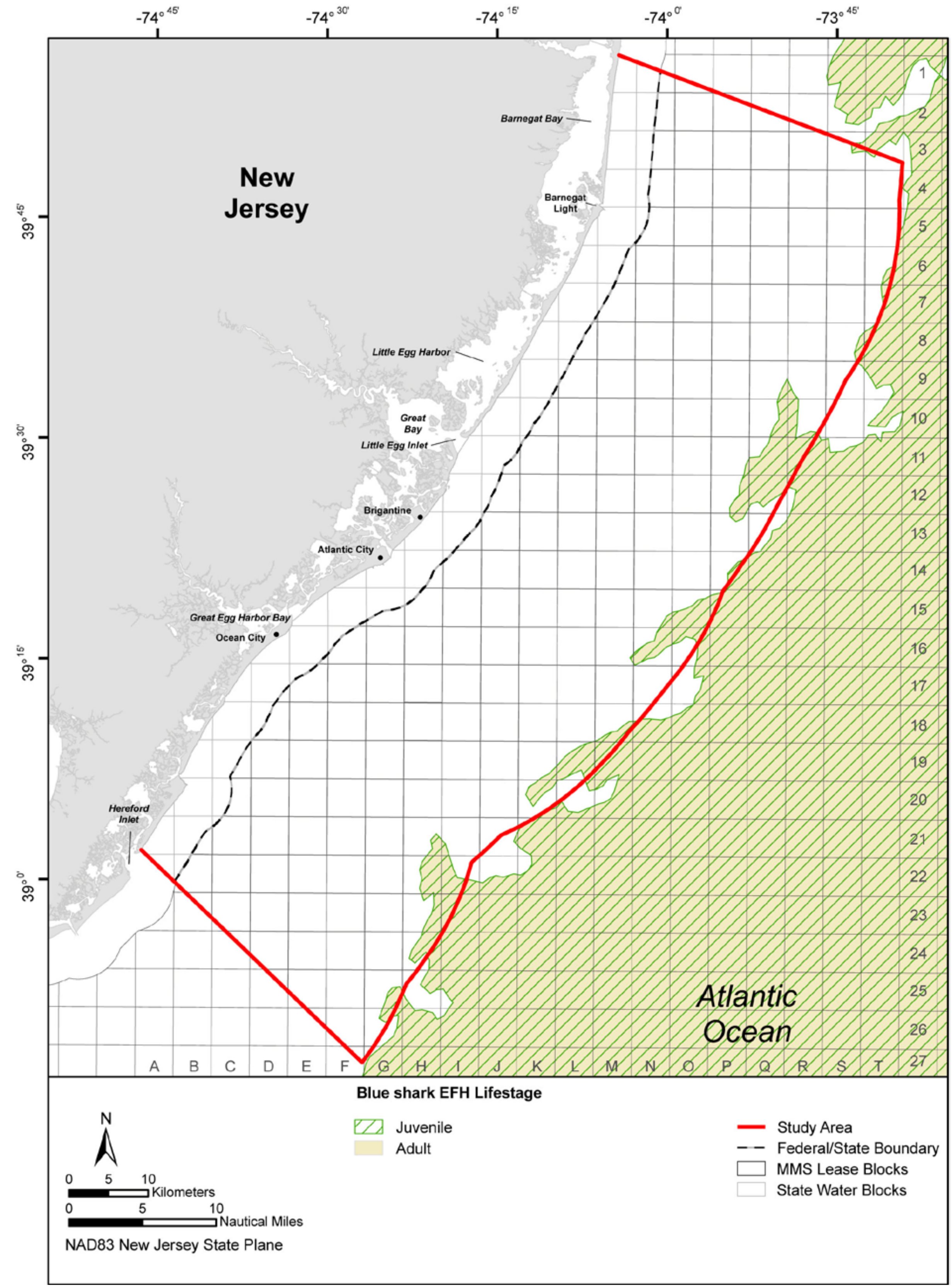


**Figure A-27. Essential fish habitat designated in the New Jersey Study Area for all lifestages of blue sharks. Source data: NMFS (2009).[8]**

- **Bluefin Tuna (*Thunnus thynnus*)**

***Management***—Bluefin tuna is managed under the Tuna MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a). They are managed as distinct western and eastern stocks separated by a management boundary at the 45°W meridian (Collette and Nauen 1983).

***Status***—Bluefin tuna are classified as overfished and overfishing is occurring (NMFS 2009d).[3] The 2009 IUCN Red List classifies bluefin tuna (western Atlantic stock) as data deficient to properly assess the population;[11] however, the eastern Atlantic stock (*T. maccoyii*) is classified as critically endangered or facing an extremely high risk of extinction in the wild.[12]

***Distribution***—Bluefin tuna have a world-wide distribution in tropical and temperate waters, from Argentina and South Africa north to Labrador and northern Scandinavia in the Atlantic Ocean, including the Gulf of Mexico and the Caribbean Sea (Schultz 2004). In the western North Atlantic Ocean, bluefin tuna range from 0°N to 45°N, but have been reported as far north as 55°N (Collette and Nauen 1983; Vinnichenko 1996; NMFS 1999b; NMFS 2006a).

***Habitat Associations***—This species can tolerate a considerable range of temperatures and has been observed to depths greater than 1,000 m (3,281 ft) (Block et al. 2001). Although bluefin tuna are epipelagic and usually oceanic, they often occur over continental shelf waters and in embayments during the summer months (Collette 2002). Fertilized eggs are buoyant (Collette 2002). Larvae are believed to associate with Gulf Stream along the continental shelf in regions of upwelling (NMFS 1999b; NMFS 2006a) which, together with upwelling nutrients, provide an area favorable for maximum growth and retention of food (McGowan and Richards 1989). Larvae have been confirmed from the Gulf of Mexico (NMFS 2009a) and have been found as far north as the Carolinas (McGowan and Richards 1989). Juveniles typically inhabit regions off the continental shelf, from North Carolina to Rhode Island, in waters with depths less than 40 m (131 ft) and temperatures greater than 20°C (68°F) in the summer (June and July) (Schuck 1982; Brill et al. 2002). Juveniles, along the continental shelf, utilize the entire water column including the benthic habitat but spend the majority of their time near the surface (Brill et al. 2002). Bluefin tuna are often found in mixed schools with skipjack tuna, consisting of similarly sized individuals. Larger individuals move into higher latitudes than do smaller fish (NMFS 2009a).

***Life History***—The western North Atlantic bluefin tuna spawns from mid-April to mid-June in the Gulf of Mexico, the Florida Straits, western edge of the Bahamas Banks, and along the eastern portion of the Florida current at temperatures of 24.9° to 29.5°C (76.8° to 85.1°F) (Gusey 1981; Collette and Nauen 1983; NMFS 1999b; Block et al. 2005). The Gulf of Mexico spawning site is considered the primary spawning area of the northwest Atlantic stock (Mather et al. 1995; Block et al. 2001). Presumed breeding bluefin tuna prefer continental slope waters with moderate SST, eddy kinetic energy, and wind speeds and low surface chlorophyll concentrations (Teo et al. 2007).

The adult bluefin tuna moves seasonally from offshore spawning grounds in the Gulf of Mexico through the Straits of Florida to waters overlying the continental shelf, slope, and Gulf Stream waters of the SAB, MAB, the Gulf of Maine, and the Nova Scotia shelf (Block et al. 2005). By early spring and summer, they move to their inshore seasonal feeding grounds along the New England continental shelf (Jeffreys Ledge, Stellwagen Bank, Cape Cod Bay, Great South Channel, and south of Martha's Vineyard) (Gusey 1981; Schuck 1982; Block et al. 2001; Chase 2002). Wilson and Block (2009) identified the following key potential North Atlantic foraging habitats: northwest Atlantic (Gulf of Maine/Scotian Shelf, Grand Banks, and Flemish Cap), off Florida and in the Bahamas, and northeast Atlantic.

Data on the southerly three-way movements of adults from these feeding areas to wintering areas and back to breeding areas (Gulf of Mexico/Florida Straits) are limited. It has been postulated that juveniles have a shorter two-way movement from feeding to wintering areas (Mather et al. 1995; Chase 2002). Recently, mixed-stocked analysis indicated that approximately 60 percent of the adult bluefin tuna collected in foraging areas off the U.S. Atlantic Ocean originated from the eastern nursery, suggesting that substantial trans-Atlantic movement of adults occur from east to west (Rooker et al. 2007).

***Forage Species***—Bluefin tuna larvae feed upon zooplankton and other larval fishes (McGowan and Richards 1989). Adults are opportunistic feeders preying upon variety of schooling fishes (anchovies, sauries [Scomberessocidae], and hakes), pelagic crustaceans, cephalopods, and benthic invertebrates including the following: silver hake, Atlantic mackerel, Atlantic herring, krill, sand lance, and squid (Schuck 1982; NMFS 1999b; Estrada et al. 2005; NMFS 2006a; Butler et al. 2010).

***EFH Designations***—(NMFS 2009a; NMFS 2009b)[8] (**Figure A-28**)

- Spawning, Eggs, and Larvae—Designated EFH includes the Gulf of Mexico from the 100 m (328.1 ft) contour to the EEZ, continuing to the mid-east coast of Florida.

- **Juveniles** (<231 cm [90.9 in.] FL)—Designated EFH includes the waters off North Carolina, south of Cape Hatteras to Cape Cod, Massachusetts.

- Adults (>231 cm [90.9 in.] FL)—Designated EFH are includes the pelagic waters of the central Gulf of Mexico, mid-east coast of Florida, North Carolina from Cape Lookout to Cape Hatteras, North Carolina and New England from Connecticut to the mid-coast of Maine.

***HAPC Designations***—Areas designated as HAPC for this species are located south of the Study Area in the Gulf of Mexico (NMFS 2009c).

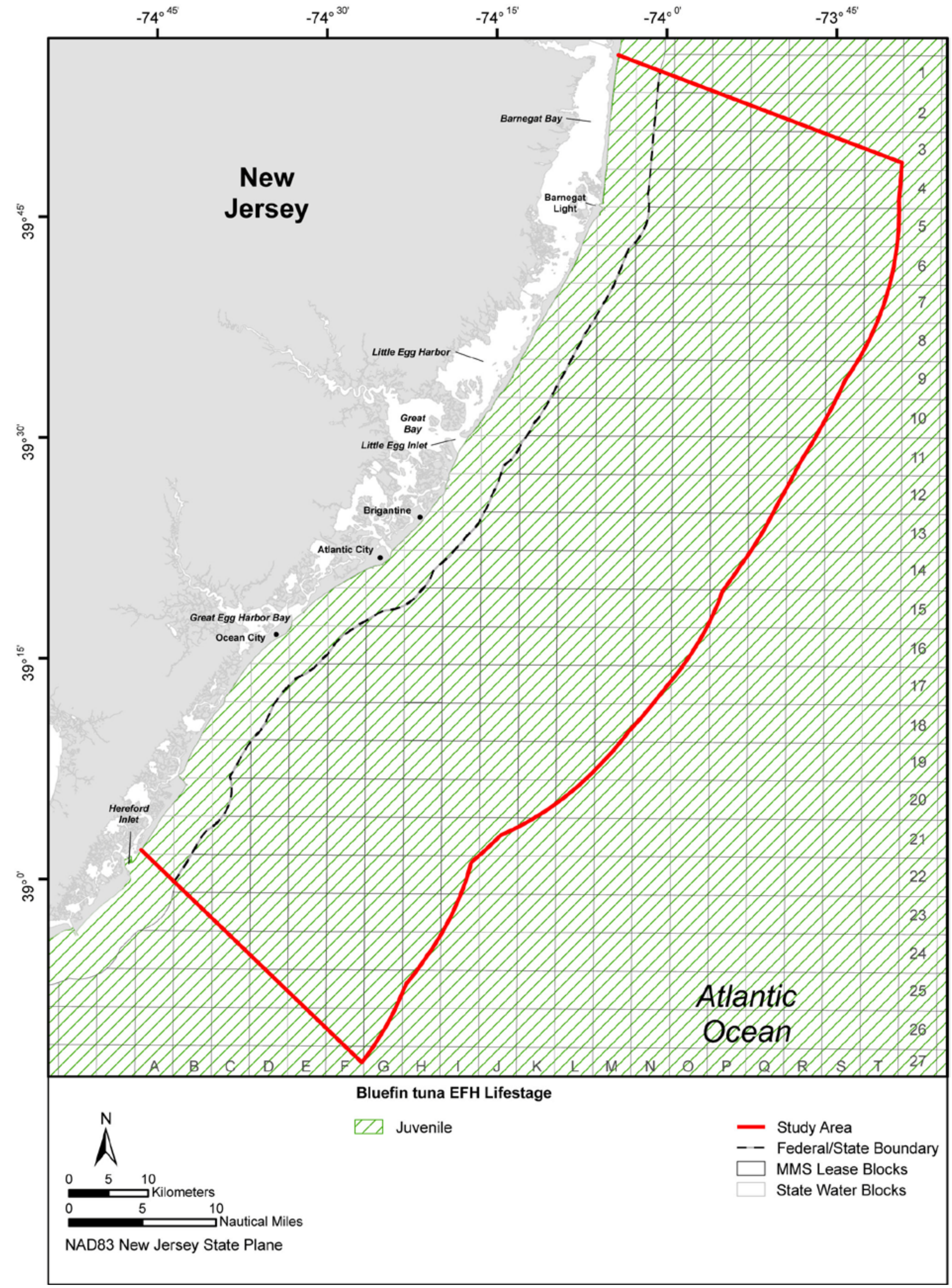


**Figure A-28. Essential fish habitat designated in the New Jersey Study Area for juvenile lifestage of bluefin tuna. Source data: NMFS (2009).[8]**

- **Dusky Shark (*Carcharhinus obscurus*)**

***Management***—Dusky shark is managed under the Prohibited Species MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—Currently, dusky shark is classified as overfished and overfishing is occurring (NMFS 2009d).[3] This species is often taken as bycatch in both bottom and pelagic longline fisheries making vulnerable to overfishing (NMFS 2009a). Dusky sharks are listed as a prohibited species to assist with rebuilding the population status. Under the Endangered Species Act (ESA) classification system, dusky shark are currently identified as a species of concern (formerly a candidate species) by NMFS (2004; 2006b). The 2009 IUCN Red List classifies dusky shark (Northwest Atlantic and Gulf of Mexico subpopulation) as vulnerable or facing a high risk of extinction in the wild in the medium-term future.[13]

***Distribution***—Dusky sharks are wide-ranging. They are distributed in warm-temperate and tropical continental waters throughout the world and can be found in the western North Atlantic Ocean from southern Massachusetts and the Georges Bank southward to the northern Caribbean Sea and Gulf of Mexico to Nicaragua and southern Brazil (Compagno 1984b; Castro 1993).

***Habitat Associations***—Dusky sharks are coastal pelagics found from the surf zone to offshore waters. They are found from surface waters to depths of 400 m (1,312 ft) (Compagno 1984b; Branstetter and Burgess 2002b). Major nursery areas have been identified in coastal waters from South Carolina coast to Massachusetts (Castro 1993; McCandless et al. 2002).

***Life History***—In the western North Atlantic Ocean, dusky shark mating occurs in the spring and birth to live young is from late winter to summer (Compagno 1984b). In Bulls Bay, North Carolina, dusky sharks typically give birth from April to May, while in the Chesapeake Bay it occurs in June and July (Castro 1993). Females mate in alternate years as a result of their long gestation period (9 to 16 months) (Compagno 1984b). It is believed that the dusky shark has a gestation period of about 16 months (NMFS 2009a). They produce a litter of six to 14 pups (Castro 1983). The dusky shark undertakes long seasonal, temperature-related migrations. On both coasts of the U.S., this species migrates northward in summer as the waters warm and retreats southward in fall as water temperatures decline (Compagno 1984b; NMFS 2003).

***Forage Species***—Dusky sharks feed on bony fish (eels, Atlantic menhaden, herring, anchovies, hakes, goosefish, black sea bass, scup, croakers, bluefish, sand lance, mackerels, tunas, and flatfish species), other sharks, crustaceans, and squid (Branstetter and Burgess 2002b).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-29**)

- **Neonate/Young-of-the Year (YOY)** (<121 cm [47.6 in.] FL)—Designated EFH includes areas along the Atlantic east coast of Florida to the mid-coast of Georgia and South Carolina to southern Cape Cod, Massachusetts.

- **Juveniles and Adults**—Designated EFH includes localized areas in the central Gulf of Mexico, southern Texas, the Florida Panhandle, the mid-west coast of Florida, and the Florida Keys and localized areas along the Atlantic coast of Florida and South Carolina to southern Cape Cod, Massachusetts.

***HAPC Designations***—There are no HAPC identified for this species.

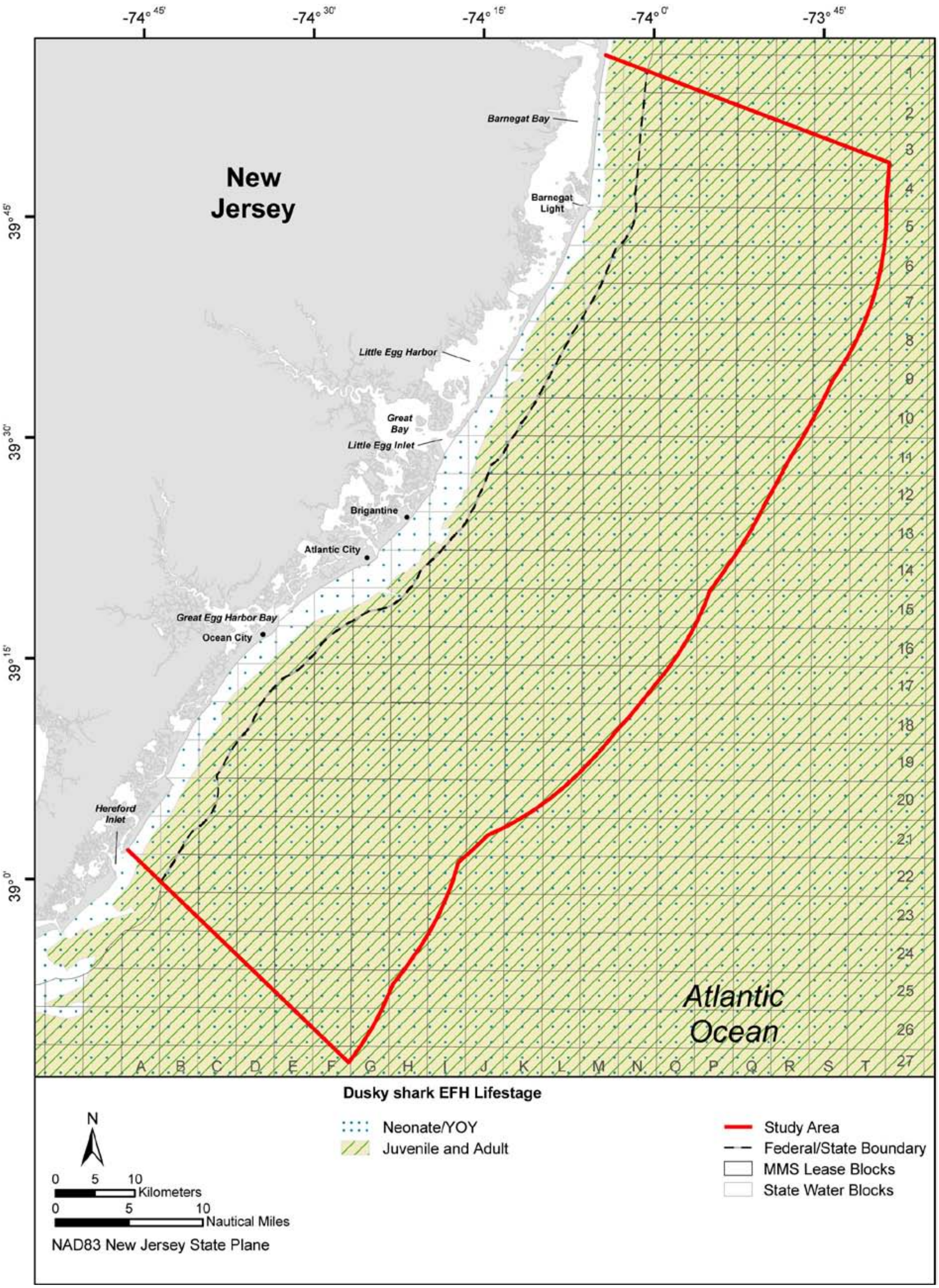


**Figure A-29. Essential fish habitat designated in the New Jersey Study Area for all lifestages of dusky sharks. Source data: NMFS (2009).[8]**

♦ **Longbill spearfish (*Tetrapturus pfluegeri*)**

***Management***—The longbill spearfish is managed under the Billfish MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—This species is neither overfished nor subject to overfishing (NMFS 2009d). The longbill spearfish is not a target species, and retention is prohibited in the U.S. EEZ when it is taken as bycatch of the tuna and swordfish longline fisheries (NMFS 2009a).

***Distribution***—The longbill spearfish ranges from 40°N to 35°S in the Atlantic and occurs in the western Atlantic Ocean from Georges Bank south through the Gulf of Mexico to Brazil (Manooch III 1988; NMFS 1999a).

***Habitat Associations***—Little is known about the habitat associations of this species (Nakamura 1985; de Sylva and Breder 1997). Longbill spearfish are an epipelagic, oceanic species usually inhabiting waters above the thermocline and are found further offshore than other billfish species (Nakamura 1985). Larvae have been collected near the mid-Atlantic Ridge from December to February, and in the Caribbean (NMFS 1999a).

***Life History***—Few data exist on reproductive behavior or locations for this species, but spawning is thought to occur in widespread areas in the tropical and subtropical Atlantic Ocean (Nakamura 1985), well offshore, from November through May (Manooch III 1988; de Sylva and Breder 1997).

***Forage Species***—Longbill spearfish, which are surface feeders, prey primarily on pelagic fishes (anchovy and dolphinfish [*Coryphaena* spp.]) and squid (NMFS 1999a). Feeding occurs during both daylight and night hours, and it is not known if this species uses its bill to aid in capturing prey (Manooch III 1988).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-30**)

- Spawning, Eggs, and Larvae—Currently, insufficient data is available to determine EFH for these lifestages.

- **Juveniles/Subadults and Adults**—Designated EFH includes the central Gulf of Mexico through eastern Louisiana to the Florida Panhandle, the Atlantic Ocean from the Florida Keys to the mid-east coast of Florida and localized areas from northern Florida to Cape Cod, Massachusetts, with concentration from North Carolina to Delaware, and Puerto Rico to the Virgin Islands.

***HAPC Designations***—No HAPC are identified for this species.

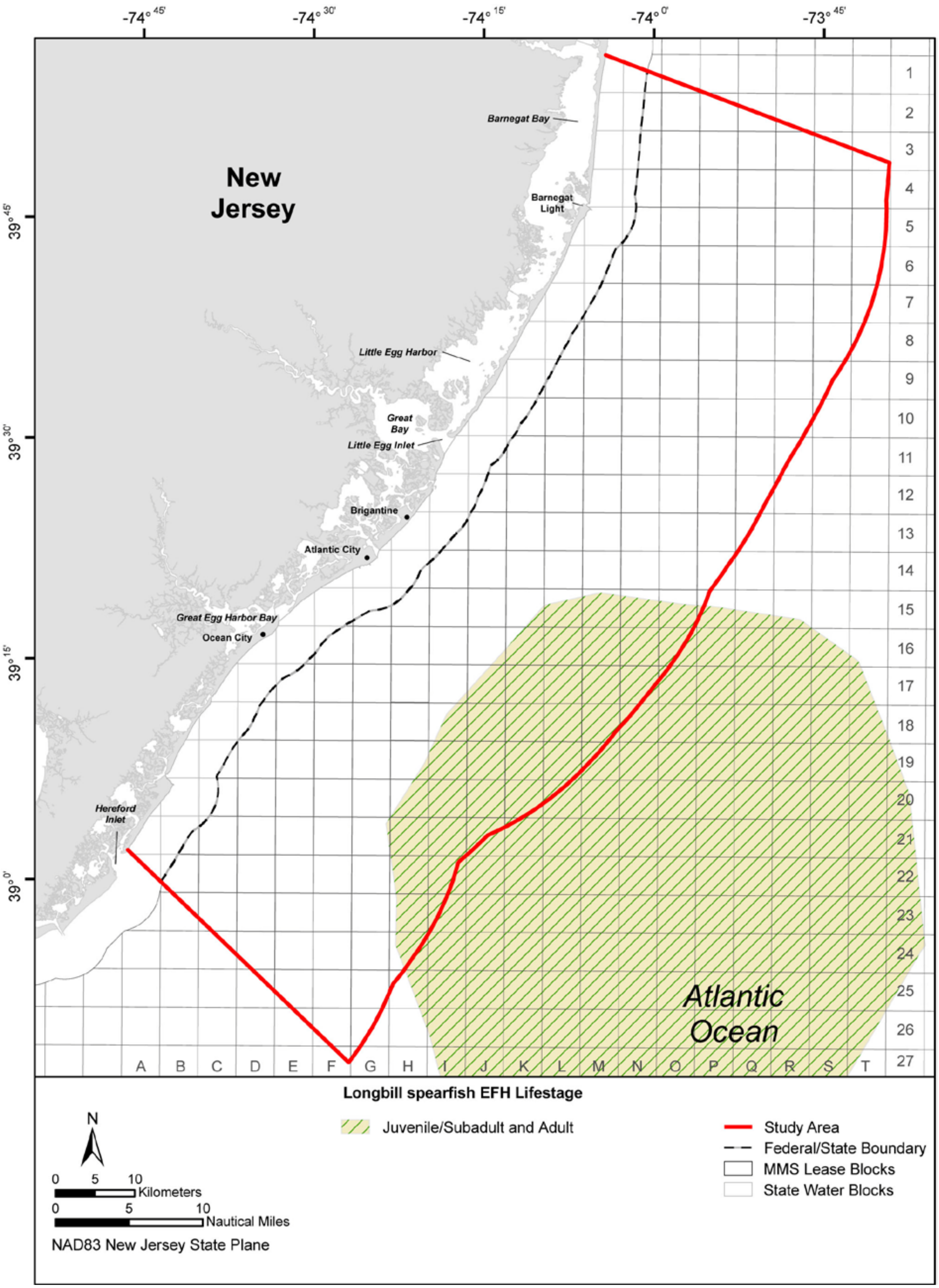


**Figure A-30. Essential fish habitat designated in the New Jersey Study Area for juvenile and adult lifestages of longbill spearfish. Source data: NMFS (2009).[8]**

♦ **Sand Tiger Shark (*Carcharias taurus*)**

***Management***—Sand tiger shark is managed under the Prohibited Species MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—The sand tiger shark does not have an overfished status nor is it subject to overfishing (NMFS 2009d). However, this species is extremely vulnerable to overfishing because it congregates in coastal areas in large numbers during mating season (NMFS 2009d). The sand tiger shark receives full protection from harvest on the Atlantic coast. In 1997, NMFS prohibited possession of this species in U.S. Atlantic waters (NMFS 2008a). Under the ESA classification system, the Atlantic and Gulf of Mexico populations of the sand tiger shark are currently identified as a species of concern (formerly a candidate species) by NMFS (2004; 2006b). The 2009 IUCN Red List classifies sand tiger shark as vulnerable or facing a high risk of extinction in the wild in the medium-term future.[14]

***Distribution***—Sand tiger sharks are known to have broad inshore distribution in tropical and warm-temperate waters throughout the world but are nonexistent in the eastern Pacific Ocean (Castro 1983; Branstetter and Burgess 2002a). In the western Atlantic, the sand tiger shark occurs from the Gulf of Maine to Florida, the northern Gulf of Mexico, the Bahamas, and Bermuda and southward to Argentina (Castro 1983; Compagno 1984a). In warmer months, this species is common from Cape Cod, Massachusetts to Delaware Bay (Castro 1983).

***Habitat Associations***—Sand tiger sharks are demersal sharks primarily found in shallow bays (4 m [13.1 ft]) and around coral or rocky reefs (depths <20 m [65.6 ft]) but also are found to depths to 191 m (627 ft) over the continental shelf (Castro 1983; Compagno 1984a; NMFS 1999b; Branstetter and Burgess 2002a). Neonate and juvenile sand tiger sharks utilize estuarine waters as nurseries from Massachusetts to South Carolina including Narrangansett Bay, Rhode Island and Sandy Hook, New Jersey and Delaware and Chesapeake bays, north and south of the Study Area (McCandless et al. 2002; NMFS 2006a). Mature sand tiger males and juveniles occur between Cape Cod, Massachusetts and Cape Hatteras, North Carolina, while mature and pregnant females inhabit the more southern waters between Cape Hatteras and Florida (Gilmore 1993).

***Life History***—Sand tiger sharks have an extremely limited reproductive potential, producing only two litter per year (NMFS 2009a). This species mates in the winter and spring with parturition believed to occur in winter (late October to end of November) in the southern portion of its range (NMFS 1999b; Branstetter and Burgess 2002a). In Florida, sand tiger sharks are born from November to February (Castro 1983), whereas Lucifora et al. (2002) reported in North America they gave birth in March and April. Sand tiger sharks are migratory in the northern portion of its range moving northward and inshore during the summer to nurseries and south to deeper waters in the fall and winter (Castro 1983; Compagno 1984a).

***Forage Species***—Sand tiger sharks are a generalized feeder, consuming a variety of teleost and elasmobranch prey (Gelsleichter et al. 1999). They feed primarily on fishes (skates, goosefish, searobins, scup, spot, bluefish, and butterfish), specifically summer flounder, as well as invertebrates (lobster, crab, and squid) (Branstetter and Burgess 2002a).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-31**)

- **Neonate/YOY** (≤129 cm [50.8 in.] TL)—Designated EFH includes areas along the Atlantic east coast from northern Florida to Cape Cod, Massachusetts.
- **Juveniles** (130 to 229 cm [51.2 to 90.2 in.] TL)—Designated EFH includes localized areas along the mid-east coast of Florida and South Carolina and from North Carolina to the mid-New Jersey coast in the Atlantic.

- **Adults** (≥230 cm [90.6 in.] TL)—Designated EFH includes localized areas along the mid and northern east coast of Florida, South Carolina, and southern North Carolina, and from Cape Lookout, North Carolina to Southern New Jersey in the Atlantic.

***HAPC Designations***—There are no HAPC identified for this species.

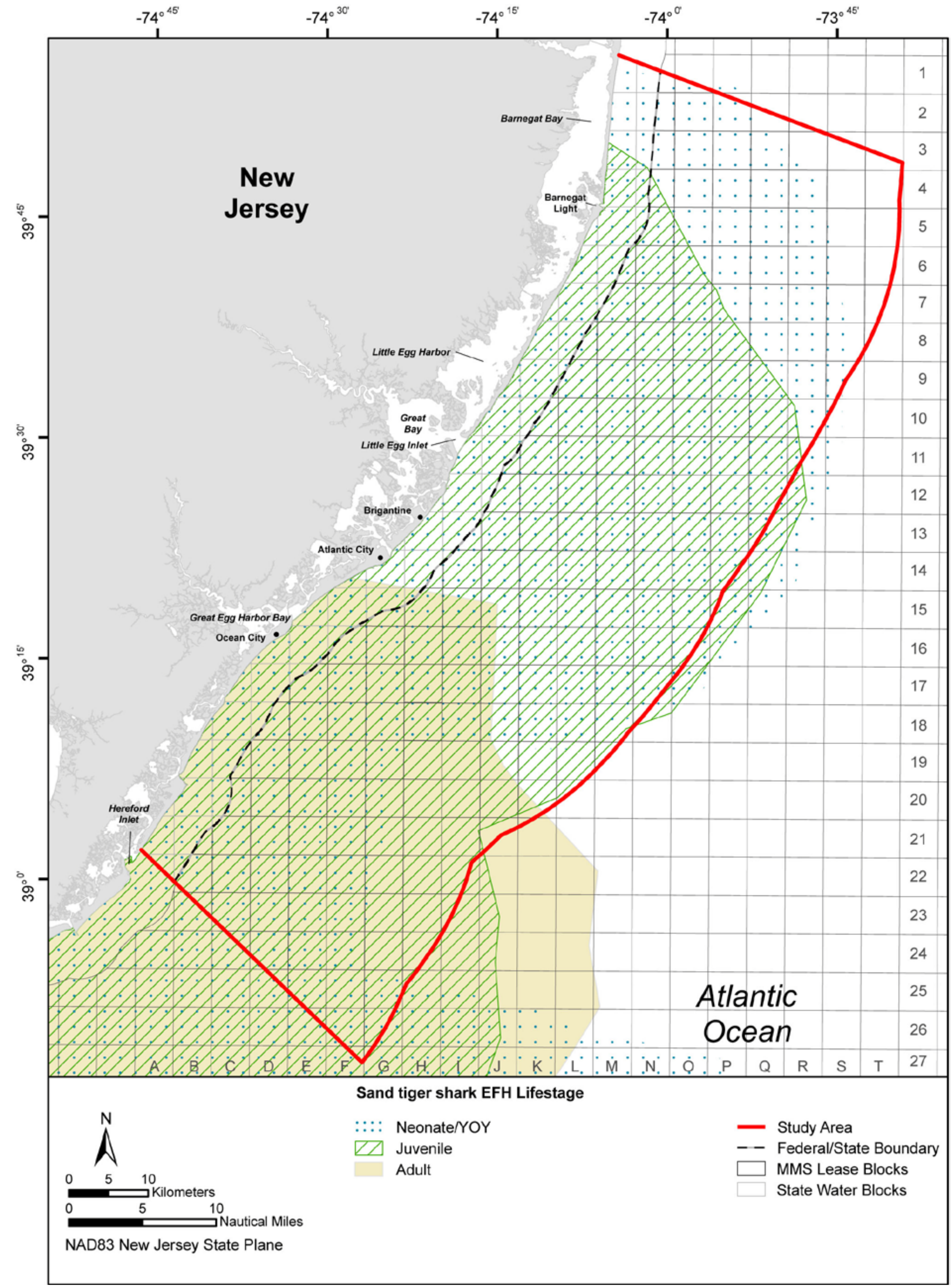


**Figure A-31. Essential fish habitat designated in the New Jersey Study Area for all lifestages of sand tiger sharks. Source data: NMFS (2009).[8]**

♦ **Sandbar Shark (*Carcharhinus plumbeus*)**

***Management***—Sandbar shark is managed under the Large Coastal Shark MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—Sandbar sharks are overfished and are subject to overfishing (NMFS 2009d).[3] It is considered highly vulnerable to overfishing because of its slow maturation and heavy fishing pressure, as evidenced in the catch-per-unit-effort (CPUE) declines in U.S. fisheries (NMFS 2009a). With the implementation of Amendment 2 to Consolidated HMS FMP (NMFS 2008b), the fishing mortality on sandbar sharks was greatly reduced by prohibiting this species from retention in recreational fishery and only allowing directed fishing under the auspices of the shark research fishery. The 2009 IUCN Red List classifies the northwest Atlantic stock as a lower risk/near threatened.[15]

***Distribution***—Sandbar sharks are cosmopolitan in distribution, found in shallow coastal waters from Cape Cod, Massachusetts, southward to Brazil, including the western Gulf of Mexico and Caribbean Sea but are most common from South Carolina to Florida and in the eastern Gulf of Mexico (Castro 1983; Branstetter and Burgess 2002b; Conrath and Musick 2007).

***Habitat Associations***—This bottom-dwelling species is found in warm temperate to subtropical waters over the continental shelf and in deep water adjacent to the shelf break. Sandbar sharks are found in water depths ranging from the intertidal zone to 280 m (919 ft) during migration, but are common in 20 to 53 m (65.6 to 174.0 ft) depths (Compagno 1984b; Knickle 1999a). Sandbar sharks avoid surf zones, coral reefs, or rough benthic substrates, preferring smooth substrates (Castro 1983; Compagno 1984b). It is common in inshore areas with mud or sand subtrates such as estuaries, river mouths, and harbors but does not enter freshwater (Compagno 1984b).

***Life History***—Sandbar shark is a slow-growing species, with about a one year gestation period and a biennial reproduction producing a litter of 1 to 14 pups (NMFS 2009a). This species is reported to make extensive seasonal migrations, where it moves to the northern part of its range in the summer and the southern part during the winter (Castro 1983). Seasonal temperature changes are the primary trigger for the migration; however, oceanographic features also influence this behavior (Compagno 1984b). Male sandbar sharks typically migrate earlier in the year and to deeper waters than females (Knickle 1999a). In the northwest Atlantic, mating occurs from May to June with young being born from March to August after a gestation period of approximately one year (Castro 1983; Knickle 1999a; NMFS 1999b). This species segregates by sex with large females dominating shallow, nursery areas from Martha's Vineyard, Massachusetts to Cape Canaveral, Florida, as well as the Gulf of Mexico (Castro 1983, 1993; McCandless et al. 2002). Great Bay, New Jersey, Delaware Bay, the Chesapeake Bay, and waters off Cape Hatteras, North Carolina are important primary and secondary nursery grounds in the mid-Atlantic (Branstetter and Burgess 2002b; Mc Candless et al. 2002). Primary nurseries are where parturition occurs and where neonate and young-of-the-year (YOY) sharks are present, whereas secondary nurseries are generally used by older sharks following departure from primary nurseries (McCandless et al. 2002).

***Forage Species***—Juvenile sandbars feed on blue crabs (*Callinectes sapidus*), mantis shrimp (*Squilla empusa*), Atlantic menhaden, summer flounder, and miscellaneous sciaenid fishes (Grubbs et al. 2005). Adults feed on benthic prey, such as finfishes (eels, skates, rays, and dogfish), invertebrates (squid, octopus, bivalves, shrimp, and crabs), and sea turtles as well as seabirds. They feed all day, but are most active at night (Knickle 1999a).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-32**)

- **<u>Neonate/YOY</u>** (≤78 cm [30.7 in.] TL)—Designated EFH includes localized coastal areas on the Florida Panhandle, Atlantic coastal areas localized along Georgia and South Carolina, and from Cape Lookout, North Carolina to Long Island, New York.

- **Juveniles** (79 to 190 cm [31.1 to 74.8 in.] TL)—Designated EFH includes localized areas along the Atlantic coast of Florida, South Carolina, and south North Carolina, and from Cape Lookout, North Carolina to southern New England.

- **Adults** (≥191 cm [75.2 in.] TL)—Designated EFH includes a localized area off of Alabama and coastal areas from the Florida Panhandle to the Florida Keys in the Gulf of Mexico as well as Atlantic coastal areas throughout Florida to southern New England.

***HAPC Designations***—HAPC has been designated in shallow areas and at the mouth of Great Bay, New Jersey; lower and middle Delaware Bay, Delaware; lower Chesapeake Bay, Maryland; and near the Outer Banks, North Carolina, and in areas of Pamlico Sound and adjacent to Hatteras and Ocracoke islands (North Carolina) and offshore of these barrier islands, since they represent important nursery and pupping grounds (NMFS 2009a). A portion of Great Bay, New Jersey, HAPC extends within the boundaries of the Study Area, while the HAPC of middle and lower Delaware Bay is found south of the Study Area.

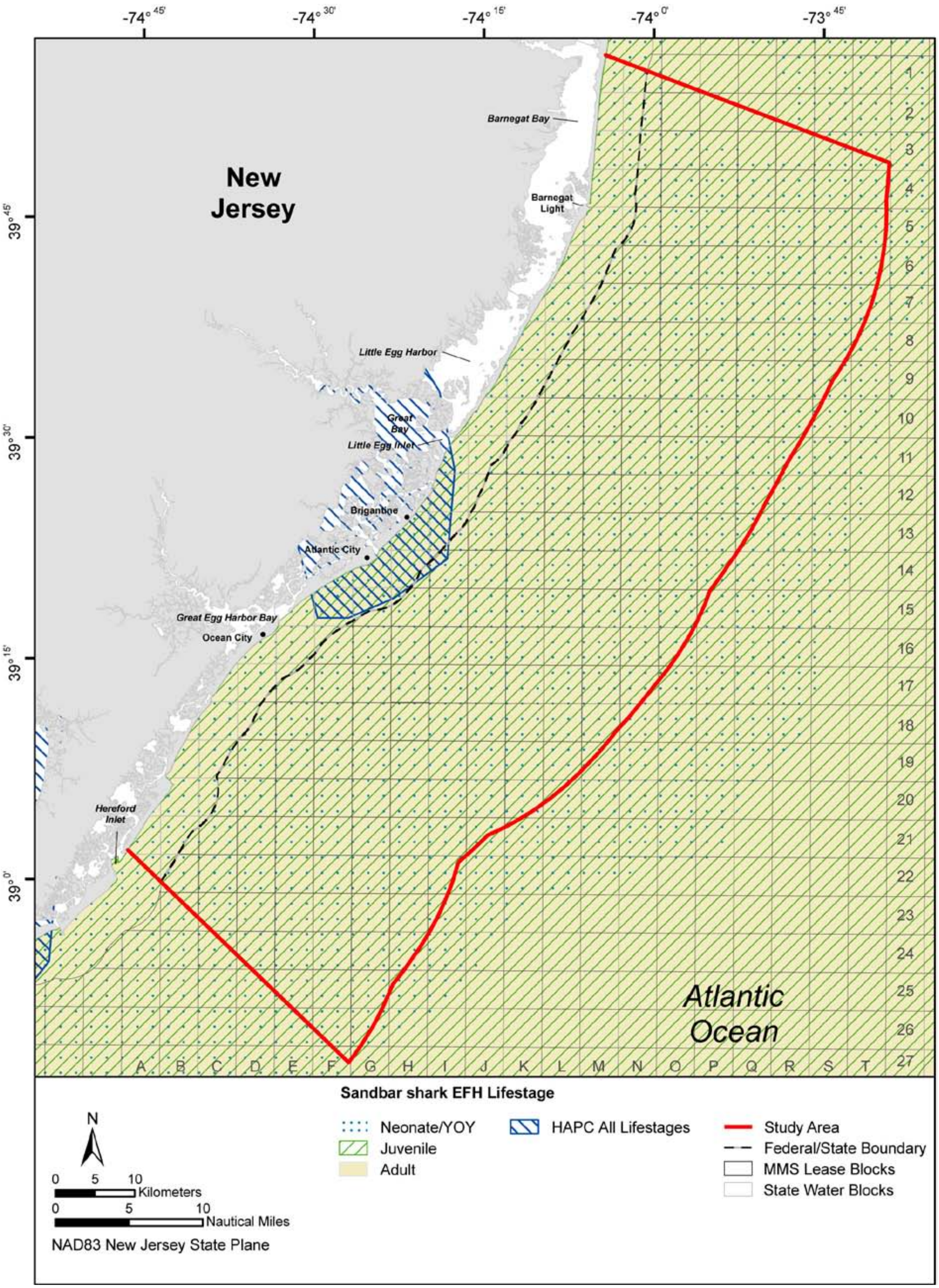


**Figure A-32. Essential fish habitat and habitat areas of particular concern (HAPC) designated in the New Jersey Study Area for all lifestages of sandbar sharks. Source data: NMFS (2009).[8]**

♦ **Scalloped Hammerhead (*Sphyrna lewini*)**

***Management***—Scalloped hammerhead shark is managed under the Large Coastal Shark MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—Scalloped hammerhead shark is neither overfished nor subject to overfishing (NMFS 2009d). It considered vulnerable to overfishing because its schooling habit in coastal areas makes it extremely vulnerable to gillnet fisheries (Hayes et al. 2009; NMFS 2009a). Scalloped hammerheads have a high potential for exploitation due to their late age at maturity, relatively small reproductive output, and long lifespan characteristics (Piercy et al. 2007). The 2009 IUCN Red List classifies the scalloped hammerhead (Northwest and Western Central Atlantic subpopulation) as endangered.[16]

***Distribution***—Scalloped hammerheads are coastal and semi-oceanic pelagic species that occur in warm-temperate to tropical waters worldwide over the continental shelf and slope (Castro 1983; Compagno 1984b). In the western Atlantic, the scalloped hammerhead range extends from New Jersey to Uruguay, as well as the Gulf of Mexico and the Caribbean Sea (Bester 1999a).

***Habitat Associations***—Scalloped hammerheads are found from the surface to depths of 275 m (902 ft). It is found close to shore, in bays and estuaries, and prefers water temperatures of at least 22°C (71.6°F) (Castro 1983; Compagno 1984b). More recent work found this species occurred over a temperature range from 18° to 31°C (32.1° to 57.6°F) and a salinity range of 20 to 37 psu (NMFS 2009a). Typically, scalloped hammerhead sharks spend the day close to shore and move to deeper waters at night to feed (Bester 1999a). Tagging data indicates that scalloped hammerheads use offshore oceanic habitats, but do not regularly roam across large distance (Kohler and Turner 2001). Rather, individuals appear to disperse readily across continental shelves and utilize discrete coastal nursery areas (Duncan et al. 2006).

***Life History***—Scalloped hammerheads give birth once a year in the summer starting around June, in shallow coastal nurseries from Virginia to the Gulf of Mexico (Castro 1983; McCandless et al. 2002). Their reproductive cycle is annual (Castro 1983) with a gestation period of 9 to 10 months possibly extending to 12 months after which they produce a large litter (>30) (Castro 1983; Compagno 1984b; Branstetter 1987). Primary and secondary nursery areas have been identified south of Study Area in estuarine and nearshore waters along the southeast Atlantic coast (e.g., South Carolina) and in the Gulf of Mexico (McCandless et al. 2002). Important feeding areas include extensive sand-shell plain of Southeast Shoal, deeper waters of the Canaveral Bight, and shelf transition zone directly south of Canaveral Bight (Adams and Paperno 2007). This species forms large schools when it migrates seasonally north to south along the eastern U.S coast (NMFS 1999b; NMFS 2006a).

***Forage Species***—Scalloped hammerhead sharks consume a wide variety of small fishes (e.g., menhaden [*Brevoortia* spp.]), as well as invertebrates (shrimp) and have been reported feeding only at night (Compagno 1984b; Adams and Paperno 2007).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-33**)

- Neonate/YOY (≤60 cm [23.6 in.] TL)—Designated EFH includes coastal areas in the Gulf of Mexico from Texas to the southern west coast of Florida and the mid-east coast of Florida to southern North Carolina along the Atlantic coast.

- **Juveniles** (61 to 179 cm [24.0 to 70.5 in.] TL)—Designated EFH includes coastal areas in the Gulf of Mexico from the southern to mid-coast of Texas, eastern Louisiana to the southern west coast of Florida, and Florida Keys, offshore areas from mid-coast of Texas to eastern Louisiana, and along the Atlantic east coast of Florida to New Jersey.

- **Adults** (≥180 [70.9 in.] TL)—Designated EFH includes coastal areas in the Gulf of Mexico along the southern coast of Texas and eastern Louisiana through the Florida Keys, off shore areas from southern Texas to eastern Louisiana, and along the Atlantic coast of Florida to Long Island, New York.

***HAPC Designations***—There are no HAPC identified for this species.

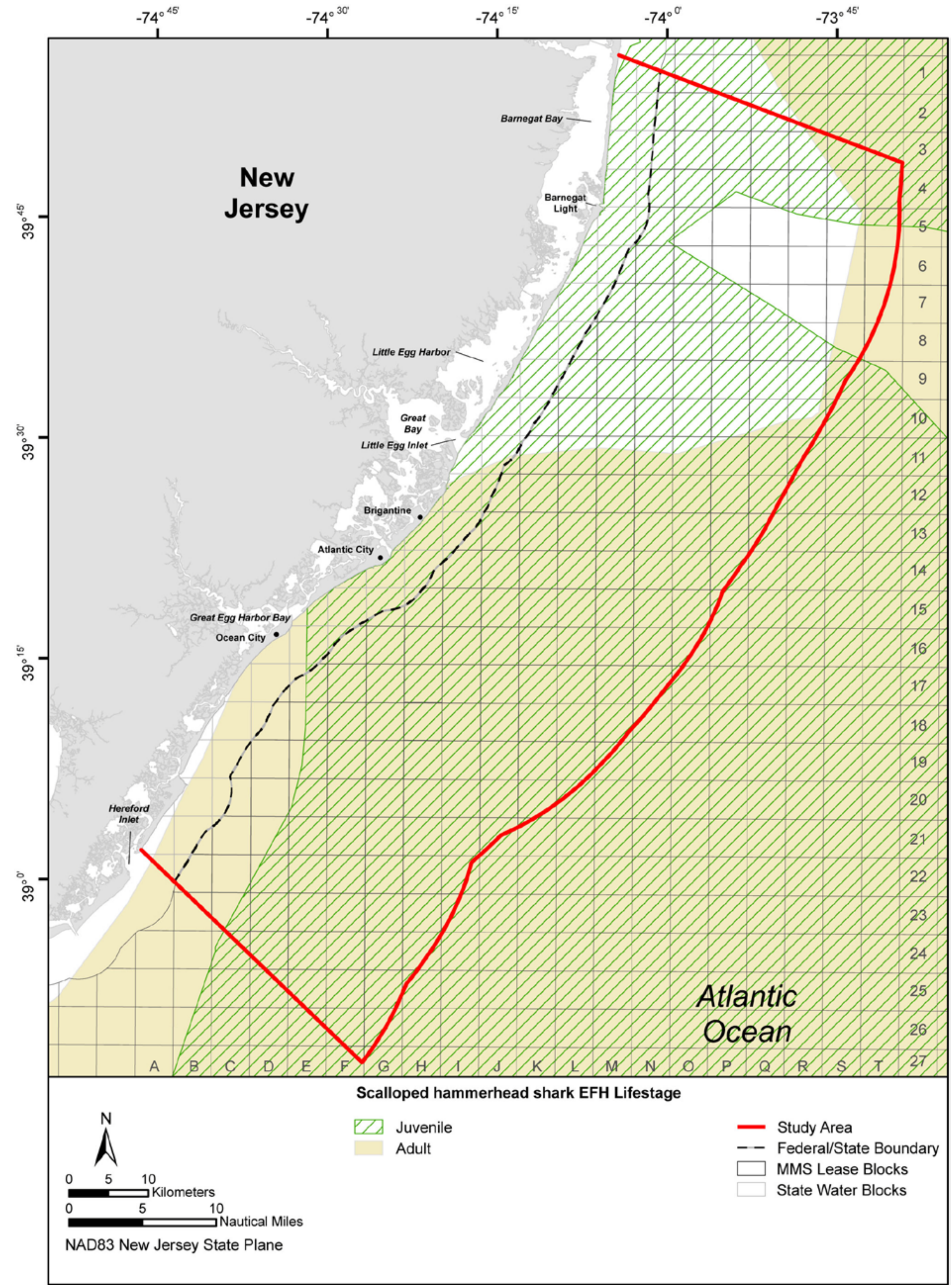


**Figure A-33. Essential fish habitat designated in the New Jersey Study Area for juvenile and adult lifestages of scalloped hammerhead sharks. Source data: NMFS (2009).[8]**

- **Shortfin Mako Shark (*Isurus oxyrinchus*)**

***Management***—Shortfin mako shark is managed under the Pelagic Shark MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—Shortfin mako shark is not classified as overfished but is subject to overfishing (NMFS 2009d).[3] This species is a common bycatch in tuna and swordfish fisheries and has shown a 38 percent decline in the northwest Atlantic between 1992 and 2005 (Baum and Blanchard 2009). The 2009 IUCN Red List classifies shortfin mako shark (Atlantic subpopulation) as vulnerable.[17]

***Distribution***—Shortfin mako shark has a world-wide distribution. In the western North Atlantic Ocean, it ranges from the Grand Banks, Newfoundland, and Gulf of Maine southward to Uruguay and northern Argentina, including Bermuda, the Gulf of Mexico, and the Caribbean (Schultz 2004). It is common offshore from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina (Castro 1983).

***Habitat Associations***—Shortfin mako shark is found in warm-temperate to tropical waters around the world, but is rarely found in water temperatures lower than 16°C (60.8°F) (Compagno 1984a). Like other lamnid sharks, this species, is endothermic using a heat-exchange circulatory system to maintain muscle visceral temperatures above that of the surrounding seawater allowing a higher level of activity (Bernal et al. 2001). Shortfin mako shark is an active offshore littoral and epipelagic species found from the surface to depths of 152 m (498.7 ft), but has been recorded as deep as 740 m (2,427.9 ft) (Compagno 1984a; Passarelli et al. 1999).

***Life History***—Tagging data suggests that within the northern extent of its range, this species follows the movement of warm-water masses towards the poles in the summer (Compagno 1984a; Kohler et al. 1998). Results from tagging study in the northwest Atlantic showed that shortfin mako make extensive movements of up to 4,542 km (2,451 NM) with 36% of recaptures caught at greater than 556 km (305 NM) from their tagging site (Stevens 2008). Similar to other sharks, reproduction does not occur annually. Shortfin mako shark is ovoviviparous and oophagus, has a 2 or 3 year reproductive cycle, a gestation period of approximately 15 to 18 months, and a late winter to mid-spring parturition with a litter size of 4 to 25 pups (Mollet et al. 2000; Compagno 2002; Maia et al. 2007). Locations of nursery areas have not been identified, but are hypothesized to be located within deep tropical waters (NMFS 1999b; NMFS 2006a). In the eastern north Atlantic, it is presumed that the Straits of Gibraltar are nursery grounds (Buencuerpo et al. 1998; Tudela et al. 2005).

***Forage Species***—Shortfin mako sharks prey upon a variety of fast-moving pelagic fishes including: swordfish, tuna, mackerel, bluefish, and other sharks (Passarelli et al. 1999) as well as clupeids, needlefishes, crustaceans, and cephalopods (Maia et al. 2006). In the western North Atlantic, bluefish are the primary prey species (Passarelli et al. 1999; Wood et al. 2009).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-34**)

- **Neonate/YOY, Juveniles, and Adults**—Designated EFH includes localized areas in the central Gulf of Mexico and the Florida Keys, in the Atlantic Ocean off of Florida, South Carolina, and Maine, and from Cape Lookout, North Carolina through southern New England.

***HAPC Designations***—There are no HAPC identified for this species.

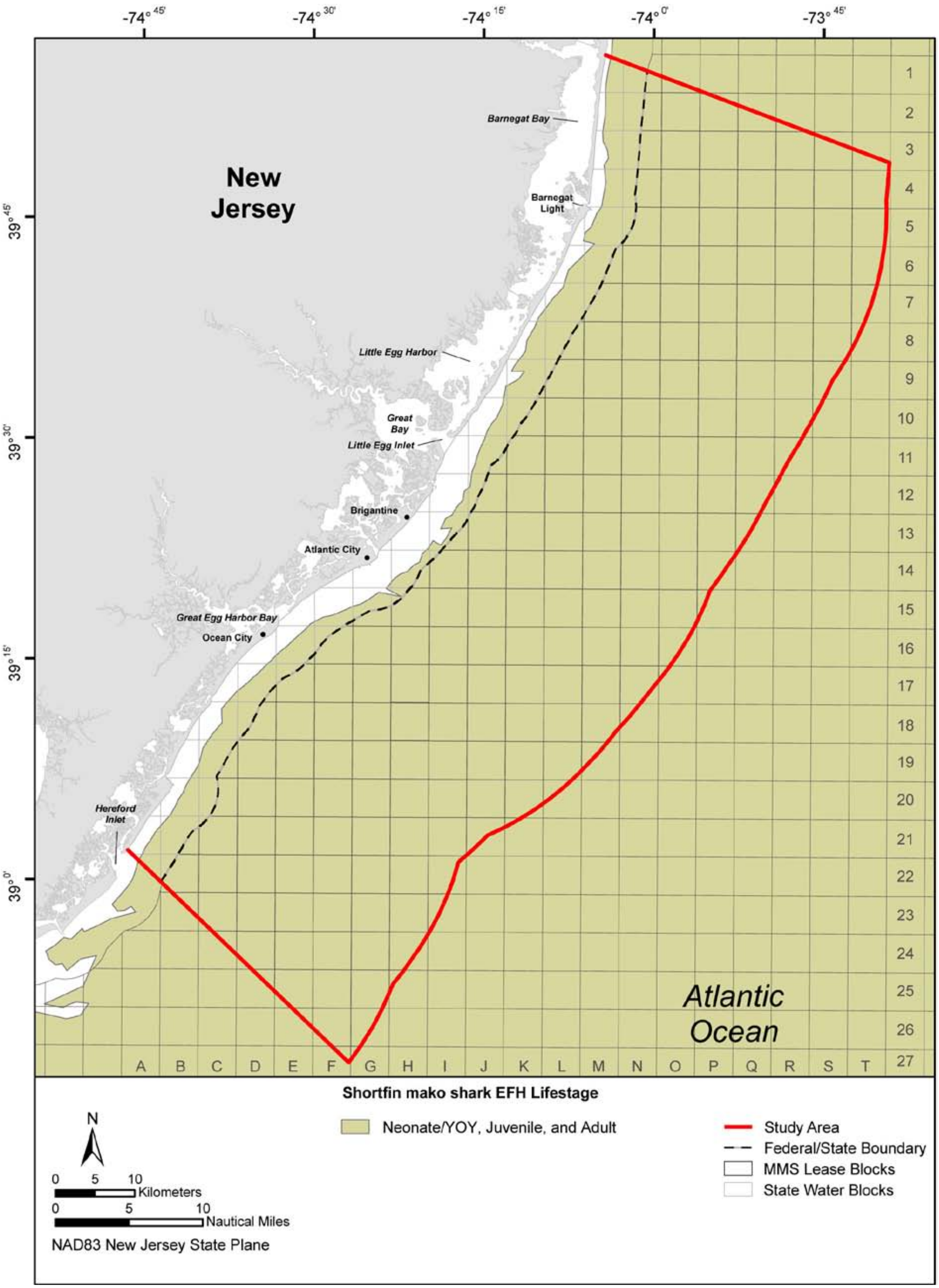


**Figure A-34. Essential fish habitat designated in the New Jersey Study Area for all lifestages of shortfin mako sharks. Source data: NMFS (2009).[8]**

- **Skipjack Tuna (*Katsuwonus pelamis*)**

***Management***—Skipjack tuna is managed under the Tuna MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—Skipjack tuna is not overfished nor is overfishing occurring (NMFS 2009d).

***Distribution***—Skipjack tuna is circumglobal in tropical and warm-temperate waters, generally limited by the 15°C (59°F) isotherm. In the northwest Atlantic, the skipjack typically ranges as far north as Newfoundland (Vinnichenko 1996) and as far south to Brazil (NMFS 1999b; Schultz 2004).

***Habitat Associations***—Skipjack tuna are an epipelagic, oceanic species that moves at the surface during the day and descends to depths of 260 m (853 ft) at night (Collette and Nauen 1983). Aggregations of skipjack tuna are associated with convergence zones and other hydrographic fronts. Adult skipjack tuna prefer waters with a temperature range of 14.7° to 30.0°C (58.5° to 86.0°F) (Collette 2002). Skipjack tuna exhibit a strong tendency to school in surface waters with birds, whales, sharks, and other tuna species, as well as drifting objects (Collette and Nauen 1983).

***Life History***—Near the equator the skipjack tuna spawn year-round, while at northern latitudes spawning is restricted to warmer months, from spring to early fall (Gardieff 1999; NMFS 1999b). Larvae have been collected off the east coast of Florida from October to December and in the Gulf of Mexico and Florida Straits from June to October (NMFS 1999b).

***Forage Species***—Skipjack tuna are opportunistic feeders that prey upon fish (herring, anchovies, and sardines), cephalopods, and crustaceans with peak feeding occurring at dawn or dusk (visual feeders) (Gardieff 1999; NMFS 1999b). Additionally, *Sargassum* and species associated with *Sargassum* have been recorded in their stomachs (NMFS 1999b; NMFS 2006a). Cannibalism is also considered common (Gardieff 1999).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-35**)

- <u>Spawning, Eggs, and Larvae</u>—Designated EFH includes the offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits.

- **<u>Juveniles/Subadults</u>** (<45 cm [17.7 in.] FL)—Designated EFH includes localized areas in the central Gulf of Mexico from Louisiana through the Florida Panhandle and in the Atlantic off of Georgia, South Carolina, and North Carolina to Maryland, and from Delaware to Cape Cod, Massachusetts and southern east coast of Florida through the Florida Keys.

- **<u>Adults</u>** (≥45 cm [17.7 in.] FL)—Designated EFH includes the central Gulf of Mexico off of Texas through Florida and localized areas in the Atlantic Ocean off of South Carolina and the northern east coast of Florida, and from Cape Hatteras, North Carolina to Cape Cod, Massachusetts the southern east coast of Florida through the Florida Keys.

***HAPC Designations***—There are no HAPC identified for this species.

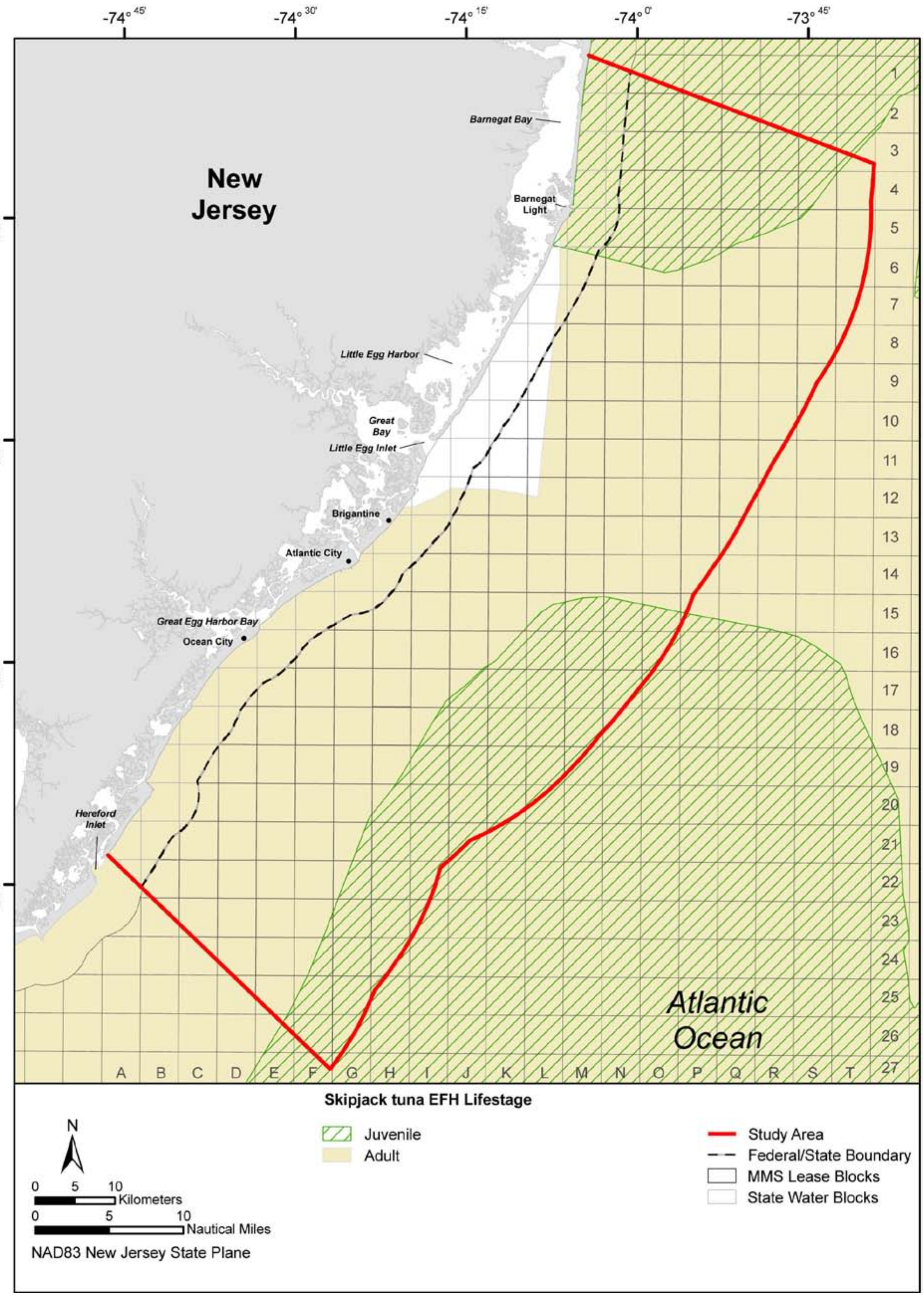


**Figure A-35. Essential fish habitat designated in the New Jersey Study Area for juvenile and adult lifestages of skipjack tuna. Source data: NMFS (2009).[8]**

♦ **Thresher shark (*Alopias vulpinus*)**

***Management***—The common thresher shark is managed under the Pelagic Shark MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—The common thresher shark does not have an overfished status nor is it subject to overfishing (NMFS 2009d). This species is moderately productive, and the most productive of all threshers (Cortés 2008; Smith et al. 2008a), but nonetheless has demonstrated its vulnerability under intensive harvest. The 2009 IUCN classifies the thresher shark as vulnerable due to its apparent decline in abundance in this region and high fishing pressure from pelagic fleets.[18]

***Distribution***—The common thresher shark is distributed circumglobally in the Atlantic, Pacific, and Indian oceans and in the Mediterranean (Compagno 1984a; Tricas et al. 1997; Compagno 2002). In the northwest Atlantic, common thresher sharks occur from Nova Scotia to Argentina, including the Gulf of Mexico (Branstetter and Burgess 2002c).

***Habitat Associations***—This species is most frequently encountered in temperate waters and the most coastal of all thresher sharks (Compagno 2002) and usually occurs within 72 to 135 km (40 to 75 miles) of land (Strasburg 1958; Litvinov 1990) in temperate and occasionally tropical seas over continental and insular shelf and slopes (Compagno 1984a). Juveniles inhabit coastal bays and nearshore waters, whereas adults are more common over the continental shelf but also occur in oceanic waters beyond the shelf break (Jordan 1999; Goldman and members of the Shark Specialist Group 2001; Branstetter and Burgess 2002c). They are commonly observed at the surface but are known to inhabit depths of up to 550 m (1,840.5 ft) (Jordan 1999).

***Life History***—The common thresher shark appears to have a seasonal reproductive cycle in various parts of its range; for example, mating presumably taking place during midsummer in the northeastern Atlantic (Moreno et al. 1989), with an estimated gestation period of about nine months (Goldman 2005). Birth is thought to occur in the spring months in the northeastern Atlantic (Moreno et al. 1989) with this ovoviviparous species producing a litter of two to four pups (Smith et al. 2008b). The common thresher in the North Hemisphere apparently undertakes inshore and northerly coastal migrations during the warm season (~April to August) in the eastern and western Atlantic (Moreno et al. 1989).

***Forage Species***—The common thresher preys on invertebrates (squid and pelagic crabs) and small schooling fishes such as anchovy, hake, sardine, and small mackerels (Preti et al. 2001; Smith et al. 2008b). Feeding is often associated with areas characterized by high biological productivity and the presence of strong frontal zones separating regions of upwelling and adjacent areas, and strong horizontal and vertical mixing of surface and subsurface waters – habitats conducive to production and maintenance of schooling pelagic prey (Smith et al. 2008b).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-36**)

- **Neonate/YOY, Juveniles, and Adults**—Designated EFH includes localized areas in the Atlantic Ocean off the mid-coasts of Florida, Georgia, South Carolina, and the Gulf of Maine, and from North Carolina through Cape Cod, Massachusetts as well as localized areas in central Gulf of Mexico and Florida Keys.

***HAPC Designations***—There are no HAPC identified for this species.

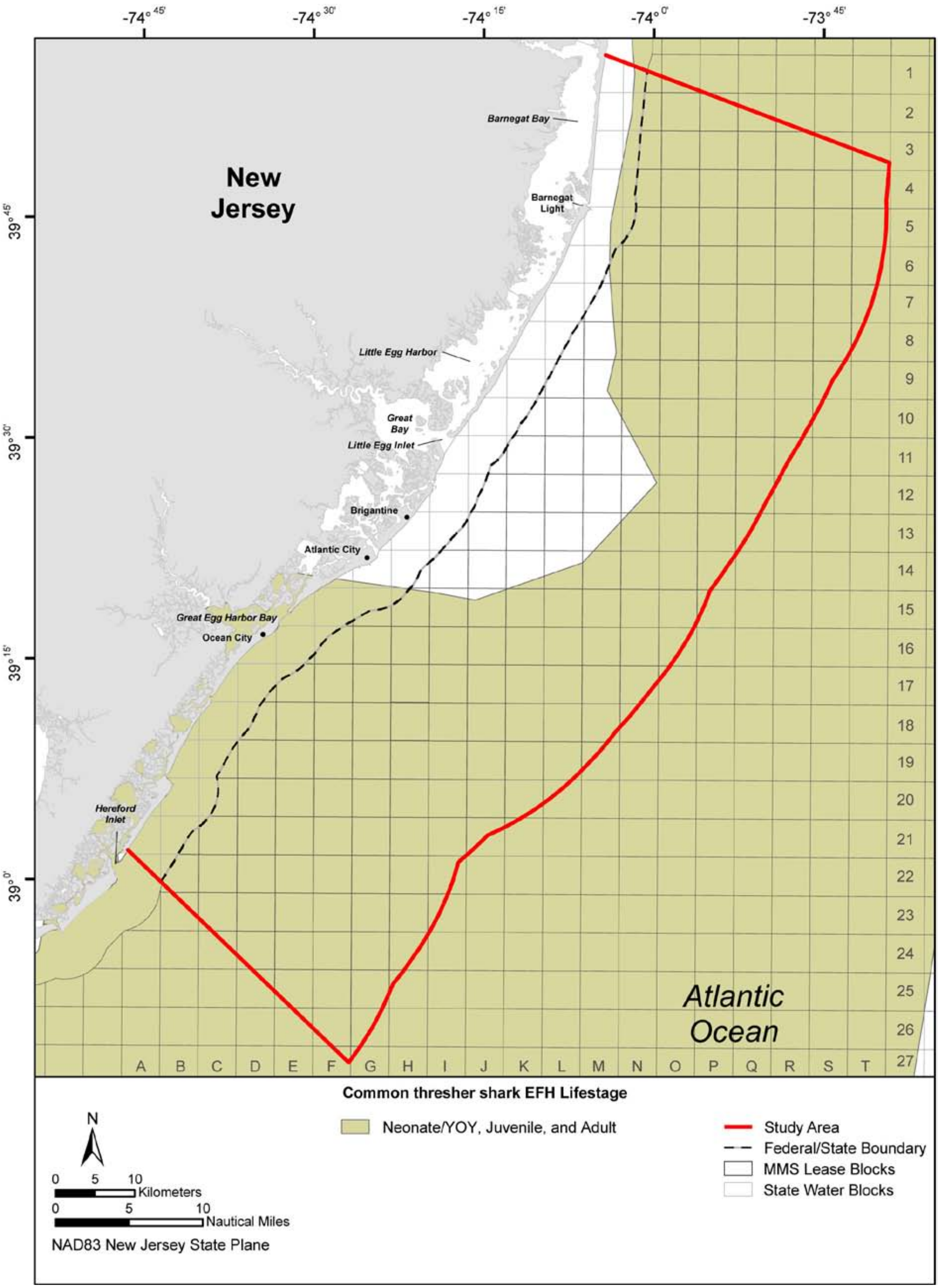


**Figure A-36. Essential fish habitat designated in the New Jersey Study Area for all lifestages of common thresher sharks. Source data: NMFS (2009).[8]**

- **Tiger Shark (*Galeocerdo cuvier*)**

***Management***—Tiger shark is managed under the Large Coastal Shark MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a).

***Status***—Currently, tiger sharks are not classified as overfished nor is overfishing occurring (NMFS 2009d). The 2009 IUCN Red List classifies tiger shark as lower risk/near threatened.[19]

***Distribution***—Tiger sharks are found throughout the temperate and tropical coastal waters of the world, with the exception of the Mediterranean Sea (Knickle 1999b; Natanson et al. 1999). In the North Atlantic, this species ranges from Cape Cod, Massachusetts to Uruguay, including the Gulf of Mexico, Bermuda, and the islands of the Caribbean (Randall 1992). It is rarely encountered north of the MAB (Skomal 2007) and is a year-round resident in the coastal waters of Florida (Natanson et al. 1999).

***Habitat Associations***—Tiger sharks are present over a wide variety of marine habitats but display a preference for cloudy or turbid coastal waters (Compagno 1984b; Knickle 1999b; Ferrari and Ferrari 2002). They are found across the continental shelf, as well as in estuaries, harbors, and inlets, from surface waters to depths of up to 350 m (1,148 ft) (Compagno 1984b; Knickle 1999b). They prefer waters with temperatures exceeding 18˚C (64.4°F) (Branstetter and Burgess 2002b). Tiger sharks are nocturnal, hunting in shallow waters of bays, estuaries, and lagoons, then returning to deeper waters during daylight hours (Compagno 1984b; Tricas et al. 1997; Ferrari and Ferrari 2002).

***Life History***—This species partakes in extensive migrations throughout the north Atlantic: seasonal - from Cuba to Nova Scotia and transoceanic - traveling distances of 2,300 km (1,241.1 NM) from Cuba to Africa (Natanson et al. 1999; Ferrari and Ferrari 2002; Driggers et al. 2008). Tiger sharks are ovoviviparous. In the northern hemisphere, mating takes place between March and May and pupping is reported to occur from April to June of the following year (Compagno 1984b; Knickle 1999b). Gestation period appears to be about 1 year producing large litters, usually consisting of 35 to 55 pups (Castro 1983; NMFS 2009a). Areas of high tiger shark neonate occurrence are considered important pupping areas within a range extending from 27° to 35°N, south of the Study Area (Driggers et al. 2008).

***Forage Species***—Tiger sharks feed on a wider variety of prey than most other shark species, including other sharks, skates, fishes (goosefish and bluefish), squid, horseshoe crab (*Limulus polyphemus*), crab, conch, birds, marine mammals, and sea turtles (Branstetter and Burgess 2002b). They also have the propensity to consume 'garbage' of human origin, including plastics, metal, sacks, kitchen scraps, and almost any other item discarded in the sea (Randall 1992).

***EFH Designations***—(NMFS 2009a; NMFS 2009b)[8] (**Figure A-37**)

- Neonate/YOY (≤204 cm [80.3 in.] TL)—Designated EFH includes the Gulf of Mexico off Texas, western Louisiana, and the Florida Panhandle and in the Atlantic Ocean from the mid-east coast from Florida to New England.

- **Juveniles** (205 to 319 cm [80.7 to 125.6 in.] TL)—Designated EFH includes the central Gulf of Mexico off Texas and Louisiana and from Mississippi through the Florida Keys and along the Atlantic east coast from Florida to New England.

- **Adults** (≥320 cm [126 in.] TL)—Designated EFH includes the Gulf of Mexico from Texas to the west coast of Florida and the Florida Keys and along the Atlantic east coast from Florida to southern New England.

***HAPC Designations***—There are no HAPC identified for this species.

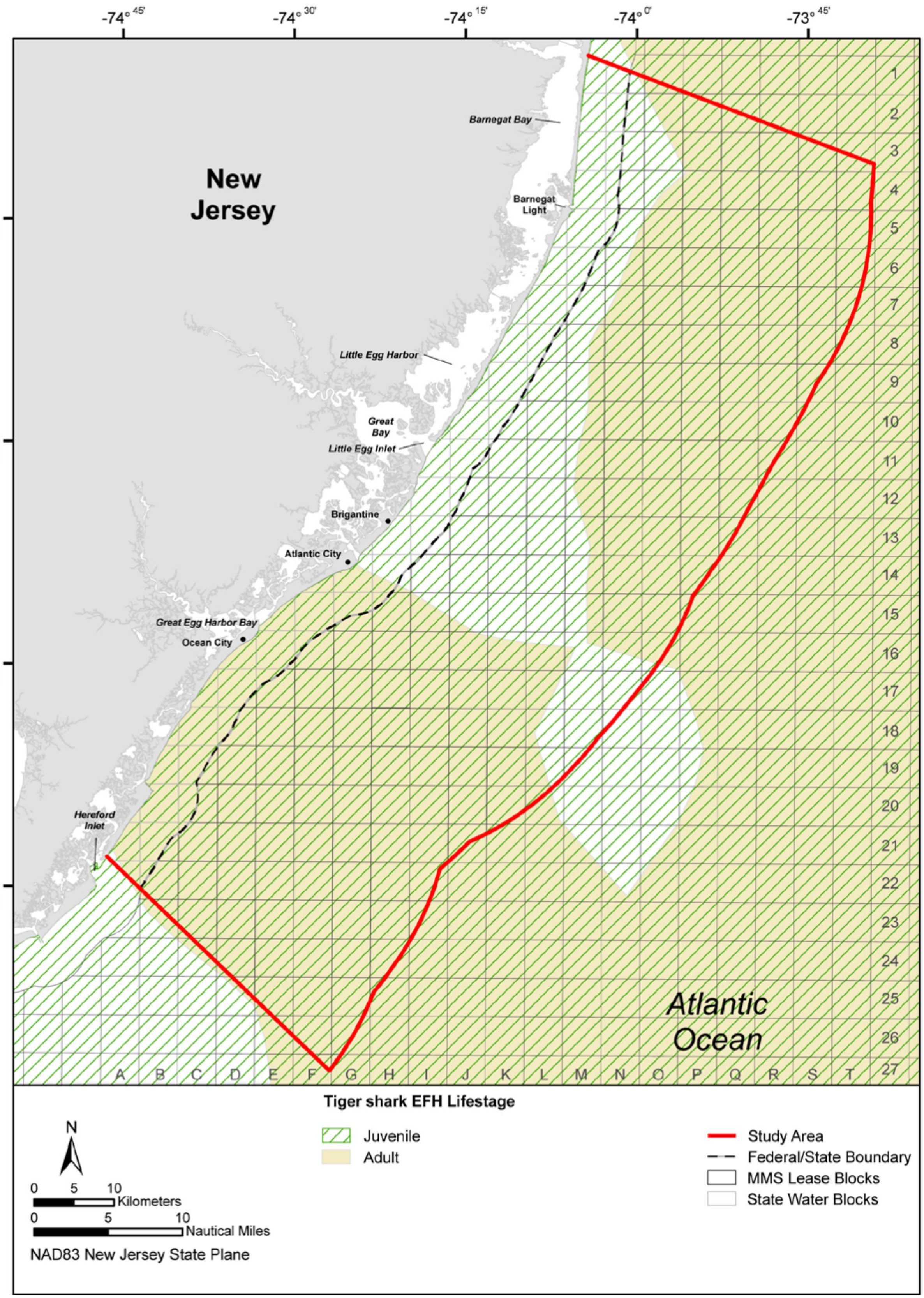


**Figure A-37. Essential fish habitat designated in the New Jersey Study Area for juvenile and adult lifestages of tiger sharks. Source data: NMFS (2009).[8]**

- **White Shark (*Carcharodon carcharias*)**

***Management—***White shark is managed under the Prohibited Species MU through the Final Consolidated Atlantic HMS FMP (NMFS 2006a)**.**

***Status***—Currently, white shark is not classified as overfished nor is overfishing occurring. In 1997, the U.S. implemented a catch-and-release only recreational fishery, while prohibiting possession of the species (NMFS 2009d). In addition, Baum et al. (2003) reported an 80% decline in longline CPUE suggesting a decrease in population size over time. The 2009 IUCN Red List classifies white shark as vulnerable or facing a high risk of extinction in the wild.[20]

***Distribution***—White sharks are found worldwide in temperate and subtropical regions, including all major ocean basins, the Mediterranean Sea, and several tropical locations (Bruce 2008). In the northwest Atlantic, it occurs from Newfoundland to Florida, the northern Gulf of Mexico, the Bahamas, and Cuba as well as from Brazil to Argentina (Castro 1983; Compagno 1984a). The white shark is rare south of Cape Hatteras, North Carolina, and in the Gulf of Mexico except during the winter (Castro 1983). White sharks (individuals <200 cm [78.8 in.]) are more abundant in the MAB (Cape Hatteras, North Carolina to Cape Cod, Massachusetts) on the continental shelf from April through December than any other region in the western North Atlantic (Casey and H.L. Pratt Jr. 1985).

***Habitat Associations***—White sharks are an epipelagic shark, but can be found utilizing depths over 250 m (820 ft) (Compagno 2002). They primarily inhabit coastal and offshore waters of continental and insular shelves occurring from the shoreline (including coastal bays, lower reaches of estuaries, surf zone, and continental islands) to shelf and slope waters (Castro 1983; Compagno 1984a; Martins and Knickle 1999). This shark is commonly found in areas of small coastal archipelagos inhabited by pinnipeds (main prey items), offshore reefs, banks, and shoals, as well as rocky headlands where deeper water is closer to shore (Martins and Knickle 1999). Larger individuals are more common in subtropical and tropical waters than smaller white sharks (<3 m [9.8 ft] in length), which typically are confined to temperate waters (Compagno 1984a) with 15˚C (27°F) isotherm being their northern latitude limit (Casey and H.L. Pratt Jr. 1985).

***Life History***—Very little is known of the white shark's reproductive behavior and habitat association, but records indicate that live young are born in warm temperate neritic shelf waters during the spring to late summer (Martins and Knickle 1999). This species is known to be oophagous and can carry 7 to 10 embryos (NMFS 2009a). The white shark inhabits waters over the continental shelf in the summer and migrates to warmer waters during the winter months (Castro 1983). Bonfil et al. (2005) reported that white sharks undergo coastal migrations as well as transoceanic return migrations. In addition, foraging juveniles may occur in the mixed layer and near the surface at night, however; daytime dive patterns suggest diurnal feeding occurs at or near the bottom (Dewar et al. 2004). The occurrence of small and intermediate size white sharks (male and female) in the continental shelf waters of the MAB up through the coastal waters of Massachusetts suggest this area serves as a nursery area for juveniles (Skomal 2007; NMFS 2008b).

***Forage Species***—White sharks feed on a wide spectrum of prey, including pelagic and demersal finfish, various other chondrichthyans, sea turtles, pinnipeds, cetaceans, cetacean carrion, some invertebrates (e.g., squids and crustaceans), and occasionally sea birds such as cormorants (Casey and H.L. Pratt Jr. 1985; Compagno 2002; Bruce 2008).

***EFH Designations***—(NMFS 2009a; NMFS 2009b) [8] (**Figure A-38**)

- **Neonate/YOY, Juveniles, and Adults**—Designated EFH includes areas along the mid- and southern west coast of Florida in the Gulf of Mexico and along the mid- and northern east coast of Florida, South Carolina, and North Carolina and from Maryland to Cape Cod, Massachusetts in the Atlantic.

***HAPC Designations***—There are no HAPC identified for this species.

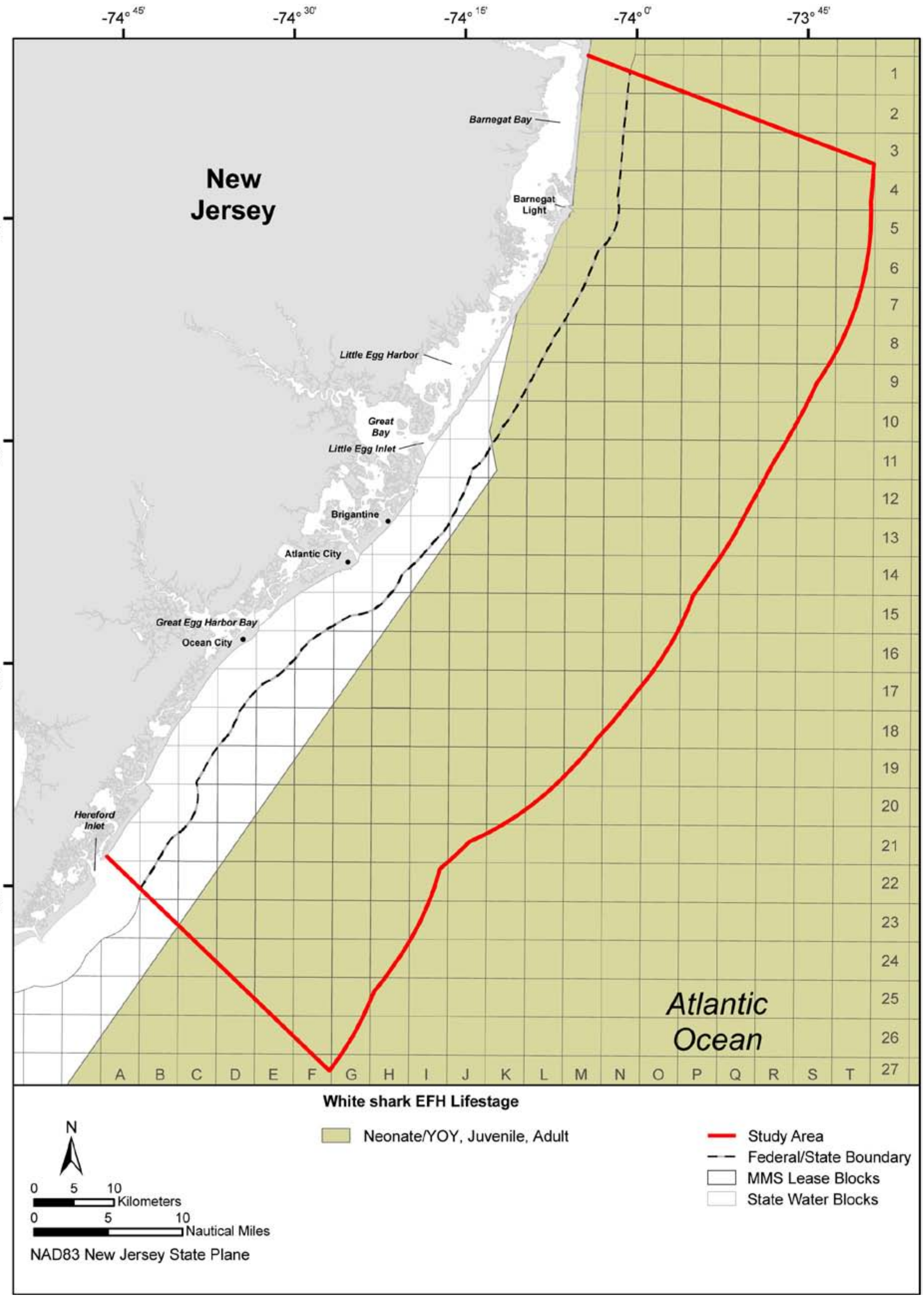


**Figure A-38. Essential fish habitat designated in the New Jersey Study Area for all lifestages of white sharks. Source data: NMFS (2009).[8]**

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# APPENDIX B

# GLOSSARY TERMS

**Abiotic**—non-living factor

**Abundant**—an indication of the plentifulness of a species at a particular place and time; an abundant species is more plentiful than an occasional or rare species

**Adult**—developmental stage characterized by sexual or physical (full size and strength) maturity

**Adhesive**—refers to being stickly

**Aggregation**—group of animals that forms when individuals are attracted to an environmental resource to which each responds independently; the term does not imply any social organization

**Algae**—a number of primarily aquatic, photosynthetic groups (taxa) of plants and plant-like protists ranging in size from single cells to large, multicellular forms that have no seeds, roots, stems, flowers or leaf system

**Amphipods**—a large group of crustacean with a shrimp-like appearance, usually with a laterally compressed body

**Anchovy**—is a small herring-like schooling saltwater plankton-feeding marine fish of the family Engraulidae

**Anadromus**—referring to the life cycle of fishes, such as Atlantic sturgeon, in which adults travel upriver from the sea to breed, usually returning to the area where they were born

**Annelids**—are invertebrate animals of the phylum Annelida in which the body is typically made up of a series of rings or segments covered by a soft cuticle and lacking jointed appendages (e.g., marine worms)

**Anthropogenic**—describing a phenomenon or condition created, directly or indirectly, as a result of human activity

**Artificial habitat**—a human-made, estuarine/marine habitat (sunken ships, artificial reefs: concrete igloos, rubble) created in the navigable waters of the U.S. to attract aquatic life

**Artificial reefs**—human-made structures (sunken ships, concrete igloos, rubble) purposefully placed into the navigable waters of the U.S. or into the marine waters overlying the continental shelf to attract aquatic life

**Assemblage**—the populations of various species from a larger taxon characteristically associated with a particular environment that can be used as an indicator of the environment

**Bank**—a submerged ridge, shoal, sandbar, or other unconsolidated material that rises from the seafloor to near the water's surface, sometimes creating a navigational hazard

**Batch spawner**—is a species that spawns repeatedly, releasing batches of eggs and sperm into the open-se marine environment for external fertilization and development

**Bay**—a body of water partly enclosed by land but with a wide outlet to the sea

**Beach groin**—is a protective structure of stone or concrete extending into the shore to protect a beach against erosion or to trap shifting sands

**Beach seine**—a seine net operated from the shore; gear is composed of a bunt (bag or lose netting) and long wings often lengthened with long ropes for towing the seine to the beach; headrope with floats is on the surface, the footrope is in permanent contact with the bottom and the seine is therefore a barrier which prevent the fish from escaping from the area enclosed by the net

**Benthic**—in, on, or near the ocean floor; the term is used irrespective of whether the sea is shallow or deep

**Benthos**—organisms that live in, on, near, or are attached to the ocean bottom substrate

**Billfish**—is a large warm-water fish usually associated with tropical and subtropical seas having a prolonged and rounded toothless upper jaw of the family Xiphidae

**Biodiversity**—refers to the diversity of living things; variety of life on earth and the ecosystems that support it

**Biogenic**—originating from living organisms

**Biomass**—the amount of living matter per unit of water surface or water volume

**Biotic**—pertaining to life or living organisms

**Bivalve**—a group of marine or freshwater mollusks that consists of a soft body protected by two hinging shells (e.g., scallops and oysters)

**Boreal**—comprising or found throughout far northern regions

**Brachiopods**—phylum of benthic invertebrates known as lamp shells; they differ from bivalves, and are characterized by a plane of bilateral symmetry through the shells and perpendicular to the hinge

**Brittle stars**—a starfish-like echinoderm belonging to the class Ophiuroidea that has five to eight elongate, slender, cylindrical arms distinctly radiating from a flat central disc

**Broadcast spawner**—a fish that releases its gametes into the water, where fertilization occurs; without parental care

**Bryozoan**—phylum of small, aquatic colonial animals that are commonly called moss animals; each zooid or animal in the colony has a crown of ciliated tentacles

**Bycatch**—are marine species incidentally caught in a fishery which intended to target another species, but which are not sold and usually not kept for personal use. Includes economic and regulatory discards; bycatch species can be either alive or dead

**Candidate species**—refers to species that are subject of petition to list and for which NMFS has determined that listing may be warranted in pursuant to ESA section 4(b)(3)(A), and species for which NMS has determined, following a status review, that listing is warranted

**Cape**—a point or head of land (e.g., a peninsula) projecting into a body of water (e.g., Cape Hatteras or Cape Lookout)

**Carrion**—dead and decaying flesh

**Catch per Unit Effort (CPUE)**—a term commonly used by fishery biologists as an index to fish population density. Calaculated as measure of a species relative abundance; expressed as the ration of the number of animals by some level of effort (e.g., hooks, sets, trips, landings, weight)

**Cephalopods**—any marine mollusk of the class Cephalopoda, with the mouth and head surrounded by tentacles (squid, octopus, nautilus, and cuttlefish)

**Chaetognaths**—are known as arrow worms that are active elongated, transparent predators in marine plankton

**Charter boat**—a vessel typically less than 91 metric ton that carries six or fewer passengers for hire

**Chondrichthyans**—are jawed cartilaginous fishes with paired fins, paired nares, scales, two-chambered hearts, and skeletons made of cartilage rather than bone; are divided into two sub-classes: Elasmobranchii (sharks, rays, and skates) and Holocephali (chimaera)

**Chumming**—practice of luring animals, usually fish or sharks, by throwing chum into the water. Chum often consist of fish parts and blood, which attract fish, and particularly sharks due to the their keen sense of smell

**Ciliates**—are a group of large protozoans (reach 2 mm in length) characterized by the presence of hair-like organelles called cilia, which are identical to flagella but typically shorter and present in much larger numbers with an undulating pattern than flagella

**Circumglobal**—distribution pattern displayed by organisms around the world, within a range of latitudes

**Cladocerns**—refers to an order of microscopic crustaceans with trunk limbs enclosed in a carapace used for feeding and antennae used for swimming; called water fleas

**Clams**—any of various hard-shell, usually edible, bivalve mollusks, some of which live in the shallows of the sea, others in freshwater

**Closed season**—a specified period during which the category of fish or marine plants may not be fished or harvested

**Coastal beach**—zone above the water line at a shore of a body of water, marked be an accumulation of sand, stone, or gravel that has been deposited by the tide or waves

**Coastal water**—water that is along, near, or relating to a coast

**Coast**—geographic term that refers to the zone of contact between land and water

**Commercial fishing**—fishing in which the fish is harvested, either in whole or part, are intended to enter commerce through sale, barter, or trade

**Competitors**—an organism that live in competition with another

**Conch**—common name whish is applied to a number of different species of medium-sized to large sea snails or their shells

**Continental shelf**—refers to an area: the province of the continental margin with a gently seaward-slopping seabed (1:1000 gradient change) extending from the low-tide line of the shoreline to 10 to 200 m water depth where there is a rapid gradient change

**Continental slope**—refers to an area: the province of the continental margin with a relatively steeply sloping bed seabed (1:6 to 1:40 gradient change) that begins at the continental shelf break (about 100 to 200 m) and extends down to the continental rise: along many coasts of the world, the slope is furrowed by deep submarine canyons

**Copepods**—very small planktonic crustaceans present in a wide variety and great abundance in marine habitats, forming an important basis of ecosystems; they are a major food of many marine animals and are the main link between phytoplankton and higher trophic levels

**Cosmopolitan**—having a broad, wide-ranging distribution

**Creel survey**—an accurate and reliable technique used to obtain information on a fishery; involves interviewing anglers to collect details about their catch (species, length, weight), time spent fishing, type of fishing (boat or shore), and the distance they have traveled to go fishing

**Croakers**—is a member of the abundant and varied family Sciaenidae, carnivorous, spiny-finned fishes including weakfishes, drums, and whitings

**Crustaceans**—arthropods that have two pairs of antennae and a hard exoskeleton, such as lobster, shrimp, and crabs

**Cusk eels**—are elongate compressed somewhat eel-shaped fishes

**Cuttlefish**—is a marine mollusk of the class Cephalopoda that has 10 arms including two long tentacles it can draw back into its body

**Decapod**—is an order of freshwater, marine, and terrestrial crustaceans having five pairs of legs on the thorax and a carapace completely covering the throat (e.g., shrimps, crabs, lobsters)

**Demersal**—applied to fishes that live close to the seafloor, such as cod and hake

**Diatoms**—are microscopic algae (Bacillariophyceae) in which the cell wall (frustule) is composed of silica and consists of two major valves and girdle bands; unicellular, colonial, or filamentous; important components of freshwater and marine habitats as members of both planktonic and benthic communities; comprised of two major types based on symmetry: pinnate – bilareal, centric – radial; forms the primary food base for marine ecosystems; may produce harmful algal blooms in marine habitats (domoic acid producing *pseudo-nitzschia*)

**Diel**—refers to 24-hour activity cycle based on daily periods of light and dark

**Distinct Population Segment**—distinct population segment, as defined by NMFS, is a vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species

**Diurnal**—active or occurring during daylight hours; having a daily cycle

**Dominant species**—species most prevalent in a particular community or at a given period

**Downwelling**—a circulation pattern in which surface water moves vertically downward; occurs when surface water converge or when winds force water to pile up along the coast

**Dredge**—an implement consisting of a net on a frame, used for gathering shellfish

**Drift gillnet**—gillnet attached to the stem of a fishing boat and allowed to drift below the surface

**Drift net**—a monofilament gillnet set at or near the surface that stretches up to 60 km or more in length; used passively (drifts) to entangle fish or invertebrates, which also catches a large number of non-target species, including marine mammals and sea turtles

**Echinoderms**—marine invertebrates of the phylum Echinodermata, characterized by radial symmetry, a calcareous endoskeleton, and a water vascular system; sea stars and sea urchins are common examples

**Ecosystem**—a system of ecological relationships in a local environment comprising both organisms and their nonliving environment, intimately linked by a variety of biological, chemical, and physical processes

**Eelgrass**—is a vascular flowering plant of the genus *Zostera* that are adapted to living under water while rooted in shallow sediments of marine bays and estuaries

**Eggs**—those individuals that have spawned but have not hatched and are completely dependent on yolk for nutrition

**Elasmobranch**—fishes of the class Chondrichthyes that are characterized by having a cartilaginous skeleton; includes sharks, skates, and rays

**Embayment**—is an indentation in the shoreline that forms a bay

**Endangered species**—any animal or plant species in danger of extinction throughout all or a significant portion of its range; the authority to list a species is shared by the USFWS (terrestrial species, sea turtles on land, manatees) and NMFS (most marine species) under provisions of the Endangered Species Act (ESA); endangered species and their habitats are protected by ESA

**Endothermic**—refers to organisms which are capable of maintaining their bodily temperature above the temperature of the external environment

**Epibenthic**—refers to organisms living on the ocean floor

**Epifauna**—animals living on the surface of the ocean floor; any encrusting fauna

**Epipelagic**—the oceanic zone from the surface to 200 m

**Essential fish habitat (EFH)**—those waters and substrate necessary to fish or invertebrates for spawning, breeding, feeding, and growth to maturity (16 U.S.C. 1802[10])

**Estuarine**—refers to, relating to, or found in an estuary

**Estuary**—a semi-enclosed body of water where freshwater mixes with saltwater; often an area of high biological productivity and important as nursery areas for many marine species

**Euphausiids**—is known as krill, these are pelagic shrimp-like crustaceans

**Euryhaline**—an organism that can tolerate waters with a wide range of salinity

**Eurythermal**—an organism that can tolerate a wide range of temperatures

**Fauna**—animal life of a region

**Fish**—as defined by the Sustainable Fisheries Act, finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds

**Fish haven**—an off-shore artificial reef preservation site

**Fishery**—one or more stocks of fish that can be treated as a unit for the purposes of conservation and management and that are identified on the basis of geographical, scientific, technical, recreational, and economic characteristics, and any fishing for such stocks

**Fishery management council**—a regional fisheries management body established by the Magnuson-Stevens Act to manage fishery resources in eight designated regions of the United States

**Fishery management plan**—a plan created by a regional Fishery Management Council to achieve specified management goals for a fishery; it includes data, analyses, and management measures (including guidelines for harvest) for a fishery

**Flatfish**—are members of the fish order Heterosomata. Flatfish swim or lie on one side of its body; sides are greatly flattened and compressed; mainly marine animals (e.g., flounders)

**Flotsam**—refers to marine debris; can also refer to the wreckage or cargo left floating on the sea surface after a shipwreck

**Forage**—search for food

**Fork length**—length of a fish measured from the tip of the snout to the fork of the tail

**Gastropods**—class of symmetrical, univalve mollusks that have a true head, an unsegmented body, and a broad, flat foot

**Gestation**—period of development in the uterus from conception until birth (pregnancy)

**Gillnet**—a type of fishing gear made of rectangular mesh panels that are set more or less vertically in the water so that fish swimming into it are entangled by their gills; they can be set to fish at the surface, midwater, or on the bottom of the water column

**Groundfish**—group of fishes that spends most of its life on or near the ocean floors (e.g., cod, haddock, hakes, and flounders); also known as demersal species

**Habitat**—the living place of an organism or community of organisms that is characterized by its physical or living properties

**Habitat areas of particular concern (HAPC)**—legally these areas are defined as subsets of EFH identified based on one or more of the following considerations: (1) the importance of the ecological function, (2) extent to which the habitat is sensitive to human-induced degradation, (3) whether, and to what extent, development activities are stressing the habitat type, or (4) rarity of habitat type (50 CFR 600.815[a][8])

**Hake**—are any of various marine food fishes of the genus *Merluccius* or *Urophycis*, related to or resembling the cod

**Handgear**—term used for types of fishing gear that are mainly operated by hand including harpoons, handlines, rods, and reels

**Handline**—fishing gear that is set and pulled by hand and consists of one vertical line to which may be attached leader lines with hooks

**Hard bottom**—area of the sea floor, usually on the continental shelf, associated with hard substrate such as outcroppings of limestone or sandstone that may serve as attachment locations for organisms such as corals, sponges, and other invertebrates or algae

**Harvest**—fish killed as a result of encounters with fishing gear

**Herring**—are various marine fishes of the family Clupeidae; these fish are important prey item for other species of the Atlantic

**Hook and line gear**—refers to fishing gear where hooks are placed at the end of a line (monofilament, cable, nylon) includes pelagic longlines used to target tuna and swordfish

**Hydrography**—the science of measuring and describing the surface waters of the Earth

**Hydroids**—class of solitary or colonial coelenterates that have a hollow cylindrical body closed at one end and a mouth surrounded by tentacles at the other end

**Ichthyofauna**—all fish that live in a particular area

**Ichthyoplankton**—fish eggs and larvae drifting in the water column

**Incidental fisheries bycatch**—the catch of additional species, such as fishes, turtles, or marine mammals, that are not targeted by a fishery but are harvested in addition to the target or sought after species

**Inlet**—a bay, cove, or other recess along a coast; a narrow passage of water, as between two islands

**Inshore**—lying close to the shore or coast

**Insular**—pertaining to or situated on an island

**Intertidal**—the area of shore exposed between high and low tide

**Invertebrate**—is an organism which lacks a backbone (e.g., crustaceans, mollusks); not a vertebrate

**Isopods**—large group of small crustaceans lacking a carapace, having a set of seven pairs of legs, and usually having a depressed body

**Isotherm**—contour of equal temperature; usually shown as a line linking points of the same temperature

**IUCN Red List**—is a list of animal species and subspecies established by the international Union for the Conservation of Nature and Natural Resources which are thought to be threatened or endangered for extinction and those which are known to have already become extinct in the wild

**Jetties**—structure used at inlets to stabilize the position of the navigation channel, to shield vessels from wave forces, and to control the movement of sand along the adjacent beaches so as to minimize the movement of sand into the channel

**Jigging**—method of fishing using lures on a vertical line that snag fish when they pass near. The line is moved up and down (jigged) by hand or mechanically; extremely efficient for fishing oceanic squids at night

**Juvenile**—mostly similar in form to an adult but not yet sexually mature; a smaller replica of the adult

**Killifish**—any of various oviparous (egg-laying) cyprinodontiform fish

**Krill**—see euphausiids

**Lagoon**—a shallow body of water, especially one separated from the sea by dunes, sandbars, or coral reefs

**Lanterfish**—refers to small, usually deep sea fish with many luminescent spots on their bodies of the family Myctophidae

**Larvae**—individuals that have hatched and have the ability to capture food items

**Life history**—a history of the changes through which an organism passes in its development from the primary stage to its natural death

**Littoral**—the zone or division of the ocean bottom that lies between the high and low tide lines; intertidal

**Longline**—a type of fishing gear using a buoyed line onto which are attached numerous branch lines each terminating in a baited hook; longlines may extend for tens of kilometers and are usually left to drift in surface waters or near the seafloor

**Macroalgae**—true oceanic plants, large in size, including bubble algae, large varieties of kelp, and *Sargassum*

**Macroinvertebrate**—animal without a backbone that can be seen by the naked eye (e.g., clams, mussels, crabs, oysters, etc.)

**Macrophyte**—refers to the macroscopic plant in an aquatic environment

**Marine Protected Area (MPA)**—any area of the marine environment reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources within the area

**Mesohaline**—water with salinity of 5 to 18 practical salinity units (psu)

**Mesopelagic**—is ocean zone of intermediate depths from about 200 to 2,000 m below the surface, where light penetration does not typically occur

**Metamorphosis**—is a process of transforming from one body to another form during development (e.g., tadpole changing to a frog)

**Microhabitat**—is a smaller part of a habitat that has some internal interactions allowing it to function self-sufficiently within a generally larger habitat

**Mid-Atlantic Bight (MAB)**—that part of the ocean coastal region extending from Cape Cod, Massachusetts to Cape Hatteras, North Carolina

**Migration**—the periodic movement between one habitat and one or more other habitats involving either the entire or significant component of an animal population; this adaptation allows an animal to monopolize areas where favorable environmental conditions exist for feeding, breeding, and/or other phases of the animal's life history

**Migratory**—is the classification of organism or group of organisms that undertake a migration as an essential of their life history

**Mollusk**—members of the Phylum Mollusca; a group of marine and terrestrial invertebrates consisting of snails, slugs, squids, octopus, clams, and others

**Mudflat**—is muddy or sandy coastal strip usually submerged by high tide; provides habitat for various marine life

**Mysids**—are small shrimp-like crustaceans

**Nautical mile (NM)**—a distance unit used in the marine environment that is equal to one minute of latitude or 1.85 km

**Nearshore**—an indefinite zone that extends seaward from the shoreline; generally refers to waters from the coast to the continental shelf

**Neddlefish**—piscivorous fish of the family Belonidae that are primarily associated with very shallow marine habitats or the surface of the open sea

**Nekton**—refers to actively swimming pelagic organisms that are able to move independently of water currents; typically within the size range of 20 nm to 20 m

**Neonate**—a newborn

**Neritic zone**—the shallow portion of pelagic ocean waters; ocean waters that lie over the continental shelf, usually no deeper than 200 m

**Nocturnal**—applied to events that occur during nighttime hours

**North Atlantic Oscillation (NAO)**—the climatic phenomenon, one phase of which leads to warmer winter ocean and atmospheric temperatures from the east coast of the U.S. to Siberia and from the Arctic Ocean to the subtropical Atlantic Ocean; this phenomenon is caused by a north-south atmospheric pressure shift and this oscillation can lead to mild, rainy weather in Europe while causing cold, dry weather in the northeastern U.S. and Canada

**Nursery habitat**—an environment crucial for the development of early-stage animals; for some species, this environment is often an open-ocean area characterized by the presence of *Sargassum* rafts and/or ocean current convergence fronts

**Ocean front**—a boundary between two water or air masses that have different densities; water density differences are caused by differences in temperature or salinity

**Oceanic zone**—refers to the deepwater portion of the pelagic ocean waters; ocean waters beyond the continental shelf or that are deeper than the depth of the water overlying the continental shelf break (typically 100 to 200 m deep)

**Offshore**—open ocean waters over the continental slope and beyond that are deeper than 200 m; water seaward of the continental shelf break

**Oophagous**—refers to an animal that feeds on eggs

**Opportunistic**—used to describe organisms that take advantage of all feeding opportunities and do not prey on a few specific items

**Otter trawl**—a type of bottom trawl gear that utilizes two wooden doors (otter doors) to keep the mouth of the trawl net open while being dragged along the seafloor

**Overfish**—a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis

**Overfished**—a stock size that is below a prescribed biomass threshold

**Overfishing**—harvesting at a rate above a prescribed fishing mortality threshold

**Ovoviviparous**—giving birth to live young which have developed from eggs that hatched within the mother's body

**Overwinter**—Staying the winter in one area

**Parturition**—is the act of giving birth

**Pathogens**—are a biological agent that causes disease or illness to its host

**Pelagic**—the water or ocean environment, excluding the ocean bottom; the major environmental division or zone in the ocean that included the entire water column and can be subdivided into the neritic (waters over the continental shelf) and oceanic (deeper waters seaward of the continental shelf) zones

**Pelagic longline**—a longline suspended by floats in the water column (i.e., not fixed or in contact with the ocean bottom)

**Pelecypod**—marine or freshwater mollusks having a soft body with plate-like gills enclosed within two hinged shells; may be burrowing, mobile, or sedentary types

**Penaeid**—a group of shrimp, chiefly found in warm water

**Phytoplankton**—microscopic, photosynthetic plankton, which are the base of the food chain on which ultimately most shellfish, fishes, birds, and marine mammals depend

**Pier**—a platform built out from the shore into the water and supported by piles; provides access to ships and boats

**Pinnipeds**—refers to seals, sea lions, fur seals, and walruses

**Pipefish**—fish with long tubular snout and slim body covered with bony plates

**Piscivorous**—is a carnivorous animal that consumes and preys upon fish

**Plankton**—organisms that drift in the water column or on the water's surface by either passively floating or weakly swimming

**Polychaete**—is a class of soft-bodied, metamerically segmented coelomate worms that bear bristles and fleshy appendages on most segments; marine, may be free-swimming, errant, burrowing or tube dwelling

**Polyhaline**—water with salinity of 18 to 30 practical salinity units (psu)

**Population**—a group of individuals of the same species occupying the same area

**Portunid**—crab of the family Portunidae, which includes the swimming crabs (i.e., blue crab)

**Pots**—traps, designed to catch fish or crustaceans, in the form of cages or baskets of various materials (wood, wicker, metal rods, wire netting, etc.) and having one or more openings or entrances. Usually set on the bottom, with or without bait, singly or in rows, connected by ropes (buoy-lines) to buoys on the surface to show their position

**Practical salinity unit (psu)**—the currently used dimensionless unit for salinity, replacing parts per thousand (ppt)

**Predators**—an organism that lives by preying on other organisms

**Prey**—animal hunted or caught for food

**Protozoans**—any large group of single-celled, usually microscopic, eukaryotic organisms, such as amoebas, cilates, flagellates, and sporozoans

**Purse seine**—a large commercial fishing net pulled by two boats, with ends that are pulled together around a shoal of fish so that the net forms a pouch or "purse"

**Range**—refers to the maximum extent of geographic area occupied or used by a species

**Recreational fishing**—fishing for sport or pleasure

**Salinity**—the concentration of salts in water, measured in practical salinity units (psu)

**Salps**—are a barrel-shaped tunicate without an exoskeleton that forms asexual polymorphoric colonies that are found in the upper levels of the ocean

**Salt marsh**—low areas covered by salt-tolerant vegetation (bushes and grasses) near the sea that are periodically flooded by seawater but not exposed to daily tides; plants in this ecosystem have special adaptations to survive in the presence of high salinities

**Sand dollars**—are any species of flattened, burrowing sea urchin belonging to the order Clypeasterioda

**Sand lances**—refers to sand eels, a common forage fish of the family Ammodytidae that has a narrow, elongate, subcylindrical body with a pointed snout and long dorsal and anal fins

**Sand ridges**—any low ridge of sand formed at some distance from the shore, and either submerged or emergent, such as a longshore bar or a barrier beach

**Sardines**—are any of various small or half-grown edible herrings or related fishes of the family Clupeidae

***Sargassum***—a genus of brown algae commonly found in temperate and tropical waters both as pelagic and benthic forms

**Sauries**—is a slender long beaked fish of the family Scombersocidae

**School**—a social group of fish, drawn together by social attraction, whose members are usually of the same species, size, and age; the members of a school move in unison along parallel paths in the same direction

**Sculpin**—refers to any of numerous spiny large-headed broad-mouthed usually scaleless scorpaenoid fishes

**Sea anemones**—large, heavy, complex polyps that belong to the cnidarian class Anthozoa

**Sea angels**—also known as cliones; and previously known as one kind of pteropods, are a group of small swimming sea slugs

**Sea squirts**—any of various sedentary tunicates of the class Ascidiacae, having a transparent sac-shaped body with two siphons

**Sea surface tempertures (SST)**—refers to the temperature of the upper most layer of seawater (approximately 0.5 m deep). Measured overlarge spatial scales by remote sensing satellite-based detectors and at point locations by moored buoys or ships

**Sea urchins**—are one of the class (Echinoidea) of echinoderms in which the body is covered by hard shell (test) composed of fitted immovable plates with often large and sharp spines that are articulated at base; may be of various sizes – spherical, discoid, or round

**Seagrasses**—rooted, grass-like flowering plants, such as eelgrass, that are adapted to live at sea, submersed, and can tolerate a saline environment

**Seahorse**—a small marine fish of the genus *Hippocampus*, characteristically swimming in an upright position and having a prehensile tail, a horse–like head, and a body covered with bony plates

**Seamounts**—refers to an undersea mountain rising more than 914 m from the sea floor, but having a summit at least 305 m meters below sea level (in contrast to an island)

**Sediment**—solid fragmented material, either mineral or organic, that is deposited by ice, water, or air

**Seine**—nets that are usually set from a boat, and can be operated either from the shore (beach seines) or from the boat itself. The manner of capture is to surround an area of water with a very long net, with or without a bag at the center. The net is usually operated by two ropes fixed to its ends, used both for hauling it in and for herding the fish

**Serial spawner**—a fish that spawns in bursts or pulses more than once in a spawning season in response to an environment stimulus

**Shallow water**—water that is between the shore and the continental shelf break or shallower than 200 m

**Shellfish**—an aquatic animal, as a mollusk, having a shell of shell-like exoskeleton

**Shoals**—a submerged ridge, bank, or bar consisting of, or covered by, unconsolidated sediments (mud, sand, gravel) which is at or near enough to the water surface to constitute a danger to navigation

**Silversides**—small fishes having a silver stripe along each side; abundant along the Atlantic coast of the U.S.

**South Atlantic Bight (SAB)**—that part of the ocean coastal region extending from Cape Hatteras, North Carolina south to Cape Canaveral, Florida

**Spawn**—the release of eggs and sperm during mating

**Species**—a population or series of populations of organisms that can interbreed freely with each other but not with members of the other species

**Species diversity**—the number of different species in a given area

**Species of concern**—identifies species about which NMFS has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA

**Species richness**—number of species in a given area

**Sponges**—any of numerous aquatic, chiefly marine invertebrate animals of phylum Porifera, characteristically having a porous skeleton composed of fibrous material or siliceous or calcareous spicules and often forming irregularly shaped colonies attached to an underwater surface

**Standard deviation**—a statistical measure of the amount by which a set of values differs from the arithmetical means; simply, a measure of how widely values are dispersed from the mean

**Standard length**—the length of a fish measured from the tip of the snout to the end of the backbone and does not include the tail

**Stock structure**—the genetic diversity of a stock

**Stock**—a group of individuals of a species that can be regarded as an entity for management or assessment purposes; a separate breeding population of a species

**Subadult**—maturing individuals that are not yet sexually mature

**Submerged aquatic vegetation (SAV)**—rooted plants and algae that live in submerged saline water during their entire life cycle (including reproduction); occur in fresh, brackish, and marine waters; in marine waters they are found in the low intertidal and subtidal zones

**Substrate**—the material to which an organism is attached or in which it grows and lives; also, the underlying layer or substance

**Subtidal**—estuarine or marine environment that lies below mean low-water; always submerged in a tidally-influenced area

**Subtropical**—the regions lying between the tropical and temperate latitudes

**Subtropical fishes**—species that tolerate a minimum water temperature between 10º to 20ºC

**Surf zone**—refers to area of water from the surf line to the beach

**Target species**—species of fish or invertebrate specifically sought by a fishery

**Taxa (taxon)**—a defined unit (e.g., species, genus, or family) in the classification of living organisms

**Teleost**—of or belonging to the Teleostei or Teleostomi, a large group of fish with bony skeletons, including most common fishes

**Temperate**—the region of the Earth at the mid-latitudes that is characterized by a mild, seasonally changing climate

**Temperate fishes**—species that prefer water temperatures of 10º C or below, with a maximum temperature tolerance of 15ºC

**Thermocline**—the depth in the ocean (water column) in which there is an abrupt temperature change

**Thermoregulatory**—an organism's ability to maintain a specific body temperature regardless of the environmental temperature

**Threatened species**—any plant or animal species likely to become endangered within the foreseeable future throughout all or a part of its range; the authority to designate a species as threatened is shared by the USFWS (terrestrial species, sea turtles on land, manatees) and National Marine Fisheries Service (most marine species) under provisions of the ESA

**Tidal creek**—portion of a stream that is affected by the ebb and flow of the ocean tides, in the case that that the subject stream discharges to an ocean, sea or strait

**Tidal flat**—a nearly flat coastal area, alternately covered and exposed by the tides, and consisting of unconsolidated sediments

**Total length**—the longest measurable distance from the outermost portion of a fish's or marine mammal's snout lengthwise to the outermost portion of the tail fin, or the notch between the flukes for cetaceans

**Trans-oceanic**—refers to on or from the other side of the ocean

**Trap**—a portable, enclosed type of baited fishing gear used to capture fishes or crustaceans (lobsters and crabs) that possesses one or more entrances but no exits and one or more lines attached to surface floats; can be made of many types of materials (wood, reeds, or wire) and in many shapes or configurations; "trap" and "pot" are fairly synonymous

**Trawl**—refers to a towed commercial fishing gear or net that consists of a cod-end or bag used for collecting the fish or other target species; trawls cab be towed at any depth of the water column

**Trolling**—angling by drawing a baited line through the water

**Trophic level**—a step in the transfer of food or energy within a chain

**Tropical**—the geographic region found in the low latitudes (30º north of the equator to 30º south of the equator) characterized by a warm climate

**Tropical fishes**—species that prefer a water temperature of 20ºC or above

**Trotline**—a method of fishing that involves a horizontal set mainline that has small floats attached to suspend it off the seabed to avoid snagging. Short, weighted lines, sometimes called snoods or trots, are attached at intervals along the length of the mainland. These are set vertically in the water and act like a series of short droplines

**Tunicates**—primitive marine animals having a saclike, unsegmented body enclosed in a tough outer covering (e.g., sea squirts, salps)

**Upwelling**—refers to the movement of dense, cold, nutrient-rich water up from ocean depths to the surface

**Wetland**—an area inundated by water (either freshwater or saltwater) frequently enough to support vegetation that requires saturated soil conditions for growth and reproduction; generally includes swamps, marshes, springs, seeps, or wet meadows

**Young-of-the-year (YOY)**—a juvenile fish less than one year old

**Zooplankton**—diverse group of non-photosynthesizing organisms that drift freely in the water or its surface; zooplankton are composed of a wide range of invertebrates, including larval forms of fish and shellfish

# APPENDIX C

# SUPPLEMENTAL LITERATURE

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