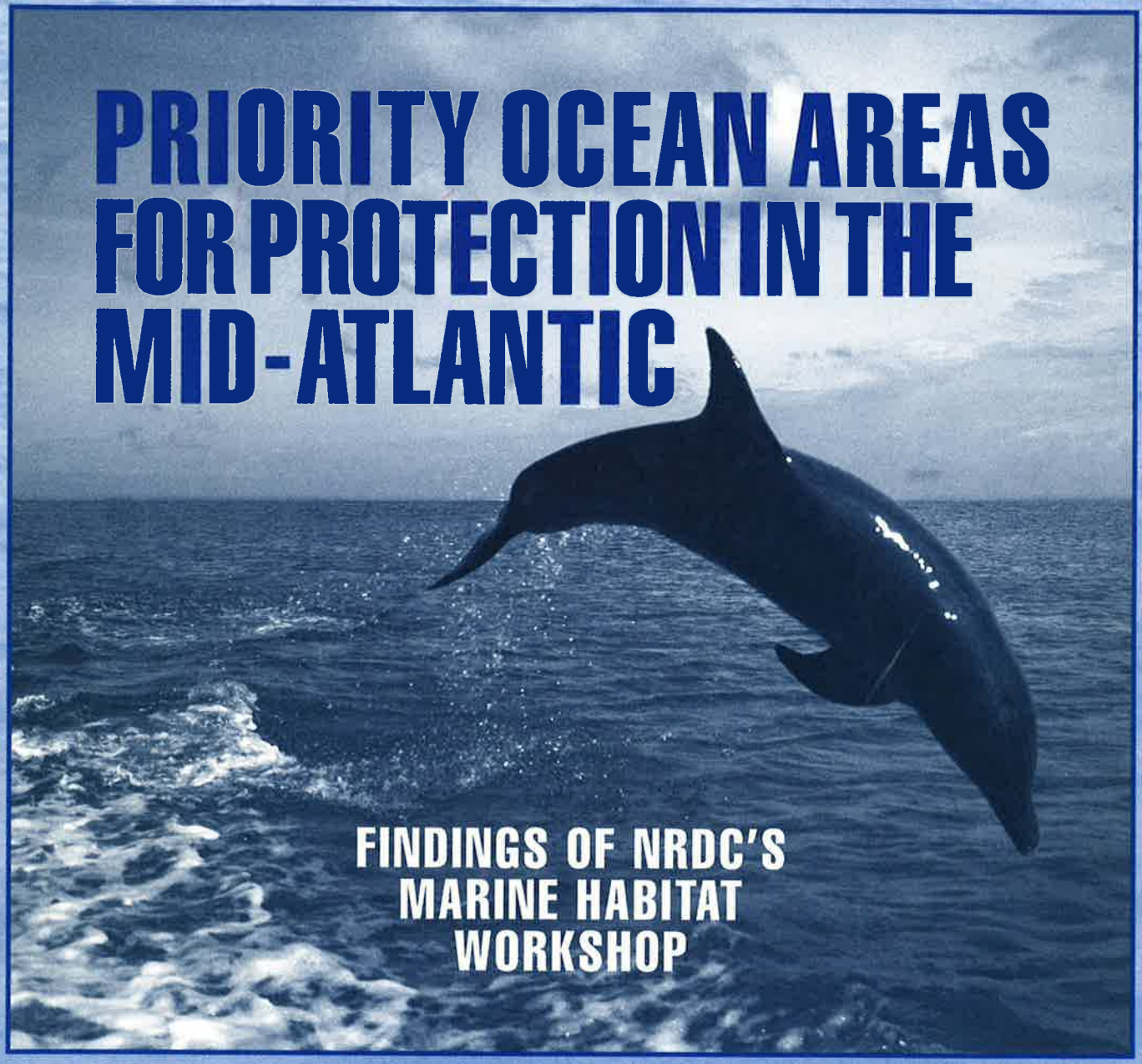
PRIORITY OCEAN AREAS FOR PROTECTION IN THE MID-ATLANTIC



FINDINGS OF NRDC'S MARINE HABITAT WORKSHOP

NRDC

THE EARTH'S BEST DEFENSE

PRIORITY OCEAN AREAS FOR PROTECTION IN THE MID-ATLANTIC

Findings of NRDC's Marine Habitat Workshop

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About NRDC

The Natural Resources Defense Council (NRDC) is a national nonprofit environmental organization dedicated to protecting the world's natural resources and ensuring a safe and healthy environment for all people. With more than 400,000 members and a staff of lawyers, scientists, and other environmental specialists, NRDC combines the power of law, the power of science, and the power of people in defense of the environment. NRDC, which has offices in New York City, Washington, DC, San Francisco, and Los Angeles, has been actively involved in protecting our coasts and oceans for many years.

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INTRODUCTION

The offshore waters of the mid-Atlantic—from Georges Bank, to the North Carolina coast—are home to extraordinary submarine canyons, fragile cold-water corals, productive fish and crustacean habitat, and migratory mammal and sea turtle species. The United States Exclusive Economic Zone (EEZ) for the mid-Atlantic extends from 3 to 200 nautical miles offshore. Within the mid-Atlantic EEZ, federal agencies continually make management decisions that have important ecological and economic impacts. These decisions involve ocean dumping of dredged material, sand and gravel mining, oil and gas development, shipping, fishing, and other activities. Increasingly, attention has been focused on the benefits of protecting some areas of the ocean from potentially harmful activities.

Appreciating the need for better understanding, management, and protection of marine resources in general and in the mid-Atlantic region in particular, the Natural Resources Defense Council (NRDC) organized a workshop designed to bring scientists together to identify specific ocean areas that are priorities for protection in this region. NRDC mapped polygons reflecting each scientist's recommended priority ocean areas for protection. Overlaying the polygons revealed multiple nominations for five ocean areas comprising some 22 percent of the study area: the nine submarine canyons; the offshore waters near Cape Hatteras, North Carolina; tilefish habitat between Cape May, New Jersey, and Cape Cod, Massachusetts; a 35-kilometer (22-mile) corridor of nearshore waters extending along the study area; and a band along the continental shelf break encompassing the upper slope. In addition to these five areas of significant overlap, other areas were identified as priorities for protection by one or more scientists.

Five ocean areas comprising 22 percent of the study area received multiple nominations from participating scientists.

NRDC has a long history of working on coastal and ocean issues both nationally and within this region. The information generated at this workshop, NRDC believes, will be of value to policymakers weighing the impact of their decisions on ocean resources, and to the general public, which may well be unaware of the rich and varied living marine resources in the region.

ABOUT THE MID-ATLANTIC

The ocean waters in the mid-Atlantic region experience the most extreme temperature variation of any marine body in the world. Partly because of its range of climate and variety of physical features, the mid-Atlantic supports highly diverse populations of fish, whales, sea turtles, crustaceans, and other invertebrates. Sea turtle populations include leatherbacks, loggerheads, and Kemp's ridleys. Cetacean species include right, sperm, beaked, pilot, sei, and fin whales, and common, Rizzo's, bottlenose, striped, and spotted dolphins. Exposed substrate in the canyons supports corals, sponges, and anemones.

In addition to its inherent biological significance, the mid-Atlantic supports a number of valuable commercial and recreational fisheries including those for flounder (including summer, winter, and witch), sea bass, herring, monkfish, mackerel, bluefish, lobsters, horseshoe crabs, scallops, ocean quahogs, surf clams, tilefish, and squid.

The continental shelf within the mid-Atlantic region extends from the shoreline to the continental slope at roughly the 200-meter isobath. Besides water depth, several

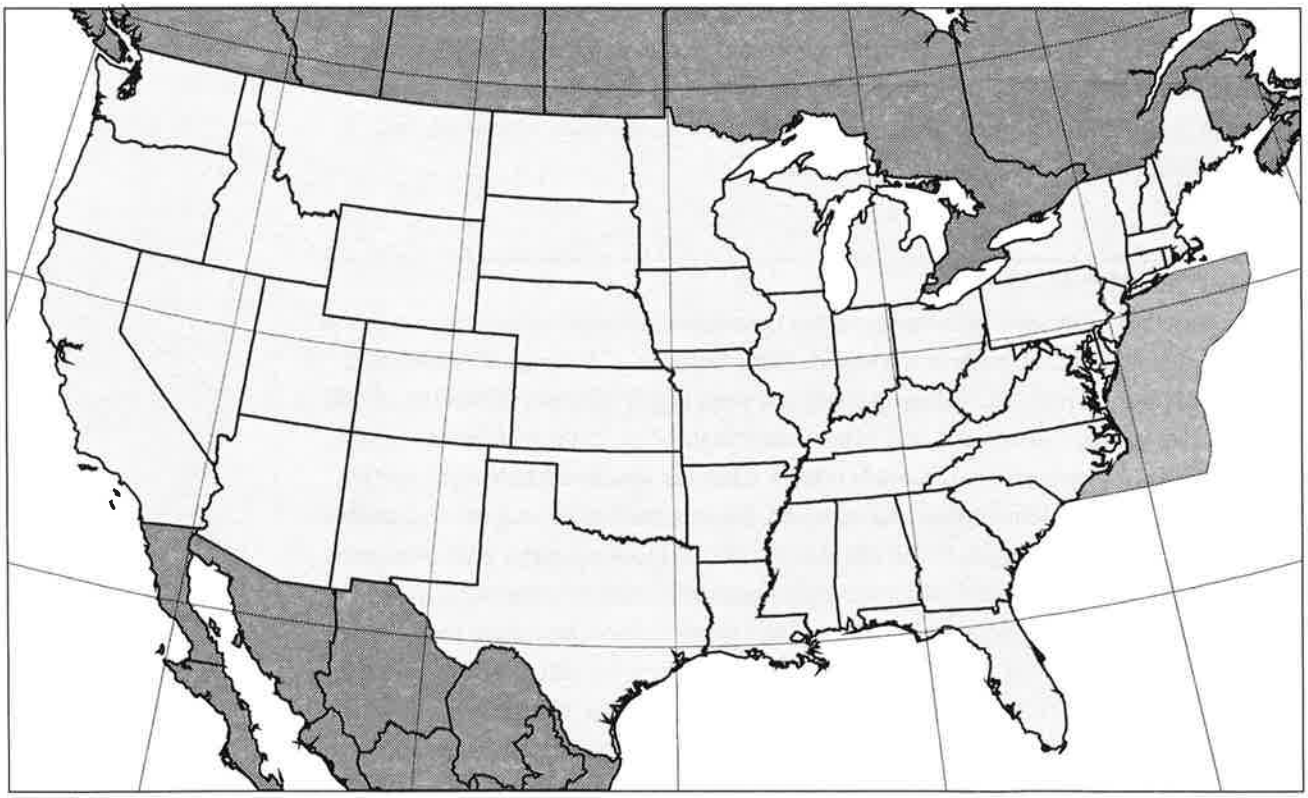
physical influences are thought to impact biological habitat in this region. First, sediment texture: the shelf is primarily composed of sand, with isolated patches of coarse-grained gravel and fine-grained silt and mud deposits. Second, seafloor variability: the main physiographic feature within the mid-Atlantic is the Hudson Shelf Valley and Canyon (see the map on page 4), extending from the inner-continental shelf, at about the 40-meter isobath, onto the continental slope. The Hudson Shelf Valley and Canyon are primarily composed of fine-grained sediments (fine sand, silt, and clay). Other significant physiographic features include several other major canyons, at least one seamount, and the unique oceanography and geology off Cape Hatteras.

Water temperature, both seasonal changes and temperature fronts, is considered a third potential factor influencing biological habitat. Bottom temperatures fluctuate across the shelf, with the highest variation near the shore and the most stable bottom temperatures occurring along the continental shelf break. The waters along the shelf break form a noticeable temperature front, even on the surface. Currents represent a fourth, related, factor: the current flowing southwest from Georges Bank tempers seasonal changes in the mid-shelf waters.

ABOUT THE WORKSHOP

NRDC invited 15 leading marine scientists (see page 56), drawn principally from academia and government, who are known for their expertise concerning marine mammals, fish, sea turtles, and invertebrates, to attend a one-and-a-half-day working

The study area covered from Georges Bank to the North Carolina coast.



conference, held on September 26–27, 2000, at the NRDC headquarters in New York City. It is important to note that, despite the wealth of knowledge and expertise of those who participated, there were certain gaps in expertise, including gaps with respect to lobsters and crabs and some fish species, such as bluefish and striped bass.

Each scientist recommended specific areas (delineated on a map and referred to as polygons in this report) as meriting protection, provided a rationale for each polygon, and supplied scientific references to support his or her recommendation. Environmental Systems Research Institute ArcView GIS (Geographical Information Systems) software was used during the workshop to display and refine those polygons on a projected map. While the workshop did not call for a consensus of viewpoints, common criteria for protection did evolve, and common or overlapping polygons recommended by more than one participant and/or for more than one reason were identified.

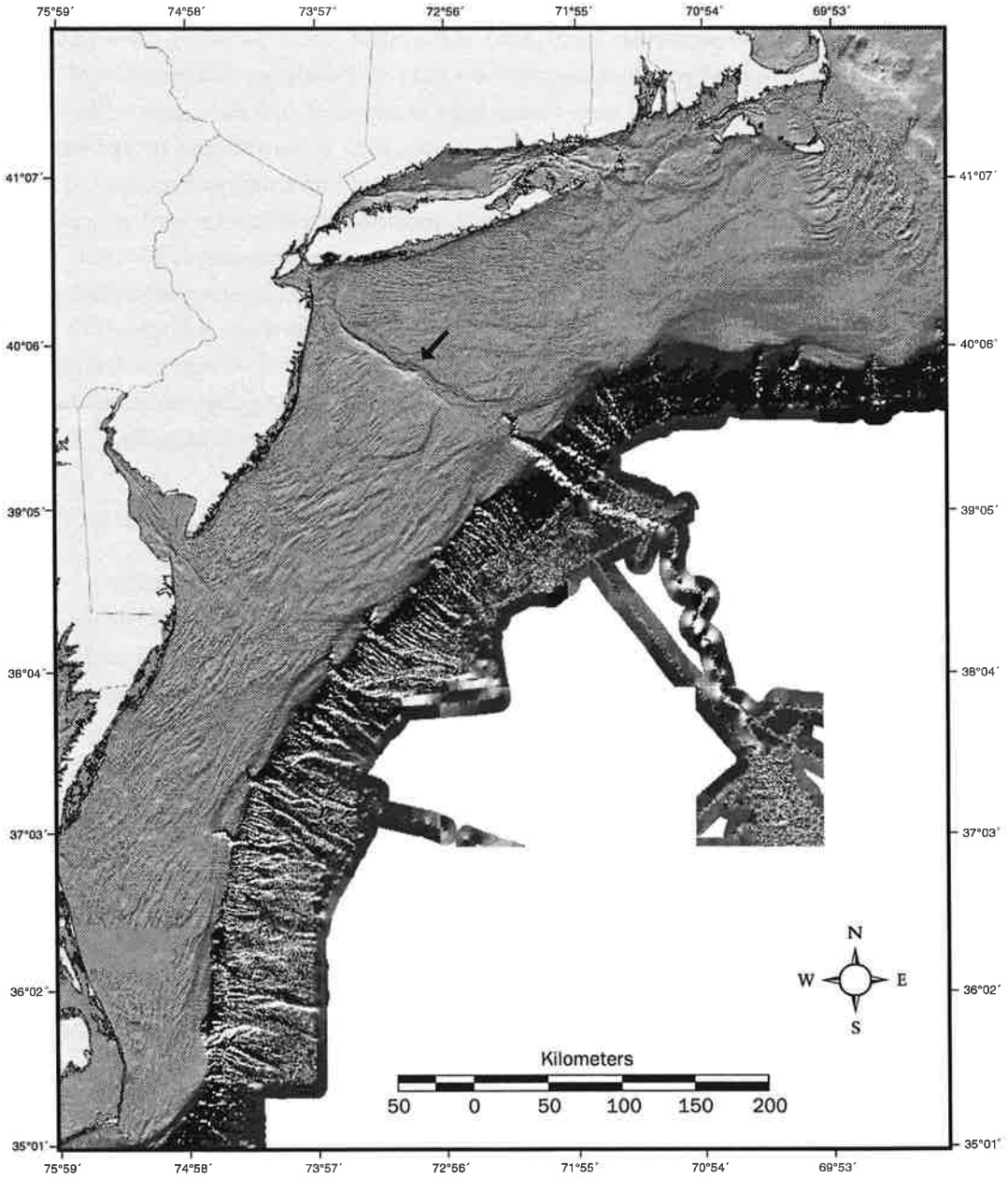
ABOUT THIS REPORT

The primary purpose of this report is to summarize the results of the scientific workshop and make this information available to policymakers and the public for use in decisions affecting marine species and habitat in federal waters of the mid-Atlantic. To this end, NRDC has produced maps reflecting the priority areas of each of the participants, with an accompanying description of why these areas are important, references supporting the designation of each area, and maps indicating where the priority areas converge. It must be understood, however, that these maps are limited by a number of factors.

First, any scientist, even one completely versed in the existing literature on a particular subject, can only speak to what he or she knows about the ocean. As many participants pointed out, there is much that is unknown about the ocean, especially in places where fishing or other human activity has not sparked inquiry. To identify areas that are priorities for protection does not suggest that other areas would not be deserving of protection if more were known.

There is much that is unknown about the ocean, particularly in places where fishing or other human activity has not sparked inquiry.

Second, the discussion at the workshop was limited to geographic and legislative boundaries that do not necessarily reflect ecological realities. NRDC originally defined the area for discussion as extending from Long Island, New York, to Cape Hatteras, North Carolina, because this area is considered a region in at least two important contexts: for fishery management and for oil and gas leasing purposes. NRDC subsequently extended the area south, since some participants observed that the area south of Cape Hatteras is a transitional area in terms of north-south migrations and supports an extraordinarily diverse suite of marine animals. Also, we decided to focus on federal waters because there is generally less understanding about the important role played by offshore waters in supporting marine life, and because decisions across this entire area come directly under federal management. Many participants, however, noted that there was no scientific basis for identifying polygons starting at the 3-mile boundary and so recommended areas for protection right into the coast and even into certain bays and sounds. This was so noted in the description of the areas, but the maps themselves identify important marine habitat



The main physiographic feature within the mid-Atlantic is the Hudson Shelf Valley and Canyon. The Hudson Shelf Valley is the drowned river valley of the Hudson River.
Image courtesy of the U.S. Geological Survey. Data source: National Geophysical Data Center, Coastal Relief Model, Volume 01, U.S. North East Atlantic Coast, National Oceanic and Atmospheric Administration (NOAA). 1 CD-ROM.

only in federal waters. Plus, since the tip of Long Island is nearly parallel with the islands around Cape Cod, many scientists mentioned Cape Cod as the northernmost point of their recommendations, especially for migratory species.

Third, the workshop did not seek any kind of consensus-based ranking of priority areas for protection. Participants were given the opportunity to review and revise their own maps but were not expected to agree with the maps of other participants.

Fourth and finally, while some specific threats to marine life were identified, the workshop did not comprehensively address threats. Nor did the workshop make recommendations as to how these areas should be managed. Those decisions will involve a much more diverse group of interests as part of a broader policy debate. The purpose of this report is to begin to establish the scientific basis for such decisions in the future.

PART ONE

SUMMARY OF FINDINGS

Seven major criteria were used in identifying priority ocean areas for protection.

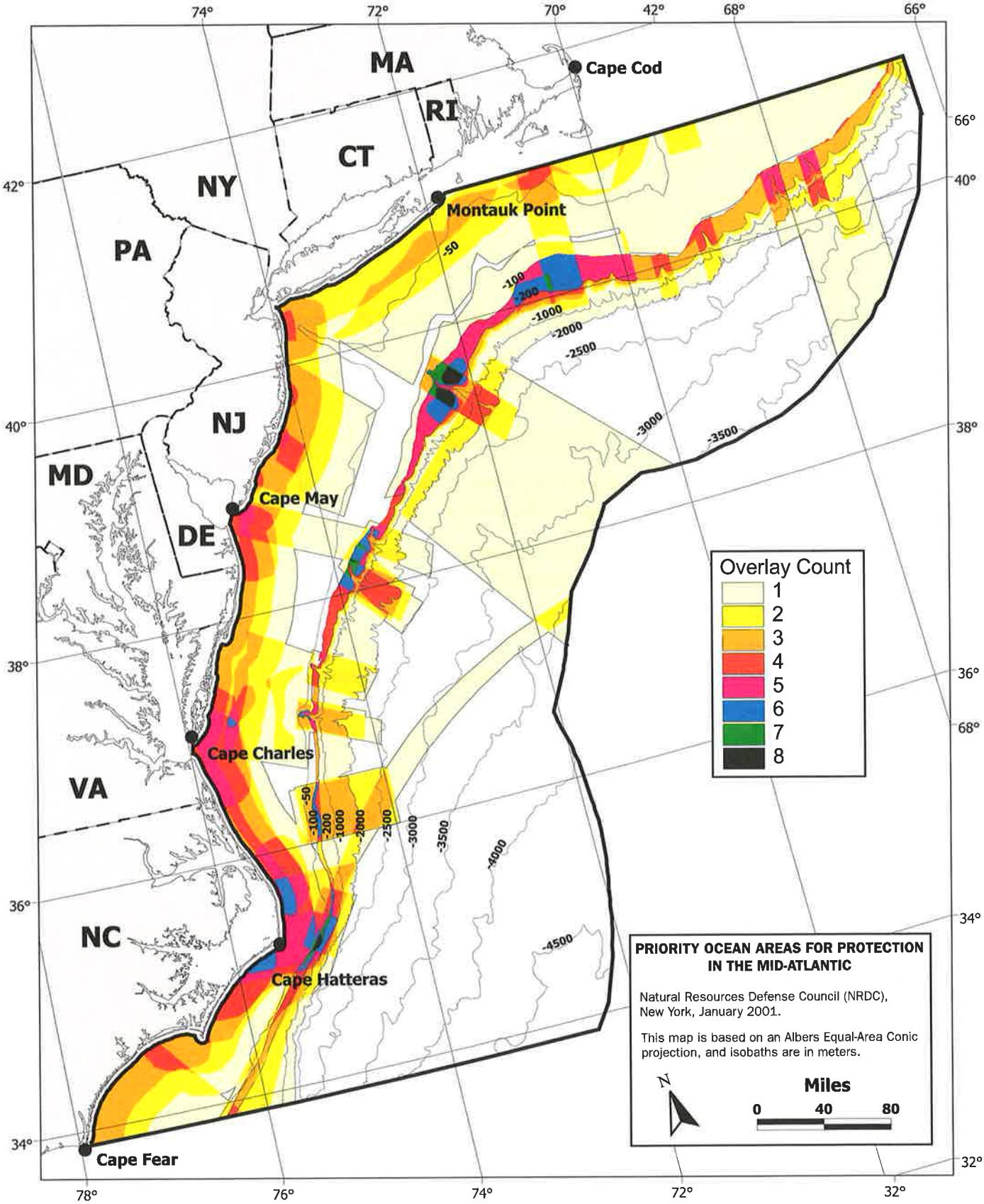
- *Biodiversity:* the presence of a wide variety of animal and plant species, often in interdependent living arrangements.
- *High abundance:* a heavy concentration of fauna and/or flora.
- *Migratory pathway:* corridors used by marine fauna, generally based on seasonal travels for the purposes of feeding, spawning, or other functions.
- *Physical features:* topographical features (such as canyons) or oceanographic occurrences (such as upwelling or temperature gradients) associated with productivity or diversity.
- *Nursery or spawning areas:* locations where important reproductive functions for particular species are known to take place, including birthing, egg laying, fertilization, and hatching.
- *Endangered or threatened species:* identification of a primary habitat or migratory pathway for a species already known to be endangered or threatened.
- *Fisheries:* the combination of fish and commercial or recreational fishing activity.

Variations on these criteria and additions to them are noted in the text supporting each individual scientist's recommendations.

PRIORITY AREAS FOR PROTECTION

NRDC used GIS software to map polygons reflecting each scientist's recommended priority ocean areas for protection. Taken together, the participants' recommendations cover 58 percent of the study area delineated at the workshop. The polygon overlay showed the areas of greatest convergence—where several participants recommended the same or overlapping areas, often for different reasons. Doing so revealed extensive overlap of scientists' selections of high-priority areas, accounting for 22 percent of the total study area.

This map shows the areas of greatest convergence—where several workshop participants recommended the same or overlappng areas.



Five areas stood out as receiving the most recommendations.

▸ Submarine canyons (south to north): Norfolk, Washington, Baltimore, Wilmington, Hudson, Veatch, Hydrographer, Oceanographer, and Lydonia.

▸ Offshore waters near Cape Hatteras, extending to the 2,000-meter isobath.

▸ Tilefish habitat between Cape May and Cape Cod, between the 80- and 400-meter isobaths.

▸ A 35-kilometer corridor (extending from shore) of nearshore waters, encompassing many subareas of importance.

▸ The continental shelf/slope break area, from the 100-meter to the 400-meter isobath.

Each of these "overlap" areas is described and discussed in Part Two of this report.

It is extremely important to note that the priority ocean areas identified in this report are not limited to the areas of overlapping recommendations. All the priority areas identified by the scientists, whether by one or by many, are important. For example, one scientist noted the significance of the ocean quahog and surf clam fisheries to this region, while another pinpointed an area along the Hague line that is biologically distinct from the rest of the mid-Atlantic. The fact that only one scientist recommended an area may simply reflect the fact that he or she is the only one with expertise regarding a particular species, population, etc. A map with each scientist's recommendations is included in Part Three.

PART TWO

DISCUSSION OF OVERLAPPING PRIORITY AREAS FOR PROTECTION

This section describes the overlapping priority areas for protection identified by several participants at NRDC's workshop. The maps and descriptions of the areas recommended by each individual participant are contained in Part Three.

SUBMARINE CANYONS

Submarine canyons support high concentrations and a great diversity of marine wildlife. Physically, they are complex, with outcrops, steep slopes, and different classes of substrates. They also provide a high flux of fine-particle nutrients and often encompass areas of upwelling, which are associated with high biological productivity.

In the mid-Atlantic there are nine major submarine canyons (from south to north): Norfolk, Washington, Baltimore, Wilmington, Hudson, Veatch, Hydrographer, Oceanographer, and Lydonia. In addition, there is also the Bear Seamount, an underwater mountain just southeast of Lydonia Canyon that is centered near 67°25′ W and 39°55′ N and offers similarly diverse habitats.

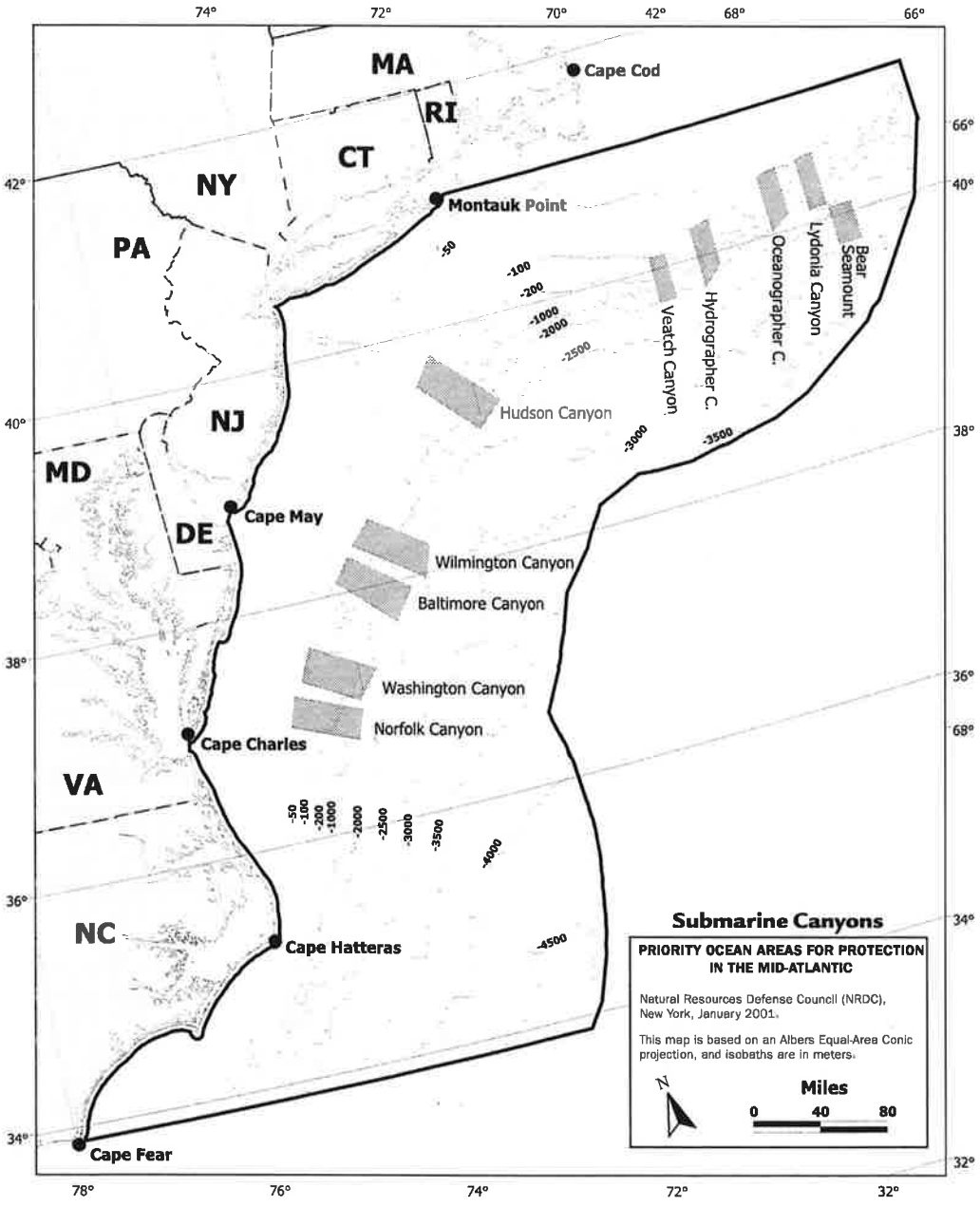
While much of the canyon bottom is sand, the hard substrate exposed at the heads of canyons and along canyon walls provides habitat for sessile species of sponges, corals, and anemones, which require a hard surface on which to attach. Because the incidence of these populations is restricted by the availability of hard substrate, and because canyons frequently provide the only such features within a wide area, disruptions to canyon environments could significantly impact these species. Some deepwater coral species have exceptionally slow growth rates and do not recover easily from disruptions.

The hard substrate exposed at the heads of canyons and along canyon walls provides habitat for sessile species of sponges, corals, and anemones.

Canyons also provide a refuge for juveniles of commercially important fish and crabs. The heterogeneous habitat provided by hard substrate outcrops and the sessile organisms inhabiting them offer refuge from predators for both juveniles and adults.

Other organisms found in high concentration in the canyons of the mid-Atlantic include cerianthids (*Cerianthus borealis*), sea pens (*Pennatula aculeata*), and holothurians (*Peniagone* sp.).

During the NRDC workshop, Hudson Canyon was cited by several participants as a priority area for protection. Besides being a dynamic environment supporting



nurseries for a variety of fish and crustaceans, the head of Hudson Canyon is home to tilefish burrows, which in turn attract secondary burrowing and support a highly diverse community. (See the "Tilefish Habitat" discussion, on page 12.)

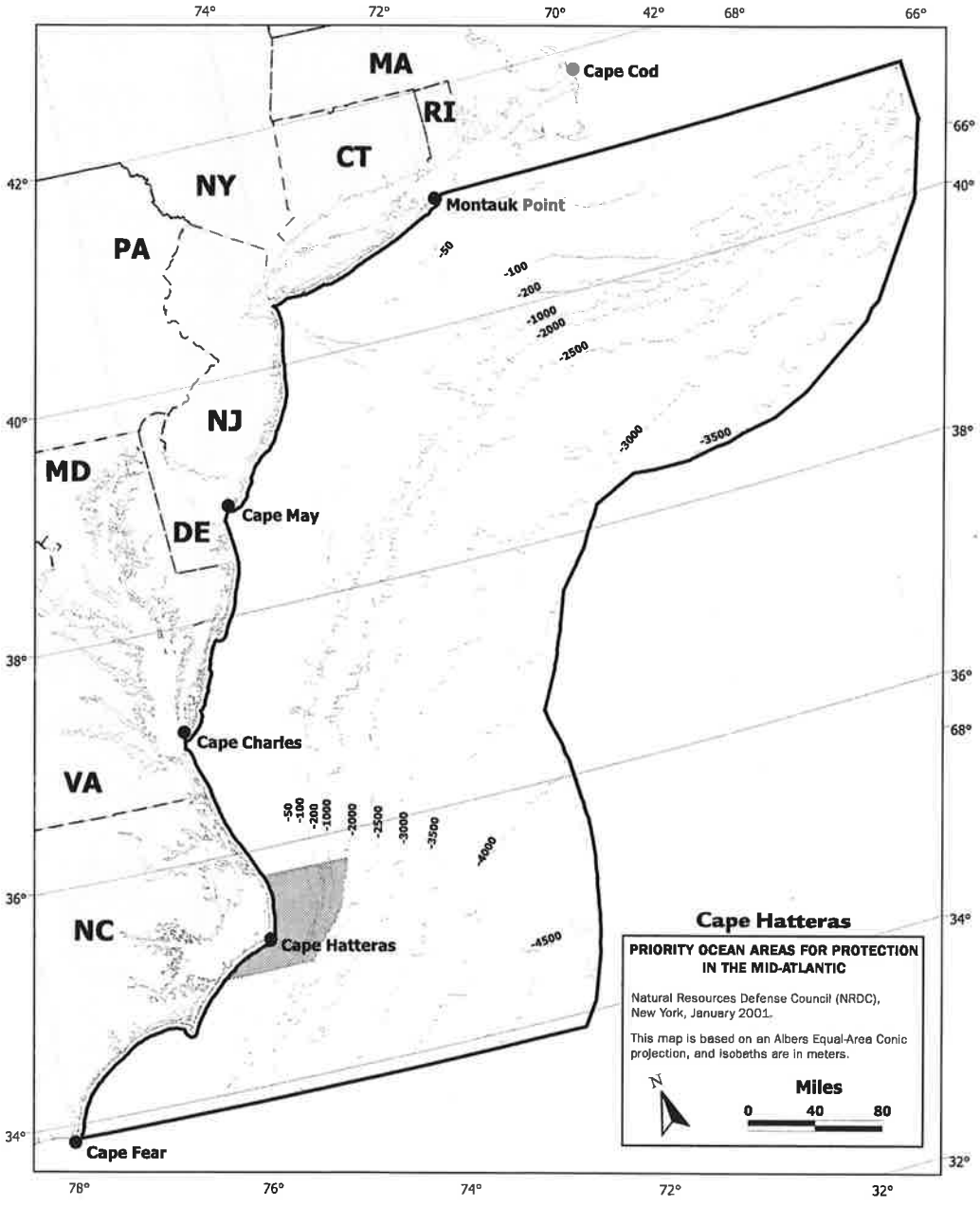
Economically important species such as tuna, lobster, and swordfish (some populations of which are overfished) are found in Hudson, Baltimore, and Norfolk Canyons. Norfolk Canyon is noteworthy because it contains what is possibly the southernmost outpost of fauna associated with boreal red coral. This canyon was nominated in 1975 as a marine sanctuary, but was never designated as such.

For more information on submarine canyons, see the discussions, maps, and references provided by Grassle, Hecker, and Musick.

CAPE HATTERAS

Cape Hatteras, North Carolina, might be called the southern gateway to the mid-Atlantic. Most coastal fauna that migrate into the mid-Atlantic from the south Atlantic pass this point. From the surface to the bottom, out to the 2,000-meter isobath, this area experiences seasonal migrations of cetaceans, sea turtles, and fishes, including sharks.

More than any other single area discussed during NRDC's workshop, the waters off Cape Hatteras were repeatedly cited for both high biodiversity and high abundance of fauna. In particular, there is an unusually high abundance of benthic fish species. The continental slope off Cape Hatteras receives exceptionally high



The Gulf Stream passes close to Cape Hatteras, making this a hydrographically dynamic area and attracting seasonal concentrations of seabirds, turtles, and other marine wildlife.

fluxes of sediment and nutrients that are funneled off the shelf above, helping to account for high abundance of infaunal organisms as well. The incline of the continental slope is particularly steep, and the waters off Cape Hatteras have the steepest temperature gradient of any area off the Atlantic coast.

Located at the convergence of currents, the area around Cape Hatteras encompasses a variety of physical features—from sandy shoals to deepwater coral systems. The Gulf Stream passes close to Cape Hatteras, making this a hydrographically dynamic area and attracting seasonal concentrations of seabirds, turtles, and other marine wildlife. The hard bottom along the edge of the Gulf Stream, extending toward the South Carolina border, hosts the most northern occurrence of some tropical fish species, such as snapper and grouper. Black sea bass and porgy are among other fish species that concentrate seasonally. The reef also provides winter habitat for loggerhead sea turtles. Crustaceans and other invertebrates tend to colonize these hard surfaces as well.

In addition, floating mats of *Sargassum* that support an array of sea creatures drift up with the Gulf Stream, which usually meanders between the 100-meter and the 2,000-meter isobaths off Cape Hatteras. The leafy structure of *Sargassum* provides a nursery environment for hatchling and small juvenile sea turtles and many fishes. Some of the fishes inhabiting *Sargassum* are prey for larger pelagic predators, making the preservation of this habitat important for the overall sustenance of the region.

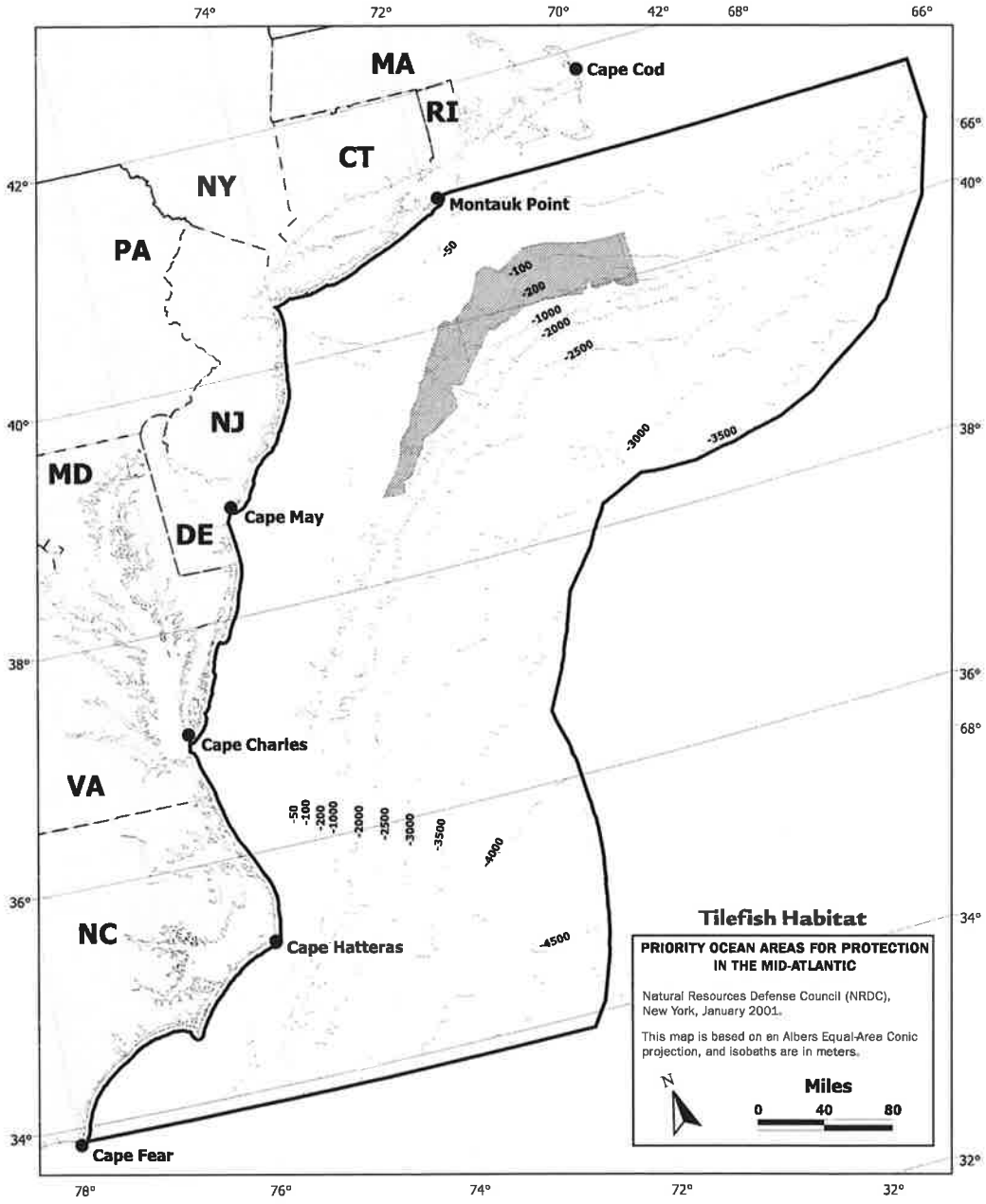
For more information on the area around Cape Hatteras, see the discussions, maps, and references provided by Able, Auster, Crowder, Hecker, Knowlton, Lipcius, Musick, and Rader.

TILEFISH HABITAT

Tilefish make their home in the mid-Atlantic from Cape May, New Jersey, to Cape Cod, Massachusetts, generally between the 80-meter and 400-meter isobaths. This area includes the head of Hudson Canyon and has been designated a Habitat Area of Particular Concern (HAPC) by the Mid-Atlantic Fishery Management Council. (See "Submarine Canyons," on page 9, for a discussion of the importance of Hudson and other submarine canyons.)

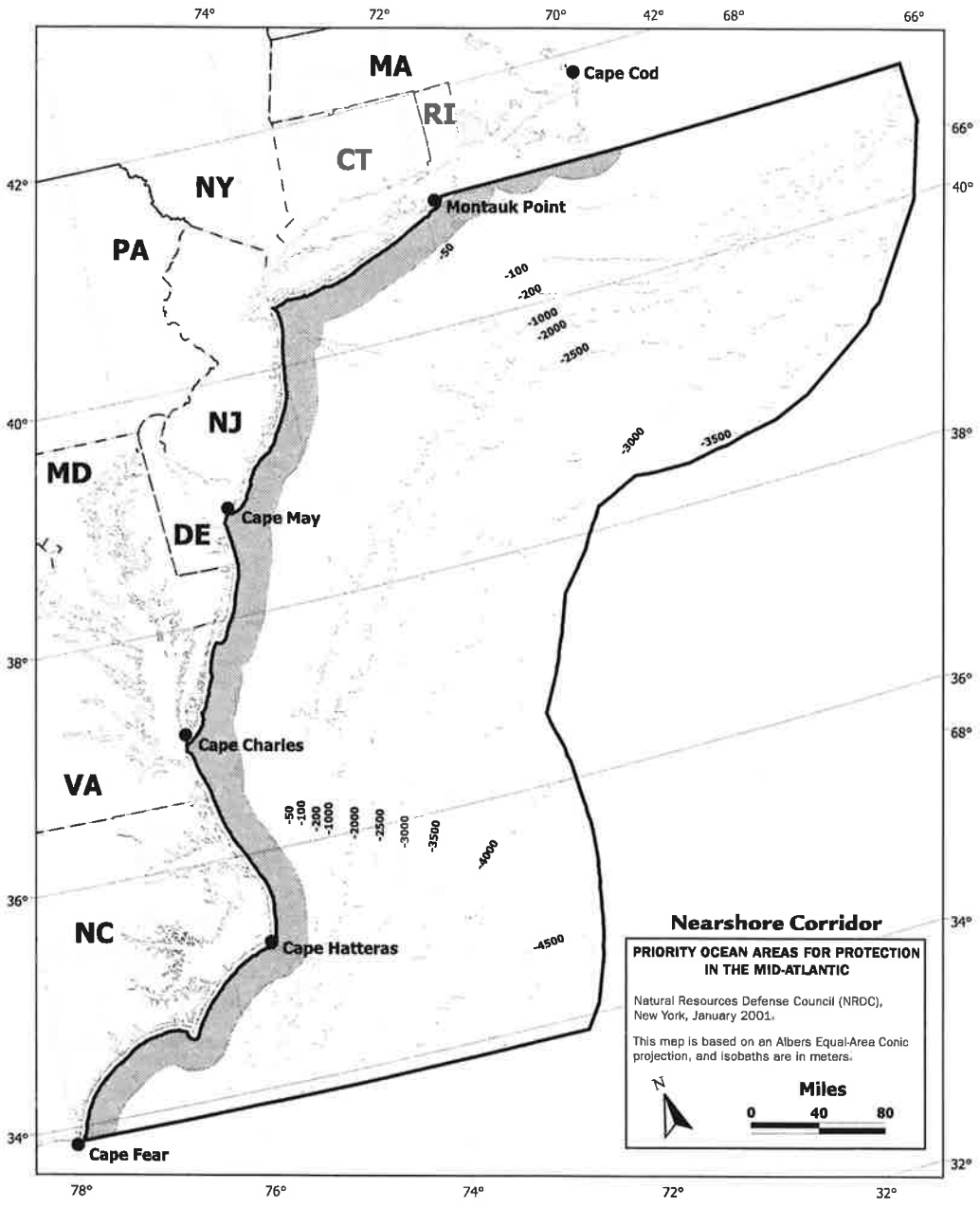
Beyond supporting an economically significant, though relatively small, commercial fishery, tilefish help to create areas of biodiversity through their unique manner of inhabiting the seafloor. The fish dig funnel-shaped burrows, up to 3 to 4 meters wide and 2 meters deep, attracting secondary burrowing by and providing shelter for lobsters, crabs, and eels. A large number of fish also find overwintering habitat in the same depths as tilefish burrows, including summer, winter, and witch flounder, scup, black sea bass, hake, and squid. Disruption of tilefish habitat would thus affect a range of fish and invertebrate species.

For more information on tilefish habitat, see the discussions, maps, and references provided by Able, Chiarella, Hecker, and Hoff.



NEARSHORE CORRIDOR

During NRDC's workshop a coastal corridor extending along the length of the study area, 35 kilometers (22 miles) from shore, evolved as a priority for protection. Several scientists recommended consideration of all or most of this corridor area (or in one case an even wider corridor), varying from approximately 19 kilometers (12 miles) to 56 kilometers (35 miles) offshore, to protect migrating right whales, sea turtles, and fish species. Other scientists pinpointed within that corridor specific areas of importance for migration, nurseries and spawning, diversity hot spots, and fish populations of commercial importance. It should be noted that NRDC's map ends at the 3-mile state-federal boundary, but all of the



rationales provided for protecting this area would also support protection into state-regulated waters.

The North Atlantic right whale, one of the most endangered large whale species in the world, feeds in the waters off the Gulf of Maine and Cape Cod during the spring through fall. Mature females migrate south in late fall to give birth off the coasts of Florida and Georgia during the winter, then return north in the spring. Most right whales seen in the mid-Atlantic have been spotted within 32 kilometers (20 miles) of the coast, although they travel out to at least 56 kilometers (35 miles) from shore, in pelagic waters, between November and April. The already low numbers of right whales are threatened by the busy shipping lanes through which they pass.

A similar broad coastal swath, out to 35 kilometers (22 miles) from shore, was identified as a migratory pathway for fish species of commercial and ecological importance, including bay anchovy, bluefish, striped bass, menhaden, summer flounder, shad, sturgeon, and sharks. Additionally, much spawning activity takes place in these coastal waters, and larvae are transported to inshore nursery areas.

A broad swath, out to 35 kilometers from shore, was identified as a migratory pathway for fish species of commercial and ecological importance.

Sea turtles also travel seasonally along the mid-Atlantic coast, typically within approximately 19 kilometers (12 miles) of shore. The major species involved in this migration include loggerheads, Kemp's ridleys, and leatherbacks. Their presence seems to be concentrated along the coast from Cape Hatteras, North Carolina, to Cape May, New Jersey.

The coastal waters off North Carolina, south of Cape Hatteras, were noted in the workshop for the degree of spawning activity of a wide variety of both pelagic and benthic fish and crustacean species. The inlets found along this varied coastline offer access to nursery areas for the larvae that drift in and out with the tides. Oregon Inlet in particular (north of Cape Hatteras) offers access to a critical nursery area for crab larvae, including blue and fiddler crabs, between May and October, and for summer flounder larvae from November through March.

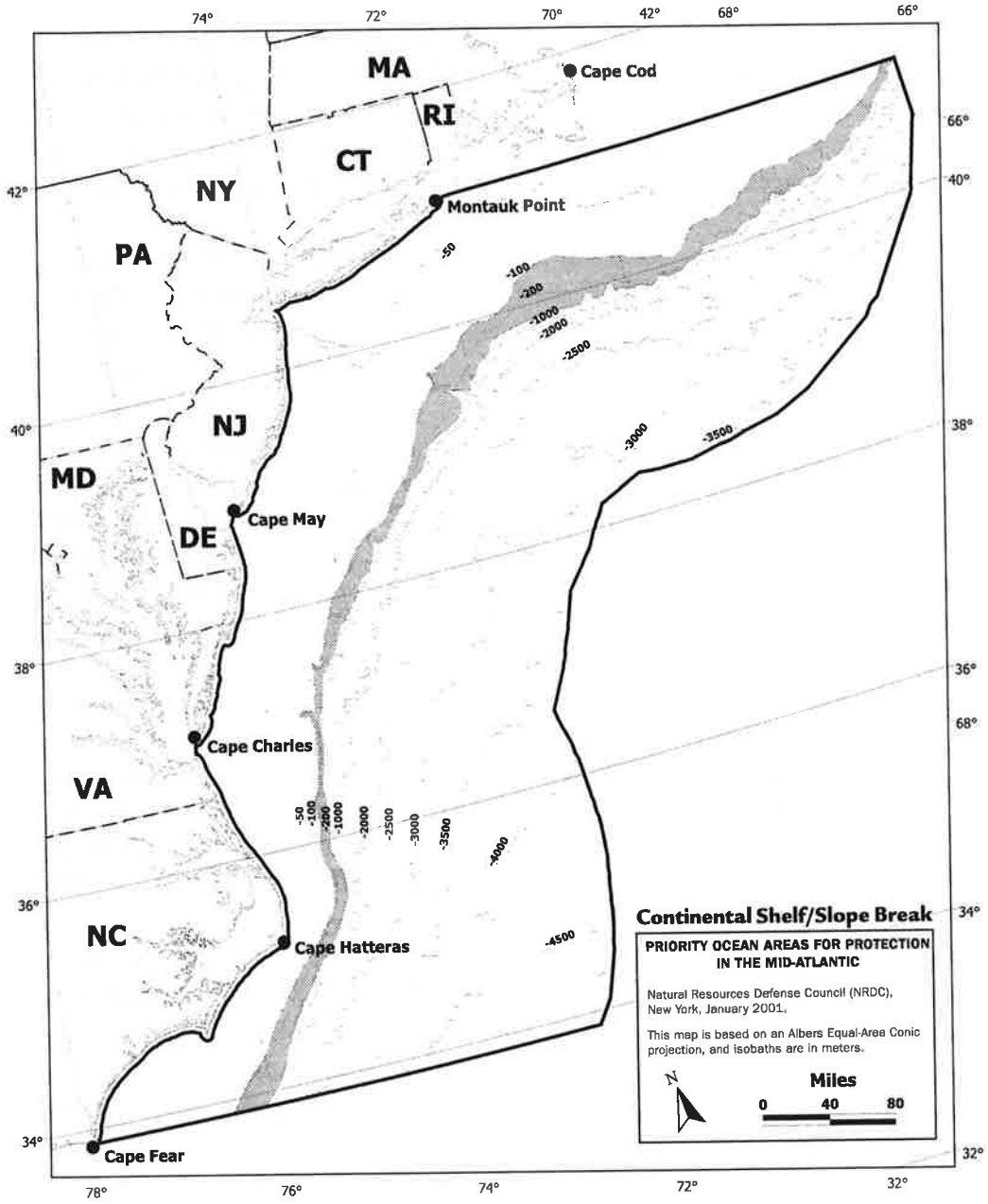
Moving north, three similar environments provide nursery areas for crab larvae and spawning grounds for pelagic fish, including summer flounder, menhaden, croaker, spot, and weakfish. These areas are the mouth of Cheseapeake Bay, the mouth of Delaware Bay, and New York Harbor. The area off Delaware Bay was cited as a diversity hot spot as well, containing a representative assemblage of benthic fish species inhabiting the mid-Atlantic, including summer flounder, bluefish, scup, *Illex* and *Loligo* squid, dogfish, black sea bass, and monkfish.

The coastal waters off New Jersey were cited by more than one participant as being highly productive habitat for bivalve populations. Upwelling in four areas distributes invertebrate larvae and is thought to increase productivity. About 76 percent of the economically important surf clam fishery, in particular, is supported by populations off the New Jersey coast. The coarse sands off this coast also support a high diversity of organisms, a high abundance of crustaceans, and include certain unusual species.

For more information about this nearshore corridor, see the discussions, maps, and references provided by Able, Auster, Grassle, Knowlton, Lipcius, Powell, Rader, and Watling.

CONTINENTAL SHELF/SLOPE BREAK

In the mid-Atlantic, the relatively flat continental shelf transitions to the steeper slope typically around the 200-meter isobath. The continental shelf/slope break is the point at which this transition from shelf to slope occurs. During NRDC's workshop, scientists studying quite different marine populations pointed to the continental shelf/slope break area as a priority area for protection. The width, length, location, and depth of their polygons varied, but taken together, their



recommendations form a strong argument for considering protection along the entire shelf/slope break area, between the 100-meter and at least the 400-meter isobath.

The benthic waters encompassing the 100- to 400-meter isobaths contain a high concentration of *Illex* and *Loligo* squid, and very likely other squid species as well. *Illex* and *Loligo* support important commercial fisheries in this area. In addition, squid are an important food source for mammals and for commercially important species such as tuna and swordfish. *Illex* are present in this area in largest numbers from May through September; *Loligo*, from October through April.

Loggerhead sea turtles are found in pelagic waters along the shelf/slope break, between the 100-meter and 250-meter isobaths (as well as throughout the mid-shelf

region). At present one of the threats to these turtles is longline fishing vessels targeting highly migratory species, particularly swordfish, which often ensnare the turtles by accident.

Many fish species are found in the upper portion of the shelf-break area, from Cape May to Cape Cod. The moderate bottom temperatures there provide habitat for warm temperate species in winter and boreal species in summer.

The pelagic waters of the continental shelf break and upper continental slope, out to the 2,000-meter isobath, contain the highest diversity of marine mammals in the mid-Atlantic EEZ. Shelf-edge cetacean species include sperm, beaked, pilot, sei, and fin whales, and common, Rizzo's, bottlenose, striped, and spotted dolphins. Some species occupy the entire swath, from Cape Hatteras, North Carolina, to Cape Cod, Massachusetts, while others occur primarily in only the more northern or southern portions of this region. Cetaceans, as migratory animals, tend to reside in these waters seasonally, but different species come and go at different times, amounting to year-round importance.

The shelf-break area off the coast of North Carolina, between the 50-meter and 2,000-meter isobaths, was cited by a number of participants as a hot spot for biodiversity. High benthic diversity of small crustaceans and infauna is found in this area, while a high diversity of both benthic and pelagic fish is also found off this coast. This is due to the steep shelf edge, a convergence of currents, and steep temperature gradients.

Finally, most of the submarine canyons in the mid-Atlantic begin near the break of the continental shelf, at the 100-meter isobath. (See "Submarine Canyons," on page 9, for a discussion of the importance of canyons for marine life.)

For more information about the shelf-break area, see the discussions, maps, and references provided by Auster, Chiarella, Crowder, Kenney, Powell, Rader, and Watling.

The pelagic waters of the continental shelf break and upper continental slope, out to the 2,000-meter isobath, contain the highest diversity of marine mammals in the mid-Atlantic EEZ.

PART THREE

INDIVIDUAL MAPS AND RECOMMENDATIONS

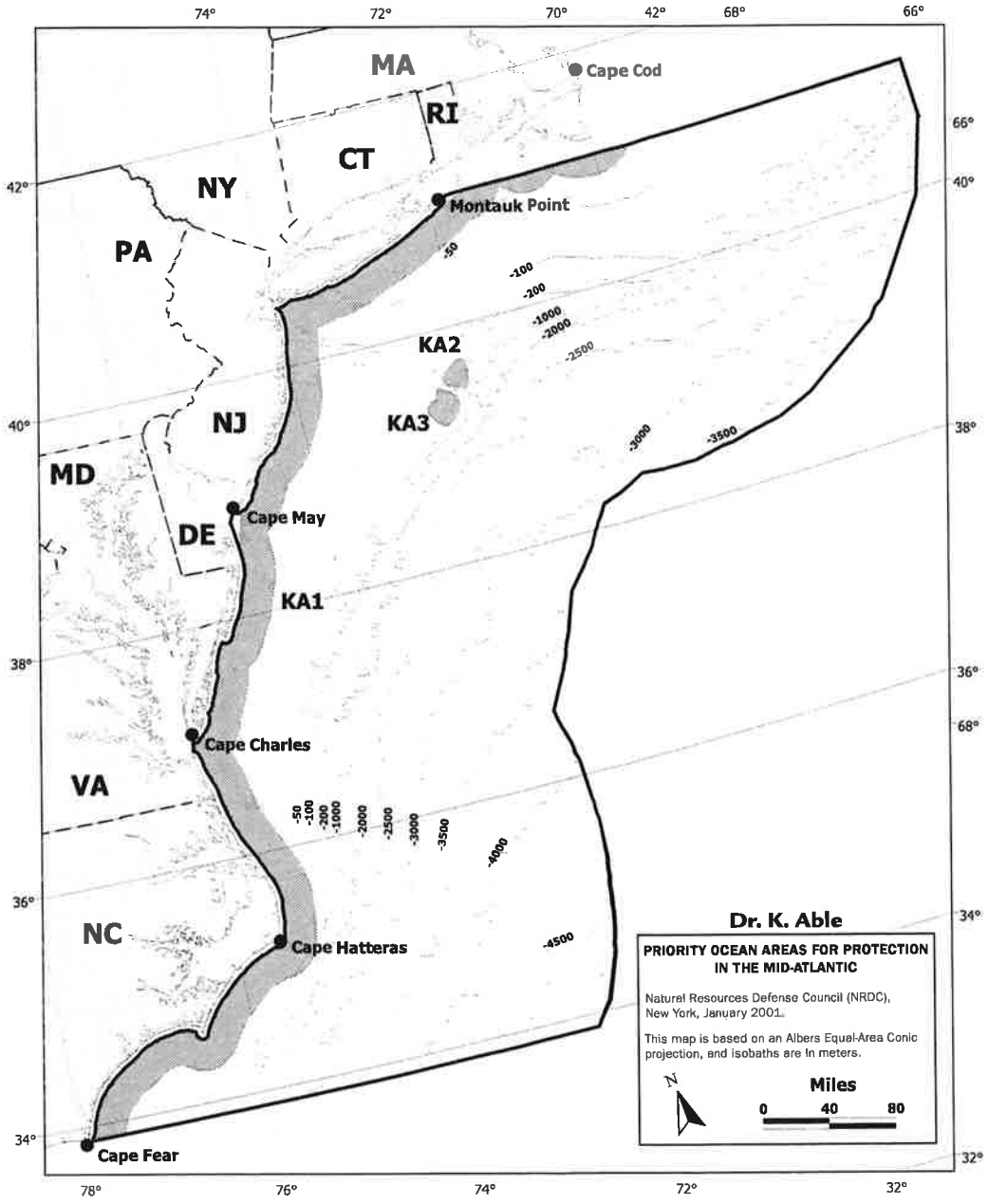
KEN ABLE

POLYGON KA1

Rationale: migratory corridor

Seasons and depths important for protection: April–October; pelagic and benthic

This inshore corridor, from the coast out to 35 kilometers (i.e., 21.7 miles from the coast, or 18.7 miles into federal waters), is a migratory pathway for fish species of commercial and ecological importance, including bay anchovy, bluefish, striped bass, menhaden, summer flounder, shad, sturgeon, and sharks. It also serves as spawning habitat and a migratory pathway for larval transport to inshore nursery areas. Migration takes place from April through October.



POLYGONS KA2 AND KA3, BORDERING HUDSON CANYON

Rationale: biodiversity

Seasons and depths important for protection: year-round; benthic

These small areas are between the 100-meter and 300-meter isobaths immediately adjacent to the Hudson Canyon. Funnel-shaped tilefish burrows in the clays on both flanks of Hudson Canyon (up to 3 to 4 meters across and 2 meters deep) provide habitat not only for tilefish but also lobsters, eels, and crabs and a thermal refuge and overwintering area for a large number of fish species, including summer flounder, scup, and black sea bass.

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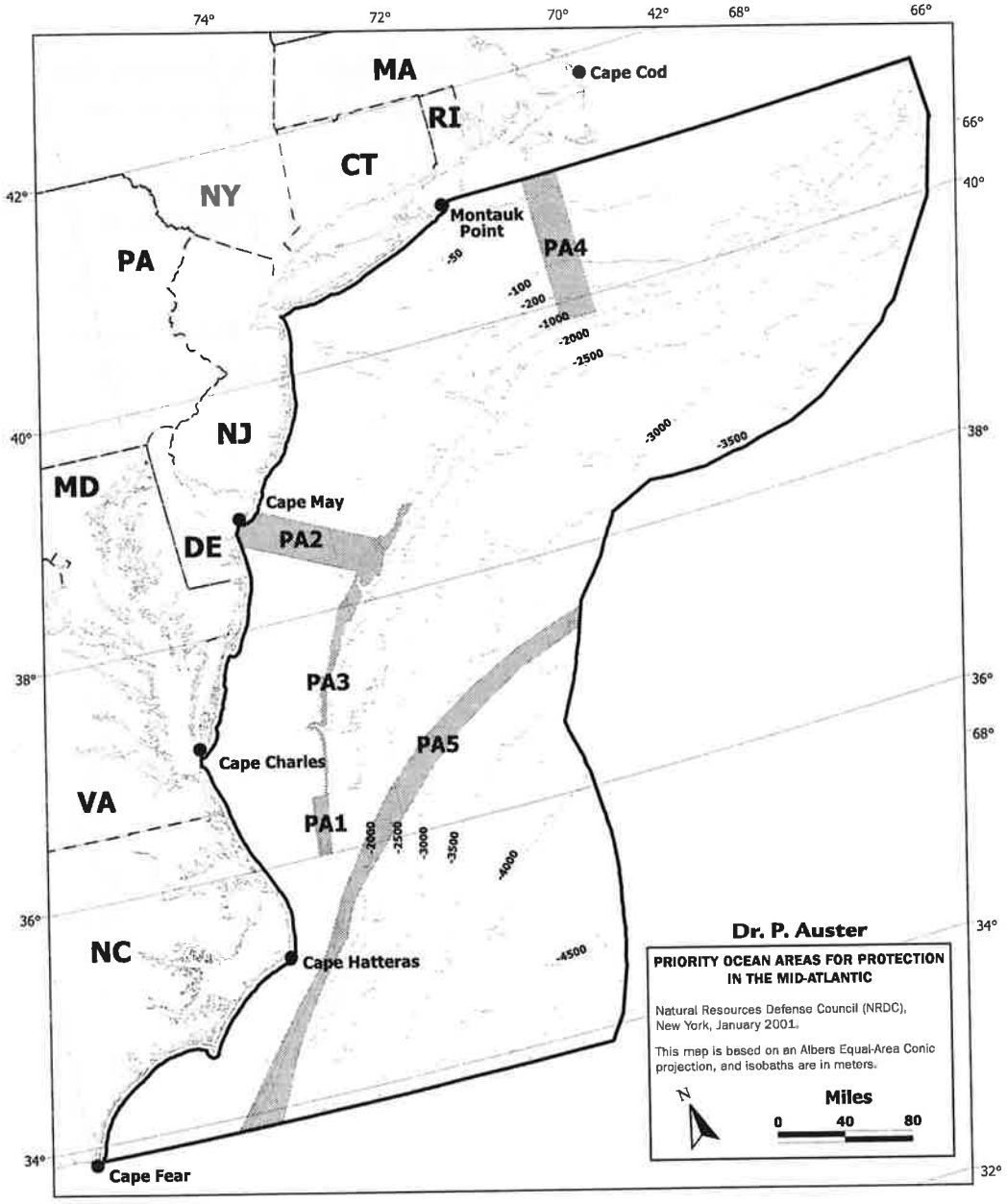
PETER AUSTER

POLYGON PA1

Rationale: biodiversity

Seasons and depths important for protection: year-round; benthic

The selection of this 20-mile-wide and 50- to 200-meter-isobath-deep polygon is based on diversity hot spots identified from georeferenced species per tow calculated from ECNASAP data (data from Brown et al., 1996; diversity analysis based on Auster, unpublished data). The use of these diversity hot spots is based on a discussion in Reid (1988).



POLYGONS PA2–4

Rationale: biodiversity; representation of communities

Seasons and depths important for protection: year-round; benthic

These cross-shelf polygons are based on the premise of capturing representative assemblages of fishes, habitats, and sediment (grain-size) diversit. (Auster and Shackell, 2000; Auster et al., 1995). The location of assemblages of mid-Atlantic fishes is based on Colvocoresses and Musick (1994). Microhabitat use and variability across the shelf is based on Auster et al. (1995). Further, the most northern cross-shelf polygon (PA4) also captures a cross-shelf fish-species diversity hot spot based on species-per-tow trawl samples (see metadata for polygon PA1; Auster, unpublished data).

Others have also identified both areas as critical habitats for other species.

POLYGON PA5–CR3–JM9

Rationale: biodiversity; nursery area

Seasons and depths important for protection: year-round; pelagic

The shape and location of this polygon is based on Auster, Crowder, and Musick's agreement on the average location of high-density regions of *Sargassum* along the Gulf Stream. *Sargassum* is essential habitat for *Sargassum*-associated fishes, fishes that serve as prey for larger pelagic predators, and as a nursery for sea turtles and many fishes.

Auster also supports the designation of Polygon BH5 (Bear Seamount) and DR1 (hard substrate area off Cape Hatteras, North Carolina).

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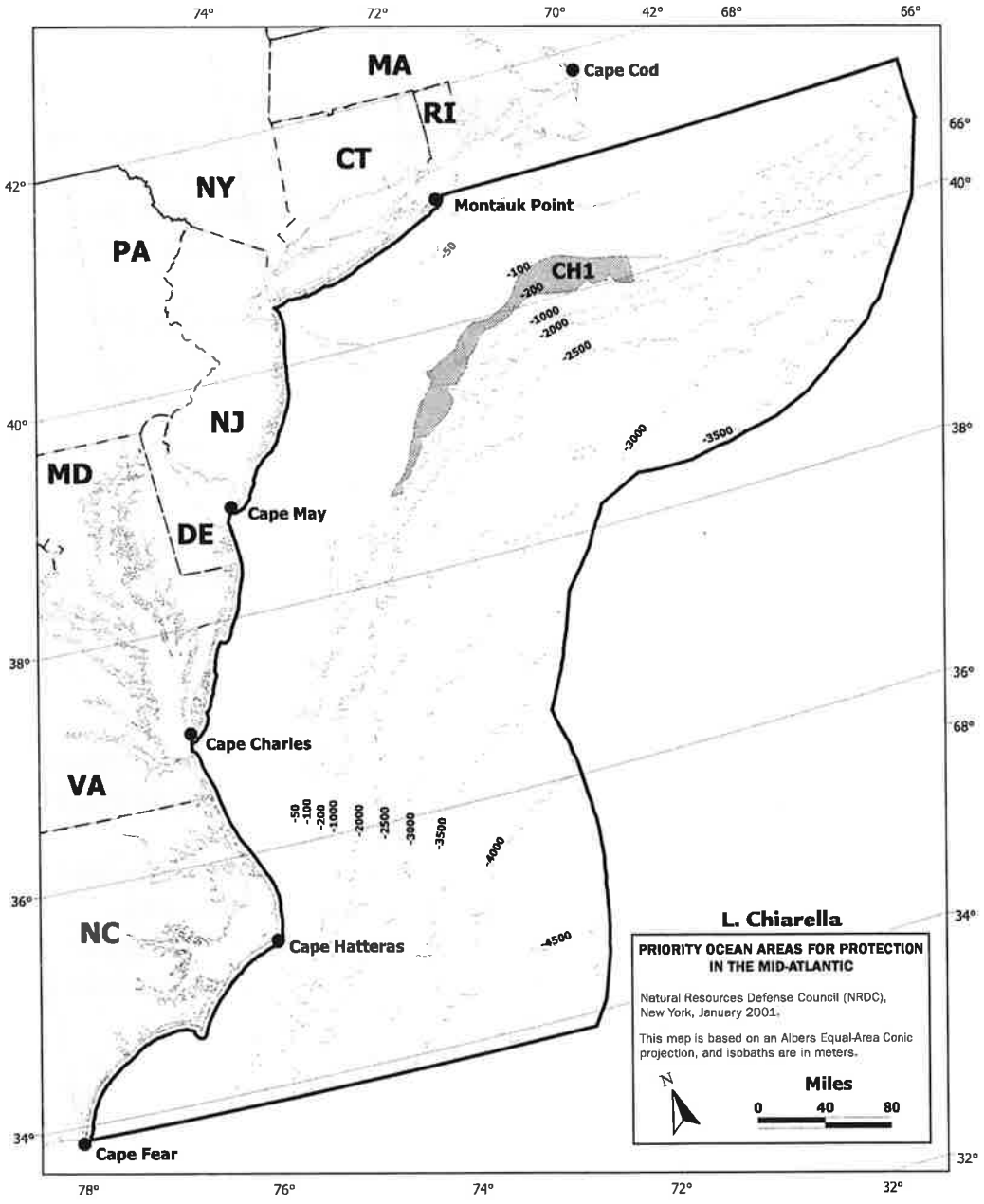
LOUIS CHIARELLA

POLYGON CH1 (TILEFISH HABITAT)

Rationale: biodiversity; also relevant for fisheries of the 18 managed fish species found
Seasons and depths important for protection: year-round; benthic

This area, between Cape May, New Jersey and Cape Cod, Massachusetts, (National Marine Fisheries Service [NMFS] fisheries statistical areas 616 and 537), and between the 100-meter and 250-meter isobaths, is important tilefish habitat. Year-round tilefish burrows in this area help to create a community of a wide variety of seasonal benthic species. It is also important for many other species. Commercially



important species—including a variety of flounders (summer, winter, witch), scup, black sea bass, hake, and squid—use this as an overwintering area. This is already a recognized HAPC.

Note: This area falls *entirely* within Hoff's polygon TH1 (which is between the 80-meter and 400-meter isobaths).

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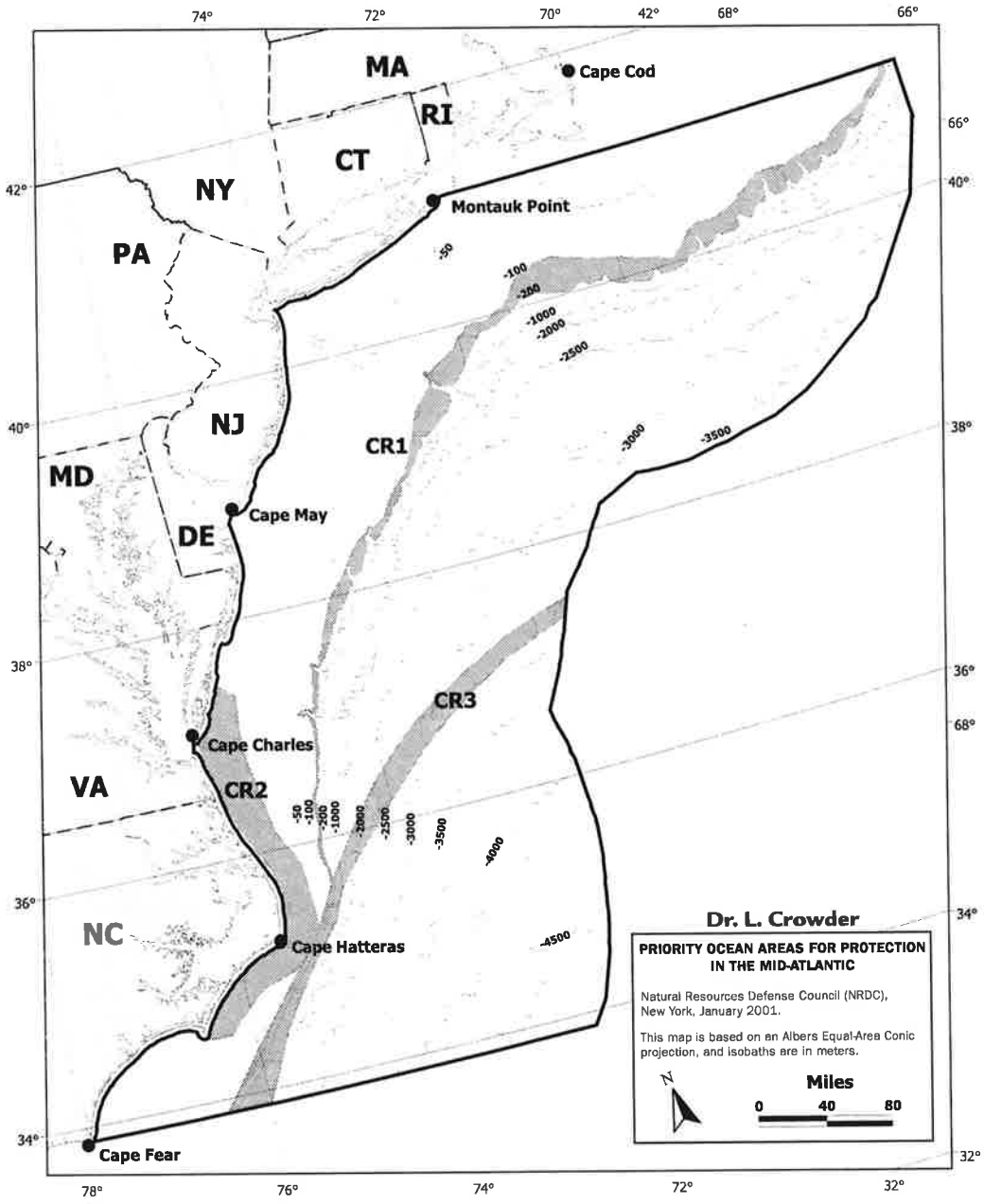
LARRY CROWDER

POLYGON CR1

Rationale: high abundance; at risk from fisheries

Seasons and depths important for protection: May–October critical; pelagic

This area, along the edge of the shelf break from Cape Hatteras to Cape Cod, is of importance for leatherback and loggerhead turtles. It overlaps with the area of the swordfish fishery and where squid are found. Information on leatherback and loggerhead populations on the shelf is partly gathered from fisheries, whose gear sometimes catches the turtles. Because they only sometimes show up dead on the



beach, and are sometimes blown out to sea, it is difficult to track the number of deaths from longline fishing gear.

POLYGON CR2

Rationale: migratory corridor

Seasons and depths important for protection: April–June and September–November critical; benthic

This is a nearshore migratory corridor along which sea turtles travel seasonally. The northern migration takes place from April through June, the return from September through November. Turtles that use this inshore corridor include loggerheads, Kemp's ridleys, and leatherbacks. It takes loggerhead turtles 20 years to mature; they are therefore an exceptionally vulnerable species. The northern subpopulation of loggerheads is disproportionately caught in longline fisheries.

POLYGON PA5–CR3–JM9

Rationale: biodiversity; nursery area

Seasons and depths important for protection: year-round; pelagic

The shape and location of this polygon is based on Auster, Crowder, and Musick's agreement on the average location of high-density regions of *Sargassum* along the Gulf Stream. *Sargassum* is essential habitat for *Sargassum*-associated fishes, fishes that serve as prey for larger pelagic predators, and as a nursery for sea turtles and many fishes.

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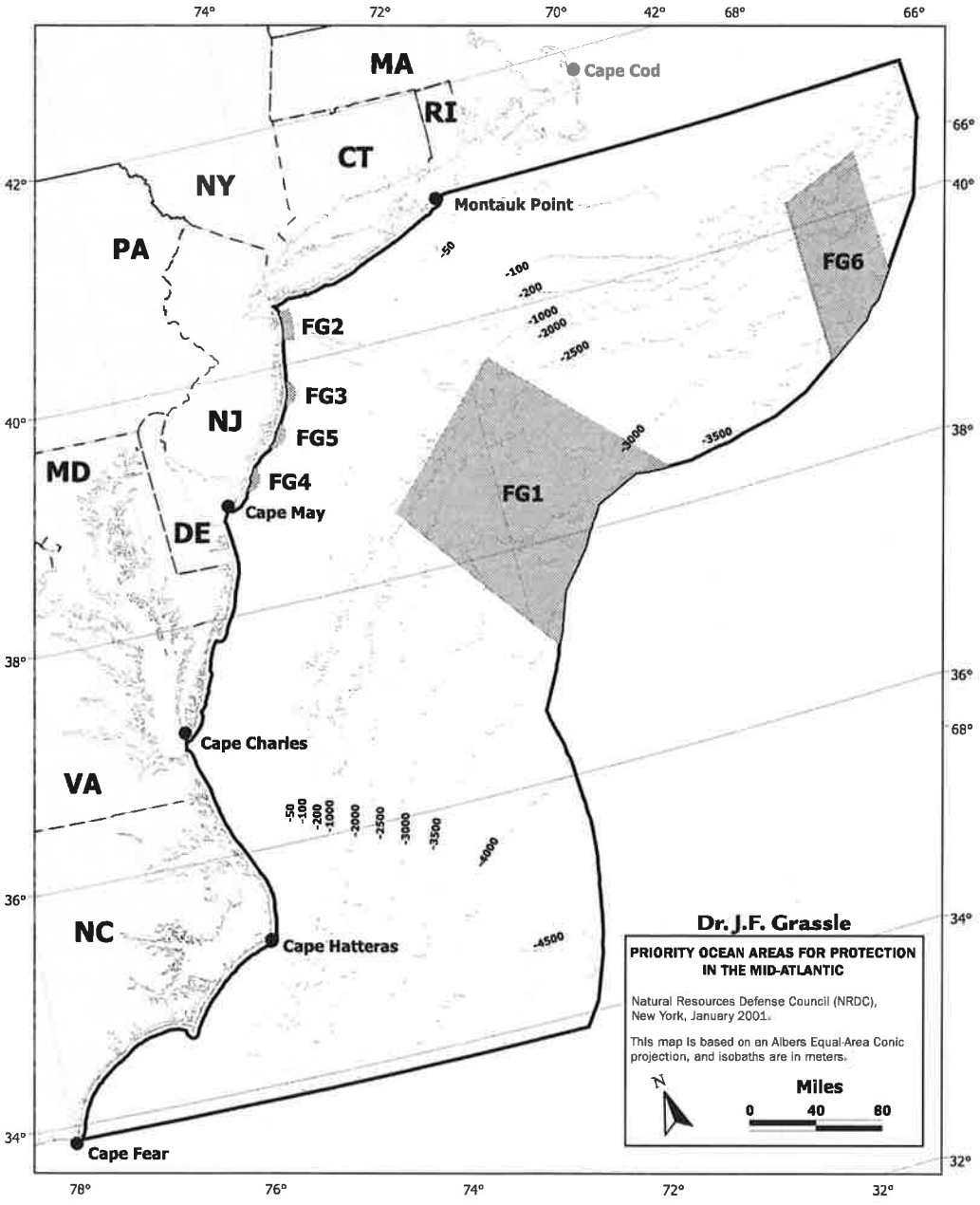
J. Frederick Grassle

POLYGON FG1 (INCLUDING HUDSON CANYON)

Rationale: physical features; biodiversity

Seasons and depths important for protection: year-round; benthic

This polygon extends from the 1,000-meter isobath out to the 200-mile limit. The deeper, farther offshore waters encompassing Hudson Canyon are internationally known for their high biodiversity of benthic invertebrates. Having been well studied, this area provides a reference for determining changes in the composition of life on the deep-sea floor.



POLYGON FG6 (INCLUDING LYDONIA CANYON AND BEAR SEAMOUNT)

Rationale: physical features; biodiversity

Seasons and depths important for protection: year-round; benthic

A companion to polygon FG1, also from the 1,000-meter isobath, this area may be used as a northerly reference area for the study of invertebrate biodiversity in the deep-sea, abyssal region.

POLYGONS FG2–5

Rationale: high abundance; physical features; highly productive sand communities in a high-energy environment

Seasons and depths important for protection: year-round; pelagic

Upwelling in these four areas (when deeper seawater rises) distributes invertebrate larvae and is associated with high productivity. Because of the high productivity and rapid growth of large bivalves, these areas may be considered valuable spawning areas. From an ecological standpoint, protection should be extended from the coast out about 8 miles. The maximum ocean depth varies from 20 meters to near 40 meters in these areas.

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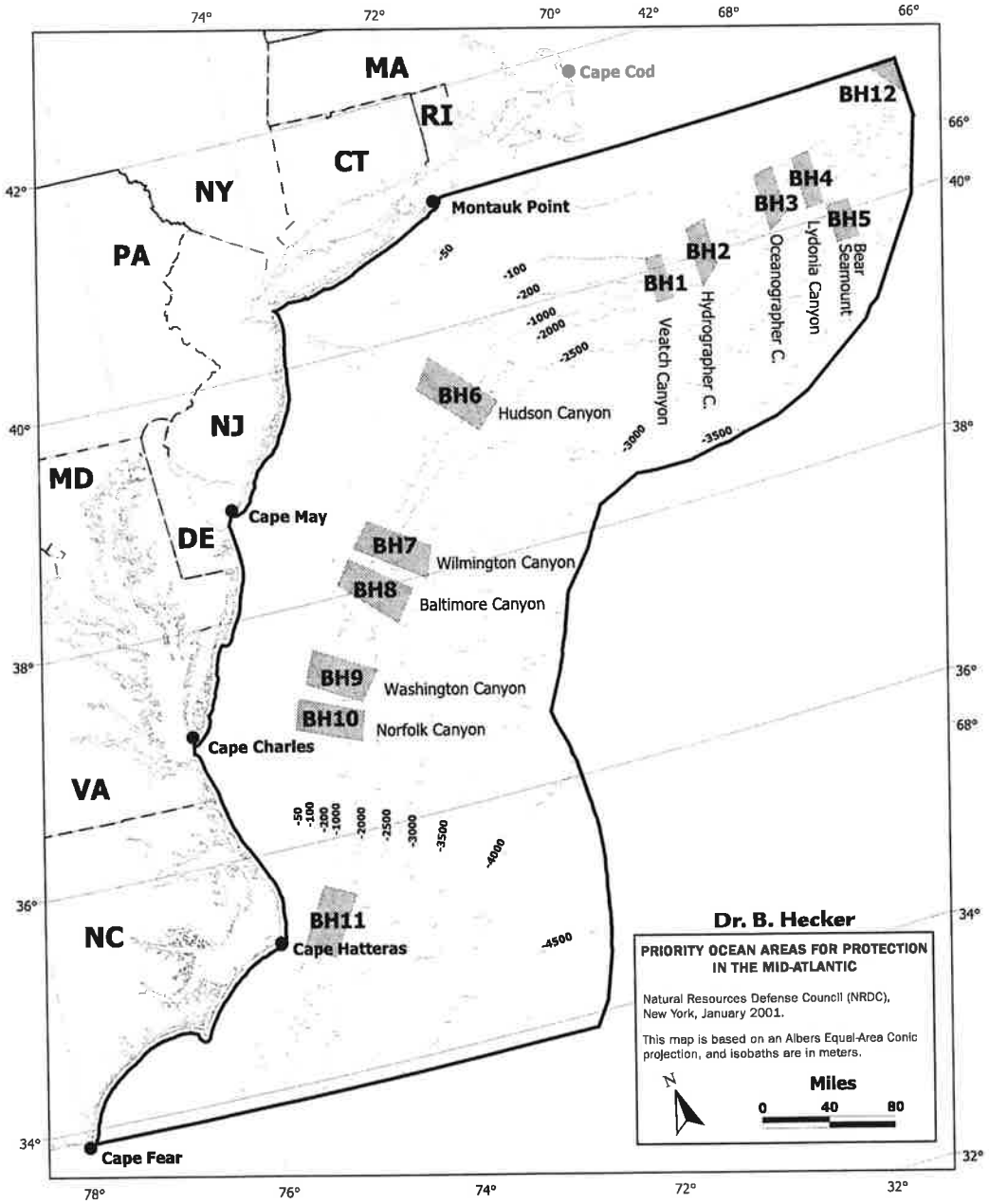
BARBARA HECKER

POLYGONS BH1–4 (VEATCH, HYDROGRAPHER, OCEANOGRAPHER AND LYDONIA CANYONS)

Rationale: physical features; nursery/spawning areas; biodiversity; high abundance
Seasons and depths important for protection: year-round; benthic

These polygons, each extending from the 100-meter isobath to the 2,000-meter isobath, are submarine canyons, which, because of their greater structural complexity, support higher densities and a greater diversity of megafaunal organisms than slope habitats. There are corals here. In general, the heads of canyons are known to be



nursery areas for many fish and crustaceans, including commercially important ones. The sessile corals, sponges, and anemones found in the northern canyons have restricted distributions in that they must live attached to hard substrates. Hence populations within the canyons could represent crucial stock populations of sessile organisms.

POLYGON BH5 (BEAR SEAMOUNT)

Rationale: physical features; biodiversity; high abundance
Seasons and depths important for protection: year-round; benthic

Little is known about the biology of the New England seamounts. However, studies in other regions of the world reveal that seamounts provide a unique habitat for a variety of diverse deepwater organisms. Seamounts frequently have complex topography, exceptionally steep inclines, exposures of hard substrate, high current intensities, and topographically induced upwelling, making them similar to the productive environment found in submarine canyons. These characteristics indicate that Bear Seamount would likely support high abundances of sessile organisms (corals and sponges) and associated invertebrates and fishes.

POLYGON BH6 (HUDSON CANYON)

Rationale: physical features; nursery/spawning areas; biodiversity; high abundance
Seasons and depths important for protection: year-round; benthic

This is a particularly dynamic environment that supports nursery areas for a variety of fish and crustaceans. Tilefish burrows in the area are known to attract secondary burrowing, creating a highly diverse community. This polygon coincides with Able's polygons KA2 and KA3. This canyon does not have many corals.

POLYGONS BH7–10 (WILMINGTON, BALTIMORE, WASHINGTON, AND NORFOLK CANYONS)

Rationale: physical features; nursery/spawning areas; productive habitat; high abundance; biodiversity
Seasons and depths important for protection: year-round; benthic

Baltimore and Norfolk Canyons have high anemone concentrations and serve as nursery areas. They have high coral presence as well as enhanced megafaunal stock. It might be assumed that the other two southern canyons are similar environments. The west wall of Baltimore Canyon has a suspected cold seep. The increased coral and megafaunal stocks in all canyons are most prevalent between 100-meter to 2,000-meter depth.

POLYGON BH11 (STEEP SLOPE AREA OFF CAPE HATTERAS)

Rationale: physical features; biodiversity; high abundance; migratory corridor
Seasons and depths important for protection: year-round; pelagic and benthic

There is a high standing stock of infauna and megafauna in this unusually dynamic area. In the pelagic and mid-water depths there is high diversity of vertebrates, migratory seabirds, mammals, and turtles as well as fish. On the bottom there is also diversity of invertebrates.

POLYGON BH12

Rationale: biodiversity and physical features

Seasons and depths important for protection: year-round; benthic

Along the international boundary (Hague line), from the 50-meter to the 2,000-meter isobath, is a dynamic area unlike the rest of the mid-Atlantic. There is an unusual nutrient flux, glacial erratics, and a high number of corals.

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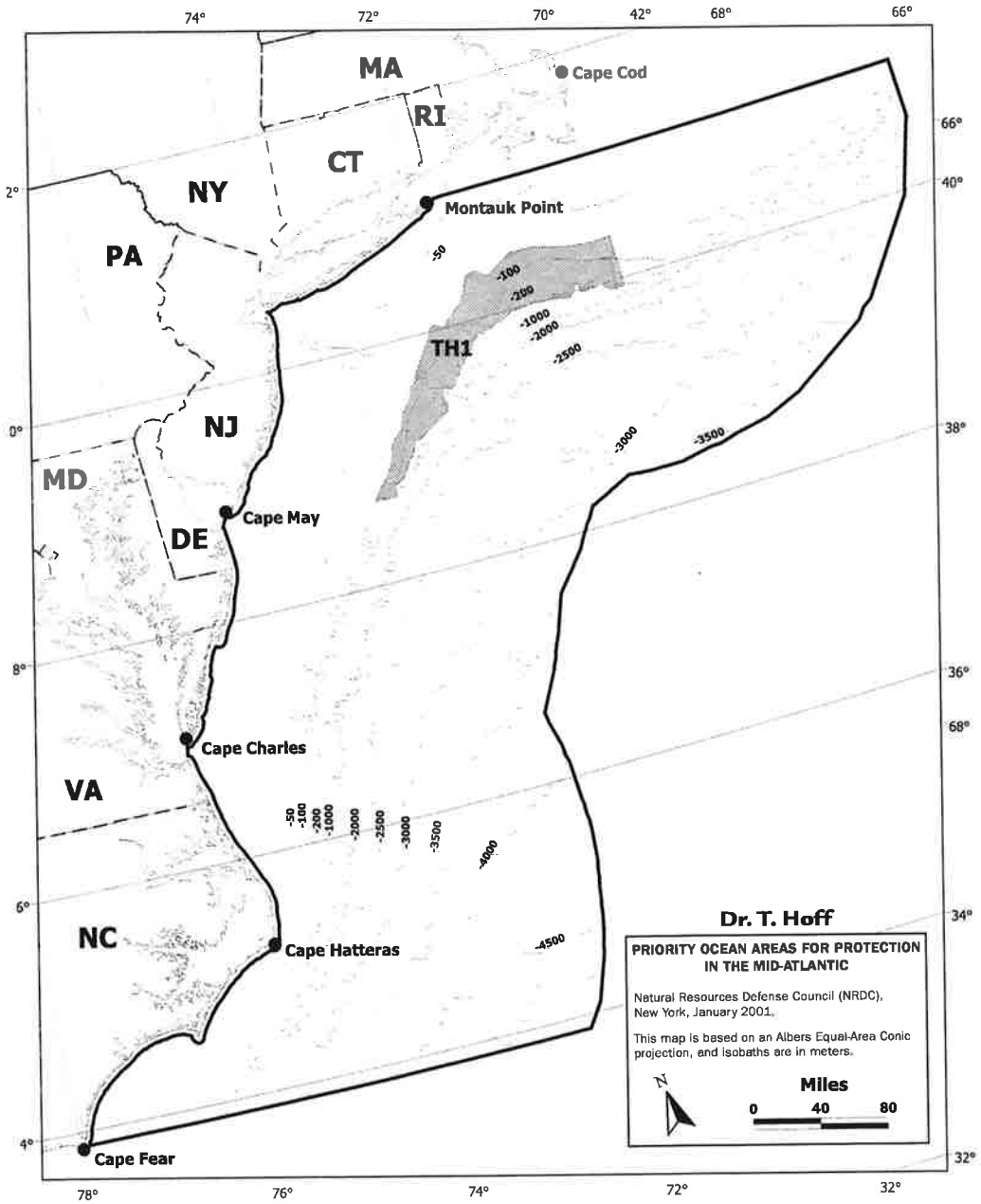
TOM HOFF

POLYGON TH1

Rationale: physical features; biodiversity

Seasons and depths important for protection: year-round; benthic

This area extends from Cape May, New Jersey, to Cape Cod, Massachusetts (NMFS fisheries statistical areas 616 and 537), between the 80-meter and 400-meter isobaths, and includes Hudson Canyon. As with most canyon heads, the area is a significant habitat for tilefish. Beyond their own importance supporting a small



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