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B APPENDIX: ESSENTIAL FISH HABITAT

B.1 Life History Accounts and Essential Fish Habitat Descriptions

B.1.1 Tuna

B.1.1.1 Atlantic Albacore Tuna

Atlantic Albacore (*Thunnus alalunga*) Albacore tuna is a circumglobal species. In the west, Atlantic albacore range from 40 to 45°N to 40°S. It is an epipelagic, oceanic species generally found in surface waters with temperatures between 15.6° and 19.4°C, although larger individuals have a wider depth and temperature range (13.5° to 25.2°C). Albacore may dive into cold water (9.5°C) for short periods and can be found at depths up to 600 m in the Atlantic. However, they do not tolerate oxygen levels lower than two milliliter/liter (ml/l). Albacore undergo extensive horizontal movements. Aggregations are composed of similarly sized individuals with groups comprised of the largest individuals making the longest journeys. Aggregations of albacore may include other tuna species such as skipjack, yellowfin and bluefin tuna. North Atlantic and south Atlantic stocks are considered separate, with no evidence of mixing between the two (ICCAT, 1997; Collette and Nauen, 1983).

Predator-prey relationships: A wide variety of fishes and invertebrates have been found in the few stomachs of albacore tuna that have been examined. As with other tuna, albacore probably exhibit opportunistic feeding behavior, with little reliance on specific prey items (Dragovich, 1969; Matthews *et al.*, 1977).

Life history: Albacore spawn in the spring and summer in the western tropical Atlantic (ICCAT, 1997). Larvae are also taken in the Mediterranean Sea and historically in the Black Sea (Vodyanitsky and Kazanova, 1954).

Fisheries: For assessment purposes, three stocks of albacore are assumed: north and south Atlantic stocks (separated at 5°N) and a Mediterranean stock (SCRS, 1997). In the north Atlantic albacore are taken by surface and longline fisheries. Surface fisheries target juveniles at 50 to 90 cm fork length (FL), and longlines catch sub-adult and adult fish at 60 to120 cm FL. **U.S. Fishery Status**: North Atlantic albacore is overfished with overfishing occurring; South Atlantic albacore is not overfished and overfishing is not occurring.

Growth and mortality: The maximum size of albacore has been reported at 127 cm FL (Collette and Nauen, 1983). For both sexes sexual maturity is reached at five years at 90 to 94 cm FL (Collette and Nauen, 1983; ICCAT, 1997). Mortality is higher for females (Collette and Nauen, 1983).

Essential Fish Habitat for Albacore Tuna:

- **Spawning, eggs, and larvae:** At this time, available information is insufficient for the identification of EFH for this life stage within the U.S. EEZ (Figure B.1).

- **Juveniles (<90 cm FL):** In surface waters with temperatures between 15.6° and 19.4°C, offshore the U.S. east coast in the Mid-Atlantic Bight from the 50 m isobath to the 2,000 m isobath with 71°W as the northeast boundary and 38°N as the southwest boundary (Figure B.2).

- **Adults (≥90 cm FL):** In surface waters with temperatures between 13.5° and 25.2°C, offshore the U.S. eastern seaboard between the 100 and 2,000 m isobaths from southeastern Georges Bank at 41.25°N, south to 36.5°N, offshore the Virginia/North Carolina border; also, in the Blake Plateau and Spur region, from 79°W east to the EEZ boundary and 29°N south to the EEZ boundary (Figure B.3).

B.1.1.2 Atlantic Bigeye Tuna

Atlantic Bigeye Tuna (*Thunnus obesus*) Scientific knowledge of Atlantic bigeye tuna is limited. Its range is almost the entire Atlantic from 50°N to 45°S. It is rarely taken in the Gulf of Mexico, and some of the points currently included in the EFH maps may require further validation (J. Lamkin, pers. comm.). Although its distribution with depth in the water column varies, it is regularly found in deeper waters than are other tuna, descending to 300–500 m and then returning regularly to the surface layer (Musyl *et al*., 2003). Smaller fish are probably restricted to the tropics, while larger individuals migrate to temperate waters. There is probably one population in the Atlantic (ICCAT, 1997). Young bigeye tuna form schools near the sea surface, mixing with other tuna such as yellowfin and skipjack tuna (Collette and Nauen, 1983).

Predator-prey relationships: The diet of bigeye tuna includes fishes, cephalopods and crustaceans (Dragovich, 1969; Matthews *et al.*, 1977). Predators include large billfishes and toothed whales (Collette and Nauen, 1983).

Life history: Bigeye tuna probably spawn between 15°N and 15°S. A nursery area is known to exist in the Gulf of Guinea (Richards, 1967) off the coast of Africa where larvae have been collected below the 25°C isotherm (Richards and Simmons, 1971). Peak spawning here occurs in January and February, whereas in the northwestern tropical Atlantic spawning occurs in June and July (SCRS, 1978, 1979). The collection of larvae in U.S. waters has not been confirmed.

Fisheries: The bigeye tuna stock has been exploited by three major gear types - longline, baitboat, and purse seine - and by many countries throughout its range of distribution. ICCAT currently recognizes one stock for management purposes, based on time/area distribution of fish and movements of tagged fish. However, other possibilities such as distinct northern and southern stocks should not be disregarded (SCRS, 1997). **U.S. Fishery Status:** Overfished and overfishing is occurring.

Growth and mortality: Growth rate for bigeye tuna is believed to be rapid. Sexual maturity is attained in the fourth year, at approximately 100 cm FL (SCRS, 1997).

Habitat associations: Juvenile bigeye form schools near the surface, mostly mixed with other tuna such as yellowfin and skipjack. These schools often associate with floating objects, whale sharks and sea mounts (SCRS, 1997).

Essential Fish Habitat for Bigeye Tuna:

- **Spawning, eggs and larvae:** Information is insufficient for the identification of EFH for this life stage within the U.S. EEZ; although it can not be identified as EFH under the Magnuson-Stevens Act because it is located outside the U.S. EEZ, the Gulf of Guinea, off the coast of Africa, is identified as important habitat for spawning adults, eggs and larvae (Figure B.4).

- **Juveniles (<100 cm FL):** In surface waters from southeastern Georges Bank to the boundary of the EEZ to Cape Hatteras, NC at 35°N from the 200 m isobath to the EEZ boundary; also, in the Blake Plateau region off Cape Canaveral, FL, from 29°N south to the EEZ boundary (28.25°N) and from 79°W east to the EEZ boundary (approximately 76.75°W) (Figure B.5).

- **Adults (≥100 cm FL):** In pelagic waters from the surface to a depth of 250 m; from southeastern Georges Bank at the EEZ boundary to offshore Delaware Bay at 38°N, from the 100 m isobath to the EEZ boundary; from offshore Delaware Bay south to Cape Lookout, NC (approximately the region off Cape Canaveral, FL), from 29°N south to the EEZ boundary (28.25°N), and from 79° W east to the EEZ boundary (76.75° W) (Figure B.6).

B.1.1.3 Atlantic Bluefin Tuna

Atlantic Bluefin Tuna (*Thunnus thynnus*) In the western north Atlantic, bluefin tuna range from 45°N to 0° (Collette and Nauen, 1983). However, they have recently been found up to 55° N in the West Atlantic (Vinnichenko, 1996). Bluefin tuna move seasonally from spring (April to June) spawning grounds in the Gulf of Mexico through the Straits of Florida to feeding grounds off the northeast U.S. coast (Mather *et al.*, 1995; Block *et al.*, 2005). It is believed that there is a single stock which ranges from Labrador and Newfoundland south into the Gulf of Mexico and the Caribbean, and also off Venezuela and Brazil. The Labrador Current may separate this western stock from that found in the east Atlantic (Tiews, 1963; Mather *et al.*, 1995; ICCAT, 1997).

From November to January bluefin tuna are concentrated into two separate groups, one in the northwest and the other in the north central Atlantic. In February, the central Atlantic aggregation breaks up, with some fish moving southeast to the Azores and some moving southwest (Suda, 1994). Southerly movements from the feeding grounds off the northern United States and wintering areas are not well understood. A three-way movement between spawning, feeding, and wintering areas is assumed for mature fish and a shorter, two-way feeding-to-wintering movement for juveniles (Mather *et al.*, 1995).

Bluefin tuna distributions are probably constrained by the 12°C isotherm, although individuals can dive to 6° to 8°C waters to feed (Tiews, 1963). Year-to-year variations in movements have been noted (Mather *et al.*, 1995). While bluefin tuna are epipelagic and usually oceanic, they do come close to shore seasonally (Collette and Nauen, 1983). They often occur over the continental shelf and in embayments, especially during the summer months when they feed actively on herring, mackerel and squids in the north Atlantic. Larger individuals move into higher latitudes than do smaller fish. Bluefin tuna are often found in mixed schools with skipjack tuna, these schools consisting of similarly sized individuals (Tiews, 1963).

Predator-prey relationships: Bluefin tuna larvae initially feed on zooplankton but switch to a piscivorous diet at a relatively small size. Small bluefin tuna larvae prey on other larval fishes and are subject to the same predators as these larvae, primarily larger fishes and gelatinous zooplankton (McGowan and Richards, 1989). Adults are opportunistic feeders, preying on a variety of schooling fish, cephalopods, and benthic invertebrates, including silver hake, Atlantic mackerel, Atlantic herring, krill, sandlance, and squid (Dragovich, 1969, 1970a; Mathews *et al.*, 1977; Estrada et. al., 2005). Predators of adult bluefin tuna include toothed whales, swordfish, sharks and other tuna (especially of smaller individuals) (Tiews, 1963; Chase, 1992).

Life history: Western north Atlantic bluefin tuna spawn from April to June in the Gulf of Mexico and in the Florida Straits (McGowan and Richards, 1989; Block *et. al*., 2005). Although individuals may spawn more than once a year, it is assumed that there is a single annual spawning period. Larvae have been confirmed from the Gulf of Mexico and off the Carolinas (Richards, 1991). Most of the larvae found were located around the 1,000 fathom curve in the northern Gulf of Mexico, with some sporadic collections off Texas. In the Florida Straits they are primarily collected along the western edge of the Florida Current, suggesting active transport from the Gulf of Mexico. This would also explain their occasional collection off the southeast United States. Atlantic bluefin tuna have not been observed spawning (Richards, 1991).

It is not believed that much spawning occurs outside the Gulf of Mexico (McGowan and Richards, 1989; Richards, 1991). Also, it appears that larvae are generally retained in the Gulf until they grow into juveniles; in June, young-of-the-year begin movements in schools to juvenile habitats (McGowan and Richards, 1989) thought to be located over the continental shelf around 34°N and 41°W in the summer and further offshore in the winter. Also, they have been identified from the Dry Tortugas area in June and July (Richards, 1991; ICCAT, 1997). Juveniles migrate to nursery areas located between Cape Hatteras, NC and Cape Cod, MA (Mather *et al*., 1995).

Fisheries: Atlantic bluefin tuna are caught using a wide variety of gear types, including longlines, purse seines, traps, and various handgears. ICCAT recognizes two management units of Atlantic bluefin, one in the east and one in the West Atlantic; however, some mixing is probably occurring, as fish tagged in one location have been retrieved in the other (Block *et. al*., 2005). These management units are divided as follows: North of 10°N they are separated at 45°W; below the equator they are separated at 25°W, with an eastward shift between those parallels

(SCRS, 1997). The effects of reduced stock size on distribution and habitat use is unknown at this time. **U.S. Fishery Status:** Overfished, and overfishing is occurring.

Growth and mortality: Bluefin tuna can grow to more than 650 kg in weight and 300 cm in length, with no apparent difference between the growth rates of males and females (Mather *et al.*, 1995). Maximum age is estimated to be more than 20 years, with sexual maturity reached at approximately 196 cm (77 inches) FL and a weight of approximately 145 kg (320 lb). This size is believed to be reached in the West Atlantic at eight years, as opposed to five years in the east Atlantic. Not only do bluefin tuna in the West Atlantic mature more slowly than those in the east Atlantic, but they also are believed to grow more slowly and reach a larger maximum size (SCRS, 1997). The rapid larval growth rate is estimated as one mm/day up to 15 mm, the size at transformation (McGowan and Richards, 1989).

Habitat associations: It is believed that there are probably certain features of the bluefin tuna larval habitat in the Gulf of Mexico which determine growth and survival rates, and that these features show variability from year to year, perhaps accounting for a significant portion of the fluctuation in yearly recruitment success (McGowan and Richards, 1989). The habitat requirements for larval success are not known, but larvae are collected within narrow ranges of temperature and salinity - approximately 26° C and 36 ppt. Along the coast of the southeastern United States onshore meanders of the Gulf Stream can produce upwelling of nutrient rich water along the shelf edge. In addition, compression of the isotherms on the edge of the Gulf Stream can form a stable region which, together with upwelling nutrients, provides an area favorable to maximum growth and retention of food for the larvae (McGowan and Richards, 1989). Size classes used for habitat analysis for bluefin tuna are based on the sizes at which they shift from a schooling behavior to a more solitary existence. Bluefin have traditionally been grouped by small schooling, large schooling, and giant. Future analyses should more fully evaluate habitat differences between the traditional size classes, if the data are available.

Essential Fish Habitat for Atlantic Bluefin Tuna:

- **Spawning, eggs, and larvae:** In pelagic and near coastal surface waters from the North Carolina/South Carolina border at 33.5° N, south to Cape Canaveral, FL from 15 miles from shore to the 200 m isobath; all waters from offshore Cape Canaveral at 28.25° N south around peninsular Florida to the U.S./Mexico border from 15 miles from shore to the EEZ boundary (Figure B.7).

- **Juveniles (<145 cm TL):** All inshore and pelagic surface waters warmer than 12° C of the Gulf of Maine and Cape Cod Bay, MA from Cape Ann, MA (~42.75° N) east to 69.75° W (including waters of the Great South Channel west of 69.75° W), continuing south to and including Nantucket Shoals at 70.5° W to off Cape Hatteras, NC (approximately 35.5° N), in pelagic surface waters warmer than 12° C, between the 25 and 200 m isobaths; also in the Florida Straits, from 27° N south around peninsular Florida to 81° W in surface waters from the 200 m isobath to the EEZ boundary (Figure B.8).

- **Adults (≥145 cm TL):** In pelagic waters of the Gulf of Maine from the 50 m isobath to the EEZ boundary, including the Great South Channel, then south of Georges Bank to 39° N from the 50 m isobath to the EEZ boundary; also, south of 39° N, from the 50 m isobath to the 2,000 m isobath to offshore Cape Lookout, NC at 34.5° N. In pelagic waters from offshore Daytona Beach, FL (29.5° N) south to Key West (82° W) from the 100 m isobath to the EEZ boundary; in the Gulf of Mexico from offshore Terrebonne Parish, LA (90° W) to offshore Galveston, TX (95° W) from the 200 m isobath to the EEZ boundary (Figure B.9).

B.1.1.4 Atlantic Skipjack Tuna

Atlantic Skipjack Tuna (*Katsuwonus pelamis*) Skipjack tuna are circumglobal in tropical and warm-temperate waters, generally limited by the 15° C isotherm. In the west Atlantic skipjack range as far north as Newfoundland (Vinnichenko, 1996) and as far south as Brazil (Collette and Nauen, 1983). Skipjack tuna are an epipelagic and oceanic species and may dive to a depth of 260 m during the day. Skipjack tuna is also a schooling species, forming aggregations associated with hydrographic fronts (Collette and Nauen, 1983). There has been no trans-Atlantic recovery of tags; eastern and western stocks are considered separate (ICCAT, 1997).

Predator-prey relationships: Skipjack tuna is an opportunistic species which preys upon fishes, cephalopods and crustaceans (Dragovich, 1969, 1970b; Dragovich and Potthoff, 1972; Collette and Nauen, 1983; ICCAT, 1997). Predators include other tuna and billfishes (Collette and Nauen, 1983). Skipjack tuna are believed to feed in surface waters down to a depth of five meters. Stomach contents often include *Sargassum* or *Sargassum* associated species (Morgan *et al.*, 1985).

Life history: Skipjack tuna spawn opportunistically in equatorial waters throughout the year, and in subtropical waters from spring to early fall (Collette and Nauen, 1983). Larvae have been collected off the east coast of Florida from October to December (Far Seas Fisheries Research Lab, 1978) and in the Gulf of Mexico and Florida Straits from June to October. However, most spawning takes place during summer months in the Caribbean, off Brazil (with the peak in January through March), in the Gulf of Mexico (April to May), and in the Gulf of Guinea (throughout the year) (Richards, 1967; SCRS, 1978/79).

Fisheries: This fishery is almost exclusively a surface gear fishery, although some skipjack tuna are taken as longline bycatch. Most skipjack tuna are taken in the east Atlantic and off the coast of Brazil, most recently with the use of floating objects to attract them. ICCAT assumes two management units for this species (eastern and western) due to the development of fisheries on both sides of the Atlantic and to the lack of transatlantic tag recoveries. **U.S. Fishery Status:** Unknown.

Growth and mortality: Maximum size of the species is reported at 108 cm FL and a weight of 34.5 kg. Size at sexual maturity is 45 cm (18 inches) for males and 42 cm for females. This size is believed to correspond to about 1 to 1.5 years of age, although significant variability in interannual growth rates makes size-to-age relationships difficult to estimate (Collette and

Nauen, 1983; ICCAT, 1997). Growth rate is variable and seasonal, with individuals from the tropical zone having a higher growth rate than those from the equatorial zone (SCRS, 1997). Life span is estimated to be eight to 12 years (Collette and Nauen, 1983).

Habitat associations: Aggregations of skipjack tuna are associated with convergences and other hydrographic discontinuities. Also, skipjack tuna associate with birds, drifting objects, whales, sharks and other tuna species (Colette and Nauen, 1983). The optimum temperature for the species is 27° C, with a range from 20° to 31° C (ICCAT, 1995).

Essential Fish Habitat for Skipjack Tuna:

- **Spawning, eggs, and larvae:** In offshore waters, from the 200 m isobath out to the EEZ boundary, from 28.25° N south around peninsular Florida and the Gulf Coast to the U.S./Mexico border (Figure B.10).

- **Juveniles/subadults (<45 cm FL):** In pelagic surface waters from 20° to 31° C in the Florida Straights off southeastern Florida, from the 25 m isobath to the 200 m isobath, from 27.25° N south to 24.75° N southwest of the coast of Key Largo, FL (Figure B.11).

- **Adults (≥45 cm FL):** In pelagic surface waters from 20° to 31° C in the Mid-Atlantic Bight, from the 25 m isobath to the 200 m isobath, from 71° W, off the coast of Martha's Vineyard, MA, south and west to 35.5° N, offshore Oregon Inlet, NC (Figure B.12).

B.1.1.5 Atlantic Yellowfin Tuna

Atlantic Yellowfin Tuna (*Thunnus albacres*) Atlantic yellowfin tuna are circumglobal in tropical and temperate waters. In the West Atlantic they range from 45° N to 40° S. Yellowfin tuna is an epipelagic, oceanic species, found in water temperatures between 18° and 31° C. It is a schooling species, with juveniles found in schools at the surface, mixing with skipjack and bigeye tuna. Larger fish are found in deeper water and also extend their ranges into higher latitudes. All individuals in the Atlantic probably comprise a single population, although movement patterns are not well known (Collette and Nauen, 1983; SCRS, 1997). There are possible movements of fish spawned in the Gulf of Guinea to more coastal waters off Africa, followed by movements toward the U.S. coast, at which time they reach a length of 60 to 80 cm (ICCAT, 1977). In the Gulf of Mexico yellowfin tuna occur beyond the 500-fathom isobath (Idyll and de Sylva, 1963).

Predator-prey relationships: Atlantic yellowfin tuna are opportunistic feeders. Stomachs have been found to contain a wide variety of fish and invertebrates (Dragovich, 1969, 1970b; Dragovich and Potthoff, 1972; Matthews *et al.*, 1977). Stomach contents of yellowfin from St. Lucia and the Caribbean contained squid and the larvae of stomatopods, crabs and squirrelfish (Idyll and de Sylva, 1963). Stomach contents often contain *Sargassum* or *Sargassum* associated fauna. Yellowfin tuna are believed to feed primarily in surface waters down to a depth of 100 m (Morgan *et al.*, 1985).

Life history: Spawning occurs throughout the year in the core areas of the species' distribution - between 15° N and 15° S - and also in the Gulf of Mexico and the Caribbean, with peaks occurring in the summer (ICCAT, 1994). Yellowfin tuna are believed to be multiple spawners, and larval distribution appears to be limited to water temperatures above 24° C and salinity greater than 33 ppt (Richards and Simmons, 1971). Larvae have been collected near the Yucatan peninsula and during September in the northern Gulf of Mexico along the Mississippi Delta (ICCAT, 1994).

Fisheries: Yellowfin tuna are caught by surface gears (purse seine, baitboat, troll, and handline) and with sub-surface gears (longline). A single stock is assumed for the Atlantic, based on transatlantic tag recaptures, time/area size frequency distribution, etc. (SCRS, 1997). **U.S. Fishery Status:** Approaching an overfished condition.

Growth and mortality: The maximum size of yellowfin tuna is over 200 cm FL (Collette and Nauen, 1983). Sexual maturity is reached at about three years of age, at 110 cm FL, and a weight of 25 kg. Although it is not known if there is a differential growth rate between males and females (ICCAT, 1994), males are predominant in catches of larger sized fish (SCRS, 1997). Natural mortality is 0.8 for fish less than 65 cm in length, and 0.6 for fish greater than 65 cm. Mortality is higher for females of this size (ICCAT, 1994).

Habitat associations: Adult yellowfin tuna are confined to the upper 100 m of the water column due to their intolerance of oxygen concentrations of less than 2 ml/l (Collette and Nauen, 1983). Association with floating objects has been observed, and in the Pacific larger individuals often school with porpoises (Collette and Nauen, 1983). Juveniles are found nearer to shore than are adults (SCRS, 1994). In the Gulf of Mexico adults usually occur 75 km or more offshore, while in the Caribbean they are found closer to shore. Although there appears to be a year-round population in the southern part of the Gulf of Mexico (Idyll and de Sylva, 1963), in June there appears to be some movement from the southern to the northern part of the Gulf of Mexico, resulting in greater catches in the northern part of the Gulf of Mexico from July to December.

Essential Fish Habitat for Yellowfin Tuna:

- **Spawning, eggs, and larvae:** In offshore waters, from the 200 m isobath out to the EEZ boundary, from 28.25° N south around peninsular Florida and the Gulf Coast to the U.S./Mexico border, especially associated with the Mississippi River plume and the Loop Current. Also, all U.S. waters in the Caribbean from the 200 m isobath to the EEZ boundary (Figure B.13).

- **Juveniles/subadults (<110 cm FL):** Pelagic waters from the surface to 100 m deep between 18° and 31° C from offshore Cape Cod, MA (70° W) southward to Jekyll Island, GA (31° N), between 500 and 2,000 m; off Cape Canaveral, FL from 29° N south to the EEZ boundary (approximately 28.25° N) and from 79° W east to the EEZ boundary (approximately 76.75° W); in the Gulf of Mexico from the 200 m isobath to the EEZ boundary (Figure B.14).

- **Adults (≥110 cm FL):** (Identical to juveniles/subadults EFH) Pelagic waters from the surface to 100 m deep between 18° and 31° C from offshore Cape Cod, MA (70° W) southward to Jekyll Island, GA (31° N), between 500 and 2,000 m; off Cape Canaveral, FL from 29° N south to the EEZ boundary (approximately 28.25° N) and from 79° W east to the EEZ boundary (approximately 76.75° W); in the Gulf of Mexico from the 200 m isobath to the EEZ boundary (Figure B.15).

B.1.2 Swordfish

Swordfish (*Xiphias gladius*) Swordfish are circumglobal, ranging through tropical, temperate and sometimes cold water regions. Their latitudinal range is from 50° N to 40-45° S in the west Atlantic, and 60° N to 45-50° S in the east Atlantic (Nakamura, 1985). The species moves from spawning grounds in warm waters to feeding grounds in colder waters. In the western north Atlantic two movement patterns are apparent: some fish move northeastward along the edge of the U.S. continental shelf in summer and return southwestward in autumn; another group moves from deep water westward toward the continental shelf in summer and back into deep water in autumn (Palko *et al.*, 1981). Swordfish are epipelagic to meso-pelagic, and are usually found in waters warmer than 13° C. Their optimum temperature range is believed to be 18° to 22° C but they will dive into 5° to 10° C waters at depths of up to 650 m (Nakamura, 1985). Swordfish migrate diurnally, coming to the surface at night (Palko *et al.*, 1981). Arocha (1997) observed different diel migrations in two groups of fish: swordfish in neritic (shallow, near-coastal) waters of the northwest Atlantic were found in bottom waters during the day, and then they moved to offshore surface waters at night. Swordfish in oceanic waters migrated vertically from a daytime depth of 500 m to 90 m at night.

Predator-prey relationships: Adult swordfish are opportunistic feeders, having no specific prey requirements. They feed at the bottom as well as at the surface, in both shallow and deep waters. In waters greater than 200 m deep, they feed primarily on pelagic fishes including small tunas, dolphinfishes, lancetfish (*Alepisaurus*), snake mackerel (*Gempylus*), flyingfishes, barracudas and squids such as *Ommastrephes*, *Loligo*, and *Illex*. In shallow water they prey upon neritic fishes, including mackerels, herrings, anchovies, sardines, sauries, and needlefishes. In deep water swordfish may also take demersal fishes such as hakes, pomfrets (Bromidae), snake mackerels, cutlass fish (trichiurids), lightfishes (Gonostomatidae), hatchet fishes (Sternoptychidae), redfish, lanternfishes, and cuttlefishes (Nakamura, 1985).

In the Gulf of Mexico swordfish were found to feed primarily on cephalopods - 90 percent of stomach contents consisted of 13 species of teuthoid squids, most of which were *Illex*, and two species of octopus (Toll and Hess, 1981). Stillwell and Kohler (1985) found that 80 percent of the stomach contents of swordfish taken off the northeast coast of the United States consisted of cephalopods, of which short-finned squid (*Illex illecebrosus*) made up 26.4 percent. Adult swordfish in neritic waters will feed inshore near the bottom during the daytime and head seaward to feed on cephalopods at night. The movement of larger individuals into higher latitudes in the summer and fall may be in part to allow those individuals access to high concentrations of *Illex* (Arocha, 1997). Predators of adult swordfish are probably restricted to sperm whales (*Physeter catodon*), killer whales (*Orcinus orca*) and large sharks, such as mako (*Isurus* spp).

Typically, swordfish larvae less than 9.0 mm in length consume small zooplankton, those 9.0 to 14.0 mm feed on mysids, phyllopods and amphipods, and at sizes greater than 21 mm they begin to feed on the larvae of other fishes. Juveniles feed on squids, fishes, and some pelagic crustaceans (Palko *et al.*, 1981). Larvae are preyed upon by other fishes, and juveniles fall prey to predatory fishes, including sharks, tunas, billfishes, and adult swordfish (Palko *et al.*, 1981).

Life history: First spawning for north Atlantic swordfish occurs at four to five years of age (74 kg) in females. Fifty percent maturity in females is reached at 179 to 182 cm LJFL, and in males at 112 to 29 cm LJFL (21 kg) at approximately 1.4 years of age (Palko *et al.*, 1981; Nakamura, 1985; Arocha, 1997). Most spawning takes place in waters with surface temperatures above 20° to 22° C, between 15° N and 35° N (Palko *et al.*, 1981; Arocha, 1997;). In the western north Atlantic spawning occurs in distinct locations at different times of the year: south of the Sargasso Sea and in the upper Caribbean spawning occurs from December to March, while off the southeast coast of the United States it occurs from April through August (Arocha, 1997). Major spawning grounds are probably located in the Straits of Yucatan and the Straits of Florida (Grall *et al.*, 1983; Govoni *et. al.*, 2000, 2003). Larvae have been found in largest abundance from the Straits of Florida to Cape Hatteras, NC and around the Virgin Islands. Larvae are associated with surface temperatures between 24° and 29°C. The Gulf of Mexico is believed to serve as a nursery area (Palko *et al.*, 1981). Grall *et al.*, (1983) found larvae ten mm and larger to be abundant in the Caribbean, the Straits of Florida and the Gulf Stream north of Florida from December to February. In the western Gulf of Mexico, large larvae were found from March to May and from September to November; many larvae of all sizes were collected in the Caribbean and were also present year-round in the eastern Gulf of Mexico, the Straits of Florida, and the Gulf Stream. Juvenile fish are frequently caught in the pelagic longline fishery in the Gulf of Mexico, the Atlantic coast of Florida, and near the Charleston Bump regions that may serve as nurseries for north Atlantic swordfish (Cramer and Scott, 1998).

Fisheries: Swordfish in the Atlantic are taken by a directed longline fishery and as bycatch of the tuna longline fishery. There are also seasonal harpooning and driftnetting efforts off Nova Scotia (harpooning), off the northeast U.S. coast, and on the Grand Banks (driftnetting) (Arocha, 1997). The effect of this reduction in stock size on habitat use and species distributions is unknown. In January 1999, NMFS prohibited the use of driftnets for the swordfish fishery. In March 1999, NMFS instituted a program requiring all swordfish imported into the United States to have a certificate of eligibility specifying the origin of the fish. If the swordfish is from the Atlantic it must meet the 33-lb dw minimum size requirement of ICCAT.

U.S. Fishery Status: North Atlantic swordfish overfished, overfishing is not occurring, stock is in recovery. South Atlantic swordfish fully fished, overfishing may be occurring.

Growth and mortality: Swordfish reach a maximum length of 445 cm total length (TL) and a maximum weight of 540 kg. Males and females have different growth rates, with females longer and heavier at any given age (Nakamura, 1985). Natural mortality rate was estimated at 0.21 to 0.43 by Palko *et al.*, (1981), but ICCAT presently uses an estimate of 0.2 (Arocha, 1997). Berkeley and Houde (1981) found a higher growth rate for females than males over two years of age, and also found males to have a higher mortality rate than females.

Habitat associations: In the winter in the north Atlantic, swordfish are restricted to the warmer waters of the Gulf Stream, while in the summer their distribution covers a larger area. Distribution is size and temperature related, with few fish under 90 kg found in waters with temperatures less than 18° C. Larvae are restricted to a narrow surface temperature range, and are distributed throughout the Gulf of Mexico, in areas of the Caribbean, and in the Gulf Stream along the U.S. coast as far north as Cape Hatteras, NC. Concentrations of adult swordfish seem to occur at ocean fronts between water masses associated with boundary currents, including the Gulf Stream and Loop Current of the Gulf of Mexico (Arocha, 1997, Govoni *et al.*, 2003).

***Essential Fish Habitat for Atlantic Swordfish*:**

- **Spawning, eggs, and larvae:** From offshore Cape Hatteras, NC (approximately 35° N) extending south around peninsular Florida through the Gulf of Mexico to the U.S./Mexico border from the 200 m isobath to the EEZ boundary; associated with the Loop Current boundaries in the Gulf and the western edge of the Gulf Stream in the Atlantic; also, all U.S. waters of the Caribbean from the 200 m isobath to the EEZ boundary (Figure B.16).

- **Juveniles/subadults (<180 LJFL):** In pelagic waters warmer than 18° C from the surface to a depth of 500 m, from offshore Manasquan Inlet, NJ at 40° N, east to 73° N, and south to the waters off Georgia at 31.5° N, between the 25 and 2,000 m isobaths; offshore Cape Canaveral, FL (approximately 29° N) extending from the 100 m isobath to the EEZ boundary (south and east) around peninsular Florida; in the Gulf of Mexico from Key West to offshore Galveston, TX (95° W) from the 200 m isobath to the EEZ boundary, with the exception of the area between 86° W and 88.5° W, where the seaward boundary of EFH is the 2,000 m isobath (Figure B.17).

- **Adults (≥180 LJFL):** In pelagic waters warmer than 13° C from the surface to 500 m deep, offshore the U.S. east and Gulf coasts from the intersection of the 100 m isobath and the EEZ boundary southeast of Cape Cod, MA to south and offshore Biscayne Bay, FL at 25.5° N, from the 100 to 2,000 m isobath or the EEZ boundary, which ever is closer to land; from offshore Tampa Bay, FL at 85° N to offshore Mobile Bay, AL at 88° N between the 200 and 2,000 m isobaths; from offshore south of the Mississippi River delta, 89° N to offshore waters south of Galveston, TX, 95° N from the 200 m isobath to the EEZ boundary (Figure B.18).

B.1.3 Billfish

B.1.3.1 Blue Marlin

Blue Marlin (*Mokaira nigricans*) Blue marlin inhabit the tropical and subtropical waters of the Atlantic, Pacific and Indian Oceans. Their geographic range is from 45° N to 35° S. In the Atlantic two seasonal concentrations occur: January to April in the southwest Atlantic from 5° to 30° S, and from June to October in the northwest Atlantic between 10° N and 35° N. May, November and December are transitional months (Rivas, 1975). This species is epipelagic and oceanic, generally found in blue water with a temperature range of 22 to 31° C. In the northern Gulf of Mexico fishermen tend to catch more blue marlin when white marlin catches are lowest and vice versa; this probably reflects differences in habitat preferences rather than any interaction between the species. Blue marlin are generally solitary, and do not occur in schools or in coastal waters (Nakamura, 1985). It had been believed that the North and South Atlantic contains two separate spawning populations, but recent evidence, including genetic data, suggests there is intermingling of the two groups. Consistent with SCRS recommendations, this amendment considers there to be a single stock of Atlantic blue marlin. Tag-recapture data from the northern Gulf of Mexico and the Bahamas suggest seasonal movements between the former in summer and the latter in winter, and also two-way movements between the Caribbean Islands and Venezuela and the Bahamas, and at least one-way movements from St. Thomas to West Africa. Blue marlin from this study traveled up to 7,000 km (4,350 mi) and have remained at-large (*i.e.*, from tagging until recapture) for up to eight years (Witzell and Scott, 1990).

As part of the Cooperative Tagging Center (CTC) program, a total of 21,547 blue marlin have been tagged and released over the last 43 years, with the recapture of 147 tagged fish reported (0.68 percent of all releases) over the 23-year collaborative tagging effort (Jones *et al.*, 1997). Most tagging activity has taken place off the U.S. east coast, Gulf of Mexico and Caribbean, generally during the months of July through September. The majority of blue marlin was recaptured in the general area of their release, traveling an average distance of 488 nm. Some individuals have exhibited extended movement patterns, and strong seasonal patterns of movement of individuals between the United States and Venezuela are evident (SCRS, 1997). A blue marlin released off Delaware and recovered off the island of Mauritius in the Indian Ocean represents the only documented inter-ocean movement of a highly migratory species in the history of the CTC. The minimum straight-line distance traveled for this fish was 9,100 nm in 1,108 days-at-large (roughly three years). Other extensive movements include trans-equatorial movements and trans-Atlantic migrations (5.4 percent of CTC recaptures; Jones *et al.*, 1997).

Predator-prey relationships: Blue marlin feed near the surface but also are known to feed in deeper waters than the other istiophorids. They feed primarily on tuna-like fishes, squid, and on a wide size range of other organisms, from 38 mm postlarval surgeonfish to 50 lb. bigeye tuna. Stomach contents have also included deep-sea fishes, such as chiasmodontids. Other important prey species vary by location and include dolphinfishes, especially bullet tuna (*Auxis* sp.) around the Bahamas, Puerto Rico, and Jamaica, and dolphinfishes and scombrids in the Gulf of Mexico. Octopods are also prey items (Rivas, 1975; Davies and Bortone, 1976; Nakamura, 1985). Predators of blue marlin are relatively unknown. Sharks will attack hooked billfish, but it is not known if they attack free-swimming, healthy individuals.

Reproduction and Early Life History: Although recent evidence indicates mixing between the two geographic areas, there are probably two separate spawning "events" (or populations); one in the north Atlantic with spawning from July to September (July to October according to de Sylva and Breder, 1997; May to November, according to Prince *et al.*, 1991) and one in the South Atlantic from February to March. May and June are the peak spawning months for fish off Florida and the Bahamas, and there is a protracted spawning period off northwest Puerto Rico from May to November. Females taken off Cape Hatteras, NC in June were found to have recently spawned (Rivas, 1975). Very few larvae have been collected in the western

Atlantic, but some have been found off Georgia, in the Gulf of Mexico, off Cat Cay, Bahamas, and in the mid- north Atlantic (Ueyanagi *et al.*, 1970; Nakamura, 1975). A few juveniles have been identified off Jamaica (Caldwell, 1962) and one from the Gulf of Mexico.

Blue marlin are sexually mature by 2 to 4 years of age (SCRS, 1997). Female blue marlin begin to mature at approximately 104 to 134 lb, while males mature at smaller weights, generally from 77 to 97 lb. Analysis of egg (ova) diameter frequency suggests that blue marlin, white marlin, and sailfish spawn more than once, and possibly up to four times a year (de Sylva and Breder, 1997). During the spawning season blue marlin release from one million to ten million small (1 to 2 mm), transparent pelagic planktonic eggs (Yeo, 1978). The number of eggs has been correlated to interspecific sizes among billfish and size of individuals within the same species. Ovaries from a 324 lb female blue marlin from the northwest Atlantic were estimated to contain 10.9 million eggs, while ovaries of a 275 lb female were estimated to contain approximately 7 million eggs.

Fisheries: Blue marlin are targeted as a recreational fishery in the United States and Caribbean, and are also caught as bycatch of tropical tuna longline fisheries which use shallow gear deployment. They are also caught by offshore longline fisheries which target swordfish, especially in the western Atlantic, as well as by directed artisanal fisheries in the Caribbean.
U.S. Fishery Status: Overfished, and overfishing is occurring. The effect of reduced stock size on habitat use, migrations or distribution is unknown but should be investigated in future research.

Growth and mortality: Blue marlin are believed to be one of the fastest growing of all teleosts in the early stages of development, and weigh between 30 and 45 kg by age 1 (SCRS, 1997). Based on analyses of daily otolith ring counts, they reach 24 cm LJFL (lower jaw fork length) in about 40 days, and about 190 cm LJFL in 500 days, with a maximum growth rate of approximately 1.66 cm/day occurring at 39 cm LJFL (Prince *et al.*, 1991). Fish larger than 190 cm LJFL tend to add weight more than length, making the application of traditional growth curve models, in which length or weight are predicted as a function of age, difficult for fish in these larger size categories. Females grow faster and reach much larger maximum sizes than males. Examination of sagitta (otolith) weight, body weight, and length/age characteristics indicate that sex-related size differences are related to differential growth between the sexes and not to differential mortality (Wilson *et al.*, 1991). Sexually dimorphic growth variation (weight only) in blue marlin appears to begin at 140 cm LJFL (Prince *et al.*, 1991). Somatic growth of male blue marlin slows significantly at about 220 lb, while females continue substantial growth throughout their lifetime (Wilson *et al.*, 1991). Male blue marlin usually do not exceed 350 lb, while females can exceed 1,200 lb.

Blue marlin are estimated to reach ages of at least 20 to 30 years, based on analysis of dorsal spines (Hill *et al.*, 1990). Although this spine ageing technique has not been validated, longevity estimates are supported by tagging data. The maximum time at liberty recorded of a tagged individual was 4,024 days (about 11 years) for a blue marlin that was estimated to weigh 65 pounds at the time of release (SCRS, 1996b). Sagitta otolith weight is suggested to be proportional to age, indicating that both sexes are equally long-lived, based on the maximum otolith weight observed for each sex (Wilson *et al.*, 1991). Additionally, predicting age from length or weight is imprecise due to many age classes in the fishery (SCRS, 1996b). Estimates of natural mortality rates for billfish would be expected to be relatively low, generally in the range of 0.15 to 0.30, based on body size, behavior, and physiology (SCRS, 1996b).

Habitat associations: Adults are found primarily in the tropics within the 24°C isotherm, and make seasonal movements related to changes in sea surface temperatures. In the northern Gulf of Mexico they are associated with the Loop Current and are found in blue waters of low productivity rather than in more productive green waters. Off Puerto Rico the largest numbers of blue marlin are caught during August, September and October. Equal numbers of both sexes occur off northwest Puerto Rico in July and August, with larger males found there in May and smaller males in September (Rivas, 1975). Very large individuals, probably females, are found off the southern coast of Jamaica in the summer and off the northern coast in winter, where males are caught in December and January.

Essential Fish Habitat for Blue Marlin:

- **Spawning, eggs, and larvae:** Offshore Florida, identical to adult EFH in that area: from offshore Ponce de Leon Inlet (29.5° N) south to offshore Melbourne, FL from the 100 m isobath to 50 mi seaward (79.25° W); from offshore Melbourne, FL south to Key West from the100 m isobath to the EEZ boundary; also, off the northwest coast of Puerto Rico (from Arecibo to Mayaguez), bounded by the 2000 m isobath to the north and 18° N to the south (Figure B.19).

- **Juveniles/Subadults (20-189 cm LJFL):** Pelagic surface waters not less than 24° C, offshore Delaware Bay to Cape Lookout, NC from the 100 to the 2000 m isobath, and grading further offshore to 73.25° W at 35° N; continuing south from offshore Cape Lookout to Cumberland Island, GA (30.75° N), from the 200 to 2000 m isobath; offshore St. Augustine, FL (30° N) south to 26° N, (Ft Lauderdale, FL) from the 100 m isobath offshore an additional 30 miles to 29° N, then south of 29° N, seaward from the 100 m isobath to the EEZ boundary; off southwest Florida from 24.5° N between the 200 m isobath and the EEZ boundary, north to 28°N, west to 86.25° W, and south to the EEZ boundary; offshore Choctawhatchee Bay to Terrebonne Parish, LA, from the 100 to the 2000 m isobath, continuing west along the 200 m isobath to the Texas/Mexico border out to 2000 meters (Figure B.20).

- **Adults (≥ 190 cm LJFL):** Pelagic surface waters not less than 24° C, from offshore Delaware Bay (38.5° N) south to offshore Wilmington, NC (33.5° N) between the100 and 2000 m isobaths; offshore Charleston, SC (32° N) from 100 m to 78° W to offshore the Georgia/Florida border (30.75° N); from offshore Ponce de Leon Inlet (29.5° N) south to offshore Melbourne, FL from the 100 m isobath to 50 mi seaward (79.25° W); from offshore Melbourne, FL south to Key West from the 100 m isobath to the EEZ boundary; from offshore Choctawhatchee Bay (86° W) to offshore Terrebonne Parish, LA (90° W) between the 100 and 2000 m isobaths; from Terrebonne Parish, LA south to offshore Galveston, TX (95° W) between the 200 and 2000 m isobaths; Puerto Rico and the U.S. Virgin Islands: from 65.25° W east and south to the EEZ northern boundary along the 100 m isobath. Also, off the northern shore of Puerto Rico out to the 2000 m isobath from 65.5° W west to the EEZ boundary, and along the southern coast of Puerto Rico out to the 2000 m isobath, east to 66.5° W (Figure B.21).

B.1.3.2 White Marlin

White Marlin (*Tetrapturus albidus*) White marlin is an oceanic, epipelagic species that occurs in the Atlantic Ocean, Gulf of Mexico, and Caribbean waters. It inhabits almost the entire Atlantic from 45°N to 45°S in the western Atlantic and 45°N to 35°S in the eastern Atlantic. In the tropics white marlin usually occur above the thermocline in deep (depths greater than 100 m), blue waters with surface temperatures above 22°C and salinities of 35 to 37 ppt. They are usually in the upper 20 to 30 m of the water column but may go to depths of 200 to 250 m where the thermocline is deep. In higher latitudes, such as between New Jersey and Virginia, they are found commonly in shallow coastal waters (de Sylva and Davis, 1963). White marlin are found at the higher latitudes of their range only in the warmer months. Although they are generally solitary, they sometimes are found in small, usually same-age groups. White marlin spawn in tropical and sub-tropical waters and move to higher latitudes during the summer (Mather *et al.*, 1975; Nakamura, 1985). Catches in some areas may include a rare species, *Tetrapturus georgei*, which is superficially similar to white marlin. The so-called "hatchet marlin" (Pristas, 1980) may also represent *T. georgei* and has been caught occasionally in the Gulf of Mexico. The similarity between species indicates some reported catches have the potential for error.

This species undergoes extensive movements, although not as extreme as those of the bluefin tuna and albacore. The longest distance traveled by a tagged and recaptured specimen, which had been at-large for 1.4 years, was 3,509 km. The longest time at-large recorded for a white marlin is 11.8 years. Transequatorial movements have not been documented for the species (Bayley and Prince, 1993). There have been 29,751 white marlin tagged and released by the CTC program, with 540 reported recaptures (1.8 percent of all releases). The majority of releases took place in the months of July through September, in the western Atlantic off the east coast of the United States. Releases of tagged white marlin also occurred off Venezuela, in the Gulf of Mexico, and in the central West Atlantic. As noted for blue marlin, the majority of recoveries occurred in the same general area as the original capture. The mean straight-line distance of recaptured white marlin is 455 nm. A substantial number of individuals moved between the mid-Atlantic coast of the United States and the northeast coast of South America. Overall, 1.1 percent of documented white marlin recaptures have made trans-Atlantic movements. The longest movement was for a white marlin tagged during July 1995 off the east coast near Cape May, NJ and recaptured off Sierra Leone, West Africa in November 1996. The fish traveled a distance of at least 3,519 nm over 476 days (1.3 years; Jones *et. al*., 1997).

Predator–prey relationships: The most important prey items of adult white marlin, at least in the Gulf of Mexico, are squid, dolphinfishes (*Coryphaena*) and hardtail jack (*Caranx crysos*), followed by mackerels, flyingfishes, and bonitos. Other food items found inconsistently and to a lesser degree include cutlassfishes, puffers, herrings, barracudas, moonfishes, triggerfishes, remoras, hammerhead sharks, and crabs. Along the central Atlantic coast food items include round herring (*Etrumerus teres*) and squid *(Loligo pealei*). Carangids and other fishes are consumed as well (Nakamura, 1985). Davies and Bortone (1976) found the most frequent stomach contents in 53 specimens from the northeastern Gulf of Mexico, off Florida and off Mississippi to include little tunny (*Euthynnus* sp.), bullet tuna (*Auxis* sp.), squid, and moonfish (*Vomer setapinnis*). They also found white marlin to feed on barracuda and puffer fish. The only predators of adult white marlin may be sharks and possibly killer whales (Mather *et al.*, 1975).

Reproduction and Early Life History: Sexual maturity of female white marlin is reached at about 61 inches LJFL (44 lb). Mature females probably spawn more than once a year and possibly up to four times during the spawning season. The spawning season probably occurs only once a year, from March to June (de Sylva and Breder, 1997). It is believed there are at least three spawning areas in the western north Atlantic: northeast of Little Bahama Bank off the Abaco Islands, northwest of Grand Bahama Island, and southwest of Bermuda. Larvae have also been collected from November to April (Mather *et al.*, 1975; Nakamura, 1985), but these may have been sailfish larvae (*Istiophorus platypterus*), as the two cannot readily be distinguished.

Fisheries: White marlin are targeted as a recreational fishery in the United States and Caribbean, and are also caught as bycatch of tropical tuna longline fisheries which use shallow gear deployment. They are also caught by offshore longline fisheries which target swordfish, especially in the western Atlantic, as well as by directed artisanal fisheries in the Caribbean.
U.S. Fishery Status: Overfished, overfishing is occurring. The effect of reduced stock size on habitat use, migrations or distribution is unknown but should be investigated in future research.

Growth and mortality: Adult white marlin grow to over 280 cm TL (total length) and 82 kg. White marlin exhibit sexually dimorphic growth patterns; females grow larger than males (Mather *et al.*, 1975; Nakamura, 1985), but the dimorphic growth differences are not as extreme as noted for blue marlin (SCRS, 1997). A minimum estimate of longevity can be calculated from the longest time at liberty for a tagged white marlin, 4,305 days (11.8 years). The individual was estimated to weigh 50 lb at the time of first capture, resulting in a minimum age estimate of 14 to15 years (SCRS, 1996b).

Habitat associations: The world's largest sport fishery for the species occurs in the summer from Cape Hatteras, NC to Cape Cod, MA especially between Oregon Inlet, NC and Atlantic City, NJ. Successful fishing occurs up to 80 miles offshore at submarine canyons, extending from Norfolk Canyon in the mid-Atlantic to Block Canyon off eastern Long Island (Mather, *et al.*, 1975). Concentrations are associated with rip currents and weed lines (fronts), and with bottom features such as steep dropoffs, submarine canyons and shoals (Nakamura, 1985). The spring peak season for white marlin sport fishing occurs in the Straits of Florida, southeast Florida, the Bahamas, and off the north coasts of Puerto Rico and the Virgin Islands. In the Gulf of Mexico summer concentrations are found off the Mississippi River Delta, at DeSoto Canyon, and at the edge of the continental shelf off Port Aransas, TX, with a peak off the Delta in July, and in the vicinity of DeSoto Canyon in August. In the Gulf of Mexico adults appear to be associated with blue waters of low productivity, being found with less frequency in more productive green waters. While this is also true of the blue marlin, there appears to be a contrast in the factors controlling blue and white marlin abundances, as higher numbers of blue marlin are caught when catches of white marlin are low and vice versa (Rivas, 1975; Nakamura, 1985). It is believed that white marlin prefer slightly cooler temperatures than blue marlin. Spawning occurs in early summer, in subtropical, deep oceanic waters with high surface temperatures and salinities (20 to 29°C and over 35 ppt). Spawning concentrations occur off the Bahamas, Cuba, and the Greater Antilles, probably beyond the U.S. EEZ, although the locations are unconfirmed. Concentrations of white marlin in the northern Gulf of Mexico and from Cape Hatteras to Cape Cod are probably related to feeding rather than spawning (Mather *et al.*, 1975).

Essential Fish Habitat for White Marlin:

- **Spawning, eggs, and larvae:** At this time the available information is insufficient to identify EFH for this life stage (Figure B.22).

- **Juvenile (20-158 cm LJFL):** Pelagic waters warmer than 22°C, from offshore the U.S. east coast from the 50 to the 2000 m isobath from the EEZ at Georges Bank at 41°N, south to offshore Miami, FL at 25.25°N; off the west coast of Florida, between the 200 and 2000 m isobath from 24.75° N to 27.75°N; then continuing between the 200 and 2000 m isobath west from 86°W to 93.5°W, then off the coast of Texas from west of 95.5°W to the 50 m isobath and south to the EEZ boundary (Figure B.23).

- **Adults (≥159 cm LJFL):** Pelagic waters warmer than 22°C, from offshore the northeast U.S. coast from the 50 to the 2000 m isobath from 33.75° N to 39.25°N, then extending along 39.25°N out to the EEZ boundary; off the coast of South Carolina in the Charleston Bump area, in the region starting from the 200 m isobath at 32.25°N, east to 78.25°W, south to 31°N, west to 79.5°W and north to the 200 m isobath; offshore Cape Canaveral, FL from the 200 m isobath, east at 29°N to the EEZ boundary, south along the 200 m isobath and out to the EEZ boundary to 82°W, in the vicinity of Key West, FL; in the Gulf of Mexico, from 86.5°W to the EEZ boundary, along the 50 m isobath near De Soto canyon, then along the 100 m isobath west to the EEZ boundary offshore the United States/Mexico border (Figure B.24).

B.1.3.3 Sailfish

Sailfish (*Istiophorus platypterus*) Sailfish have a circumtropical distribution (Post, 1998). They range from 40°N to 40°S in the western Atlantic and 50°N to 32°S in the eastern Atlantic. Sailfish are epipelagic and coastal to oceanic, and are usually found above the thermocline at a temperature range of 21 to 28°C, but may dive into deeper, colder water. These are the least oceanic of the Atlantic billfish, often moving to inshore waters. They are found over the shelf edge, and are associated with land masses. However, they have been found to travel farther offshore than was previously thought.

A total of 62,740 sailfish have been tagged and released through the efforts of the CTC program, with reported recapture of 1,090 sailfish (1.7 percent of all releases). Most releases occurred off southeast Florida, from north Florida to the Carolinas, the Gulf of Mexico, Venezuela, Mexico, the northern Bahamas, and the U.S. Virgin Islands. One tagged and recaptured specimen traveled from Juno, FL to the mid-Atlantic, a distance of 2,972 km (Bayley and Prince, 1993). The longest movement tracked by tagging was 3,509 km, with this specimen at-large for 1.4 yrs. The longest period a recaptured tagged animal was found to be at-large was 10.9 years (Bayley and Prince, 1993). During the winter sailfish are restricted to the warmer parts of their range and move farther from the tropics during the summer (Beardsley *et al.*, 1975; Nakamura, 1985). The summer distribution of sailfish does not extend as far north as for marlins. Tag-and-recapture efforts have recovered specimens only as far north as Cape Hatteras, NC. Few transatlantic or transequatorial movements have been documented using tag-recapture methods (Bayley and Prince, 1993).

Predator-prey relationships: Early larvae feed on copepods, but shift to eating fish when they reach 6.0 mm in size. The diet of adult sailfish caught around Florida consists mainly of pelagic fishes such as little thunny (*Euthynnus alletteratus*), halfbeaks (*Hemiramphus* spp.), cutlassfish (*Trichiurus lepturus*), rudderfish (*Strongylura notatus*), jacks (*Caranx ruber*), pinfish (*Lagodon rhomboides*), and squids, including *Argonauta argo* and *Ommastrephes bartrami* (Nakamura, 1985). Sailfish are opportunistic feeders, and there is unexpected evidence that they may feed on demersal species such as sea robin (Triglidae), cephalopods, and gastropods found in deep water. Sailfish in the western Gulf of Mexico have been found to contain a large proportion of shrimp in their stomachs (Beardsley *et al.*, 1975; Nakamura, 1985). Davies and Bortone (1976) report that the stomach contents of 11 sailfish from the Gulf of Mexico most frequently contained little thunny, bullet tuna (*Auxis* sp.), squid, and Atlantic moonfish (*Vomer setapinnis*). Adult sailfish are probably not preyed upon often, but predators include killer whales (*Orcinus orca*), bottlenose dolphin (*Tursiops turncatus*), and sharks (Beardsley *et al.*, 1975).

Reproduction and Early Life History: Spawning has been reported to occur in shallow waters (30-40 ft) around Florida, from the Keys to the region off Palm Beach on the east coast. Spawning is also assumed, based on presence of larvae, offshore beyond the 100 m isobath from Cuba to the Carolinas, from April to September. However, the spawning has not been observed. Sexual maturity occurs in the third year, with females at a weight of 13 to18 kg and males at 10 kg (de Sylva and Breder, 1997). Sailfish are multiple spawners, with spawning activity moving northward in the western Atlantic as the summer progresses. Larvae are found in Gulf Stream waters in the western Atlantic, and in offshore waters throughout the Gulf of Mexico from March to October (Beardsley *et al.*, 1975; Nakamura, 1985; de Sylva and Breder, 1997).

Fisheries: Sailfish are primarily caught in directed sportfisheries and as bycatch of the commercial longline fisheries for tunas and swordfish. Historically, nearly all sailfish from commercial catches have been reported as Atlantic sailfish; however, nearly all of these represent longbill spearfish (and perhaps other spearfish), and it is probable that very few sailfish are taken commercially in offshore waters of the Atlantic. Thus, it is impossible to determine historical trends in sailfish catches since at least two species have been combined. **U.S. Fishery Status:** Unknown.

Growth and mortality: Most sailfish examined that have been caught off Florida are under three years of age. Mortality is estimated to be high in this area, as most of the population consists of only two year classes (Beardsley *et al.*, 1975). Sailfish are probably the slowest growing of the Atlantic istiophorids. Sexual dimorphic growth is found in sailfish, but it is not as extreme as with blue marlin (SCRS, 1997). An individual sailfish that was recaptured after

5,862 days (16 years) at liberty can be used to estimate minimum age of longevity. Unfortunately, the size at release is not available for this fish (SCRS, 1996b). The maximum age can be 13 to15 or more years. Growth rate in older individuals is very slow - 0.59 kg/yr (Prince *et al.*, 1986).

Habitat associations: In the winter sailfish are found in schools around the Florida Keys and eastern Florida, in the Caribbean, and in offshore waters throughout the Gulf of Mexico. In the summer they appear to diffuse northward along the U.S. coast as far north as the coast of Maine, although there is a population off the east coast of Florida all year long. During the summer some of these fish move north along the inside edge of the Gulf Stream. After the arrival of northerlies in the winter they regroup off the east coast of Florida. Sailfish appear to spend most of their time above the thermocline, which occurs at depths of 10 to 20 m to 200 to 250 m, depending on location. The 28°C isotherm appears to be the optimal temperature for this species. Sailfish are mainly oceanic but migrate into shallow coastal waters. Larvae are associated with the warm waters of the Gulf Stream (Beardsley *et al.*, 1975; Nakamura, 1985; Post, 1998).

Essential Fish Habitat for Sailfish:

- **Spawning, eggs, and larvae:** From 28.25°N south to Key West, FL, associated with waters of the Gulf Stream and Florida Straits from 5 mi offshore out to the EEZ boundary (Figure B.25)**.**

- **Juveniles/Subadults (20-142 cm LJFL):** In pelagic and coastal surface waters between 21 and 28°C, from 32°N south to Key West, FL in waters from 5 mi offshore to125 mi offshore, or the EEZ boundary, whichever is nearer to shore; west of Key West, FL, all waters of the Gulf of Mexico from the 200 to the 2000m isobath or the EEZ boundary, whichever is nearer to shore (Figure B.26).

- **Adults (≥143 cm LJFL):** In pelagic and coastal surface waters between 21 and 28°C, offshore of the U.S. southeast coast from 5 mi off the coast to 2000 m, from 36°N to 34°N, then from 5 mi offshore to 125 mi offshore, or the EEZ boundary, whichever is nearer to shore, south to Key West, then from the 200 m isobath to the 2000 m isobath. Additional EFH is delineated in the Gulf of Mexico near DeSoto Canyon up to the 50 m isobath, and areas 5 mi offshore southeast Texas, from Corpus Christy to the EEZ boundary, or the 2000 m isobath, whichever is closer (Figure B.27).

B.1.3.4 Longbill Spearfish

Longbill Spearfish (*Tetrapturus pfluegeri*) Only relatively recently (1963) has the longbill spearfish been reported as a new (distinct) species. It is known, but rare, from off the east coast of Florida, the Bahamas and the Gulf of Mexico, and from Georges Bank to Puerto Rico. More recently it has been observed to be more widely distributed, mostly in the western Atlantic. The range for this species is from 40°N to 35°S. It is an epipelagic, oceanic species, usually inhabiting waters above the thermocline (Robins, 1975; Nakamura, 1985). The species is generally found in offshore waters.

Predator-prey relationships: The diet of the longbill spearfish consists of pelagic fishes and squids. However, little data for diet specific to fish in the north Atlantic is available.

Life history: Spawning is thought to occur in widespread areas in the tropical and subtropical Atlantic (Nakamura, 1985) in the winter from November to May (de Sylva and Breder, 1997). There are a few records of larvae caught near the Mid-Atlantic Ridge from December to February, and in the Caribbean (Ueyanagi *et al.*, 1970; de Sylva and Breder, 1997)

Fisheries: Longbill spearfish is not a target species, but is taken in the recreational fishery; the sportfishery catches only about 100 individuals per year. It is, however, taken as bycatch of the tuna longline fishery. **U.S. Fishery Status:** Unknown.

Growth and mortality: The maximum weight of females at first maturity is approximately 45 kg (de Sylva and Breder, 1997).

Habitat associations: The species ranges farther offshore than sailfish. Nothing is known about its habitat associations.

Essential Fish Habitat for Longbill Spearfish:

- **Spawning, eggs, and larvae:** At this time available information is insufficient to describe and identify EFH for this life stage (Figure B.28).

- **Juvenile/Subadult (~20-182 cm LJFL):** Offshore North Carolina, from 36.5°N to 35°N, from the 200 m isobath to the EEZ boundary (Figure B.29).

- **Adults (≥183 cm LJFL):** The Charleston Bump area of the South Atlantic Bight from 78°W to 79°W, and from 37°N to 31°N; and southwest of the U.S. Virgin Islands from 65° W east to the EEZ boundary or the 2000 m isobath, whichever is nearer to shore (Figure B.30).

B.1.4 Large Coastal Sharks

B.1.4.1 Basking Sharks

Basking shark (*Cetorhinus maximus*) The basking shark is the second largest fish in the world, its size exceeded only by the whale shark. Like the whale shark, it is a filter-feeding plankton eater. It is a migratory species of the subpolar and cold temperate seas throughout the world, spending the summer in high latitudes and moving into warmer water in winter (Castro, 1983). In spite of its size and local abundance in summer, its habits are very poorly known. Sims and Quayle (1998) have shown that basking sharks forage along thermal fronts and seek the highest densities of zooplankton. During the European autumn basking sharks disappear and are not seen until the following summer, when they return after giving birth. Distribution data for the basking shark is incomplete largely because the species is not commonly taken by fisheries. According to one OMB reviewer, EFH for the basking shark may need to include waters east of the Great South Channel and the Gulf of Maine to the Bay of Fundy. Pertinent information on life history and distribution of the basking shark in the North Atlantic may be found in Templeman (1963), Owen (1984), Kenney *et al.* (1985), Sims and Merrett (1997), Sims and Quayle (1998), Sims (1999), Sims *et al.* (2000), Skomal *et al.* (2004), and Wilson (2004).

Reproductive potential: Little is known about basking shark reproductive processes. Males are believed to reach maturity between 460 and 610 cm (Bigelow and Schroeder, 1948), at an estimated age of four to five years (Parker and Stott, 1965). However, these age estimates have not been validated. Females mature at 810 to 980 cm (Compagno, 1984). It is believed that female basking sharks give birth to young measuring about 180 cm total length (TL), probably in high latitudes. There are no modern reports on the size of litters or data on reproductive cycles.

Impact of fisheries: Fishing for the basking shark is prohibited in U.S. waters, although basking sharks are common off the east coast in winter.

***Essential Fish Habitat for Basking Shark*:**

- **Neonate (≥182 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.31).

- **Juveniles (183 to 809 cm TL):** Offshore the mid-Atlantic United States south of Nantucket Shoals at 70°W to the north edge of Cape Hatteras, NC at 35.5°N in waters 50 to 200 m deep; associated with boundary conditions created by the western edge of the Gulf Stream (Figure B.32).

- **Adults (≥810 cm TL):** Offshore southern New England, west of Nantucket Shoals at 70°W to Montauk, Long Island, NY at 72°W, out to the continental shelf in waters 50 to 200 m deep, where water column physical conditions create high abundances of zooplankton (Figure B.33).

B.1.4.2 Hammerhead Sharks

Great hammerhead (*Sphyrna mokarran*) This shark found both in open oceans and shallow coastal waters. One of the largest sharks, the great hammerhead is circum-tropical in warm waters (Castro, 1983). It is usually a solitary fish, unlike the more common scalloped hammerhead which often forms very large schools.

Reproductive potential: In Australian waters males mature at about 210 to 258 cm TL and females mature usually at 210 to 220 cm TL (Stevens and Lyle, 1989). Pups measure about 67 cm TL at birth (Stevens and Lyle, 1989) and litters consist of 20 to 40 pups (Castro, 1983). The gestation period lasts about 11 months (Stevens and Lyle, 1989). The reproductive cycle is biennial (Stevens and Lyle, 1989). There are few reports and little data on its nurseries. Hueter (CSR data) found small juveniles from Yankeetown, FL to Charlotte Harbor, FL from May to October at temperature of 23.9 to 28.9°C and salinities of 21.9 to 34.2 ppt.

Impact of fisheries: Great hammerheads are caught in coastal longline shark fisheries as well as in pelagic tuna and swordfish longline fisheries. Its fins bring the highest prices in the shark fin market. Although finning is prohibited in the Atlantic, in many fishing operations elsewhere the fins are removed while the carcasses are discarded at sea. The great hammerhead is vulnerable to overfishing because of its biennial reproductive cycle and because it is caught both in directed fisheries and as bycatch in tuna and swordfish fisheries.

***Essential Fish Habitat for Great Hammerhead*:**

- **Neonate (≤74 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.34).

- **Juveniles (71 to 209 cm TL):** Off the Florida coast, all shallow coastal waters out to the 100 m isobath from 30°N south around peninsular Florida to 82.5°W, including Florida Bay and adjacent waters east of 81.5°W (north of 25°N), and east of 82.5°W (south of 25°N) (Figure B.35).

- **Adults (≥210 cm TL):** Off the entire east coast of Florida, all shallow coastal waters out to the 100 m isobath, south of 30°N, including the west coast of Florida to 85.5°W (Figure B.36).

Scalloped hammerhead (*Sphyrna lewini*) This is a very common, large, schooling hammerhead of warm waters. It is the most common hammerhead in the tropics and is readily available in abundance to inshore artisanal and small commercial fisheries as well as offshore operations (Compagno, 1984). It migrates seasonally north-south along the eastern United States. Additional life history information can be found in Lessa *et al.* (1998), Hazin *et al.* (2001), and Bush and Holland (2002).

Reproductive potential: Males in the Atlantic mature at about 180 to 185 cm TL (Bigelow and Schroeder, 1948), while those in the Indian Ocean mature at 140 to 165 cm TL (Bass *et al.*, 1973). Females mature at about 200 cm TL (Stevens and Lyle, 1989). The young are born at 38 to 45 cm TL, litters consisting of 15 to 31 pups (Compagno, 1984). The reproductive cycle is annual (Castro, 1993b), and the gestation period is nine to ten months (Stevens and Lyle, 1989). Castro (1993b) found nurseries in the shallow coastal waters of South Carolina; Hueter (CSR data) found small juveniles from Yankeetown to Charlotte Harbor on the west coast of Florida, in temperatures of 23.2° to 30.2 °C, salinities of 27.6 to 36.3 ppt, and DO of 5.1 to 5.5 ml/l.

Impact of fisheries: Because the scalloped hammerhead forms very large schools in coastal areas, it is targeted by many fisheries for its high priced fins. The scalloped hammerhead is considered vulnerable to overfishing because its schooling habit makes it extremely vulnerable to gillnet fisheries and because scalloped hammerheads are actively pursued in many fisheries throughout the world.

***Essential Fish Habitat for Scalloped Hammerhead*:**

- **Neonate (≤62 cm TL):** Shallow coastal waters of the South Atlantic Bight, off the coast of South Carolina, Georgia, and Florida, west of 79.5°W and north of 30°N, from the shoreline out to 25 miles offshore. Additionally, as displayed on Figure 6-10e: shallow coastal bays and estuaries less than 5 m deep, from Apalachee Bay to St. Andrews Bay, FL (Figure B.37).

- **Juveniles (63 to 227 cm TL):** All shallow coastal waters of the U.S. Atlantic seaboard from the shoreline to the 200 m isobath from 39° N, south to the vicinity of the Dry Tortugas and the Florida Keys at 82° W; also in the Gulf of Mexico, in the area of Mobile Bay, AL and Gulf Islands National Seashore, all shallow coastal waters from the shoreline out to the 50 m isobath (Figure B.38).

- **Adults (≥228cm TL):** In the South Atlantic Bight from the 25 to 200 m isobath from 36.5°N to 33°N, then continuing south from the 50 m isobath offshore to the 200 m isobath to 30°N, then from the 25 m isobath to the 200 m isobath from 30°N south to 28°N; also, in the Florida Straights between the 25 and 200 m isobaths, from 81.5°W west to 82.25°W in the vicinity of Key West and the Dry Tortugas (Figure B.39).

Smooth hammerhead (*Sphyrna zygaena*) This is an uncommon hammerhead of temperate waters. Fisheries data for hammerheads includes this species and the scalloped and great hammerheads; however, there is little data specific to the species.

***Essential Fish Habitat for Smooth Hammerhead*:**

- **Neonate (≤66 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.40).

- **Juveniles (67 t0 283 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.41).

- **Adults (≥284 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.42).

B.1.4.3 Mackerel Sharks

White shark (*Carcharodon carcharias*) The white shark is the largest of the lamnid, or mackerel, sharks. It is a poorly known apex predator found throughout temperate, subtropical, and tropical waters. Its presence is usually sporadic throughout its range, although there are a few localities (*e.g.*, off California, Australia, and South Africa) where it is seasonally common. Large adults prey on seals and sea lions and are sometimes found around their rookeries. The white shark is also a scavenger of large dead whales. It has been described as the most voracious of the fish-like vertebrates and has been known to attack bathers, divers, and even boats. According to one OMB reviewer, EFH for the white shark may need to be modified. The review by Casey and Pratt (1985) is a comprehensive size-specific examination of white shark distribution, life history, and nursery habitat in the western North Atlantic. Preliminary estimates of age and growth of this species were recently conducted by Natanson (2002). Estrada *et al.* (in press) present new information on the trophic ecology of this species in the western North Atlantic based on stable isotopes.

Reproductive potential: Very little is known of its reproductive processes because only two gravid females have been examined by biologists in modern times. Both specimens contained seven embryos. Recent observations show that white sharks carry seven to ten embryos that are born at 120 to 150 cm TL (Francis, 1996; Uchida *et al.*, 1996). The lengths of the reproductive and gestation cycles are unknown. White sharks are believed to mature at between 370 and 430 cm at an estimated age of nine to ten years (Cailliet *et al.*, 1985). Cailliet *et al.*, (1985) estimated growth rates of 25.0 to 30.0 cm/year for juveniles and 21.8 cm/year for older specimens, and gave the following von Bertalanffy parameters: n = 21, L_∞ = 763.7 cm, K = 0.058, t_o = -3.53. They estimated that a 610 cm TL specimen would be 13 to 14 years old. The types of habitats and locations of nursery areas are unknown. It is likely that the nurseries will be found in the warmer parts of the range in deep water.

Impact of fisheries: The white shark is a prized game fish because of its size. It is occasionally caught in commercial longlines or in near-shore drift gillnets, but it must be released in a manner which maximizes its survival. Its jaws and teeth are often seen in specialized markets where they bring high prices. Preliminary observations (Strong *et al.*, 1992) show that populations may be small, highly localized, and very vulnerable to overexploitation. The white shark has been adopted as a symbol of a threatened species by some conservation organizations, and has received protected status in South Africa, Australia, and the State of California. In 1997, the Unites States implemented a catch-and-release only recreational fishery for the white shark, while prohibiting possession of the species. There are no published population assessments, or even anecdotal reports, indicating any population decreases of the white shark. Nevertheless, it is a scarce apex predator and a long-lived species of a limited reproductive potential that is vulnerable to longlines.

***Essential Fish Habitat for White Shark*:**

- **Neonate (≤166 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.43).

- **Juveniles (167 to 479 cm TL):** Offshore northern New Jersey and Long Island, NY in pelagic waters from the 25 to 100 m isobath in the New York Bight area, bounded to the east at 71.5°W and to the south at 39.5°N; also, offshore Cape Canaveral, FL between the 25 and 100 m isobaths from 29.5° N south to 28°N (Figure B.44).

- **Adults (≥480 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.45).

B.1.4.4 Nurse Sharks

Nurse shark (*Ginglymostoma cirratum* The nurse shark inhabits littoral waters in both sides of the tropical and subtropical Atlantic, ranging from tropical West Africa and the Cape Verde Islands in the east, and from Cape Hatteras, NC to Brazil in the west. It is also found in the east Pacific, ranging from the Gulf of California to Panama and Ecuador (Bigelow and

Schroeder, 1948). It is a shallow water species, often found lying motionless on the bottom under coral reefs or rocks. It often congregates in large numbers in shallow water (Castro, 1983; Pratt and Carrier, 2002).

Reproductive potential: The nurse shark matures at about 225 cm total length (Springer, 1938). Litters consist of 20 to 30 pups, the young measuring about 30 cm total length at birth. The gestation period is about five to six months and reproduction is biennial (Castro, 2000). The age at maturity is unknown, but the nurse shark is a long-lived species. Clark (1963) reported an aquarium specimen living up to 24 years in captivity.

Its nurseries are in shallow turtle grass (*Thalassia*) beds and shallow coral reefs (Castro, 2000; Pratt and Carrier 2002). However, juveniles are also found around mangrove islands in south Florida. Hueter and Tyminski (2002) found numerous juveniles along the west coast of Florida, in temperatures of 17.5° to 32.9°C, salinities of 28.0 to 38.5 ppt, and DO of 3.1 to 9.7 mg/l. Large numbers of nurse sharks often congregate in shallow waters off the Florida Keys and the Bahamas at mating time in June and July (Fowler, 1906; Gudger, 1912; Pratt and Carrier, 2002). A small area has been set up for protection of mating sharks at Fort Jefferson in the Dry Tortugas. It is not certain, however, whether this area is a primary mating ground or a refuge for mated females.

Impact of fisheries: In North America and the Caribbean the nurse shark has often been pursued for its hide, which is said to be more valuable than that of any other shark (Springer, 1950a). The fins have no value, and the meat is of questionable value (Springer, 1979). The U.S. commercial bottom longline fleet catches few nurse sharks.

***Essential Fish Habitat for Nurse Shark*:**

- **Neonate (≤ 36 cm total length):** Areas of shallow coastal areas from West Palm Beach, FL, south to the Dry Tortugas in waters less than 25 m deep, including Charlotte Harbor, FL at 82°W and 26.8°N in waters less than 25 m deep (Figure B.46).

  Juvenile (37 to 221 cm total length): Shallow coastal waters from the shoreline to the 25 m isobath off the east coast of Florida from south of Cumberland Island, GA (at 30.5°N) to the Dry Tortugas; also shallow coastal waters from Charlotte Harbor, FL (at 26°N) to the north end of Tampa Bay, FL (at 28°N); also, off southern Puerto Rico, shallow coastal waters out to the 25 m isobath from 66.5°W to the southwest tip of the island. Areas in the northeast Gulf of Mexico (Apalachee Bay, Apalachicola Bay, and Crooked Island Sound, FL) (Figure B.47).

- **Adults (≥ 221 cm total length):** Shallow coastal waters from the shoreline to the 25 m isobath off the east coast of Florida from south of Cumberland Island, GA (at 30.5°N) to the Dry Tortugas; also, shallow coastal waters from Charlotte Harbor, FL (at 26°N) to the north end of Tampa Bay, FL (at 28°N); also, off southern Puerto Rico, shallow coastal waters out to the 25 m isobath from 66.5°W to the southwest tip of the island (Figure B.48).

B.1.4.5 Requiem Sharks

<u>Bignose shark (*Carcharhinus altimus*)</u> The bignose shark is a poorly known, bottom dwelling shark of the deeper waters of the continental shelves. It is found in tropical and subtropical waters throughout the world (Castro, 1983).

Reproductive potential: The smallest mature specimens recorded by Springer (1960) were a 213 cm TL male and a 221 cm TL female. Springer (1950c) reported litters of seven to eight pups, while Stevens and McLoughlin (1991) noted from three to 15 pups. Birth size is probably around 70 cm TL based on the largest embryos (65 to 70 cm TL) reported by Fourmanoir (1961), and free swimming specimens with fresh umbilical scars seen by Bass *et al.*, (1973). The lengths of the gestation period and of the breeding cycle have not been reported. The location of the nurseries is unknown.

Impact of fisheries: Springer (1950c) stated that the bignose shark appeared to be the most common large shark of the edges of the continental shelves in the West Indian region, and that the species made up a substantial portion of the catch in the Florida shark fishery of the1940s. In some areas bignose sharks are mistaken for sandbar sharks.

***Essential Fish Habitat for Bignose Shark*:**

- **Neonate (≤67 cm TL):** From offshore the Delmarva Peninsula at 38°N, to offshore Bull's Bay, SC at 32°N, between the 100 and 200 m isobaths (Figure B.49).

- **Juveniles (68 to 225 cm TL):** From offshore the Delmarva Peninsula at 38°N, to offshore Bull's Bay, SC at 32°N, between the 100 and 500 m isobaths; also, from St. Augustine, FL at 30°N, south to offshore West Palm Beach, FL at 27°N, between the 100 and 500 m isobaths (Figure B.50).

- **Adults (≥226 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.51).

<u>Blacktip shark (Ca*rcharhinus limbatus*)</u> The blacktip shark is circumtropical in shallow coastal waters and offshore surface waters of the continental shelves. In the southeastern United States it ranges from Virginia to Florida and the Gulf of Mexico. Garrick (1982), on examining a large number of museum specimens, believed it to be a single worldwide species. Dudley and Cliff (1993), working off South Africa, and Castro (1996), working on blacktip sharks off the southeastern United States, showed that there were significant differences among the various populations. For example, the median size for blacktip sharks in the Atlantic is 126.6 cm fork length, whereas the median size in the Gulf region is 117.3 cm fork length. The blacktip shark is a fast moving shark that is often seen at the surface, frequently leaping and spinning out of the water. It often forms large schools that migrate seasonally north-south along the coast. This species is much sought after in the eastern United States because of the quality of its flesh. The blacktip and the sandbar shark are the two primary species in the U.S. commercial fisheries. In the markets of the United States "blacktip" has become synonymous with good quality shark; therefore, many other species are also sold under that name.

Additional information on blacktip shark nursery habitat can be found in Heupel and Hueter (2002), Heupel and Simpfendorfer (2002), Keeney *et al.* (2003), Heupel *et al.* (2004), Keeney *et al.* (2005), and Heupel and Simpfendorfer (2005a; 2005b).

Reproductive potential: Off the southeastern United States males mature at between 142 and 145 cm total length and females at about 156 cm total length (Castro, 1996). According to Branstetter and McEachran (1986), in the western north Atlantic males mature at 139 to 145 cm total length at four to five years and females at 153 cm total length at six to seven years. A similar pattern is evident in the Atlantic and Gulf of Mexico, with larger size at maturity in the Atlantic than in the Gulf region. However, these ages are unvalidated and based on a small sample. Branstetter and McEachran (1986) estimated the maximum age at ten years, and gave the von Bertalanffy parameters for combined sexes as: L_∞ = 171, K= 0.284, t_o= -1.5.

The young are born at 55 to 60 cm total length in late May and early June in shallow coastal nurseries from Georgia to the Carolinas (Castro, 1996), and in Bay systems in the Gulf of Mexico (Carlson, 2002; Parsons, 2002), and the Texas coast (Jones and Grace, 2002) Litters range from one to eight pups (Bigelow and Schroeder, 1948) with a mean of four. The gestation cycle lasts about a year; the reproductive cycle is biennial (Castro, 1996).

According to Castro (1993b), the nurseries are on the seaward side of coastal islands of the Carolinas, at depths of two to four meters. Carlson (2002) found neonates in depths of 2.1 to 6.0 m under a variety of habitat conditions. Castro (1993b) found neonates over muddy bottoms off Georgia and the Carolinas, while Hueter found them over seagrass beds off west Florida (unpublished Mote Laboratory CSR data). Neonates and juveniles were found off west Florida (from the Florida Keys to Tampa Bay) at temperatures of 18.5^o to 33.6^{o}C, salinities of 15.8 to 37.0 ppt, and DO of 3.5 to 9.0 mg/l. The neonates were found from April to September, while juveniles were found there nearly year-round.

Impact of fisheries: The blacktip shark is caught in many diverse fisheries throughout the world. Off the southeastern United States it is caught in commercial longlines set in shallow coastal waters, but it is also pursued as a gamefish. There are localized gillnet fisheries in Federal waters off Florida that target blacktips during their migrations, when the schools are close to shore in clear waters. Aircraft are often used to direct net boats to the migrating schools, often resulting in the trapping of large schools. The species is pursued commercially throughout its range and is targeted because it is often found in shallow coastal waters. Their habit of migrating in large schools along shorelines makes it extremely vulnerable to organized drift gillnet fisheries.

Essential Fish Habitat for Blacktip Shark

- **Neonate (≤ 69 cm total length):** Shallow coastal waters to the 25 m isobath, from Bull's Bay, SC at 33.5°N, south to Cape Canaveral, FL at 28.5°N; also, on the west coast of Florida from Thousand Islands at 26°N to Cedar Key, FL at 29°N, especially Tampa Bay and Charlotte Harbor, FL. Additionally, shallow coastal waters with muddy bottoms less than five meters deep on the seaward side of coastal islands from Apalachee Bay to St. Andrews Bay, FL.

EFH areas are identified above with the following modifications from Amendment 1. EFH includes shallow coastal waters south of the Thousand Islands, FL at 26°N south to Key West, FL at 24.5°N; also the northeastern Gulf of Mexico (Apalachee Bay, Apalachicola Bay, St. Joseph Bay, Crooked Island Sound and St Andrew Bay) at 85°W to the mouth of St. Louis Bay and the Terrebonne Timbalier Bay System, LA at 91.2°W; also, all major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre (Figure B.52).

Juvenile (69 to 155 cm total length): Shallow coastal waters from the shoreline to the 25 m isobath: from Cape Hatteras, NC at 35.25°N to 29°N at Ponce de Leon Inlet; the west coast of Florida, including the Florida Keys and Florida Bay, north to Cedar Key at 29°N; from Cape San Blas, FL north of 29.5°N to the east coast of the Mississippi River delta north of 29°N; also, the west coast of Texas from Galveston, west of 94.5°N, to the U.S./Mexico border. Areas from the northeastern Gulf of Mexico (Apalachee Bay, Apalachicola Bay, St. Joseph Bay, Crooked Island Sound and St Andrew Bay) to the mouth of St. Louis Bay and the Terrebonne Timbalier Bay System, LA; also, all major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre (Figure B.53).

- **Adult (≥ 155 cm total length):** Shallow coastal waters of the Outer Banks, NC from the shoreline to the 200 m isobath between 36°N and 34.5°N; shallow coastal waters offshore to the 50 m isobath from St. Augustine, FL (30°N) to offshore Cape Canaveral, FL (28.5°N); on the west coast of Florida, shallow coastal waters to the 50 m isobath from 81°W in Florida Bay, to 85°W, east of Cape San Blas, FL. Areas north of St. Augustine, FL at 30°N to Cumberland Island, GA at 30.9°N, but excludes areas south from Apalachicola Bay to Tarpon Springs at 28.2°N (Figure B.54).

Bull shark (*Carcharhinus leucas*) The bull shark is a large, shallow water shark that is cosmopolitan in warm seas and estuaries (Castro, 1983). It often enters fresh water, and may penetrate hundreds of kilometers upstream.

Reproductive potential: Males mature at 210 to 220 cm TL or 14 to 15 years of age, while females mature at >225 cm TL or 18+ years of age (Branstetter and Stiles, 1987). Growth parameters have been estimated by Branstetter and Stiles (1987) as L_∞ = 285 cm TL, K= 0.076, t_o = -3.0 yr. Thorson and Lacy (1982) estimated that females reached “their larger size at approximately 16 years and that males of maximum size were 12 years old.” The pups measure about 75 cm TL at birth (Clark and von Schmidt, 1965). Jensen (1976) stated that litters ranged from one to ten pups and that the average size was 5.5 pups. The gestation period is estimated at ten to eleven months (Clark and von Schmidt, 1965). The length of the reproductive cycle has not been published, but it is probably biennial. In the United States the nursery areas are in low-salinity estuaries of the Gulf of Mexico Coast (Castro, 1983) and the coastal lagoons of the east coast of Florida (Snelson *et al.,* 1984). Hueter (CSR data), working off the Florida west coast, found neonates in Yankeetown, Tampa Bay, and Charlotte Harbor from May to August. The neonates were in temperatures of 28.2° to 32.2°C, with salinities of 18.5-28.5 ppt. Hueter (CSR data) found juveniles off the west coast of Florida in temperatures of 21.0° to 34.0°C, salinities of 3.0 to 28.3 ppt, and DO of 3.7 to 8.4 ml/l.

Additional information on bull shark life history and nursery habitat can be found in Tremain *et al.* (2004), Neer *et al.* (2005), and Simpfendorfer *et al.* (2005).

Impact of fisheries: The bull shark is a common coastal species that is fished in both artisanal and industrial/modern fisheries. Clark and von Schmidt (1965) found it to be the most common shark caught in their survey of the sharks of the central Gulf coast of Florida, accounting for 18 percent of the shark catch. Dodrill (1977) reported it to be the seventh most commonly taken shark at Melbourne Beach, Florida, composing 8.6 percent of all longline landings. Thorson (1976) recorded a marked decline of the Lake Nicaragua-Rio, San Juan population from 1963 to1974, resulting from a small-scale, but sustained commercial fishing operation. This fishery intensified in 1968, and by 1972 bull sharks in the area had become so scarce that Thorson (1976) predicted that any other developments would eliminate the bull shark from Lake Nicaragua. Russell (1993) indicated that the bull shark constituted three percent of the shark catch in the directed shark fishery in the U.S. Gulf of Mexico. Castillo (1992) referred to the species in Mexico as "intensely exploited in both coasts." The bull shark is vulnerable to overfishing because of its slow growth, limited reproductive potential, and because it is pursued in numerous fisheries.

***Essential Fish Habitat for Bull Shark*:**

- **Neonate (≤83 cm TL):** In shallow coastal waters, inlets and estuaries in waters less than 25 m deep: from just north of Cape Canaveral, FL at 29°N to just south of Cape Canaveral, FL at 28°N; from just south of Charlotte Harbor, FL at 26.5°N north to Cedar Key, FL at 29°N; the mouth of Mobile Bay, AL from 87.75°W to 88.25°W; the mouth of Galveston Bay, TX from 94.5°W to 95°W; from South Padre Island, TX south of 28.5°N to Laguna Madre, TX at 27°N (Figure B.55).

- **Juveniles (84 to 225 cm TL):** In shallow coastal waters, inlets and estuaries in waters less than 25 m deep: from Savannah Beach, GA at 32°N southward to the Dry Tortugas, FL; from Ten Thousand Islands, FL at 26°N north to northern Cedar Key, FL at 29°N; from Apalachiacola, FL at 85°W to the Mobile Bay, AL area at 88.5°W; from just east of Galveston Bay, TX at 94.5°W to the U.S./Mexico border (Figure B.56).

- **Adults (≥226 cm TL):** In shallow coastal waters, inlets and estuaries in waters less than 25 m deep: from just south of Charlotte Harbor, FL at 26.5°N to Anclote Key, FL at 28°N (Figure B.57).

Caribbean reef shark *(Carcharhinus perezi)* The Caribbean reef shark inhabits the southeast coast of Florida, the Caribbean, and the west Atlantic south to Brazil. This is a poorly known, bottom-dwelling species that inhabits shallow coastal waters, usually around coral reefs (Castro, 1983).

Reproductive potential: Males mature about 170 cm TL and females at about 200 cm TL. Pups are born at about 70 cm TL, litters consisting of four to six pups. The reproductive cycle is biennial (Castro, unpub.). The nurseries have not been described.

***Essential Fish Habitat for Caribbean Reef Shark*:**

- **Neonate (≤66 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.58).

- **Juveniles (67 to 199 cm TL):** Shallow coastal waters of the Florida Keys less than 25 m deep from Key Largo to the Dry Tortugas (Figure B.59).

- **Adults (≥200 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.60).

Dusky shark (*Carcharhinus obscurus*). The dusky shark is common in warm and temperate continental waters throughout the world. It is a migratory species which moves north-south with the seasons. This is one of the larger species found from inshore waters to the outer reaches of continental shelves. It used to be important as a commercial species and a game fish, but is currently prohibited.

Reproductive potential: Males mature at 290 cm total length and reach at least 340 cm total length. The females mature at about 300 cm total length and reach up to 365 cm total length. The dusky shark matures at about 17 years and is considered a slow growing species (Natanson, 1990). Litters consist of six to14 pups, which measure 85 to 90 cm total length at birth (Castro, 1983). The gestation period is believed to be about 16 months (Clark and von Schmidt, 1965), but this has not been confirmed. Natanson (1990) gave the following parameters for males L_{max}= 351 cm FL (420 cm total length), K= .047, t_o = −5.83; and females at L_{max}= 316 cm total length (378 cm total length), K= .061, t_o=-4.83. The growth rate is believed to be about ten cm/yr for the young and five cm/yr for the adults. Age and growth information can also be found in Natanson *et al.* (1995).

The nursery areas are in coastal waters. Castro (1993c) reported that dusky sharks gave birth in Bulls Bay, SC in April and May. Musick and Colvocoresses (1986) stated that the species gives birth in the Chesapeake Bay, MD in June and July, however, Grubbs and Musick (2002) note that they use nearshore waters in VA as nursery areas but rarely enter estuaries.

Impact of fisheries: The dusky shark has played an important role in the coastal shark fisheries for flesh and fins and is taken as bycatch in the swordfish and tuna fisheries. The dusky shark is one of the slowest growing requiem sharks and is often caught on both bottom and pelagic longlines, making it highly vulnerable to overfishing. Dusky sharks are currently prohibited and are a candidate for listing under the ESA.

Essential Fish Habitat for Dusky Shark:

- **Neonate (≤ 110 cm total length):** Shallow coastal waters, inlets and estuaries to the 25 m isobath from the eastern end of Long Island, NY at 72°W south to Cape Lookout, NC at 34.5°N; from Cape Lookout south to West Palm Beach, FL (27.5°N), shallow coastal waters, inlets and estuaries and offshore areas to the 90 m isobath. Areas out to the 200 m isobath off the states of Maryland south to North Carolina, and out to the 70 m isobath off New Jersey north to Long Island, NY (Figure B.61).

- **Juvenile (110 to 299 cm total length):** Areas off the coast of southern New England from 70°W west and south, coastal and pelagic waters between the 25 and 200 m isobaths; shallow coastal waters, inlets and estuaries to the 200 m isobath from Assateague Island at the Virginia/Maryland border (38°N) to Jacksonville, FL at 30°N; shallow coastal waters, inlets and estuaries to the 500 m isobath continuing south to the Dry Tortugas, FL at 83° W (Figure B.62).

  Adult (≥ 299 cm total length): Pelagic waters offshore the Virginia/North Carolina border at 36.5°N south to Ft. Lauderdale, FL at 28°N between the 25 and 200 m isobaths, includes coastal waters offshore from the Virginia/North Carolina border at 36.5°N south to Cape Romain, NC out to the 25 m isobath; also, coastal waters offshore from the Georgia/Florida border at 30.8°N to Cape Canaveral at 28.5°N (Figure B.63).

Galapagos shark (*Carcharhinus galapagensis*) The Galapagos shark is circumtropical in the open ocean and around oceanic islands (Castro, 1983). It is very similar to the dusky shark and is often mistaken for it, although the dusky prefers continental shores (Castro, 1983). The Galapagos shark is very seldom seen in the continental United States. A few Galapagos sharks are undoubtedly caught off the east coast every year, but they can be easily misidentified as dusky sharks.

Reproductive potential: Males reach maturity between 205 and 239 cm TL and females between 215 and 245 cm TL (Wetherbee *et al.*, 1996). Pups are born at slightly over 80 cm TL, and litters range from four to16 pups, the average being 8.7. The gestation cycle is estimated to last about a year (Wetherbee *et al.*, 1996), but the length of the reproductive cycle is not known.

Essential Fish Habitat for Galapagos Shark:

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults (≥215 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage.

<u>Lemon shark (*Negaprion brevirostris*)</u> The lemon shark is common in the American tropics, inhabiting shallow coastal areas, especially around coral reefs. It is reported to use coastal mangroves as some of its nursery habitats, although this is not well documented in the literature. The primary population in continental U.S. waters is found off south Florida, although adults stray north to the Carolinas and Virginia in the summer. Additional life history information can be found in Sundstrom *et al.* (2001) and Barker *et al.* (2005).

Reproductive potential: Lemon sharks mature at about 228 cm TL (Springer, 1950b). Brown and Gruber (1988) estimated an age at maturity of 11.6 years for males and 12.7 years for females, showing the species to be slow growing and long lived. Brown and Gruber reported the von Bertalanffy parameters as: L_∞ =317.65, K= .057, and t_o= -2.302. Litters consist of five to 17 pups, which measure about 64 cm TL at birth (Springer, 1950b; Clark and von Schmidt, 1965). Its reproductive cycle is biennial (Castro, 1993c), and gestation lasts ten (Springer, 1950b) to12 months (Clark and von Schmidt, 1965). Its nurseries are in shallow waters around mangrove islands (Springer 1950b) off tropical Florida and the Bahamas. Hueter (CSR data) found lemon shark neonates in Tampa Bay, FL during the month of May, at temperatures of 22.0° to 25.4°C, salinities of 26.8 to 32.6 ppt, and DO of 5.9 to 9.6 ml/l. He also found juveniles over a wider area off western Florida and in a wider range of temperatures and salinities.

Impact of fisheries: The lemon shark is caught throughout its range, although it is not a primary commercially important species along the Atlantic coast. Anecdotal evidence indicates that lemon sharks are vulnerable to local depletions.

***Essential Fish Habitat for Lemon Shark*:**

- **Neonate (≤68cm TL):** Shallow coastal waters, inlets and estuaries out to the 25 m isobath from Savannah, GA at 32°N, south to Indian River Inlet, FL at 29°N; shallow coastal waters, inlets and estuaries from Miami around peninsular Florida to Cape Sable at 25.25°N including the Keys in waters less than 25 m deep; waters of Tampa Bay, FL including waters immediately offshore the mouth of the bay; shallow coastal waters, inlets and estuaries from South Padre Island, TX at 95.5°N south to the U.S./Mexico border in waters less than 25 m deep (Figure B.64).

- **Juveniles (69 to 235 cm TL):** Shallow coastal waters, inlets and estuaries offshore to the 25 m isobath, west of 79.75°W from Bull's Bay, SC to south of Cape Canaveral (West Palm Beach), FL at 28°N; Shallow coastal waters, inlets and estuaries offshore to the 25 m isobath from Miami at 25.5°N, around peninsular Florida to Tampa Bay, FL (including the Keys) to 28°N; shallow coastal waters, inlets and estuaries offshore to the 25 m isobath off the south coast of Puerto Rico from 66°W to 67°W (Figure B.65).

- **Adults (≥236 cm TL):** Shallow coastal waters, inlets and estuaries offshore to the 25 m isobath from Cumberland Island, GA at 31°N to St. Augustine, FL at 31°N; from West Palm Beach, FL at 27°N around peninsular Florida to 28.5° N near Anclote Key in shallow coastal waters, inlets and estuaries and offshore to the 25 m isobath (Figure B.66).

<u>Narrowtooth shark (*Carcharhinus brachyurus*)</u> This is a coastal-pelagic species of widespread distribution in warm temperate waters throughout the world. In general, it is a temperate shark, absent or rare in tropical waters (Bass *et al.*, 1973). Although the species has been reported for the California coast by Kato *et al.*, (1967) as *C. remotus*, and for the southwest Atlantic, few data exist for the western north Atlantic.

Reproductive potential: Males mature between 200 and 220 cm TL, and females mature below 247 cm TL. The young are born at about 60 to 70 cm TL. Six pregnant females averaged 16 embryos, with a range of 13 to 20 pups per litter (Bass *et al.*, 1973). Walter and Ebert (1991) calculated age at sexual maturity at 13 to 19 years for males and 19 to 20 years for females. Gestation is believed to last a year (Cliff and Dudley, 1992). The length of the reproductive cycle is not known, but it is probably biennial as it is for most large carcharhinid sharks.

Impact of fisheries: Because it appears to be a very slow growing carcharhinid (based on the unvalidated ages by Walter and Ebert (1991)), the narrowtooth shark is probably vulnerable to overfishing.

***Essential Fish Habitat for Narrowtooth Shark*:**

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.
- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.
- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

<u>Night shark (*Carcharhinus signatus*)</u> This carcharhinid shark inhabits the waters of the western north Atlantic from Delaware to Brazil and the west coast of Africa. It is a tropical species that seldom strays northward. It is usually found at depths greater than 275 to 366 m during the day and about 183 m at night (Castro, 1983).

Reproductive potential: There is little information on night shark reproductive processes. Litters usually consist of 12 to 18 pups which measure 68 to 72 cm TL at birth (Castro, 1983). Length at maturity has been reported for females as 150 cm FL (178 cm TL) (Compagno, 1984). The nurseries remain undescribed. Hazin *et al.* (2000) and Santana and Lessa (2004) provide additional information on reproduction and age and growth, respectively.

Impact of fisheries: The night shark was abundant along the southeast coast of the United States and the northwest coast of Cuba before the development of the swordfish fishery of the 1970s. Martinez (1947) stated that the Cuban shark fishery relied heavily on the night shark, which constituted 60 to 75 percent of the total shark catch, and that the average annual catch for 1937 to1941 was 12,000 sharks. Guitart Manday (1975) documented a precipitous decline in night shark catches off the Cuban northwest coast during the years 1971 to 1973.

Berkeley and Campos (1988) stated that this species represented 26.1 percent of all sharks caught in swordfish fisheries studied by them along the east coast of Florida from 1981 to 1983. Anecdotal evidence from commercial swordfish fishermen also indicates that in the late 1970s it was not unusual to have 50 to 80 dead night sharks, usually large gravid females, in every set from Florida to the Carolinas. During the 1970s sports fishermen in south Florida often resorted to catching night sharks when other more desirable species (marlins) were not biting. The photographic record of sport fishing trophies landed shows that large night sharks were caught daily and landed at the Miami docks in the 1970s. Today, the species is rare along the southeast coast of the United States. The decline of the night shark may be an example of how a species can decline due to bycatch mortality.

***Essential Fish Habitat for Night Shark*:**

- **Neonate (≤70 cm TL):** At this time, the information available is insufficient to identify EFH for this life stage (Figure B.67).

- **Juveniles (71 to 177 cm TL):** From offshore Assateague Island, MD at 38°N south to offshore Cape Fear at 33.5°N, from the 100 to 2,000 m isobath (Figure B.68).

- **Adults (≥178 cm TL):** In the South Atlantic Bight, from the 100 m isobath to either the 2,000 m isobath, 100 miles from shore, or the EEZ boundary, whichever is nearest, from 36°N offshore Oregon Inlet, NC to 25.5°N, off the coast of Miami, FL (Figure B.69).

Sandbar shark (*Carcharhinus plumbeus*) The sandbar shark is cosmopolitan in subtropical and warm temperate waters. It is a common species found in many coastal habitats. It is a bottom-dwelling species most common in 20 to 55 m of water, but occasionally found at depths of about 200 m.

Reproductive potential: The sandbar shark is a slow growing species. Both sexes reach maturity at about 147 cm total length or approximately 5 feet (Merson, 1998). Estimates of age at maturity range from 15 to 16 years (Sminkey and Musick, 1995) to 29 to 30 years (Casey and Natanson, 1992), although 15 to 16 years is the commonly accepted age of maturity. The von Bertalanffy growth parameters were proposed for combined sexes are L_∞= 186 cm FL (224 cm total length; 168 cm PCL), K= 0.046, t_o= -6.45 by Casey and Natanson (1992); and re-evaluated by Sminkey and Musick (1995) as L_∞= 164 cm PCL (219 cm total length; 182 cm Fl), K= 0.089, and t_o= -3.8. Young are born at about 60 cm total length (smaller in the northern parts of the North American range) from March to July. Litters consist of one to 14 pups, with nine being the average (Springer, 1960). The gestation period lasts about a year and reproduction is biennial (Musick *et al.*, 1993). Hoff (1990) used an age at maturity of 15 years, a life span of 35 years, and a two-year reproductive cycle to calculate that each female may reproduce only ten times. New maturity estimates and the increased mortality in the fishery may reduce that reproductive potential much further.

In the United States the sandbar shark has its nurseries in shallow coastal waters from Cape Canaveral, FL (Springer, 1960), to Great Bay, NJ (Merson and Pratt, 2002). Delaware

Bay, DE (McCandless *et al.*, 2002), Chesapeake Bay, MD (Grubbs and Musick, 2002), and the waters off Cape Hatteras, NC (Jensen *et al.*, 2002) are important primary and secondary nurseries. Juveniles return to Delaware Bay after a winter absence around May 15, and are found as far north as Martha's Vineyard, MA in the summer. Neonates have been captured in Delaware Bay in late June. Young of the year were present in Delaware Bay until early October when the temperature fell below 21°C. Another nursery may exist along the west coast of Florida and along the northeast Gulf of Mexico. Hueter and Tyminski (2002) found neonates off Yankeetown, FL from April to July, in temperatures of 25.0° to 29.0°C and salinities of 20.4 to 25.9 ppt. Neonate sandbar sharks were found in an area between Indian Pass and St. Andrew Sound, FL in June when the temperature had reached 25°C (Carlson 2002).

Impact of fisheries: The sandbar shark is one of the most important commercial species in the shark fishery of the southeastern United States, along with blacktip sharks. It is a preferred species because of the high quality of its flesh and large fins. Commercial longline fishermen pursue sandbar stocks in their north-south migrations along the coast; their catches can be as much as 80 to 90 percent sandbar sharks in some areas. Musick *et al.* (1993) have documented a severe decline in CPUE of the sandbar shark in the Chesapeake Bay area. 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.

***Essential Fish Habitat for Sandbar Shark*:**

- **Neonate (≤ 71 cm total length):** Shallow coastal areas to the 25 m isobath from Montauk, NY at 72°W, south to Cape Canaveral, FL at 80.5°W (all year); nursery areas in shallow coastal waters from Great Bay, NJ to Cape Canaveral, FL, especially Delaware and Chesapeake Bays (seasonal-summer); also shallow coastal waters to up to a depth of 50 m on the west coast of Florida and the Florida Keys from Key Largo at 80.5°W north to south of Cape San Blas, FL at 85.25°W. Typical parameters: salinity-greater than 22 ppt; temperatures-greater than 21°C. Also on the west coast of Florida from the 50 m isobath to the 30 m isobath and approximately 20 miles offshore from the Virginia/Maryland border at 37.8°N south to Pamlico Sound, NC at 35.4°N (Figure B.70).

- J**uvenile (71 to 147 cm total length):** Areas offshore southern New England and Long Island, NY, all waters, coastal and pelagic, north of 40°N and west of 70°W; also, south of 40°N at Barnegat Inlet, NJ, to Cape Canaveral, FL (27.5° N), shallow coastal areas to the 25 m isobath; also, in the winter, from 39°N to 36°N, in the Mid-Atlantic Bight, at the shelf break, benthic areas between the 90 and 200 m isobaths; also, on the west coast of Florida, from shallow coastal waters to the 50 m isobath, from Florida Bay and the Keys at Key Largo north to Cape San Blas, FL at 85.5°W. Includes Cape Poge Bay, MA around Chappaquiddick Island, MA, and off the south shore of Cape Cod, MA (Figure B.71).

- **Adult (≥ 147 cm total length):** Areas on the east coast of the U.S., shallow coastal areas from the coast to the 50 m isobath from Nantucket, MA, south to Miami, FL; also, shallow coastal areas from the coast to the 90 m isobath around peninsular

Florida to the Florida panhandle at 85.5°W, near Cape San Blas, FL, including the Keys and saline portions of Florida Bay (Figure B.72).

- **Habitat Areas of Particular Concern (HAPC):** Important nursery and pupping grounds have been identified in shallow areas and at the mouth of Great Bay, NJ, in lower and middle Delaware Bay, DE, lower Chesapeake Bay, MD, and near the Outer Banks, NC, and in areas of Pamlico Sound and adjacent to Hatteras and Ocracoke Islands, NC, and offshore of those islands (Figure B.73).

Silky shark (*Carcharhinus falciformis*) The silky shark inhabits warm, tropical, and subtropical waters throughout the world. Primarily, the silky is an offshore, epipelagic shark, but juveniles venture inshore during the summer. The silky shark is one of the most abundant large sharks in the world.

Reproductive potential: Data on the silky shark are variable. There is a strong possibility that different populations may vary in their reproductive potential. Litters range from six to 14 pups, which measure 75 to 80 cm TL at birth (Castro, 1983). According to Bonfil *et al.* (1993), the silky shark in the Campeche Bank, Mexico, has a 12-month gestation period, giving birth to ten to 14 pups, with an average of 76 cm TL during late spring and early summer, possibly every two years. Males mature at 225 cm TL (about ten years) and females at 232-245 cm TL (>12 yrs of age). The von Bertanffy parameters estimated by Bonfil *et al.* (1993) are: L_∞ = 311 cm TL, K= 0.101, and t_o= -2.718 yr. Maximum ages were 20+ years for males and 22+ years for females (Bonfil *et al.*, 1993). Springer (1967) describes reefs on the outer continental shelf as nursery areas. Bonfil *et al*, (1993) mentions the Campeche Bank as a prime nursery area in the Atlantic.

Impact of Fisheries: The silky shark is caught frequently in swordfish and tuna fisheries. Berkeley and Campos (1988) found it to constitute 27.2 percent of all sharks caught in swordfish vessels off the east coast of Florida from 1981 to1983. Bonfil *et al*, (1993) considered that the life-history characteristics of slow growth, late maturation, and limited offspring may make it vulnerable to overfishing. In all probability, local stocks of this species cannot support sustained heavy fishing pressure.

***Essential Fish Habitat for Silky Shark*:**

- **Neonate (≤85 cm TL):** Waters off Cape Hatteras, NC between the 100 and 2,000 m isobaths; plus shallow coastal waters just north and immediately west of Cape Hatteras; waters off St. Augustine, FL south to off Miami in depths 25 to 1,000 m, (likely along the west edge of the Gulf Stream); off northwest FL- De Soto Canyon area between the 200 and 2,000 m isobaths (Figure B.74).

- **Juveniles (86 to 231 cm TL):** Waters off the mouth of the Chesapeake Bay, MD south to waters offshore west of the North Carolina/South Carolina border from the 50 to 2,000 m isobath; from the North Carolina/South Carolina border south to Key West paralleling the 200 m isobath; the area northwest of Key West to west of Ten Thousand Islands between the 50 and 2,000 m isobaths (Figure B.75).

- **Adults (≥232 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.76).

Spinner shark (*Carcharhinus brevipinna*) The spinner shark is a common, coastal-pelagic, warm-temperate and tropical shark of the continental and insular shelves (Compagno, 1984). It is often seen in schools, leaping out of the water while spinning. It is a migratory species, but its patterns are poorly known. Off eastern North America it ranges from Virginia to Florida and in the Gulf of Mexico.

Reproductive potential: Males mature at 130 cm TL or four to five years, females mature at 150 to 155 cm TL or seven to eight years (Branstetter, 1987). According to Branstetter (1987), males reach maximum size at ten to 15 years and females at 15 to 20 years. However, he added the caveat that as sharks near their maximum size, their growth is slower, therefore, their maximum ages may be much greater. Branstetter (1987) gave von Bertalanffy parameters for both sexes were: L_∞ = 214 cm, K= 0.212, t_o = -1.94 yr. The ages have not been validated. According to Garrick (1982), the species reaches 278 cm TL. The young are born at 60 to 75 cm TL in late May and early June. The litters usually consist of six to 12 pups (Castro, 1983). It has a biennial reproductive cycle (Castro, 1993c). In the Carolinas the nursery areas are in shallow coastal waters (Castro, 1993c); however, the extent of the nursery areas is unknown. Hueter (CSR data) found juveniles along the west coast of Florida in temperatures of 21.9° to 30.1° C, salinities of 21.0 to 36.2 ppt, and DO 3.5 to 5.0 ml/l. Additional life history information on the spinner shark can be found in Allen and Wintner (2002), Capape *et al.* (2003), Bethea *et al.* (2004), Carlson and Baremore (2005), and Joung *et al.* (2005).

Impact of fisheries: Unknown. The spinner shark is similar in reproductive potential and habits to the blacktip shark, and its vulnerability to fisheries is probably very similar to that of the blacktip. In fact, the blacktip-spinner complex is a commonly used category that combines the landings of these two species because of species similarities and difficulties in distinguishing the two species.

***Essential Fish Habitat for Spinner Shark*:**

- **Neonate (≤71 cm TL):** Along the coast of the southeastern United States and the west coast of Florida, shallow coastal waters out to the 25 m isobath, from Cape Hatteras, NC at 35.25° N around Florida including Florida Bay and the Florida Keys, and north to 29.25° N. Additionally, as displayed in Figure 6-25e: shallow coastal waters with muddy bottoms less than five meters deep, on the seaward side of coastal islands, and in shallow bays along seagrass beds from Apalachee Bay to St. Andrews Bay, FL (Figure B.77).

- **Juveniles (72 to 184 cm TL):** Off the east coast from the Florida/Georgia border at 30.7° N south to 28.5° N, from shallow coastal waters to the 200 m isobath (Figure B.78).

- **Adults (≥185 cm TL):** Off the east coast of Florida, from shallow coastal waters out to the 100 m isobath, from 30° N to 28.5° N offshore Cape Kennedy (Figure B.79).

Tiger shark (*Galeocerdo cuvieri*). The tiger shark inhabits warm waters in both deep oceanic and shallow coastal regions (Castro, 1983). It is one of the larger species of sharks, reaching over 550 cm TL and over 900 kg. Its characteristic tiger-like markings and unique teeth make it one of the easiest sharks to identify. It is one of the most dangerous sharks and is believed to be responsible for many attacks on humans (Castro, 1983).

Reproductive potential: Tiger sharks mature at about 290 cm TL (Castro, 1983; Simpfendorfer, 1992). The pups measure 68 to 85 cm TL at birth. Litters are large, usually consisting of 35 to 55 pups (Castro, 1983). According to Branstetter *et al.* (1987), males mature in seven years and females in ten years, and the oldest males and females were 15 and 16 years of age. The ages have not been validated. Branstetter *et al*, (1987) gave the growth parameters for an Atlantic sample as L_∞ = 440 cm TL, K= 0.107, and t_o= -1.13 years, and for a Gulf of Mexico sample as L_∞ = 388 cm TL, K= 0.184, and t_o= -0.184. There is little data on the length of the reproductive cycle. Simpfendorfer (1992) stated that the females do not produce a litter each year. The length of the gestation period is also uncertain. Clark and von Schmidt (1965) stated that the gestation period may be slightly over a year. While this estimate has not been confirmed, it is probably correct, given that many large carcharhinid sharks have biennial reproduction and year-long gestation periods. The nurseries for the tiger shark appear to be in offshore areas, but they have not been described. More recent age and growth information on the tiger shark can also be found in Natanson *et al.* (1999) and Wintner and Dudley (2000).

Impact of Fisheries: This species is frequently caught in coastal shark fisheries but is usually discarded due to low fin and meat value.

***Essential Fish Habitat for Tiger Shark*:**

- **Neonate (≤90cm TL):** From shallow coastal areas to the 200 m isobath from Cape Canaveral, FL north to offshore Montauk, Long Island, NY (south of Rhode Island); and from offshore southwest of Cedar Key, FL north to the Florida/Alabama border from shallow coastal areas to the 50 m isobath (Figure B.80).

- **Juveniles (91 to 296 cm TL):** Shallow coastal areas from Mississippi Sound (just west of Mississippi/Alabama border) to the 100 m isobath south to the Florida Keys; around the peninsula of Florida to the 100 m isobath to the Florida/Georgia border; north to Cape Lookout, NC from the 25 to100 m isobath; from Cape Lookout north to just south of the Chesapeake Bay, MD from inshore to the 100 m isobath; north of the mouth of Chesapeake Bay to offshore Montauk, Long Island, NY (to south of Rhode Island between the 25 and 100 m isobaths; south and southwest coasts of Puerto Rico from inshore to the 2,000 m isobath (Figure B.81).

- **Adults (≥297 cm TL):** Offshore from Chesapeake Bay, MD south to Ft. Lauderdale, FL to the western edge of the Gulf Stream; from Cape San Blas, FL to

Mississippi Sound between the 25 and 200 m isobaths; off the south and southwest coasts of Puerto Rico from inshore to the 2,000 m isobath (Figure B.82).

B.1.4.6 Sand Tiger Sharks

Bigeye sand tiger (*Odontaspis noronhai*) This is one of the rarest large sharks. Its large eyes and uniform dark coloration indicate that it is a deep-water species. The few catch records that exist indicate that it frequents the upper layers of the water column at night. The species was originally described based on a specimen from Madeira, FL (?). A few specimens were caught at depths of 600-1,000 m off Brazil (Compagno, 1984). A 321 cm TL immature female was caught in the Gulf of Mexico, about 70 miles east of Port Isabel, TX in 1984. Another specimen was caught in the tropical Atlantic (5° N; 35° W) at a depth of about 100 m where the water was about 3,600 m deep. These appear to be all the records for the species. Nothing is known of its habits. Possession of this species is prohibited in Atlantic waters of the United States.

***Essential Fish Habitat for Bigeye Sand Tiger Shark*:**

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

Sand tiger shark (*Carcharias taurus*) The sand tiger is a large, coastal species found in tropical and warm temperate waters throughout the world. It is often found in very shallow water (4 m) (Castro, 1983). It is the most popular large shark in aquaria, because, unlike most sharks, it survives easily in captivity. It has been fished for its flesh and fins in coastal longline fisheries; although possession of this species in Atlantic waters of the United States is now prohibited.

Reproductive potential: According to Gilmore (1983), males mature at about 191.5 cm TL. According to Branstetter and Musick (1994), males reach maturity at 190 to 195 cm TL or four to five years and females at more than 220 cm TL or six years. The largest immature female seen by J. Castro was 225 cm TL and the smallest gravid female was 229 cm TL, suggesting that maturity is reached at 225 to 229 cm TL. The oldest fish in Branstetter and Musick's (1994) sample of 55 sharks was 10.5 years old, an age that has been exceeded in captivity (Govender *et al.*, 1991). The von Bertalanffy parameters, according to Branstetter and Musick (1994), are for males: L_{max}= 301 cm, K= 0.17, and t_o= -2.25; and for females: L_{max}= 323 cm, K= 0.14, and t_o= -2.56 yrs. Gilmore (1983) gave growth rates of 19 to 24 cm/yr for the first years of life of two juveniles born in captivity. The sand tiger has an extremely limited reproductive potential, producing only two young per litter (Springer, 1948). In North America the sand tiger gives birth in March and April to two young that measure about 100 cm TL. Parturition (birth of the young) is believed to occur in winter in the southern portions of its range, and the neonates migrate northward to summer nurseries. The nursery areas are the following Mid-Atlantic Bight estuaries: Chesapeake, Delaware, Sandy Hook, and Narragansett Bays as well as coastal sounds. Branstetter and Musick (1994) suggested that the reproductive cycle is biennial, but other evidence suggests annual parturition. Additional information on the sand tiger shark may be found in Gelsleichter *et al.* (1999) and Lucifora *et al.* (2002).

Impact of fisheries: The species is extremely vulnerable to overfishing because it congregates in coastal areas in large numbers during the mating season. These aggregations are attractive to fishermen, although the effects of fishing these aggregations probably contribute to local declines in the population abundance. Its limited fecundity (two pups per litter) probably contributes to its vulnerability. In the United States there was a very severe population decline in the early 1990s, with sand tigers nearly disappearing from North Carolina and Florida waters. Musick *et al.*, (1993) documented a decrease in the Chesapeake Bight region of the U.S. Mid-Atlantic coast. In 1997, NMFS prohibited possession of this species in U.S. Atlantic waters.

***Essential Fish Habitat for Sand Tiger Shark*:**

- **Neonate (≤117cm TL):** Shallow coastal waters from Barnegat Inlet, NJ south to Cape Canaveral, FL to the 25 m isobath (Figure B.83).

- **Juveniles (118 to 236 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage (Figure B.84).

- **Adults (≥237 cm TL):** Shallow coastal waters to the 25 m isobath from Barnegat Inlet, NJ to Cape Lookout; from St. Augustine to Cape Canaveral, FL (Figure B.85).

B.1.4.7 Whale Sharks

Whale shark (*Rhincodon typus*) The whale shark is a sluggish, pelagic filter feeder, often seen swimming on the surface. It is the largest fish in the oceans, reaching lengths of 1210 cm TL and perhaps longer. It is found throughout all tropical seas, usually far offshore (Castro, 1983). Possession of this species in Atlantic waters of the United States is now prohibited.

Reproductive potential: For many years the whale shark was believed to be oviparous, based on a presumably aborted egg case trawled from the Gulf of Mexico many years ago. Recent discoveries (Joung *et al.*, 1996) proved the whale shark to be viviparous and the most prolific of all sharks. The only gravid female examined carried 300 young in several stages of development. The embryos measured 580 to 640 mm TL, the largest appearing ready for birth. The length of the reproductive cycle is unknown, but is probably biennial such as the closely related nurse shark (*Ginglymostoma cirratum*) and most other large sharks (Castro, 1996). Based on unpublished information on the growth rate of one surviving embryo from a female reported by Joung *et al.*, (1996), the whale shark may be the fastest growing shark. Only a handful of small juveniles have ever been caught, probably because of the extremely fast growth rate or high mortality rate of juveniles. The location of the whale shark nurseries is unknown and remains as one of the interesting mysteries of shark biology. Additional life history information can be found in Chang *et al.* (1997), Colman (1997), and Wintner (2000).

Impact of fisheries: There are very few observations of aggregations of whale sharks. The range of the whale shark may be extremely vast, perhaps encompassing entire ocean basins. Thus it may be necessary to consider whale shark fisheries on an ocean-wide perspective. There have been a few small fisheries for whale sharks in India, the Philippines, and Taiwan, but it is of little commercial importance elsewhere. The whale shark used to be fished for its flesh, but presently the fins and oil are also used. Generally, the size of the whale shark safeguards it from most fisheries. Records of the Taiwanese fishery demonstrate that whale sharks, like most elasmobranchs, are susceptible to overfishing. In 1997, NMFS prohibited possession of this species in U.S. Atlantic waters.

***Essential Fish Habitat for Whale Shark*:**

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

B.1.4.8 Small Coastal Shark

Atlantic angel shark *(Squatina dumerili)* The angel shark is a flattened shark that resembles a ray. It inhabits coastal waters of the United States from Massachusetts to the Florida Keys, the Gulf of Mexico, and the Caribbean. It is common from southern New England to the Maryland coast (Castro, 1983).

Reproductive potential: Maturity is probably reached at a length of 90 to 105 cm TL. The pups measure 28 to 30 cm TL at birth. Up to 16 pups in one litter have been observed (Castro, 1983). Very little is known about its biology.

***Essential Fish Habitat for Atlantic Angel Shark*:**

- **Neonate (≤31 cm TL):** Off the coast of southern New Jersey, Delaware, and Maryland from 39° N to 38° N, in shallow coastal waters out to the 25 m isobath, including the mouth of Delaware Bay (Figure B.86).

- **Juveniles (32 to 113 cm TL):** (Identical to neonate EFH) Off the coast of southern New Jersey, Delaware, and Maryland from 39° N to 38° N, in shallow coastal waters out to 25 m isobath, including the mouth of Delaware Bay (Figure B.87).

- **Adults (≥113 cm TL):** (Identical to neonate EFH) Off the coast of southern New Jersey, Delaware, and Maryland from 39° N to 38° N, in shallow coastal waters out to the 25 m isobath, including the mouth of Delaware Bay (Figure B.88).

B.1.4.9 Hammerhead Sharks

Bonnethead (*Sphyrna tiburo*) The bonnethead is a small hammerhead that inhabits shallow coastal waters where it frequents sandy or muddy bottoms. It is confined to the warm waters of the western hemisphere (Castro, 1983).

Reproductive potential: Males mature at about 70 cm TL, and females at about 85 cm TL (Parsons, 1993). Litters consist of eight to12 pups, with the young measuring 27 to 35 cm TL at birth (Castro, 1983; Parsons, 1993). Parsons (1993) estimated the gestation period of two Florida populations at 4.5 to 5 months, one of the shortest gestation periods known for sharks. The reproductive cycle is annual (Castro, pers. obs.). Hueter (CSR data) found young of the year and juveniles in the west coast of Florida at temperatures of 16.1° to 31.5° C, salinities of 16.5 to 36.1 ppt, and DO of 2.9 to 9.4 ml/l. Additional life history information can be found in Cortes *et al.* (1996), Cortes and Parsons (1996), Cortes *et al.* (1996), Carlson and Parsons (1997), Lessa and Almeida (1998), Marquez-Farias *et al.* (1998), Carlson *et al.* (1999), and Lombardi-Carlson *et al.* (2003).

Impact of fisheries: The bonnethead is at a lesser risk of overfishing because it is a fast growing species that reproduces annually and, due to its small size, is generally not targeted by commercial fisheries. Although bonnetheads are caught as bycatch in gillnet fisheries operating in shallow waters of the southeastern United States, many of these fisheries have been prohibited by various states and therefore forced into deeper Federal waters where gillnets are less effective. Bonnethead bycatch in the U.S. Gulf of Mexico shrimp fishery seems to have remained stable over the last twenty years, from 1974 to 1994 (Pellegrin, 1996).

***Essential Fish Habitat for Bonnethead Shark*:**

- **Neonate (≤38 cm TL):** Shallow coastal waters, inlets and estuaries less than 25 m deep from Jekyll Island, GA to just north of Cape Canaveral, FL; in shallow waters on the Gulf-side of the Florida Keys as far north as Cape Sable in water less than 25 m deep. Additionally, as displayed on Figure 6-31e: shallow coastal bays and estuaries less than five meters deep, from Apalachee Bay to St. Andrews Bay, FL (Figure B.89).

- **Juveniles (39 to 82 cm TL):** Shallow coastal waters, inlets and estuaries from Cape Fear, NC southward to West Palm Beach, FL in waters less than 25 m deep; shallow coastal waters, inlets and estuaries from Miami around peninsular Florida as far north as Cedar Key in waters less than 25 m deep; shallow coastal waters, inlets and estuaries from the Mississippi River westward to the Rio Grande River (Texas/Mexico border) (Figure B.90).

- **Adults (≥83 cm TL):** Shallow coastal waters, inlets and estuaries from Cape Fear, NC to Cape Canaveral, FL; shallow waters around the Florida Keys; shallow coastal waters from Mobile Bay, AL west to South Padre Island, TX from inshore to the 25 m isobath (Figure B.91).

B.1.4.10 Requiem Sharks

Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) The Atlantic sharpnose shark is a small coastal carcharhinid, inhabiting the waters of the northeast coast of North America. It is a common year-round resident along the coasts of South Carolina, Florida, and in the Gulf of Mexico and an abundant summer migrant off Virginia. Frequently, these sharks are found in schools of uniform size and sex (Castro, 1983).

Reproductive potential: The male Atlantic sharpnose sharks mature at around 65 to 80 cm TL and grow to 103 cm TL. The females mature at 85 to 90 cm TL and reach a length of 110 cm TL. Litters range from four to seven pups, which measure 29 to 32 cm TL (Castro, 1983). Mating is in late June; the gestation period is about 11 to 12 months (Castro and Wourms, 1993). The von Bertalanffy growth parameter estimates for the species are L_∞ = 108, K= 0.359, and t_o= -0.985 yr (Branstetter, 1987). Cortés (1995) calculated the population's intrinsic rate of increase was, at best, r= .044, or a finite increase of e_r = 1.045. Off South Carolina the young are born in late May and early June in shallow coastal waters (Castro and Wourms, 1993). Hueter (CSR data) found neonates off the west coast of Florida at Yankeetown and Anclote Key during the months of May to July. These neonates were found in temperatures of 24.0° to 30.7° C, salinities of 22.8 to 337 ppt, and DO of 5.7 ml/l. Larger juveniles were also found in the area in temperatures of 17.2° to 33.3° C, salinities of 22.8 to 35.5 ppt, and DO of 4.5 to 8.6 ml/l. Additional life history information can be found in Cortes (1995), Marquez-Farias and Castillo-Geniz (1998), Gelsleichter et al. (1999), Carlson and Baremore (2003), Hoffmayer and Parsons (2003), Loefer and Sedberry (2003), and Bethea et al. (2004).

Impact of fisheries: Large numbers of sharpnose are taken as bycatch in the U.S. shrimp trawling industry. The Texas Recreational Survey, NMFS Headboat Survey, and the U.S. Marine Recreational Fishing Statistics Survey have estimated a slow increase in the sharpnose fishery. The Atlantic sharpnose is a fast-growing species that reproduces yearly. In spite of being targeted by recreational fisheries and the large bycatch in the shrimp industry, the populations seem to be maintaining themselves.

Essential Fish Habitat for Atlantic Sharpnose:

- **Neonate (≤40 cm TL):** Shallow coastal areas including bays and estuaries out to the 25 m isobath from Galveston Island south to the Rio Grande (Texas/Mexico border); from Daytona Beach north to Cape Hatteras, NC. Additionally, as displayed on Fig. 32e: shallow coastal bays and estuaries less than five meters deep, from Apalachee Bay to St. Andrews Bay, FL (Figure B.92).

- **Juveniles (41 to 78 cm TL):** Shallow coastal areas including bays and estuaries out to the 25 m isobath from Galveston Island south to the Rio Grande (Texas/Mexico border); off Louisiana from the Atchafalya River to Mississippi River Delta out to the 40 m isobath; from Daytona Beach, FL north to Cumberland Island, GA; Hilton Head Island, SC north to Cape Hatteras, NC out to the 25 m isobath (slightly deeper - to the 50 m isobath off North Carolina) (Figure B.93).

- **Adults (≥79 cm TL):** From Cape May, NJ south to the North Carolina/South Carolina border; shallow coastal areas north of Cape Hatteras, NC to the 25 m isobath; south of Cape Hatteras between the 25 and 100 m isobaths; offshore St. Augustine, FL to Cape Canaveral, FL from inshore to the100 m isobath, Mississippi Sound from Perdido Key to the Mississippi River Delta to the 50 m isobath; coastal waters from Galveston to Laguna Madre, TX to the 50 m isobath (Figure B.94).

Blacknose shark (*Carcharhinus acronotus*) The blacknose shark is a common coastal species that inhabits the western north Atlantic from North Carolina to southeast Brazil (Bigelow and Schroeder, 1948). It is very abundant in coastal waters from the Carolinas to Florida and the Gulf of Mexico during summer and fall (Castro, 1983). Schwartz (1984) hypothesized that there are two separate populations in the West Atlantic.

Reproductive potential: Maturity is reached at about 100 cm TL. Litters consist of three to six pups, which measure 50 cm TL at birth (Castro, 1983). Dodrill (1977) estimated the gestation period to be ten to eleven months and suggested that the breeding cycle was biennial. Schwartz (1984) estimated that the largest adult male captured was 164 cm TL and was 9.6 years old, while an adult female 154 cm TL was also 9.6 years old. Castro (1983) stated that in South Carolina nursery areas were in shallow waters. The species is common throughout the year off Florida, suggesting that part of the population may be non-migratory and that nursery areas may exist in Florida as well. Hueter (CSR data) found 13 neonates in the Ten Thousand Islands and off Sarasota in June and July at temperatures 29° to 30.1° C, salinities of 32.2 to 37.0 ppt, and DO of 6.5 ml/l. He also found young of the year and juveniles at temperatures of 17.3° to 34° C, salinities of 25.0 to 37.0 ppt, and DO of 4.8 to 8.5 ml/l. Additional life history information can be found in Carlson *et al*. (1999), Hazin *et al*. (2002), and Driggers *et al*. (2004a; 2004b).

Impact of fisheries: Large numbers of blacknose sharks are caught in shallow coastal waters of the southeastern United States. The species is vulnerable to overfishing because it has typical carcharhinid characteristics such as biennial reproductive cycle, and it is targeted in the shark fisheries in the southeastern United States.

***Essential Fish Habitat for Blacknose Shark*:**

- **Neonate (≤52 cm TL):** Shallow coastal waters to the 25 m isobath from North Carolina/South Carolina border south to Cape Canaveral, FL; shallow waters to the 25 m isobath from Ten Thousand Islands north to just south of Tampa Bay, FL (Figure B.95).

- **Juveniles (53 to 106 cm TL):** Shallow coastal waters to the 25 m isobath from the Georgia/Florida border south to West Palm Beach, FL; shallow waters to the 25 m isobath from the Florida Keys north to the mouth of Tampa Bay, FL. Additionally, as displayed on Figure 6-33e: shallow coastal bays and estuaries less than five meters deep with expanses of seagrasses, from Apalachee Bay to St. Andrews Bay, FL (Figure B.96).

- **Adults (≥107 cm TL):** Shallow coastal waters to the 25 m isobath from St. Augustine south to Cape Canaveral, FL; shallow waters to the 25 m isobath from the Florida Keys north to Cedar Key, FL; Mississippi Sound from Mobile Bay, AL to the waters off Terrebonne Parish, LA in waters 25 to100 m deep (Figure B.97).

Caribbean sharpnose shark (*Rhizoprionodon porosus*) The Atlantic sharpnose and the Caribbean sharpnose sharks are cognate species, separable only by having different numbers of precaudal vertebrae (Springer, 1964). However, they have non-overlapping ranges - the Caribbean sharpnose shark inhabits the Atlantic from 24° N to 35° S, while the Atlantic sharpnose is found at latitudes higher than 24° N. Their biology is very similar.

***Essential Fish Habitat for Caribbean Sharpnose*:**

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

Finetooth shark (*Carcharhinus isodon*) This is a common inshore species of the west Atlantic. It ranges from North Carolina to Brazil. It is abundant along the southeastern United States and the Gulf of Mexico (Castro, 1983). Sharks captured in the northeastern Gulf of Mexico ranged in size from 48 to 150 cm total length were generally found in water temperatures averaging 27.3°C and depths of 4.2 m (Carlson, 2002). Important nursery habitat is also located in South Carolina (Ulrich and Riley, 2002), Louisiana (Neer *et al.*, 2002), and the coast of Texas (Jones and Grace, 2002).

Reproductive potential: Males mature at about 130 cm total length and females mature at about 135 cm total length. The young measure 48 to 58 cm total length at birth. Litters range from two to six embryos, with an average of four. The gestation period lasts about a year, and the reproductive cycle is biennial. Some of the nurseries are in shallow coastal waters of South Carolina (Castro, 1993b). Additional life history information can be found in Carlson *et al.* (2003), Hoffmayer and Parsons (2003), and Bethea *et al*. (2004).

Impact of fisheries: According to the SCS stock assessment, finetooth sharks are caught commercially almost exclusively in the South Atlantic region and mostly with gillnets (approximately 80 percent of finetooth landings) and longlines (approximately 20 percent). The SCS stock assessment estimates 16,658 finetooth sharks were landed commercially in 2000, and of these, only 8 percent were from HMS fisheries. The majority of the catch thus appears to come from fishermen in non-HMS fisheries. The species is vulnerable to overfishing because of its biennial reproductive cycle and small brood size.

***Essential Fish Habitat for Finetooth Shark*:**

Neonate (≤ 65 cm total length): The 1999 HMS FMP identified EFH for neonates (≤90 cm total length) as shallow coastal waters of South Carolina, Georgia, and Florida out to the 25 m isobath from 33° N to 30° N. Additionally, shallow coastal waters less than five meters deep with muddy bottoms, and on the seaward side of coastal islands from Apalachee Bay to St. Andrews Bay, FL, especially around the mouth of the Apalachicola River. Includes coastal waters out to the 25 m isobath from Mobile Bay, AL to Bay St. Louis, MS from 88° W to 89.5° W, and from near Sabine Pass, TX to Laguna Madre, TX (Figure B.98).

Juvenile (65 to 135 cm total length): Shallow coastal waters of South Carolina, Georgia, and Florida out to the 25 m isobath from 33° N to 30° N. Additionally, shallow coastal waters less than five meters deep with muddy bottoms, and on the seaward side of coastal islands from Apalachee Bay to St. Andrews Bay, FL, especially around the mouth of the Apalachicola River. Includes coastal waters out to the 25 m isobath from Mobile Bay, AL to Atchafalaya Bay, LA from 88° W to 91.4° W, and from near Sabine Pass, TX at 94.2° W to Laguna Madre, TX at 26° N; also, coastal waters out to the 25 m isobath from South Carolina north to Cape Hatteras, NC at 35.5° N (Figure B.99).

Adult (≥ 135 cm total length): Shallow coastal waters of South Carolina, Georgia, and Florida out to the 25 m isobath from 33°N to 30° N. Additionally, shallow coastal waters less than five meters deep with muddy bottoms, and on the seaward side of coastal islands from Apalachee Bay to St. Andrews Bay, FL, especially around the mouth of the Apalachicola River. Includes areas identical to those for juveniles: coastal waters out to the 25 m isobath from Mobile Bay, AL to Atchafalaya Bay, LA from 88° W to 91.4° W, and from near Sabine Pass, TX at 94.2° W to Laguna Madre, TX at 26° N; also, coastal waters out to the 25 m isobath from South Carolina north to Cape Hatteras, NC at 35.5° N (Figure B.100).

Smalltail shark *(Carcharhinus porosus)* This is a small, tropical, and subtropical shark that inhabits shallow coastal waters and estuaries in the West Atlantic, from the Gulf of Mexico to south Brazil, and the east Pacific from the Gulf of California to Peru (Castro, 1983). A few specimens have been caught in the Gulf of Mexico off Louisiana and Texas.

Reproductive potential: There is almost no published data on its reproductive processes. Females observed in Trinidad were in different stages of gestation, suggesting a wide breeding season. Embryos up to 35 cm TL were observed. The reproductive cycle appears to be annual. Additional life history information can be found in Lessa and Santana (1998) and Lessa *et al*. (1999b).

Impact of fisheries: The species is marketed in many areas of Central America; Springer (1950a) stated that large numbers were sold in the Trinidad market.

Essential Fish Habitat for Smalltail Shark (Figure B.101)**:**

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

B.1.5 Pelagic Sharks

B.1.5.1 Cow sharks

Bigeye sixgill shark (*Hexanchus vitulus*) This is a poorly known deep-water shark that was not described until 1969. Most specimens have been accidental captures at depths of 400 m in tropical waters (Castro, 1983). In North America most catches have come from the Bahamas and the Gulf of Mexico.

Essential Fish Habitat for Bigeye Sixgill Shark (Figure B.102)**:**

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

Sevengill shark (*Heptranchias perlo*) This is a deep-water species of the continental slopes, where it appears to be most common at depths of 180 to 450 m. It has a world-wide distribution in deep tropical and warm temperate waters. In the United States the sevengill shark ranges from South Carolina to the Gulf of Mexico.

Reproductive potential: Maturity is reached at about 85-90 cm TL. Litters consist of nine to 20 pups, which measure about 25 cm TL at birth (Castro, 1983). According to Tanaka and Mizue (1977), off Kyushu, Japan the species reproduces year round. The lengths of the reproductive and gestation cycles are unknown. The location of the nurseries is unknown.

Impact of fisheries: The sharpnose sevengill shark is sometimes caught in large numbers as bycatch in fisheries using bottom trawls or longlines (Compagno, 1984). In North America it is occasionally seen in small numbers as bycatch of tilefish longlines (Castro, unpublished).

Essential Fish Habitat for Sevengill Shark (Figure B.103):

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

Sixgill shark (*Hexanchus griseus*) One of the largest sharks, the sixgill is a common, bottom-dwelling, species usually reported from depths of 180 to 1,100 m, in deep, tropical, and temperate waters throughout the world (Castro, 1983). It often comes close to the surface at night, where it may take longlines set for other species. Juveniles stray into very shallow cool waters.

Reproductive potential: Very few mature sixgill sharks have been examined by biologists; thus the reproductive processes are poorly known. Ebert (1986) reported a 421-cm TL female to be gravid with term embryos. Harvey-Clark (1995) stated that males mature at 325 cm TL, without providing any evidence for this. The species has not been aged. It is probably long-lived, as the Greenland shark, another deep-water giant shark. The pups measure 60 to 70 cm TL at birth. Litters are large - up to 108 pups have been reported (Castro, 1983). Juveniles are often caught in coastal waters, suggesting that the nurseries are in waters much shallower than those inhabited by the adults. Nothing else is known about its nurseries. Additional life history information can be found in Ebert (2002) and McFarlane *et al*. (2002).

Impact of fisheries: Although juveniles are common in deep continental shelf waters and often enter coastal waters, the adults are seldom taken (Springer and Waller, 1969; Ebert, 1986). Apparently, adults are in waters deeper than those regularly fished, or perhaps these very large animals break the gear and escape. Thus, the very deep habitat of the adults or perhaps their large size seems to convey some measure of protection from most fisheries. According to Harvey-Clark (1995), in 1991 the sixgill shark became the target of a directed, subsidized, longline fishery off British Columbia, Canada. At about the same time, the species also became of interest as an ecotourism resource, with several companies taking diving tourists out to watch sixgill sharks in their environment. The fishery was unregulated and lasted until 1993, when the commercial harvest of sixgill sharks was discontinued due to conservation and management concerns. According to Harvey-Clark (1995), diver observations of sharks decreased in 1993, and it was unclear at the time whether the fishery or the ecotourism could be sustained. It is difficult to evaluate the vulnerability of the sixgill shark because of the lack of fisheries or landings data. The only fishing operations on record collapsed in a few years, suggesting that the species may be very vulnerable to overfishing.

Essential Fish Habitat for Sixgill Shark (Figure B.104):

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

B.1.5.2 Mackerel Shark

Longfin mako shark (*Isurus paucus*) This is a deep dwelling lamnid shark found in warm waters. The species was not described until 1966 and it is very poorly known.

Reproductive potential: There is very little data on the reproductive processes of the longfin mako. Litters consist of two to eight pups, which may reach 120 cm TL at birth (Castro, unpublished).

Impact of fisheries: The longfin mako is a seasonal bycatch of the pelagic tuna and swordfish fisheries. Possession of this species in Atlantic waters of the United States is now prohibited.

***Essential Fish Habitat for Longfin Mako Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate (≤149 cm TL):** Off the northeast U.S. coast from the 100 m isobath out to the EEZ boundary, from south Georges Bank to 35° N; from 35° N south to 28.25° N off Cape Canaveral, FL, from the 100 m isobath to the 500 m isobath; from 28.25° N south around peninsular Florida and west to 92.5° W in the Gulf of Mexico, from the 200 m isobath to the EEZ boundary (Figure B.105).

- **Juveniles (150 to 244 cm TL):** (Identical to neonate EFH) Off the northeast U.S. coast from the 100 m isobath out to the EEZ boundary, from south Georges Bank to 35° N; from 35° N south to 28.25° N off Cape Canaveral, FL, from the 100 m isobath to the 500 m isobath; from 28.25° N south around peninsular Florida and west to 92.5° W in the Gulf of Mexico, from the 200 m isobath to the EEZ boundary (Figure B.106).

- **Adults (≥245 cm TL):** (Identical to neonate EFH) Off the northeast U.S. coast from the 100 m isobath out to the EEZ boundary, from south Georges Bank to 35° N; from 35° N south to 28.25° N off Cape Canaveral, FL, from the 100 m isobath to the 500 m isobath; from 28.25° N south around peninsular Florida and west to 92.5° W in the Gulf of Mexico, from the 200 m isobath to the EEZ boundary (Figure B.107).

Porbeagle (*Lamna nasus*) The porbeagle is a lamnid shark common in deep, cold temperate waters of the north Atlantic, south Atlantic and south Pacific Oceans. It is highly esteemed for its flesh. There have been fisheries for this species in the north Atlantic for many years.

Reproductive potential: Very little is known about its reproductive processes. Aasen (1963) estimated that maturity was reached at 150 to 200 cm TL for males and 200 to 250 cm TL for females. Castro (year or unpublished?) estimated that porbeagles reach 20 years of age and possibly 30. Shann (1911) reported an embryo 61 cm TL, and estimated that porbeagles were probably born at about 76 cm TL. Bigelow and Schroeder (1948) recorded a free swimming specimen at 76 cm TL. Gauld (1989) gave 3.7 as the mean number of embryos in a sample of 12 females. The frequency of reproduction is not known. According to Aasen (1963), the porbeagle probably reproduces annually, but there is no evidence to support this claim. The nurseries are probably in continental shelf waters. More recent life history information can be found in Francis and Stevens (2000), Jensen *et al*. (2002), Joyce *et al.* (2002), Natanson *et al.* (2002), Campana and Joyce (2004), and Francis and Duffy (2005).

Impact of fisheries: The porbeagle is presently targeted in northern Europe and along the northeast coast of North America. Whether the porbeagles in the north Atlantic constitute one or more separate stocks is not known. A small porbeagle fishery resumed in the early 1990s in the northeastern United States, after being practically non-existent for decades. Intensive fisheries have depleted the stocks of porbeagles in a few years wherever they have existed, demonstrating that the species cannot withstand heavy fishing pressure.

***Essential Fish Habitat for Porbeagle Shark*:**

- **Neonate (≤79 cm TL):** From the 100 m isobath to the EEZ boundary from offshore Cape May, NJ, approximately 39° N to approximately 42° N (west of Georges Bank) (Figure B.108).

- **Juveniles (80 to 209 cm TL):** From the 200 m isobath to the EEZ boundary; from offshore Great Bay, approximately 38° N to approximately 42° N (west of Georges Bank) (Figure B.109).

- **Adults (≥210 cm TL):** From offshore Portland, ME south to Cape Cod, MA along the 100 m isobath out to the EEZ boundary and from Cape Cod south to the 2,000 m isobath out to the EEZ boundary (Figure B.110).

Shortfin mako shark (*Isurus oxyrinchus*) The shortfin mako is found in warm and warm-temperate waters throughout all oceans. It is an oceanic species at the top of the food chain, feeding on fast-moving fishes such as swordfish, tuna, and other sharks (Castro, 1983). It is considered one of the great game fish of the world, and its flesh is considered among the best to eat.

Reproductive potential: According to Pratt and Casey (1983), females mature at about 7 years of age. Cailliet *et al.* (1983) estimated the von Bertalanffy parameters (*n*= 44) for the shortfin as: L_∞ = 3210 mm, K= .072, and t_o= -3.75. Cailliet and Mollet (1997) estimated that a female mako lives for approximately 25 years, matures at four to six years, has a two-year reproductive cycle, and a gestation period of approximately 12 months. The litters range from 12 to 20 pups, although only a handful have been examined (Castro, unpubl.). There is circumstantial evidence that the nursery areas are in deep tropical waters. The life span of the species has been estimated at 11.5 years (Pratt and Casey, 1983). Additional life history information can be found in Stillwell and Kohler (1982), Pratt and Casey (1983), Heist *et al.* (1996), Mollet *et al.* (2000), Campana *et al.* (2002), Estrada *et al.* (2003), Francis and Duffy (2005), Loefer *et al.* (2005), and MacNeil *et al.* (2005).

Impact of fisheries: The shortfin mako is a common bycatch in tuna and swordfish fisheries. Because of their high market value, shortfin mako are usually the only sharks retained in some pelagic fleets with high shark bycatch rates. Off the northeast coast of North America, most of the catch consists of immature fish (Casey and Kohler, 1992). The index of abundance for shortfin makos in the commercial longline fishery off the Atlantic coast of the United States shows a steady decline (Cramer, 1996a). The few indices available (ICES, 1995; Cramer, 1996a; Holts *et al.*, 1996) indicate substantial population decreases. Because the species is commonly caught in widespread swordfish and tuna operations, it is reasonable to assume that similar decreases are occurring in areas for which there are limited data.

***Essential Fish Habitat for Shortfin Mako*:**

- **Neonate (≤85 cm TL):** Between the 50 and 2,000 m isobaths from Cape Lookout, NC, approximately 35° N, north to just southeast of Georges Bank (approximately 42° N and 66° W) to the EEZ boundary; and between the 25 and 50 m isobaths from offshore the Chesapeake Bay (James River) (North Carolina/Virginia border) to a line running west of Long Island, NY to just southwest of Georges Bank, approximately 67° W and 41° N (Figure B.111).

- **Juveniles (108 to 262 cm TL):** Between the 25 and 2,000 m isobaths from offshore Onslow Bay, NC north to Cape Cod, MA; and extending west between 38° N and 41.5° N to the EEZ boundary (Figure B.112).

- **Adults (≥263 cm TL):** Between the 25 and 2,000 m isobaths from offshore Cape Lookout, NC north to Long Island, NY; and extending west between 38.5° N and 41° N to the EEZ boundary (Figure B.113).

B.1.5.3 Requiem Sharks

Blue shark (*Prionace glauca*) One of the most common and widest-ranging of sharks, the blue shark is cosmopolitan in tropical, subtropical and temperate waters. It is a pelagic species that inhabits clear, deep, blue waters, usually in temperatures of 10° to 20° C, at depths greater than 180 m (Castro, 1983). Its migratory patterns are complex and encompass great distances, but are poorly understood. The biology, migrations, and the impact of fisheries on the blue shark must be considered on the basis of entire ocean basins. Males and females are known to segregate in many areas (Strasburg, 1958; Gubanov and Grigoryev, 1975). Strasburg (1958) showed that blue sharks are most abundant in the Pacific between latitudes of 40° N and 50° N.

Reproductive potential: Although some authors have examined very large numbers of blue sharks, the data on its size at maturity are imprecise. This may be due to poor criteria for maturity, incomplete samples, samples that did not include animals of all sizes, or some peculiarities of the blue shark. Pratt (1979) used different criteria for determining maturity of males and gave a range of 153 to 183 cm FL for male maturity, but when he used the standard criterion of clasper calcification, he observed that the males reached maturity at 183 cm FL (218 cm TL). Bigelow and Schroeder (1948) suggested that females mature at 213 to 243 cm TL. Strasburg (1958) stated that the smallest gravid female seen by him measured 214 cm TL. Nakano (1994) used data from 105,600 blue sharks and stated that females matured at 140 to160 cm (166 and 191 cm TL, using the regression of Pratt), and males at 130 to 160 cm PCL, based on clasper development.

This is probably the most prolific of the larger sharks; litters of 28 to 54 pups have been reported often (Bigelow and Schroeder, 1948; Pratt, 1979), but up to 135 pups in a litter have also been reported (Gubanov and Grigoryev, 1975). Nakano (1994) observed 669 pregnant females in the North Pacific and stated that the number of embryos ranged from one to 62, with an average of 25.6 embryos. Strasburg (1958) gave the birth size as 34 to 48 cm TL. Suda (1953) examined 115 gravid females from the Pacific Ocean and concluded that gestation lasts nine months and that birth occurs between December and April. Pratt (1979) examined 19 gravid females from the Atlantic and used data from 23 other Atlantic specimens to arrive at a gestation period of 12 months. Nakano (1994) stated that gestation lasts about a year, based on length frequency histograms, but did not state how many gravid animals had been observed nor showed any data. The length of the reproductive cycle is believed to be annual. Nakano (1994) gave the age at maturity as four or five years for males and five or six years for females, based on growth equations. According to Cailliet *et al*, (1983), blue sharks become reproductively mature at six or seven years of age and may reach 20 years. The nursery areas appear to be in open oceanic waters in the higher latitudes of the range. Strasburg (1958) attributed the higher CPUE in the 30° N to 40° N zone of the Pacific Ocean in summer to the presence of newborn blue sharks, and commented on the absence of small blue sharks in the warmer parts of the range. Nakano (1994) also stated that parturition occurred in early summer between latitudes of 30° N to 40° N of the Pacific Ocean. Additional life history and ecological information can be found in Kenney et al. (1985), Estrada et al. (2003), and Skomal and Natanson (2003).

Impact of fisheries: Although finning is now prohibited in U.S. Atlantic waters, blue sharks have historically been finned and discarded because of the low value of their flesh. Large numbers of blue sharks are caught and discarded yearly in pelagic tuna and swordfish fisheries. The blue shark is one of the most abundant large vertebrates in the world, yet it may be vulnerable to overfishing because it is caught in tremendous numbers as bycatch in numerous longline fisheries. Preliminary catch rate information for some areas suggests that this species may be declining.

***Essential Fish Habitat for Blue Shark*:**

- **Neonate (≤60 cm TL):** North of 40° N from Manasquan Inlet, NJ to Buzzards Bay, MA in waters from 25 m to the EEZ boundary (Figure B.114).

- **Juveniles (61 to 183 cm TL):** From 45°N (offshore Cape Hatteras, NC) in waters from the 25 m isobath to the EEZ boundary (Figure B.115).

- **Adults (≥184 cm TL):** From 45°N (offshore Cape Hatteras, NC) in waters from the 25 m isobath to the EEZ boundary; extending around Cape Cod, MA to include the southern part of the Gulf of Maine (Figure B.116).

<u>Oceanic whitetip shark (*Carcharhinus longimanus*)</u> The oceanic whitetip is one of the most common large sharks in warm oceanic waters (Castro, 1983). It is circumtropical and nearly ubiquitous in water deeper than 180 m and warmer than 21° C.

Reproductive potential: Both males and females appear to mature at about 190 cm TL (Bass *et al.*, 1973). The young are born at about 65-75 cm TL (Castro, 1983). The number of pups per litter ranges from two to ten, with a mean of six (Backus *et al.*, 1956; Guitart Manday, 1975). The length of the gestation period has not been reported, but it is probably ten to 12 months as for most large carcharhinids. The reproductive cycle is believed to be biennial (Backus *et al.*, 1956). Although the location of nurseries has not been reported, preliminary work by Castro indicates that very young oceanic whitetip sharks are found well offshore along the southeastern United States in early summer, suggesting offshore nurseries over the continental shelves. Additional life history information can be found in Lessa *et al.* (1999a), Lessa *et al.* (1999c), and Whitney *et al.* (2004).

Impact of fisheries: Large numbers of oceanic whitetip sharks are caught as bycatch each year in pelagic tuna and swordfish fisheries. Strasburg (1958) reported that the oceanic whitetip shark constituted 28 percent of the total shark catch in exploratory tuna longline fishing south of 10° N in the central Pacific Ocean. According to Berkeley and Campos (1988), oceanic whitetip sharks constituted 2.1 percent of the shark bycatch in the swordfish fishery along the east coast of Florida in 1981 to1983. Guitart Manday (1975) demonstrated a marked decline in the oceanic whitetip shark landings in Cuba from 1971 to1973. The oceanic whitetip shark is probably vulnerable to overfishing because of its limited reproductive potential, and because it is caught in large numbers in various pelagic fisheries and in directed fisheries. There are no data on populations or stocks of the species in any ocean.

***Essential Fish Habitat for Oceanic Whitetip Shark*:**

- **Neonate (≤83 cm TL):** In the vicinity of the Charleston Bump, from the 200 m isobath to the 2,000 m isobath, between 32.5° N and 31° N (Figure B.117).

- **Juveniles (84 to 136 cm TL):** Offshore the southeast U.S coast from 32° N to 26° N, from the 200 m isobath to the EEZ boundary, or 75° W, whichever is nearer (Figure B.118).

- **Adults (≥137 cm TL):** Offshore the southeast U.S. coast from the 200 m isobath out to the EEZ boundary, from 36° N to 30° N; also, in the Caribbean, south of the U.S. Virgin Islands, from east of 65° W to the EEZ boundary or the 2,000 m isobath, whichever is nearer (Figure B.119).

B.1.5.4 Thresher Sharks

Bigeye thresher shark (*Alopias superciliosus*) The bigeye thresher is cosmopolitan in warm and warm-temperate waters. It is a deep-water species which ascends to depths of 35 to 150 m at night. It feeds on squid and small schooling fishes (Castro, 1983), which it stuns with blows from its tail. This is one of the larger sharks, reaching up to 460 cm TL (Nakamura, 1935).

Reproductive potential: Males mature at about 270 cm TL and females at about 340 cm TL (Moreno and Moron, 1992). Litters consist of two pups, one in each uterus. Gestation probably lasts about a year, but there is no evidence to support this. The length of the reproductive cycle and the location of nursery areas are unknown. Additional life history information can be found in Chen *et al.* (1997), Liu *et al.* (1998), and Weng and Block (2004).

Impact of fisheries: The bigeye thresher is often caught as bycatch of swordfish fisheries. A shark will often dislodge several baits before impaling or hooking itself. The flesh and fins of the bigeye thresher shark are of poor quality, thus it is usually discarded dead in swordfish and tuna fisheries. Possession of this species in Atlantic waters of the United States is now prohibited.

***Essential Fish Habitat for Bigeye Thresher Shark*:**

- **Neonate (≤116 cm TL):** At this time, available information is insufficient to identify EFH for this life stage.

- **Juveniles (117 to 340 cm TL):** Offshore North Carolina, from 36.5° N to 34° N, between the 200 and 2,000 m isobaths (Figure B.120).

- **Adults (≥341 cm TL):** Offshore North Carolina, from 35.5° N to 35° N, between the 200 and 2,000 m isobaths (Figure B.121).

Thresher shark (*Alopias vulpinus*) The common thresher shark is cosmopolitan in warm and temperate waters. It is found in both coastal and oceanic waters, but according to Strasburg (1958) it is more abundant near land. It is a large shark that uses its tremendously large tail to hit and stun the small schooling fishes upon which it feeds.

Reproductive potential: According to Strasburg (1958), females in the Pacific mature at about 315 cm TL. According to Cailliet and Bedford (1983), males mature at about 333 cm TL. Cailliet and Bedford (1983) stated that the age at maturity ranges from three to seven years. Litters consist of four to six pups, which measure 137 to 155 cm TL at birth (Castro, 1983). According to Bedford (1985), gestation lasts nine months and female threshers give birth annually every spring (March to June). New age and growth information can be found in Gervelis (2005).

Impact of fisheries: Thresher sharks are caught in many fisheries. The most detailed data available are for the California drift gillnet fishery which started in 1977 for thresher sharks, shortfin makos, and swordfish, extending from the Mexican border to San Francisco, CA

(Hanan, 1984). After 1982, the fishery expanded northward yearly, ultimately reaching the states of Oregon and Washington (Cailliet *et al.*, 1991). Thresher shark landings peaked in 1982, and the thresher shark resource quickly began to decline after that year (Bedford, 1987). Catches have continued to decline and the average size has remained small in spite of numerous regulations restricting fishing (Hanan *et al.*, 1993). Cailliet *et al.*, (1991) summarized the condition of the resource by stating, "The coastwise fishery for this once abundant shark is now a thing of the past." Legislation passed in 1986 limited the directed thresher shark fishery in the Pacific. Off the U.S. Atlantic coast, the CPUE has shown a considerable decline (Cramer, 1996).

***Essential Fish Habitat for Thresher Shark*:**

- **Neonate (≤175 cm TL):** Offshore Long Island, NY and southern New England in the northeastern United States, in pelagic waters deeper than 50 m, between 70° W and 73.5° W, south to 40° N (Figure B.122).

- **Juveniles (176 to 388 cm TL):** (Identical to neonate EFH): Offshore Long Island, NY and southern New England in the northeastern United States, in pelagic waters deeper than 50 m, between 70° W and 73.5° W, south to 40° N (Figure B.123).

- **Adults (≥389 cm TL):** (Identical to neonate EFH) Offshore Long Island, NY and southern New England in the northeastern United States, in pelagic waters deeper than 50 m, between 70° W and 73.5° W, south to 40° N (Figure B.124).

Table B.1 1999 FMP size ranges for different life stages of sharks.

	Map Neonates/ early juveniles TL (cm) ≤ or range	Text Pup size TL (cm)	Map Late Juveniles/ subadults TL (cm)	Text: M maturity TL (cm) ≥ or range	Text: F maturity TL (cm) ≥ or range	Map Adults TL (cm) ≥ or range
Large Coastal Sharks						
Cetorhinidae						
Cetorhinus maximus	N/A (text 270)	180	271-810	460-610	810-980	810
Sphyrnidae						
Sphyrna mokarran	N/A (text 70)	67	71-220	210-258	210-220	221
S. lewini	45	38-45	46-249	140-185	200	250
S. zygaena	N/A		N/A			N/A
Lamnidae						
Carcharodon carcharias	(text 175)	120-150	175-479	370-340	370-340	(text 480)
Ginglymostomatidae						
Ginglymostoma cirratum	13-60	30	61-225	225	225	226
Carcharhinidae						
Carcharhinus altimus	70-155	70	156-220	213	221	N/A (text 221)
C. limbatus	99 (text 100)	55-60	100-155 (text 100-156)	139-145	153-156	156
C. leucas	110	75	111-225	210-220	225	226
C. perezi	N/A (text 105)	70	106-199	170	200	N/A (text 200)
C. obscurus	115	85-100	116-300	290	300	301

	Map Neonates/ early juveniles TL (cm) ≤ or range	**Text Pup size TL (cm)**	**Map Late Juveniles/ subadults TL (cm)**	**Text: M maturity TL (cm) ≥ or range**	**Text: F maturity TL (cm) ≥ or range**	**Map Adults TL (cm) ≥ or range**
C. galapagensis	N/A	80	N/A	205-239	215-245	N/A (text 215)
Negaprion brevirostris	90	64	91-228	228	228	229
C. brachyurus	N/A (text 100)	60-70	N/A (text 101-230)	200-220	247 (text 231)	N/A
C. signatus	N/A (text 100)	68-72	101-178	N/A	178	179
C. plumbeus	90	60	90-179	180	180	180
C. falciformis	55-97	75-80	98-231	225	232-245	N/A (text 232)
C. brevipinna	90	60-75	91-154	130	150-155	155
Galeocerdo cuvier	120	68-85	121-289	290	290	290
Odontaspididae Odontaspis noronhai	N/A	N/A	N/A	N/A	N/A	N/A
Carcharias taurus	125	100	N/A (text 126-220)	190-195	220-229	221
Rhincodontidae Rhincodon typus	N/A	N/A	N/A	N/A	N/A	N/A
Small Coastal Sharks **Squatinidae** Squatina dumeril	50	28-30	51-105	90-105	90-105	106

	Map Neonates/ early juveniles TL (cm) ≤ or range	Text Pup size TL (cm)	Map Late Juveniles/ subadults TL (cm)	Text: M maturity TL (cm) ≥ or range	Text: F maturity TL (cm) ≥ or range	Map Adults TL (cm) ≥ or range
Sphyrnidae Sphyrna tiburo	50	27-35	51-84	70	85	85
Carcharhinidae Rhizoprionodon terraenovae	17-55	29-32	56-84	65-80	85-90	85
Carcharhinus acronotus	35-75	50	76-99	100	100	100
R. porosus	N/A	N/A	N/A	N/A	N/A	N/A
C. isodon	90	48-58	91-135	130	135	136
C. porosus	N/A	N/A	N/A	N/A	N/A	N/A
Pelagic Sharks **Hexanchidae** Hexanchus vitulus	N/A	N/A	N/A	N/A	N/A	N/A
Heptranchias perlo	N/A	25	N/A	85-90	85-90	N/A
Hexanchus griseus	N/A	60-70	N/A	325	421	N/A
Lamnidae Isurus paucus	no sizes	N/A	no sizes	N/A	N/A	no sizes
Lamna nasus	50-100	76	101-224	150-200	200-250	225-280
I. oxyrinchus	95	N/A	96-279	N/A	N/A	280

	Map Neonates/ early juveniles TL (cm) ≤ or range	Text Pup size TL (cm)	Map Late Juveniles/ subadults TL (cm)	Text: M maturity TL (cm) ≥ or range	Text: F maturity TL (cm) ≥ or range	Map Adults TL (cm) ≥ or range
Carcharhinidae						
Prionace glauca	75	34-48	76-220	218	166-243	221
Carcharhinus longimanus	115	65-75	116-190	190	190	191
Alopiidae						
Alopias superciliosus	N/A (text 135)	N/A	136-339	270	340	340
A. vulpinus	200	137-155	200-319	333	315	320

Table B.2 Size ranges used in this Amendment for mapping distribution data for different life stages of sharks.

	Neonates max embyro+10% TL (cm) ≤	Literature embryo size range or max embryo size in term females TL (cm)	Juveniles TL (cm)	Literature M maturity TL (cm) ≥ or range	Literature F maturity TL (cm) ≥ or range	Adults F 1st mat TL (cm) ≥
Large Coastal Sharks						
Cetorhinidae Cetorhinus maximus	182	165** Castro 83	183-809		810 Castro 99	810
Sphyrnidae Sphyrna mokarran	74	67.5 Clarke & von Schmidt 65	75-209		210-220 Steven & Lyle 89	210
S. lewini	50	39-51 Clarke 71, Carlson 2002	51-227		228 Steven & Lyle 89	228
S. zygaena	66	60** NMFS upubl.	67-283		284 Castro & Mejuto 95	284
Lamnidae Carcharodon carcharias	166	151 Uchida *et al* 96	167-479		480 Uchida *et al* 96	480
Ginglymostomatidae Ginglymostoma cirratum	N/A*	28-30.5 Castro 00	37-221	214-214.6 Castro 00	222-232 Castro 00	222
Carcharhinidae Carcharhinus altimus	67	61 Springer 60	68-225		226 Springer 60	226
C. limbatus	66	45-70***	67-149	125-140	141-152	156
C. leucas	83	55-85 Clarke & von Schmidt 65	84-225		226 Branstetter & Stiles 87	226
C. perezi	66	60**** Castro 83	67-199		200 Compagno 84	200
C. obscurus	110	85-100 Castro 83	111-299	290 Castro 83	300 Castro 83	300

	Neonates **max embyro+10%** **TL (cm)** **≤**	**Literature** embryo size range or max embryo size in term females **TL (cm)**	**Juveniles** **TL (cm)**	**Literature** **M maturity** **TL (cm)** **≥ or range**	**Literature** **F maturity** **TL (cm)** **≥ or range**	**Adults** **F 1st mat** **TL (cm)** **≥**
C. galapagensis - NO DATA (all Atlantic data off Bermuda)	N/A	81 Wetherbee *et al* 96	N/A		215 Wetherbee *et al* 96	N/A
Negaprion brevirostris	68	62 Clarke & von Schmidt 65	69-235		236 Clarke & von Schmidt 65	236
C. brachyurus - NO DATA	N/A	N/A	N/A	N/A	N/A	N/A
C. signatus	70	55-75 Raschi *et al* 82	71-199	185-190	200-205	200
C. plumbeus	70	44.2-64 Castro 93b	71-147	139-153 Merson 98	148-175 Merson 98	148
C. falciformis	85	77 Bonfil *et al* 93	86-231		232 Branstetter 87 Bonfil *et al* 93	232
C. brevipinna	71	60-75 Branstetter 81	72-184		185	185
Galeocerdo cuvier	90	82 NMFS upubl.	91-296		297 Clarke & von Schmidt 65	297
Odontaspididae Odontaspis noronhai - NO DATA	N/A	N/A	N/A	N/A	N/A	N/A
Carcharias taurus	117	106 Gilmore *et al* 83	118-236		236.6 Gilmore *et al* 83	237
Rhincodontidae Rhincodon typus LITTLE DATA, ONE MAP	N/A		N/A			N/A
Small Coastal Sharks						
Squatinidae Squatina dumeril	28	26****	26-82	84	89	89

	Neonates **max embyro+10%** **TL (cm)** ≤	**Literature** embryo size range or max embryo size in term females **TL (cm)**	**Juveniles** **TL (cm)**	**Literature** **M maturity** **TL (cm)** **≥ or range**	**Literature** **F maturity** **TL (cm)** **≥ or range**	**Adults** **F 1st mat** **TL (cm)** ≥
Sphyrnidae Sphyrna tiburo	38	22-30*****	40-66	66-83	77-94 Parsons 93	77
Carcharhinidae Rhizoprionodon terraenovae	40	36 Parsons 83	41-75	73-75	70-85 Loefer & Sedberry 03 Carlson and Baremore 03	76
Carcharhinus acronotus	48	38-44	95	108	115 Hazin *et al* 02	115
R. porosus - NO DATA	N/A					N/A
C. isodon	64	43.7-58 Castro 93a & 93b	65-120	119-130	123-132	123
C. porosus LITTLE DATA, ONE MAP	N/A	30	30-70	71-75	70	70
Pelagic Sharks **Hexanchidae** Hexanchus vitulus LITTLE DATA, ONE MAP	N/A		N/A		158 Springer & Waller 69	N/A
Heptranchias perlo LITTLE DATA, ONE MAP	N/A		N/A		89-93 Compagno 84	N/A
Hexanchus griseus LITTLE DATA, ONE MAP	N/A		N/A		421 Ebert 86	N/A
Lamnidae Isurus paucus	149	135.5 NMFS upubl	150-244		245 Guitart-Manday 66	245
Lamna nasus	79	72 Jensen *et al* 02	80-209		210 Jensen *et al* 02	210
I. oxyrinchus	85	77	108-262		263	263

	Neonates max embyro+10% TL (cm) ≤	**Literature** embryo size range or max embryo size in term females **TL (cm)**	**Juveniles** TL (cm)	**Literature M maturity TL (cm) ≥ or range**	**Literature F maturity TL (cm) ≥ or range**	**Adults F 1st mat TL (cm) ≥**
		Duffy & Francis 01			Mollet *et al* 00	
Carcharhinidae Prionace glauca	60	54.4 Pratt 1979	61-183		184 Williams 1977	184
C. longimanus	83	75 Seki *et al* 98	84-136		137 Seki *et al* 98	137
Alopiidae Alopias superciliosus	116	105.5 Gilmore 83	117-340		341 Moreno & Moron 92	341
A. vulpinus	175	159 Moreno *et al* 89	176-388		389 Moreno *et al* 89	389

*nurse sharks below 37 cm TL in the 1999 FMP database were actually embryos and not free swimming sharks
**confirmed report of the smallest free swimming individual, not an embryo
***Castro has seen one litter with sizes beyond the above range (70.4-74.2 cmTL). This litter was not included because it was unusually large for this species.
****based on estimated size at birth
*****average of three full term embryos from one female collected in Tampa Bay, FL

Table B.3 **Blacktip shark (*Carcharinus limbatus*) Life History and Habitat Characteristics.** From Amendment 1 to the FMP.

Life Stage	Species Distributions		Habitat Characteristics				Source*
	Location	Season	Temp (°C)	DO (mg/l)	Sal (ppt)	Depth (m)	
			B = bottom and S = surface				
Neonate and young of the year (YOY)	Off Yaupon and Holden Beaches, NC	summer primary nursery	no data	no data	no data	no data	Jensen et al (2002)
	SC estuarine and nearshore waters	summer primary nursery, pupping late May/early June to early July	no data	no data	no data	no data	Ulrich and Riley, SEAMAP (2002)
	GA estuarine waters	summer primary nursery (June-Sept)	21-30.4	4.35-6.08	22-36.1	0.5-11.6	Belcher and Shierling Gurshin
	Yankeetown to 10,000 Islands on the west coast of Florida, Cape Canaveral on the east coast of FL and the Florida Keys. Also found in the Marquesas Islands west of the Florida Keys	summer primary nursery (June-Oct); FL Keys – found year round; Marquesas Islands – overwintering grounds	19.1-33.6	3.28-9.26	15.8-41.1	0.9-12.5	Hueter and Tyminski, Michel and Steiner
	Northeast Gulf of Mexico (Apalachee Bay, Apalachicola Bay, St. Joseph Bay, Crooked Island Sound and St Andrew Bay)	summer primary nursery	22.5-31.4	3.6-7	19-38	2.1-6	Carlson
	From the mouth of St Louis Bay, MS to the tip of Fort Morgan, AL	summer primary nursery	B 29.3 S 30.6	B 6.6 S 6.6	B 20.3 S 17.8	3.4	Parsons (env. parameters are average values
	Terrebonne/Timbalier Bay System, LA	summer primary nursery (May-Sept)	22.6-32.4	no data	18-34.7	1.2-5.2	Neer et al
	All major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre	summer primary nursery (May-Sept)	16.7-34	no data	0-54	no data	Jones and Grace

Life Stage	Species Distributions		Habitat Characteristics				Source*
Juvenile	Nearshore and inshore waters from Cape Hatteras and Core Sound to Holden Beach, NC	summer secondary nursery	no data	no data	no data	no data	Jensen et al.
	SC estuarine and nearshore waters	secondary summer and overwintering nursery (May-Dec)	18-24	no data	no data	no data	Ulrich and Riley, SEAMAP, Hueter and Tyminski
	GA estuarine waters	summer secondary nursery (June-Sept)	21-30.4	4.35-6.08	22-36.1	0.5-11.6	Belcher and Shierling, Gurshin
	Yankeetown to 10,000 Islands on the west coast of Florida, Cape Canaveral on the east coast of FL and the Florida Keys	summer secondary nursery (March-Nov); warm water effluents of Tampa Bay and Yankeetown power plants during winter months	20.8-33.6	2-8.3	27-38	0.7-5	Hueter and Tyminski, Michel and Steiner
	Northeast Gulf of Mexico (Apalachee Bay, Apalachicola Bay, St. Joseph Bay, Crooked Island Sound and St Andrew Bay)	summer secondary nursery	16-32.5	1.9-8.3	19-38	0.7-6.4	Carlson
	north central Gulf of Mexico	summer secondary nursery	B 27.3-28.1	B 3.2-6.2	B 34.3-37	5.8-7.6	
	Coastal Alabama off Dauphin Island and Mobile Point	summer secondary nursery	B 28 S 28.8	B 6.3 S 6.9	B 19.4 S 17.7	3.1	Gurshin
	From the mouth of St Louis Bay, MS to the tip of Fort Morgan, AL	summer secondary nursery (April-Nov)	22.6-32.4	no data	18-34.7	1.2-5.2	Parsons (env. parameters are average values)
	Terrebonne/Timbalier Bay System, LA	summer secondary nursery					Neer et al
	All major bay systems along the Gulf coast of Texas from Galveston Bay to Lower Laguna Madre, except Corpus Christi Bay						Jones and Grace
Adult	Outer Banks of NC, St Augustine to Cape Canaveral, FL,		Unk	Unk	Unk	Unk	

* Contributing authors in: McCandless, C.T., H.L. Pratt Jr., and N.E. Kohler. 2002. Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: an overview. Authors and papers are cited separately in References section.

Table B.4 Dusky shark (*Carcharinus obscurus*) Life History and Habitat Characteristics.

Life Stage	Species Distributions		Habitat Characteristics				Source*
	Location	Season	Temp (°C)	DO (mg/l)	Sal (ppt)	Depth (m)	
			B = bottom and S = surface				
Neonate and young of the year (YOY)	Nearshore waters from Cape Hatteras to Bogue Banks and off Holden Beach, NC	Oct and Nov; pupping April and May off Holden beach	no data	no data	no data	no data	Jensen et al, SEAMAP
	SC coastal waters	transient or overwintering nursery (Nov)	18	no data	no data	no data	Ulrich and Riley
Juvenile	In the coastal waters of Martha's Vineyard, MA (off East and South Beaches of Chappaquiddick Island)	summer secondary nursery	17-24	no data	no data	4.8-19.2	Skomal
	Exposed nearshore waters in Virginia, rarely enter the estuaries (one juvenile female (79cm PCL) caught in lower Chesapeake Bay in August of 1990	summer secondary nursery	no data	no data	no data	no data	Grubbs and Musick
	Nearshore waters from Cape Hatteras to Holden Beach, NC	summer secondary and overwintering nursery grounds	18.1-22.2	no data	no data	4.3-15.5	Jensen et al, SEAMAP
	SC coastal waters	transient or overwintering nursery (Nov)	18	no data	no data	no data	Ulrich and Riley
Adult	Pelagic waters offshore the Virginia/North Carolina border and south to Fort Lauderdale, FL Nearshore waters beginning at the border of Georgia and Florida south to Fort Lauderdale	Migrations moving north-south with the seasons	Unk	Unk	Unk	Unk	

* Contributing authors in: McCandless, C.T., H.L. Pratt Jr., and N.E. Kohler. 2002. Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: an overview. Authors and papers are cited separately in References section.

Table B.5 Sandbar shark (*Carcharinus plumbeus*) Life History and Habitat Characteristics

Life Stage	Species Distributions		Habitat Characteristics				Source*
	Location	Season	Temp (°C)	DO (mg/l)	Sal (ppt)	Depth (m)	
			B = bottom and S = surface				
Neonate and young of the year (YOY)	Great Bay, NJ	summer primary nursery (pupping early July)	23.8	7.01	26.5	2.4	Merson and Pratt
	Delaware Bay (DE & NJ waters)	summer primary nursery (June-Oct with majority of pupping from late June to early July)	18-29.9	no data	18.3-30.4	0.9-16.6	McCandless et al
	Lower Chesapeake Bay, VA and the tidal creeks and lagoons along Virginia's Eastern Shore	summer primary nursery	17-28	no data	no data	no data	Grubbs and Musick
	In coastal waters from Cape Hatteras to Bogue Banks, off Holden Beach and in Pamlico Sound, NC	summer primary nursery (May-July); overwintering grounds off Cape Hatteras, NC (catches increase greatly in Oct and Nov)	no data	no data	no data	no data	Jensen et al, SEAMAP
	SC estuarine and nearshore coastal waters	summer primary nursery (May-Sept), with coastal waters also serving as overwintering grounds	no data	no data	no data	no data	Ulrich and Riley
	GA estuarine waters	summer primary nursery (June-Sept)	26.9-30.1	4-5.9	29.6-30.1	3.7-13.1	Belcher and Shierling
	Off Yankeetown, FL (N=3)	summer primary nursery	25-29	no data	20.4-25.4	2.4-3.7	Hueter and Tyminski
	Northeast Gulf of Mexico (Apalachicola Bay and Crooked Island	summer primary nursery	26.6-30.8	5-7.3	19-39	3-5.2	Carlson

Life Stage	Species Distributions		Habitat Characteristics				Source*
Juvenile	Cape Poge Bay, MA, around Chappaquiddick Island, MA (East and South Beaches), and off the south shore of Cape Cod, MA	summer secondary nursery (June -Oct)	20-24	no data	no data	2.4-6.4	Skomal
	Delaware Bay (DE & NJ waters)	summer secondary nursery (May-Oct)	15.5-30	no data	18.3-31.4	0.8-23	McCandless et al
	Lower Chesapeake Bay, VA and the tidal creeks and lagoons along Virginia's Eastern Shore	summer secondary nursery (May-Oct)	17-28	no data	no data	no data	Grubbs and Musick
	Coastal NC waters	summer secondary nursery; overwintering grounds off Cape Hatteras, NC	22.6-28.1	no data	no data	no data	Jensen et al, SEAMAP
	SC estuarine and coastal waters	summer secondary (April - Sept) and overwintering grounds (Dec)	15-28	no data	no data	no data	Ulrich and Riley, SEAMAP
	GA estuarine waters	summer secondary nursery (June-Sept)	26.9-30.1	4-5.9	29.6-30.1	3.7-13.1	Belcher and Shierling
	Northeast Gulf of Mexico (Apalachicola Bay and Crooked Island Sound)	summer secondary nursery	19.8-30.8	5-7.3	19-36	2.1-5.2	Carlson
	North central Gulf of Mexico (just north of Cat and Horn Islands, MS) (N=4)	summer secondary nursery	23.3-24.4	8-8.3	13.4-14.8	2.1	Parsons
	Upper Texas coast, LA coast, and Bulls Bay, SC	spring/summer secondary nursery	no data	no data	no data	no data	Hueter and Tyminski
Adult	Unk	Unk	Unk	Unk	Unk	Unk	

* Contributing authors in: McCandless, C.T., H.L. Pratt Jr., and N.E. Kohler. 2002. Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: an overview. Authors and papers are cited separately in References section.

Table B.6 Nurse shark (*Ginglymostoma cirratum*) Life History and Habitat Characteristics.

Life Stage	Species Distributions		Habitat Characteristics				Source*
	Location	Season	Temp (°C)	DO (mg/l)	Sal (ppt)	Depth (m)	
			B = bottom and S = surface				
Neonate and young of the year (YOY)	Charlotte Harbor, FL and the Florida Keys	primary nursery	31.7	7.01	33.9	2.1	Hueter and Tyminski
Juvenile	Tampa Bay, Charlotte Harbor, 10,000 Islands Estuary and the Florida Keys Dry Tortugas, FL Northeast Gulf of Mexico (Apalachee Bay, Apalachicola Bay, and Crooked Island Sound)	secondary nursery (April-Nov) summer secondary nursery summer secondary nursery	17.5-32.9 no data 22.6-28.1	3.1-9.7 no data 5-8.3	28-38.5 no data 27-37	0.6-2.9 no data 3.5-6	Hueter and Tyminski, Michel and Steiner Pratt and Carrier Carlson
Adult	From tropical West Africa and the Cape Verde Islands in the east, and from Cape Hatteras to Brazil in the west. Littoral waters of the tropical and subtropical Atlantic, shallow water, often under coral reefs or rocks	Unk	Unk	Unk	Unk	Unk	

* Contributing authors in: McCandless, C.T., H.L. Pratt Jr., and N.E. Kohler. 2002. Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: an overview. Authors and papers are cited separately in References section.

Table B.7 Essential fish habitat maps by species.

TUNAS Figure B.1 to B.3 Atlantic Albacore (*Thunnus alalunga*) Figure B.4 to B.6 Atlantic Bigeye Tuna (*Thunnus obesus*) Figure B.7 to B.9 Atlantic Bluefin Tuna (*Thunnus thynnus*) Figure B.10 to B.12 Atlantic Skipjack (*Katsuwonus pelamis*) Figure B.13 to B.15 Atlantic Yellowfin Tuna (*Thunnus albacares*) **SWORDFISH** Figure B.16 to B.18 Swordfish (*Xiphias gladius*) **BILLFISH** Figure B.19 to B.21 blue marlin (*Makaira nigricans*) Figure B.22 to B.24 white marlin (*Tetrapturus albidus*) Figure B.25 to B.27 sailfish (*Istiophorus platypterus*) Figure B.28 to B.30 spearfish (*Tetrapturus pfluegeri*) **LARGE COASTAL SHARKS** **Basking sharks - Cetorhnidae** Figure B.31 to B.33 basking shark (*Cetorhinus maximus*) **Hammerhead sharks - Sphyrnidae** Figure B.34 to B.36 great hammerhead (*Sphyrna mokarran*) Figure B.37 to B.39 scalloped hammerhead (*S. lewini*) Figure B.40 to B.42 smooth hammerhead (*S. zygaena*) **Mackerel sharks - Lamnidae** Figure B.43 to B.45 white shark (*Carcharodon carcharias*) **Nurse sharks - Ginglymostomatidae** Figure B.46 to B.48 nurse shark (*Ginglymostomatidae cirratum*) **Requiem sharks - Carcharhinidae** Figure B.49 to B.51 bignose shark (*Carcharhinus altimus*) Figure B.52 to B.54 blacktip shark (*C. limbatus*) Figure B.55 to B.57 bull shark (*C. leucas*) Figure B.58 to B.60 Caribbean reef shark (*C. perezi*) Figure B.61 to B.63 dusky shark (*C. obscurus*) Figure B.64 to B.66 lemon shark (*Negaprion brevirostris*) Figure B.67 to B.69 night shark (*C. signatus*) Figure B.70 to B.73 sandbar shark (*C. plumbeus*) Figure B.74 to B.76 silky shark (*C. falciformis*) Figure B.77 to B.79 spinner shark (*C. brevipinna*) Figure B.80 to B.82 tiger shark (*Galeocerdo cuvieri*)	**Sand tiger sharks - Odontaspididae** Figure B.83 to B.85 sand tiger shark (*Odontaspis taurus*) **SMALL COASTAL SHARKS** **Angel sharks - Squatinidae** Figure B.86 to B.88 Atlantic angel sharks (*Squatina dumerili*) **Hammerhead sharks - Sphyrnidae** Figure B.89 to B-91 bonnethead (*Sphyrna tiburo*) **Requiem sharks - Carcharhinidae** Figure B.92 to B-94 Atlantic sharpnose (*R.. terraenovae*) Figure B.95 to B-97 blacknose shark (*C. acronotus*) Figure B.98 to B-100 finetooth shark (*C. isodon*) Figure B.101 smalltail shark (*C. porosus*) **PELAGIC SHARKS** **Cow sharks - Hexanchidae** Figure B.102 bigeye sixgill shark (*Hexanchus vitulus*) Figure B.103 sevengill shark (*Heptranchias perlo*) Figure B.104 sixgill shark (*Hexanchus griseus*) **Mackerel sharks - Lamnidae** Figure B.105 to B.107 longfin mako (*Isurus paucus*) Figure B.108 to B.110 porbeagle shark (*Lamna nasus*) Figure B.111 to B.113 shortfin mako (*Isurus oxyrinchus*) **Requiem sharks - Carcharhinidae** Figure B.114 to B.116 blue shark (*Prionace glauca*) Figure B.117 to B.119 oceanic whitetip shark (*C. longimanus*) **Thresher sharks - Alopiidae** Figure B.120 to B.121 bigeye thresher (*Alopias superciliosus*) Figure B.122 to B.124 thresher shark (*A. vulpinus*)

Table B.8 List of abbreviations and acronyms for EFH data sources used in the maps.

Belcher	Belcher and Shierling 2002
Carlson	Carlson 2002
COASTSPAN	Cooperative Atlantic States Shark Pupping and Nursery Area Program
CSTP	Cooperative Shark Tagging Program
CTS	Cooperative Tagging System
Govoni	Govoni *et al*., 2003
Gurshin	Gurshin 2002
Jensen	Jensen *et al*., 2002
Jones/Grace	Jones and Grace 2002
Michel/ST	Michel and Steiner 2002
Mote	Mote Marine Laboratory
Neer	Neer *et al*., 2002
Parsons	Parsons 2002
POP	Pelagic Observer Program
SEAMAP	Southeast Area Monitoring and Assessment Program
SELL	Southeast Longline Survey
SOP	Shark Observer Program
Ulrich	Ulrich and Riley 2002

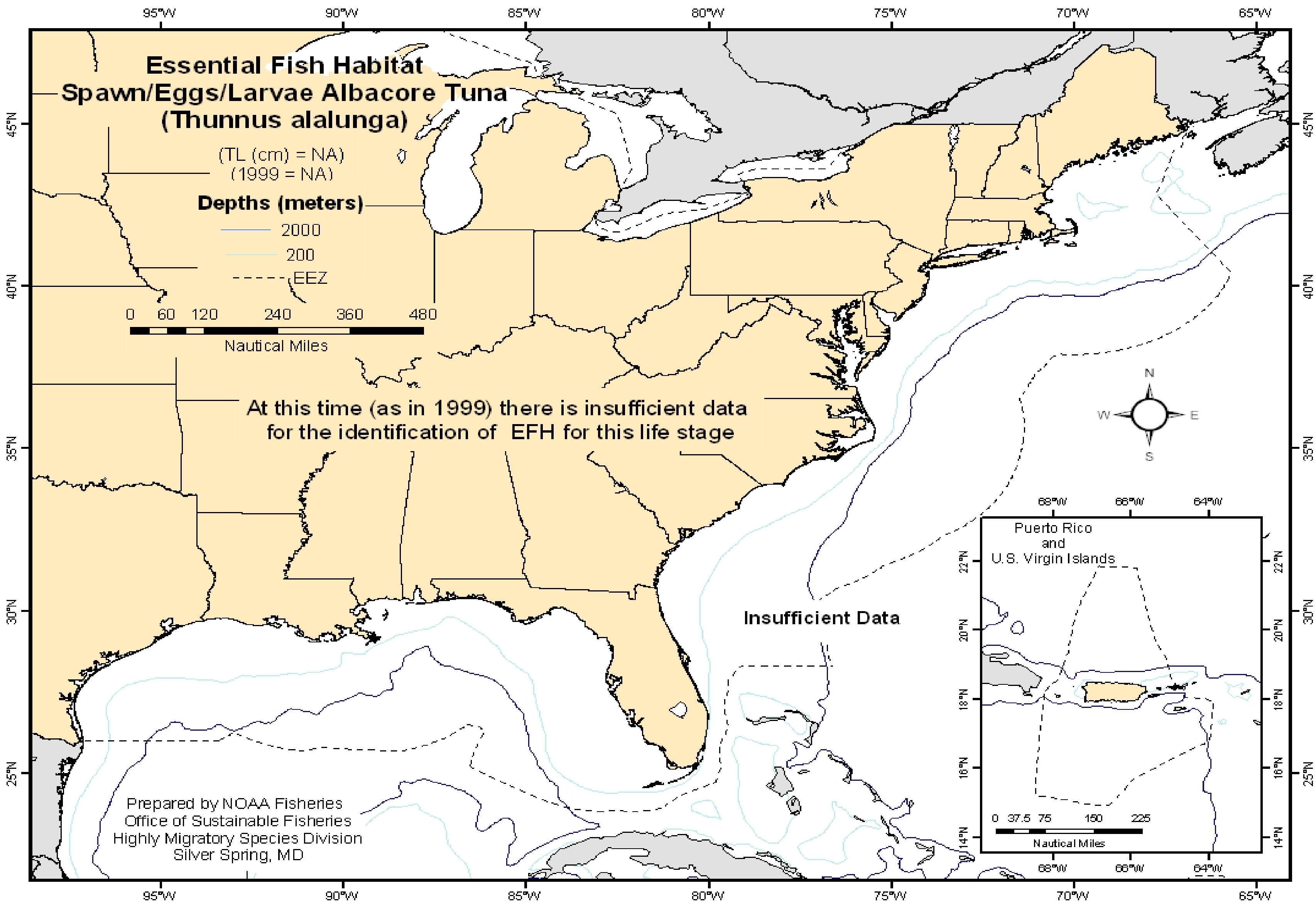

Figure B.1 Atlantic Albacore Tuna: Spawning, Eggs, and Larvae.

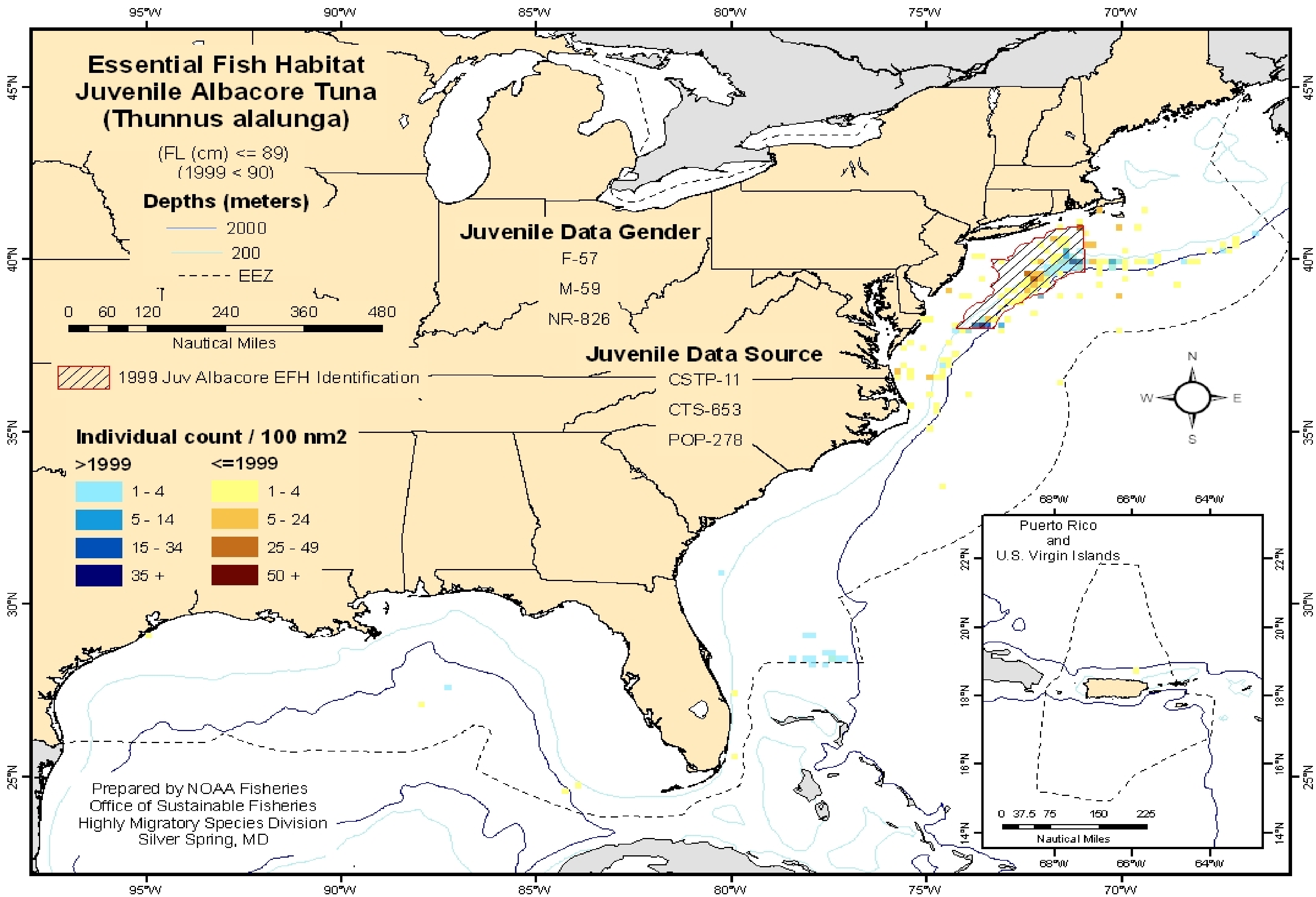

Figure B.2 Atlantic Albacore Tuna: Juvenile.

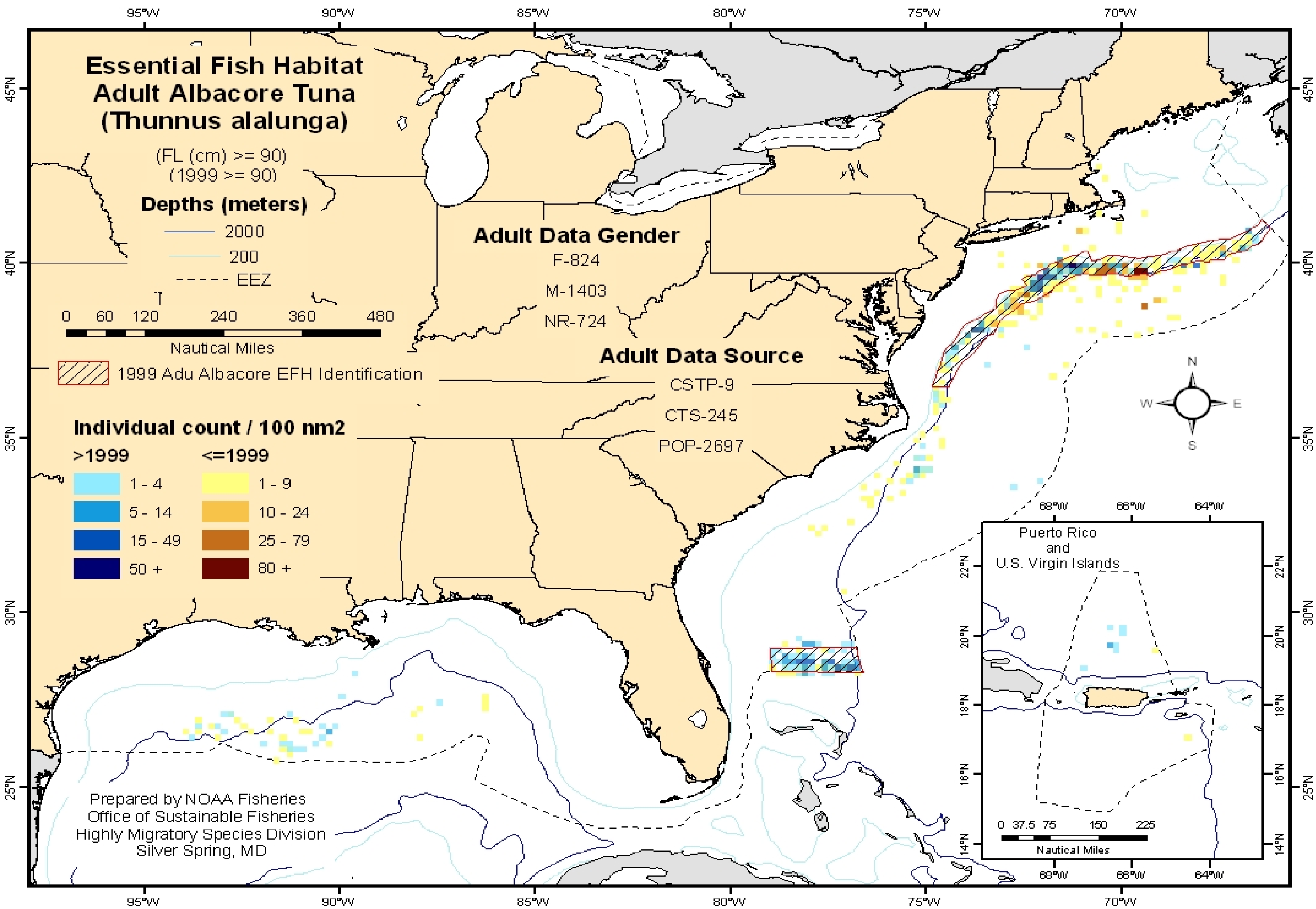

Figure B.3 Atlantic Albacore Tuna: Adult.

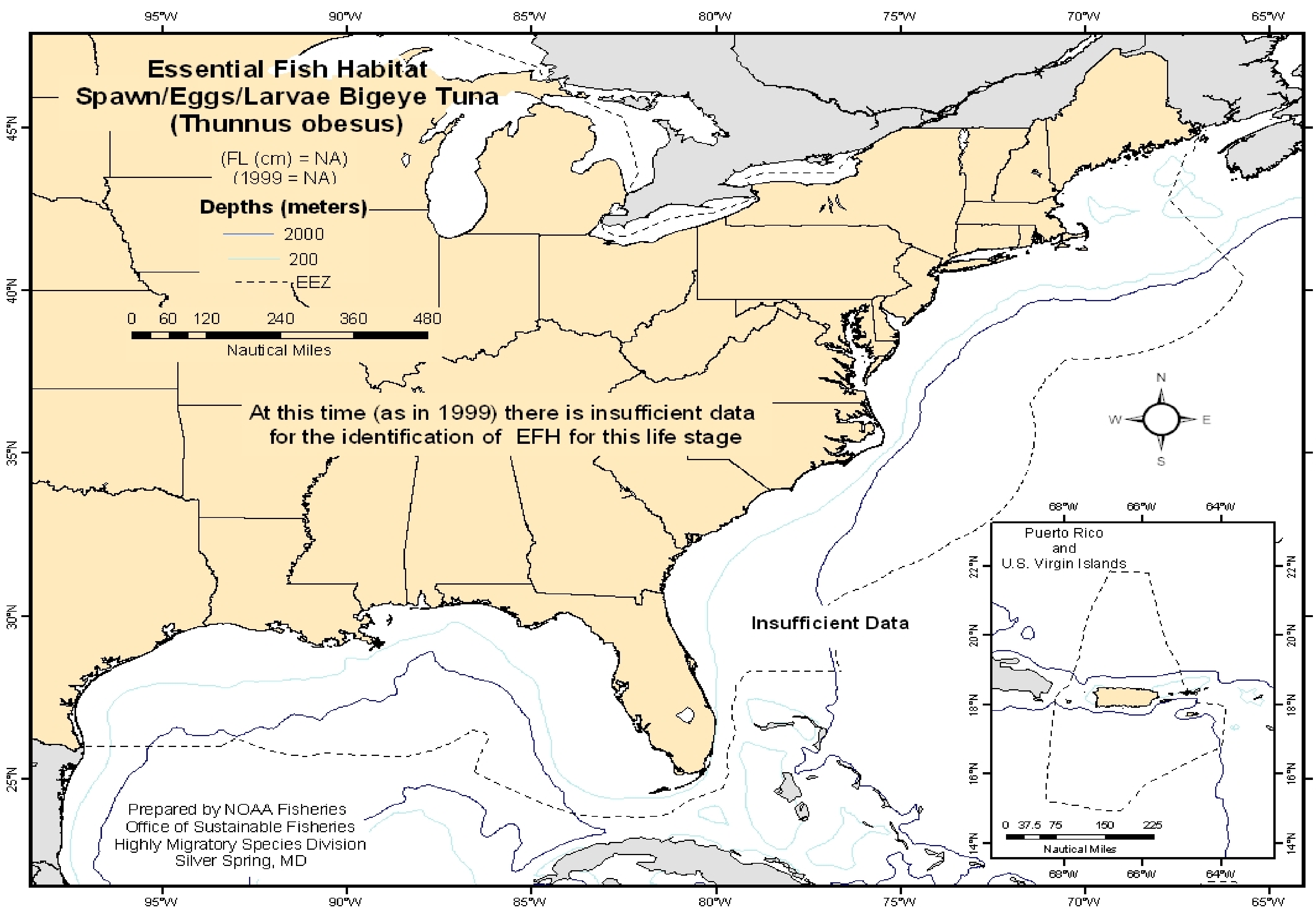

Figure B.4 **Atlantic Bigeye Tuna: Spawning, Eggs, and Larvae.**

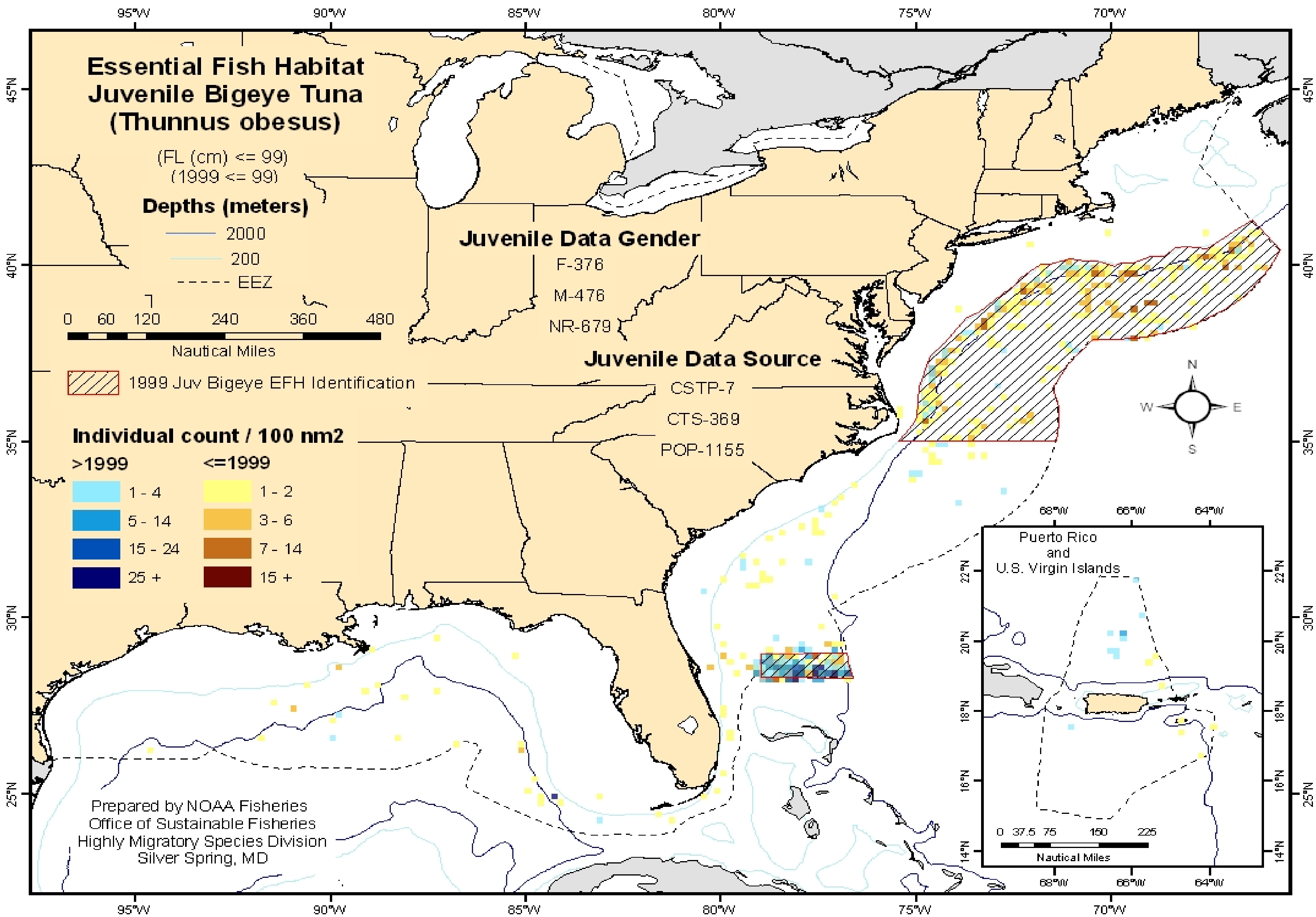

Figure B.5 Atlantic Bigeye Tuna: Juvenile.

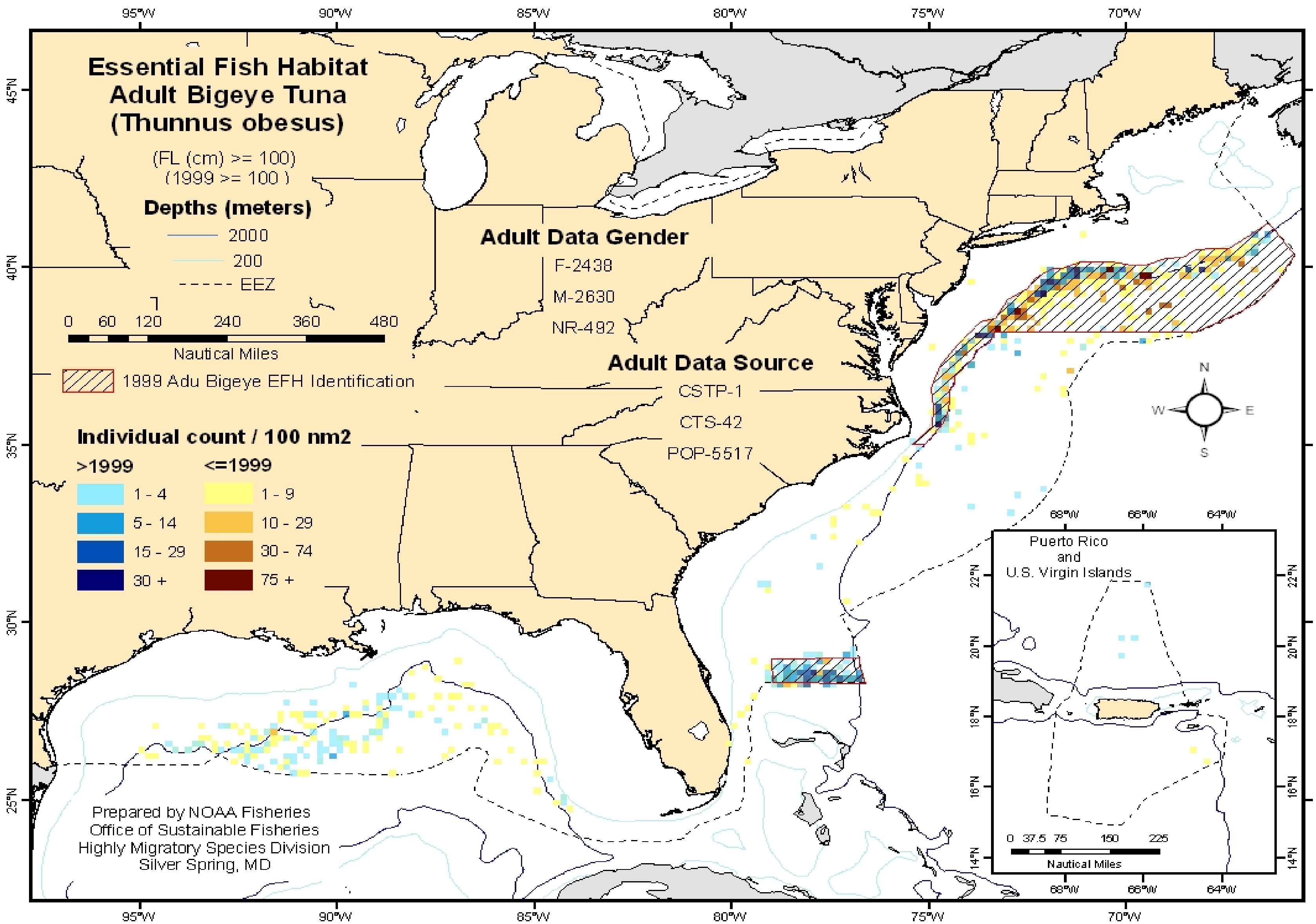

Figure B.6 Atlantic Bigeye Tuna: Adult.

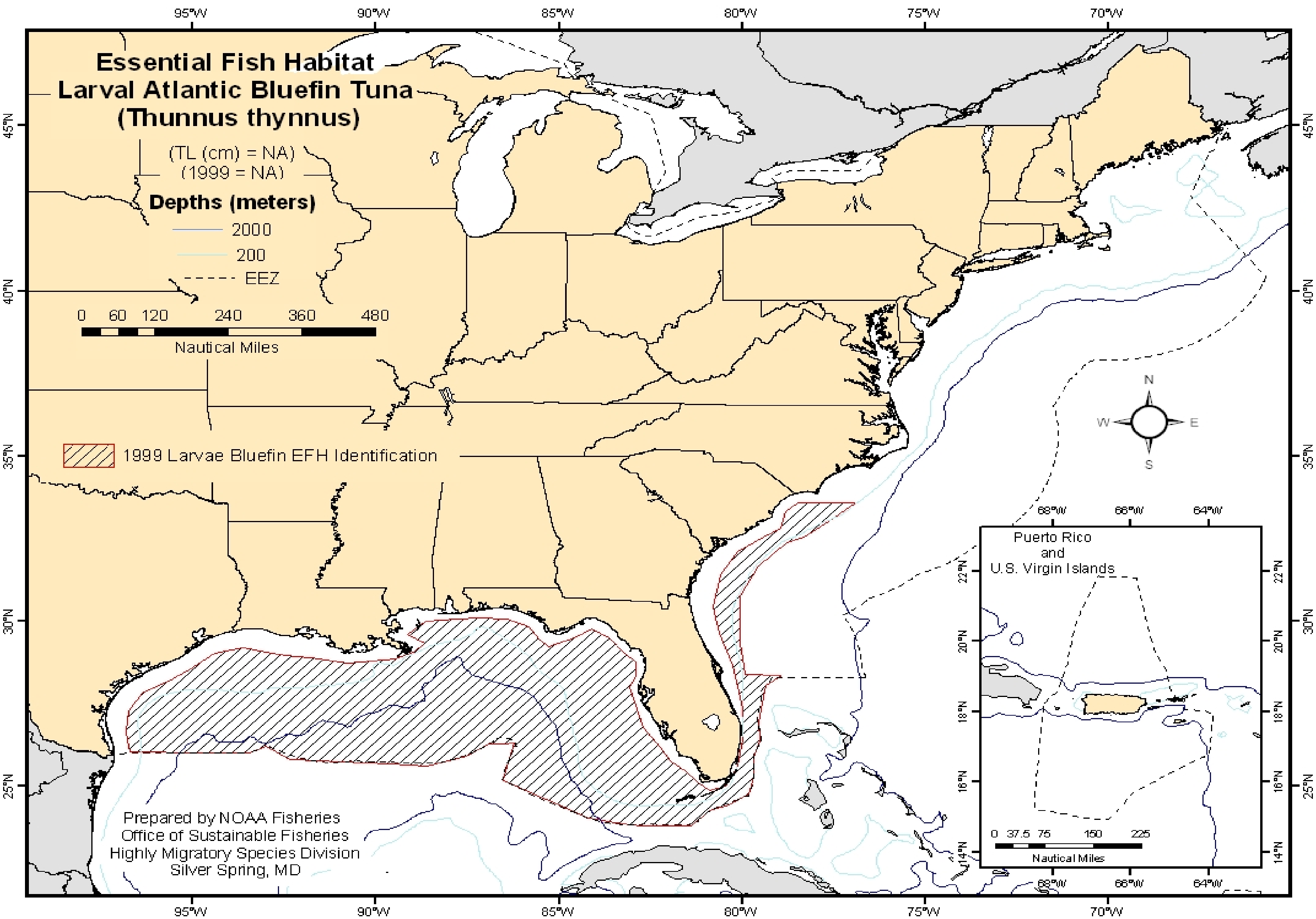

Figure B.7 Atlantic Bluefin Tuna: Spawning, Eggs, and Larvae.

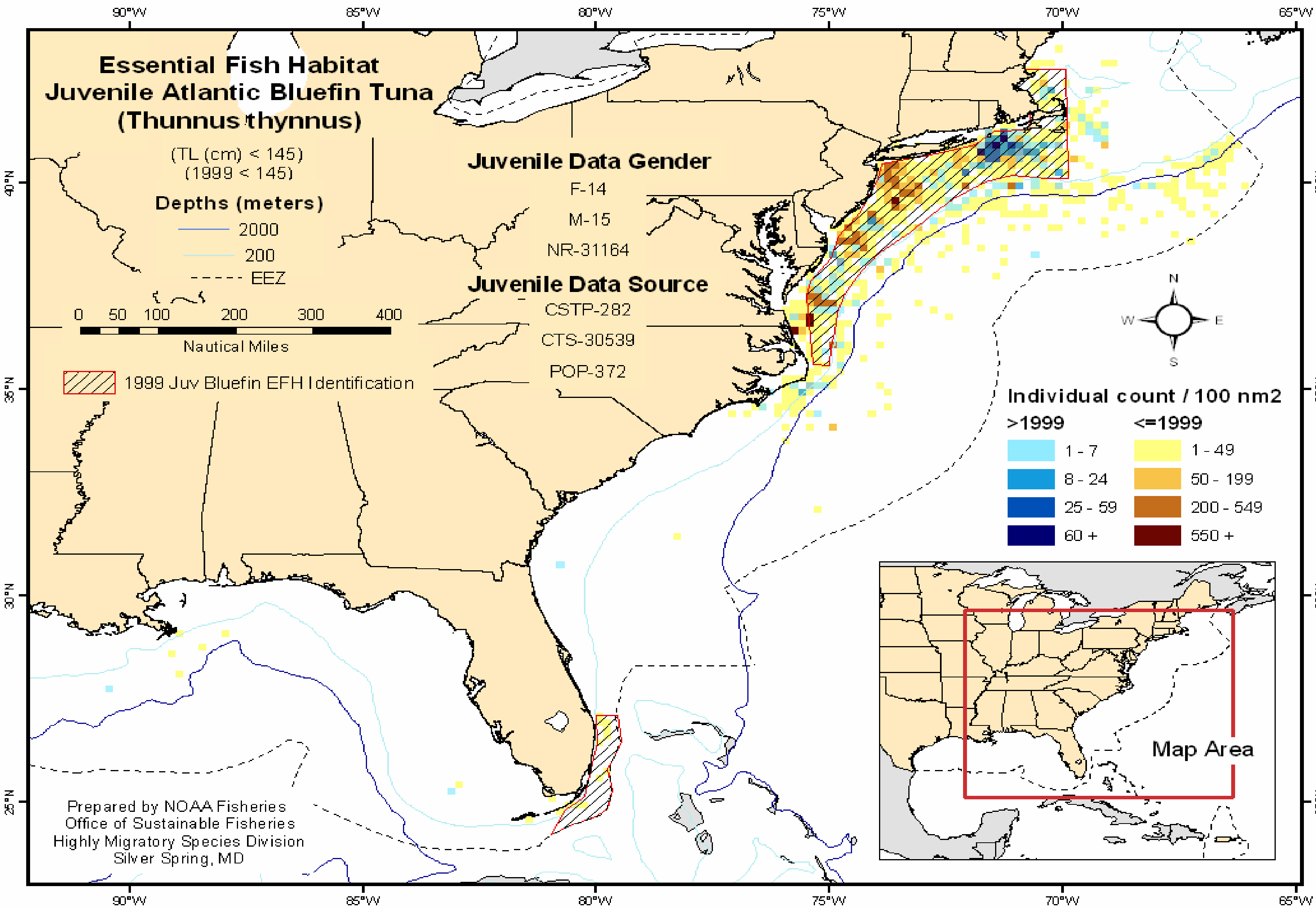

Figure B.8 **Atlantic Bluefin Tuna: Juveniles.**

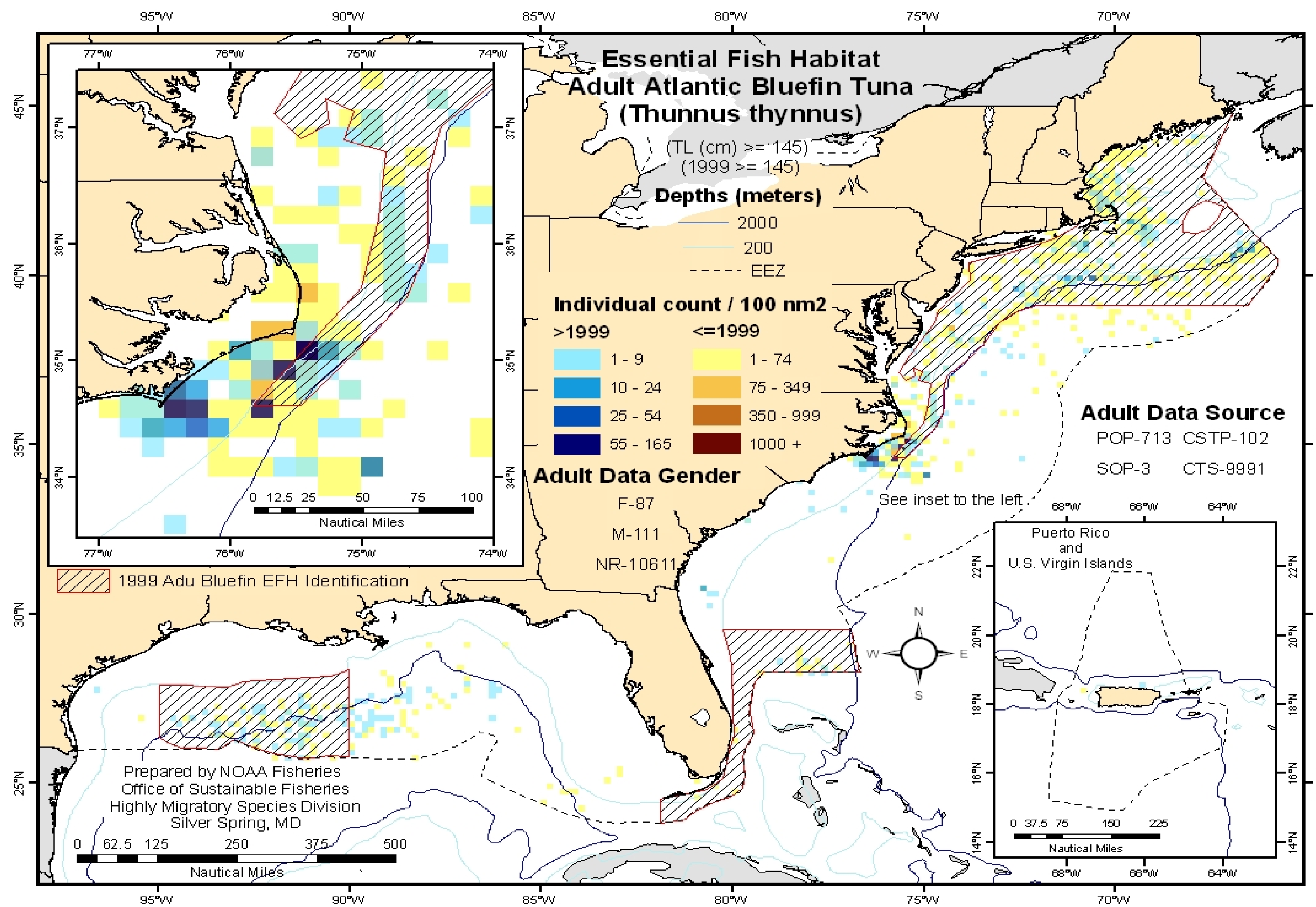

Figure B.9 **Atlantic Bluefin Tuna: Adults.**

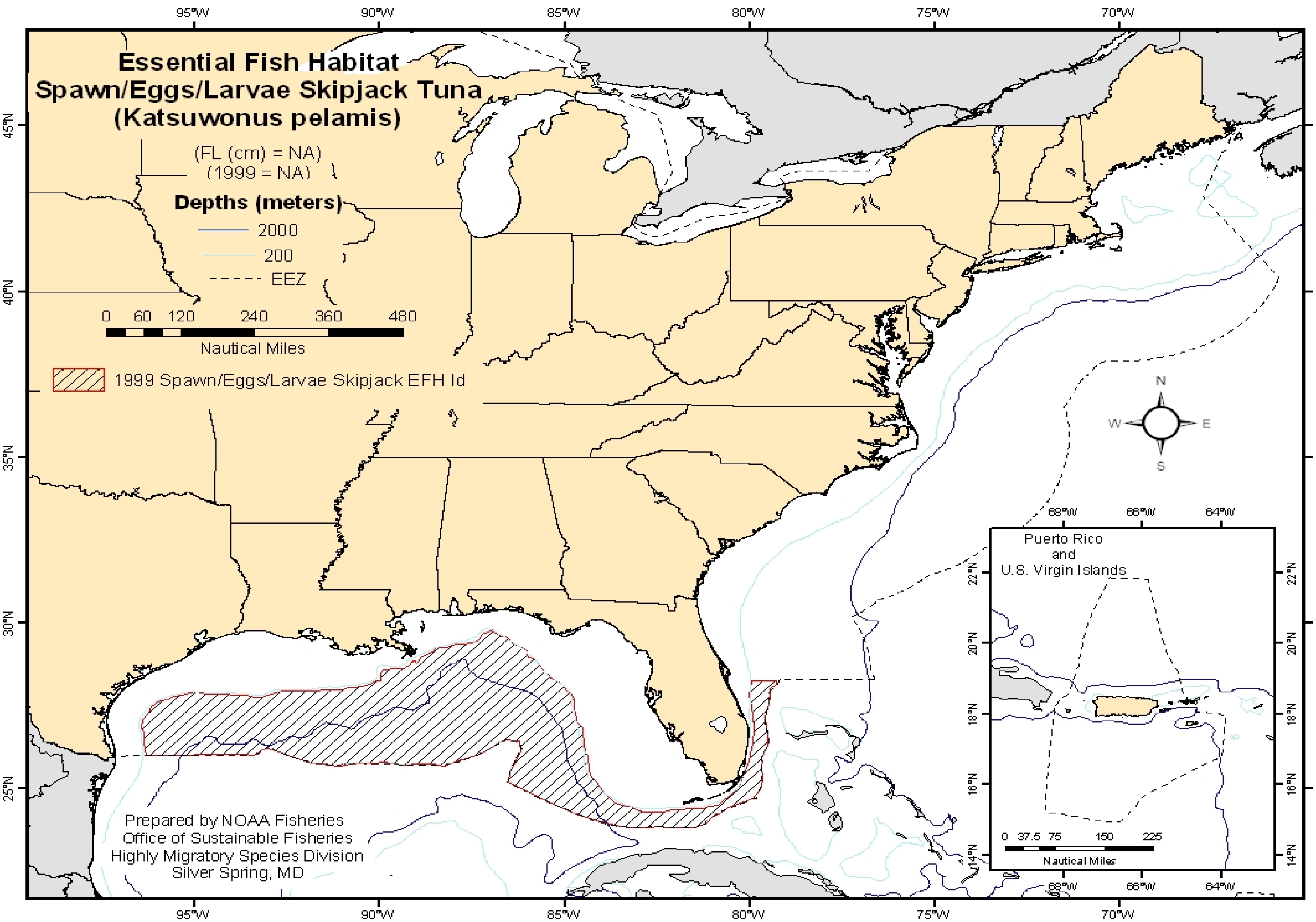

Figure B.10 **Atlantic Skipjack Tuna: Spawning, Eggs, and Larvae.**

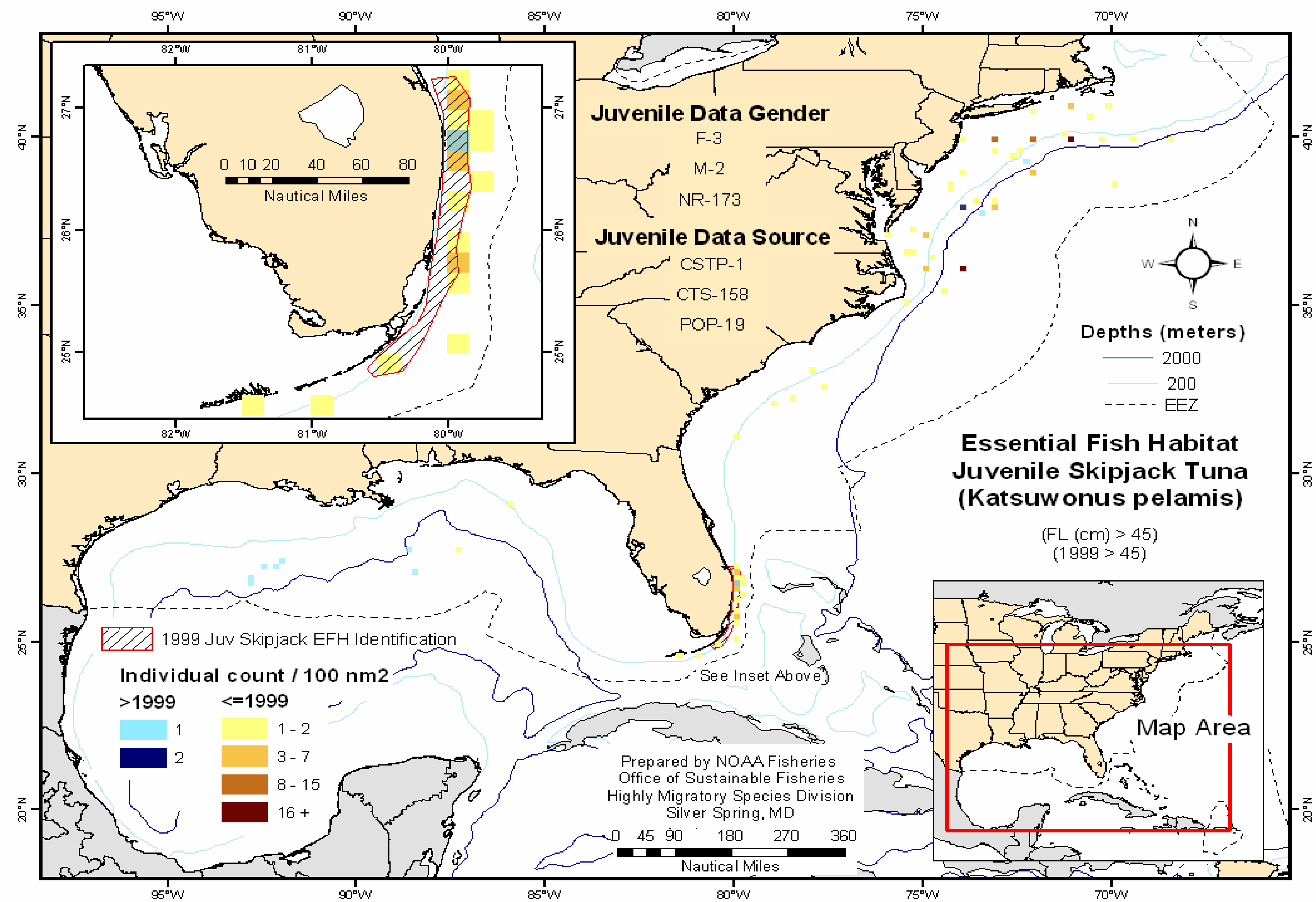

Figure B.11 **Atlantic Skipjack Tuna: Juvenile.**

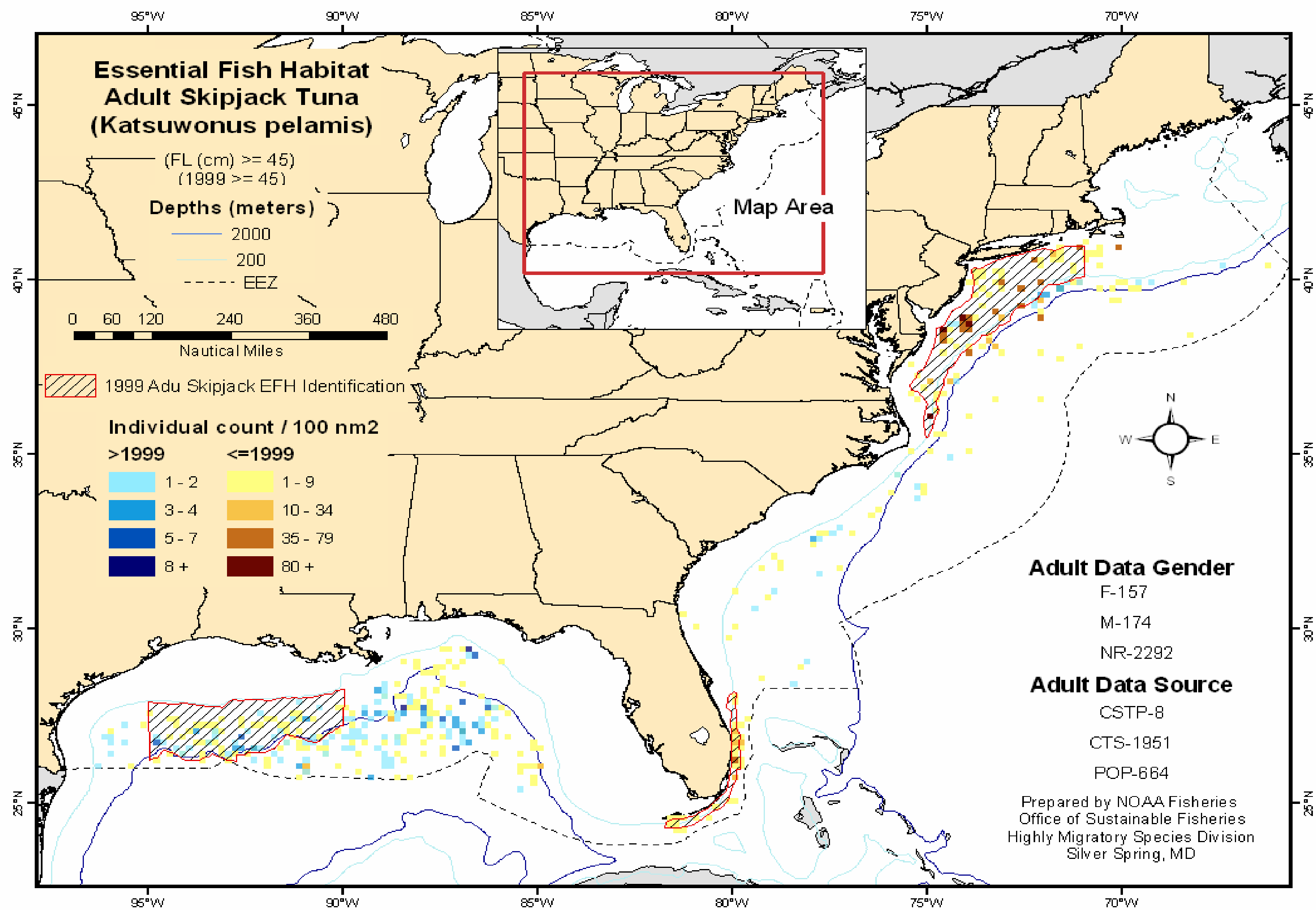

Figure B.12 Atlantic Skipjack Tuna: Adult.

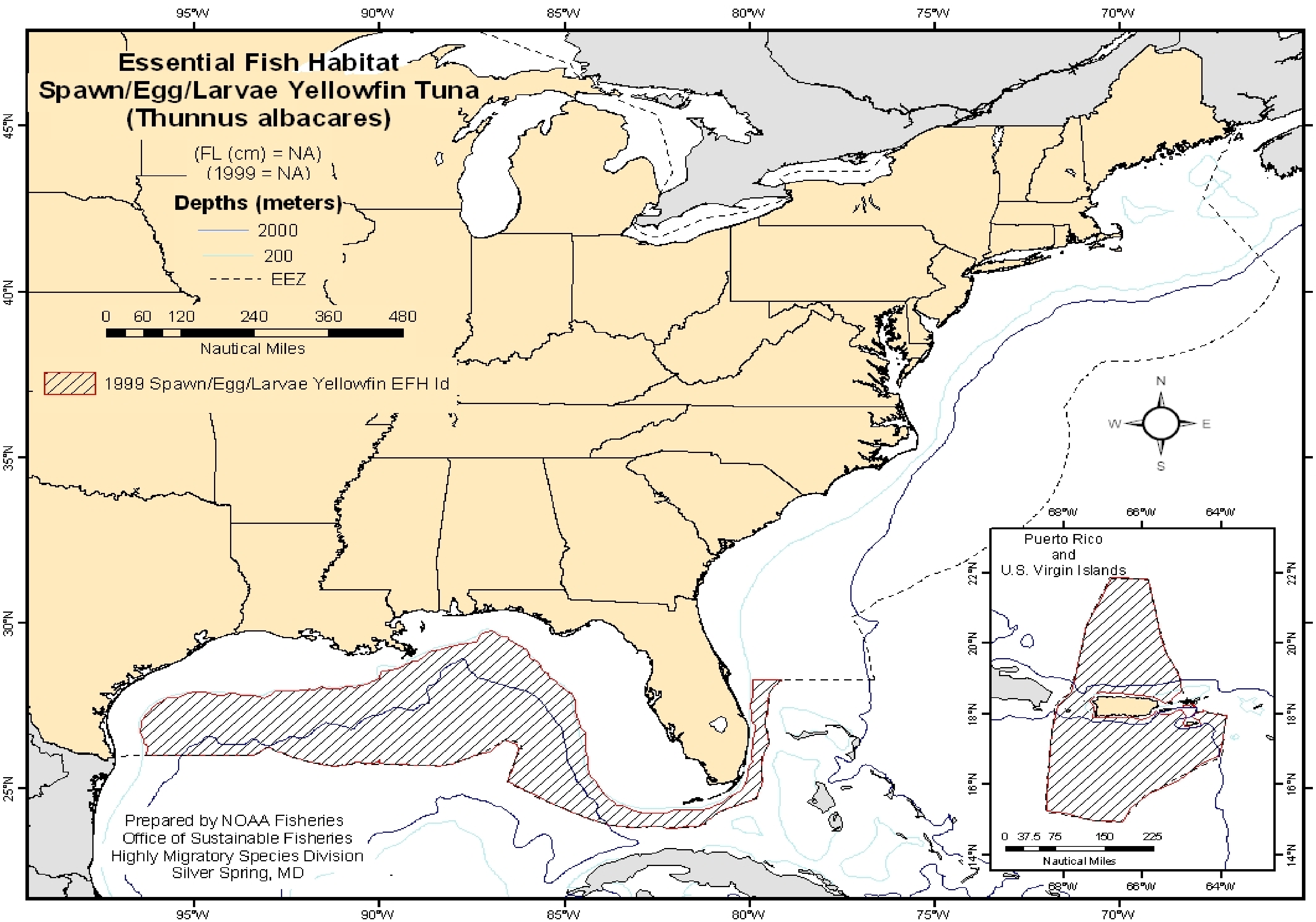

Figure B.13 Atlantic Yellowfin Tuna: Spawning, Eggs, and Larvae.

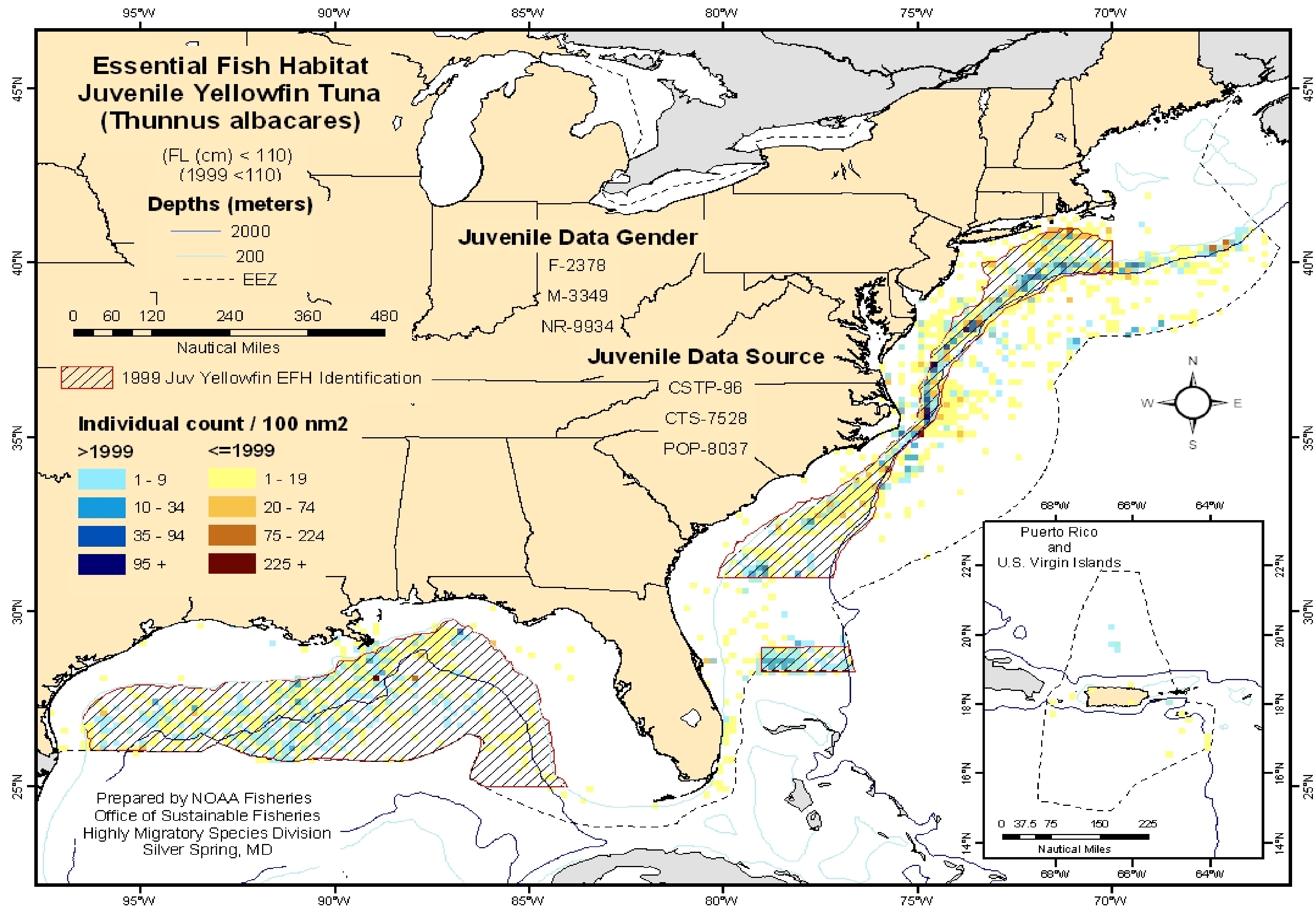

Figure B.14 Atlantic Yellowfin Tuna: Juvenile.

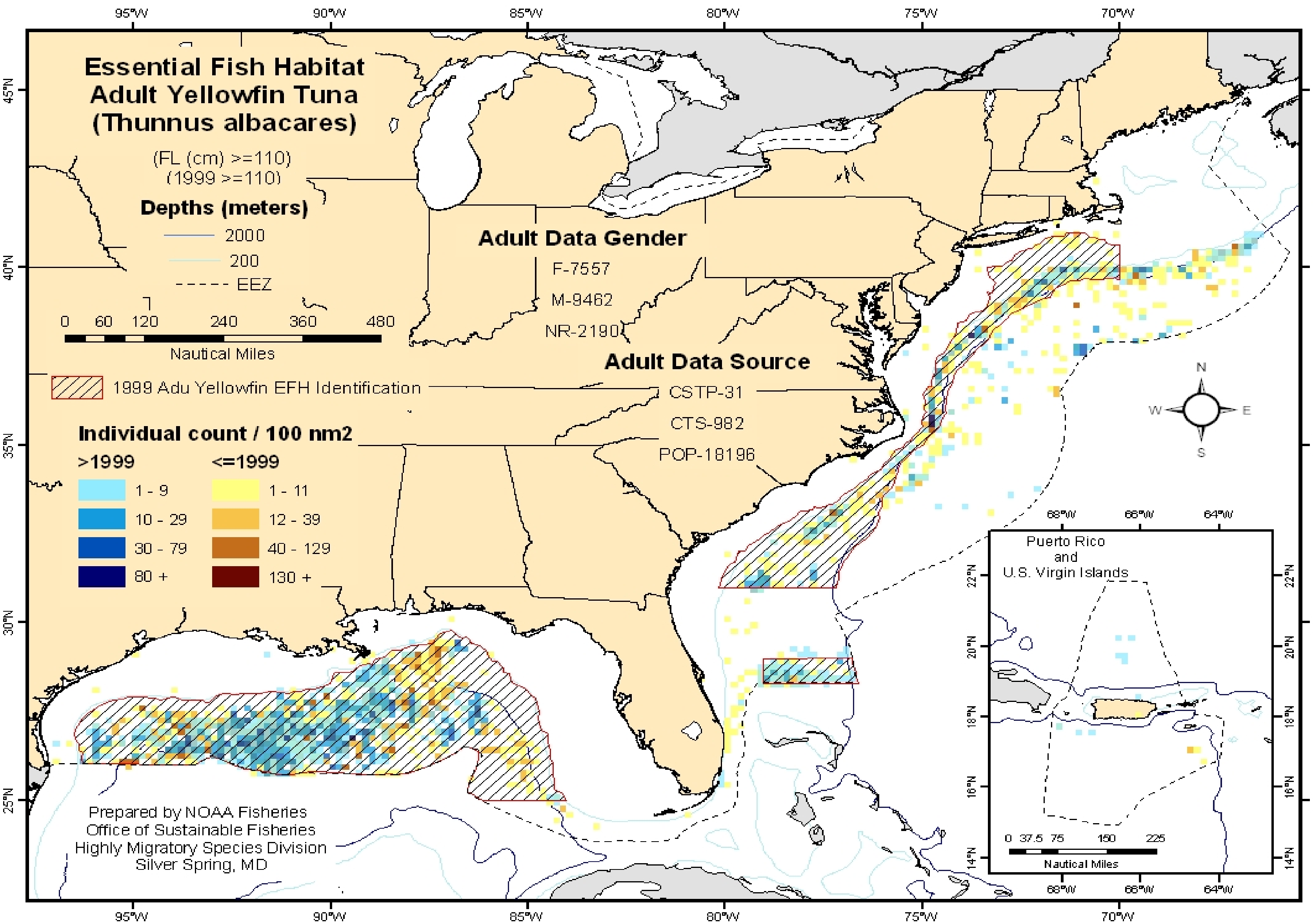

Figure B.15 Atlantic Yellowfin Tuna: Adult.

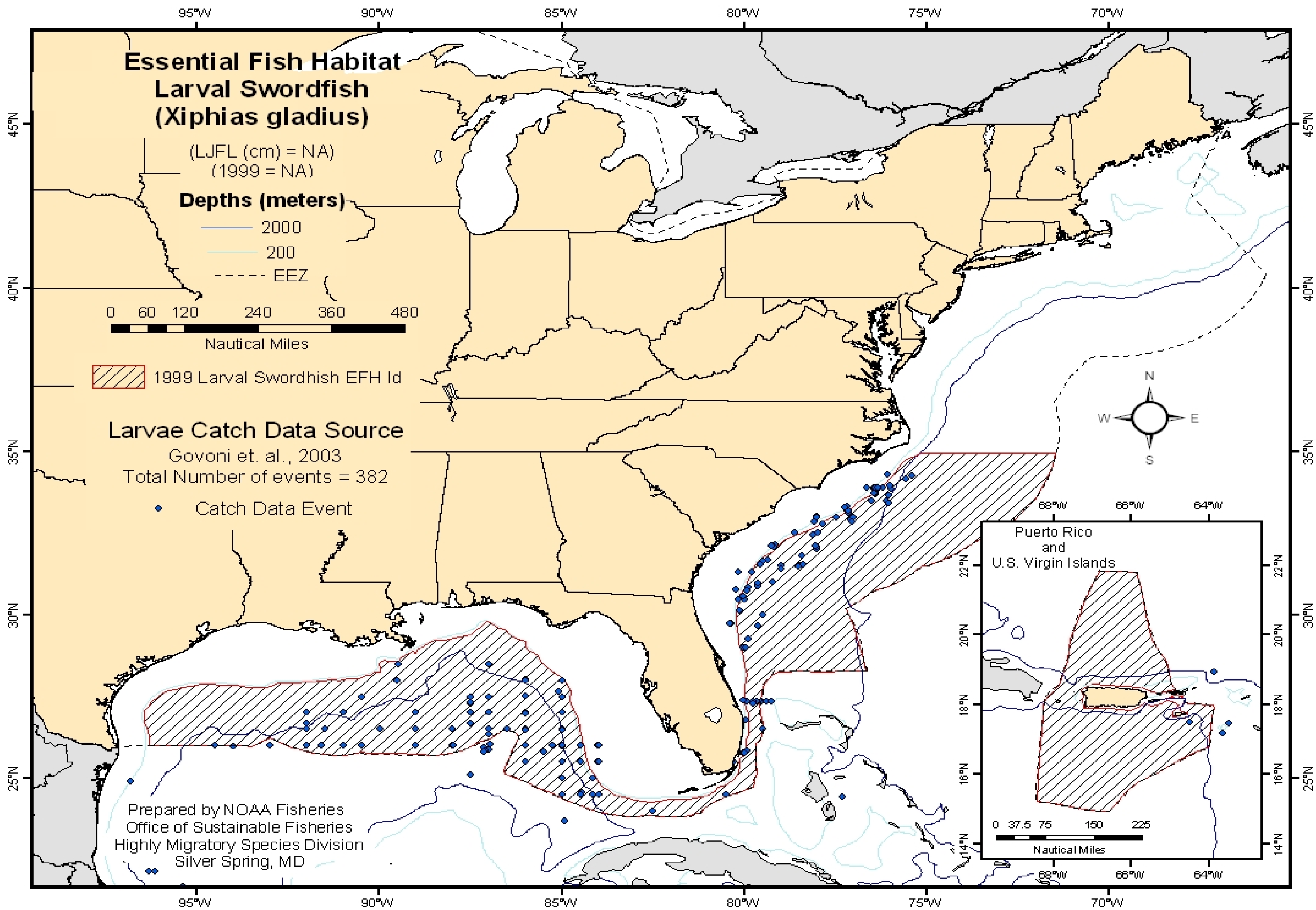

Figure B.16 **Atlantic Swordfish: Spawning, Eggs, and Larvae.**

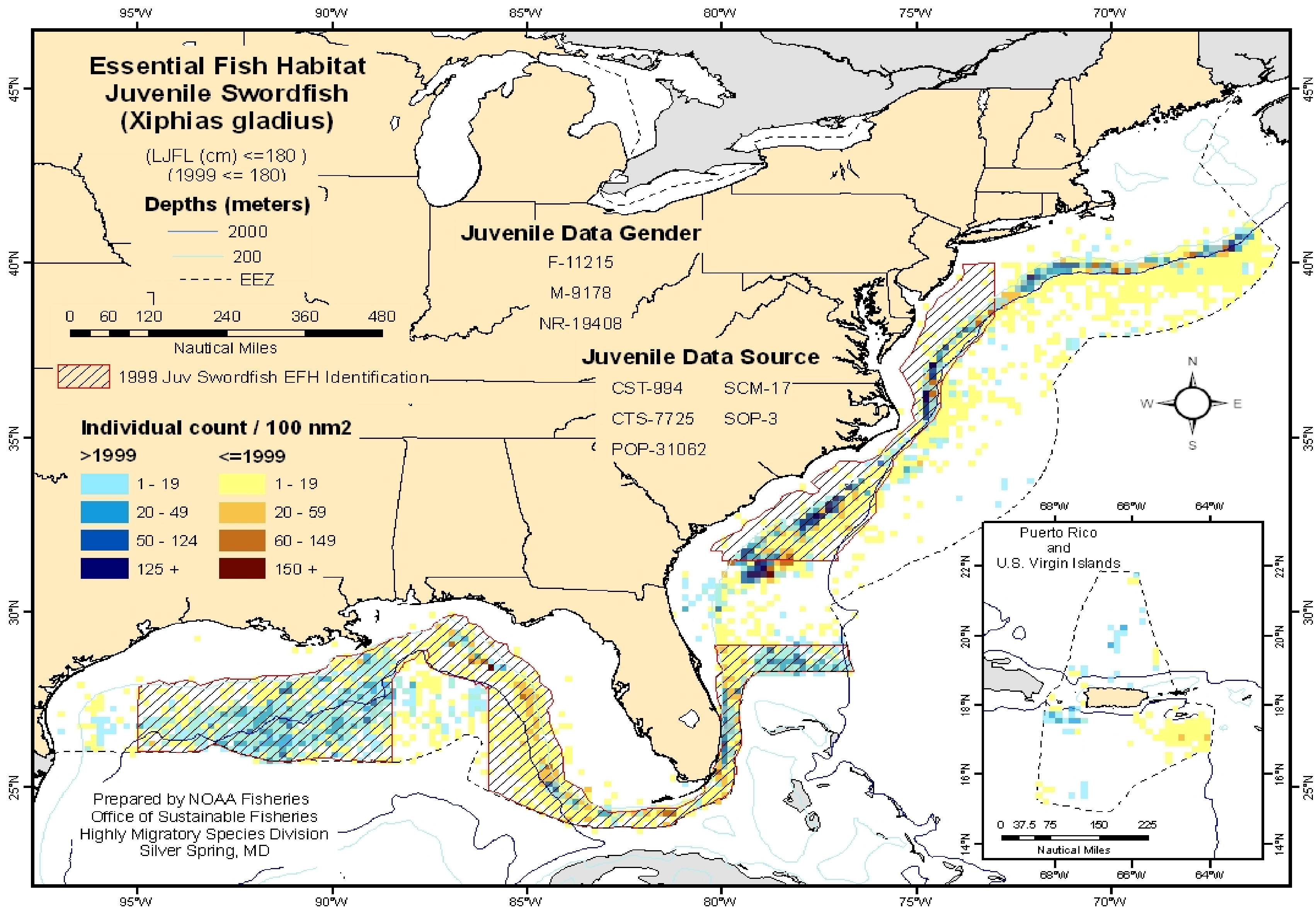

Figure B.17 **Atlantic Swordfish: Juvenile.**

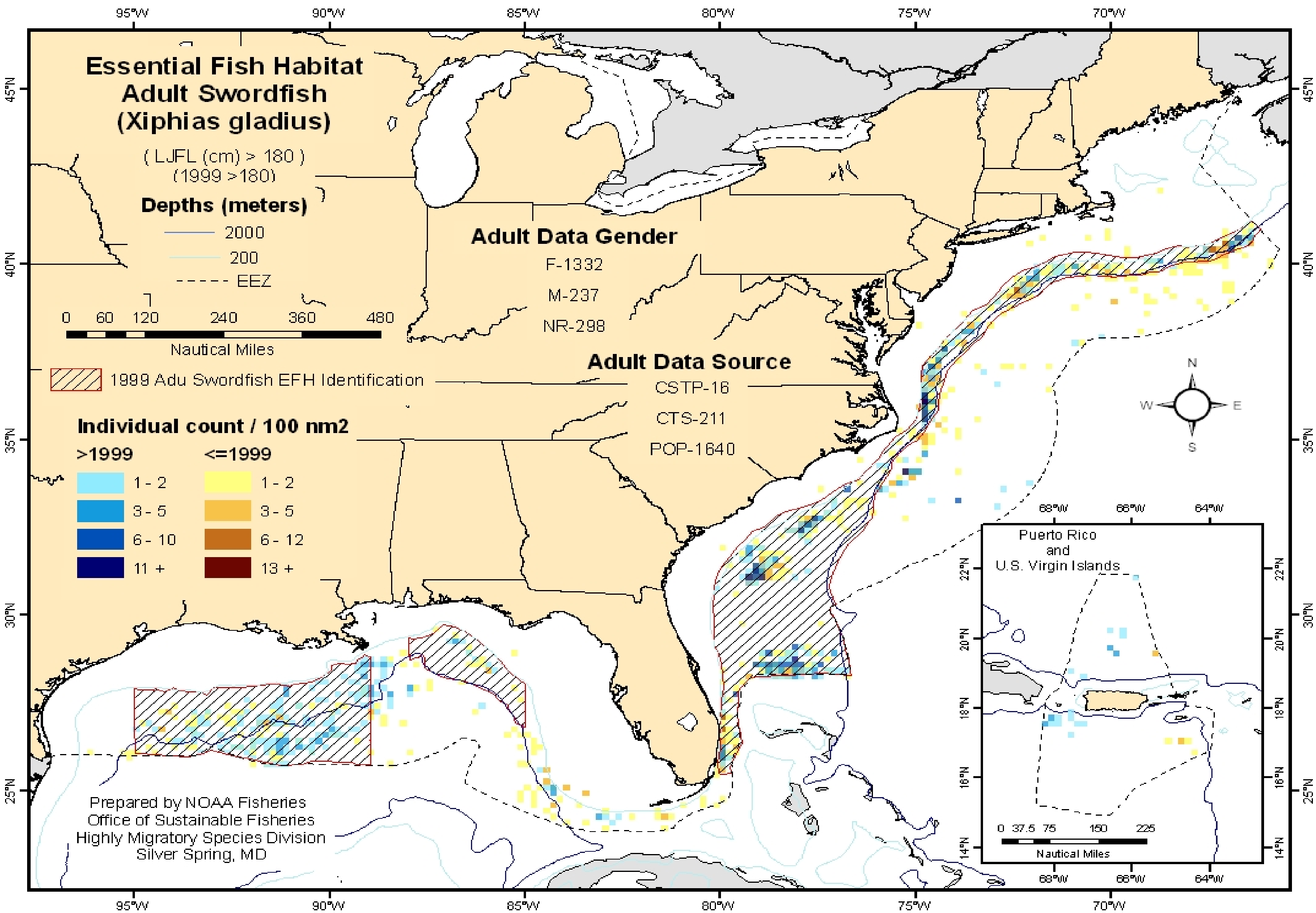

Figure B.18 **Atlantic Swordfish: Adult.**

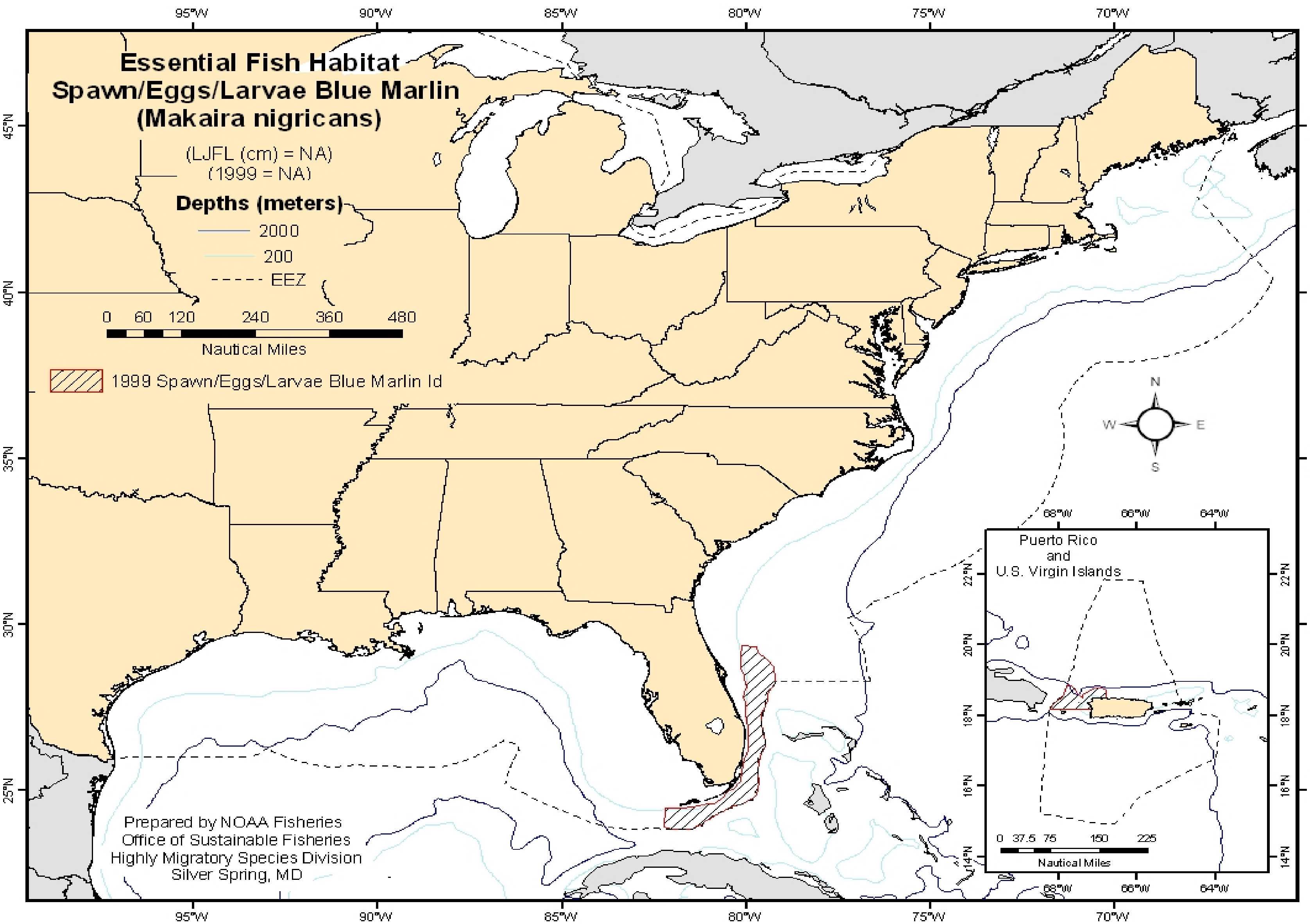

Figure B.19 **Blue Marlin: Spawning, Eggs, and Larvae.**

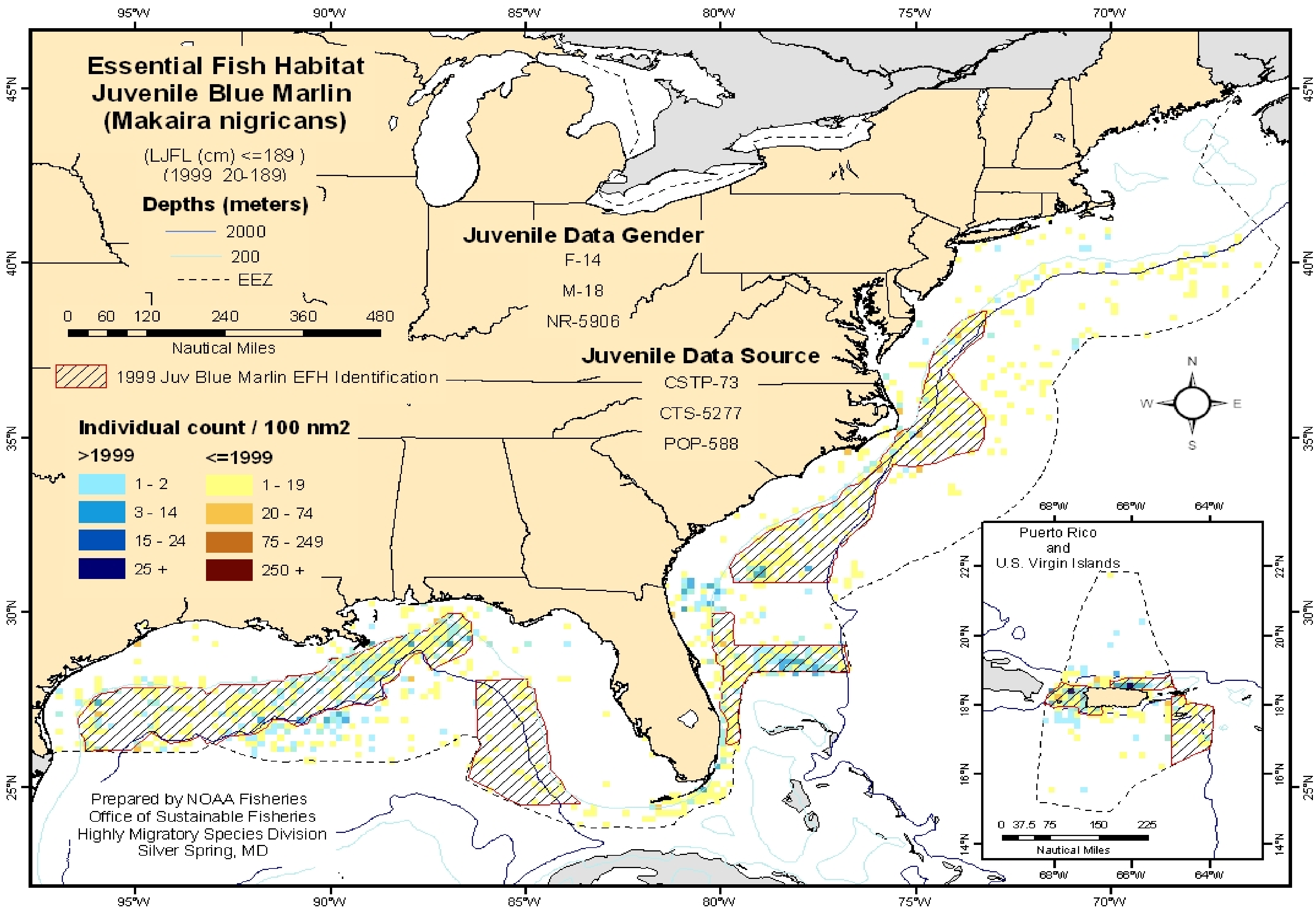

Figure B.20 Blue Marlin: Juvenile.

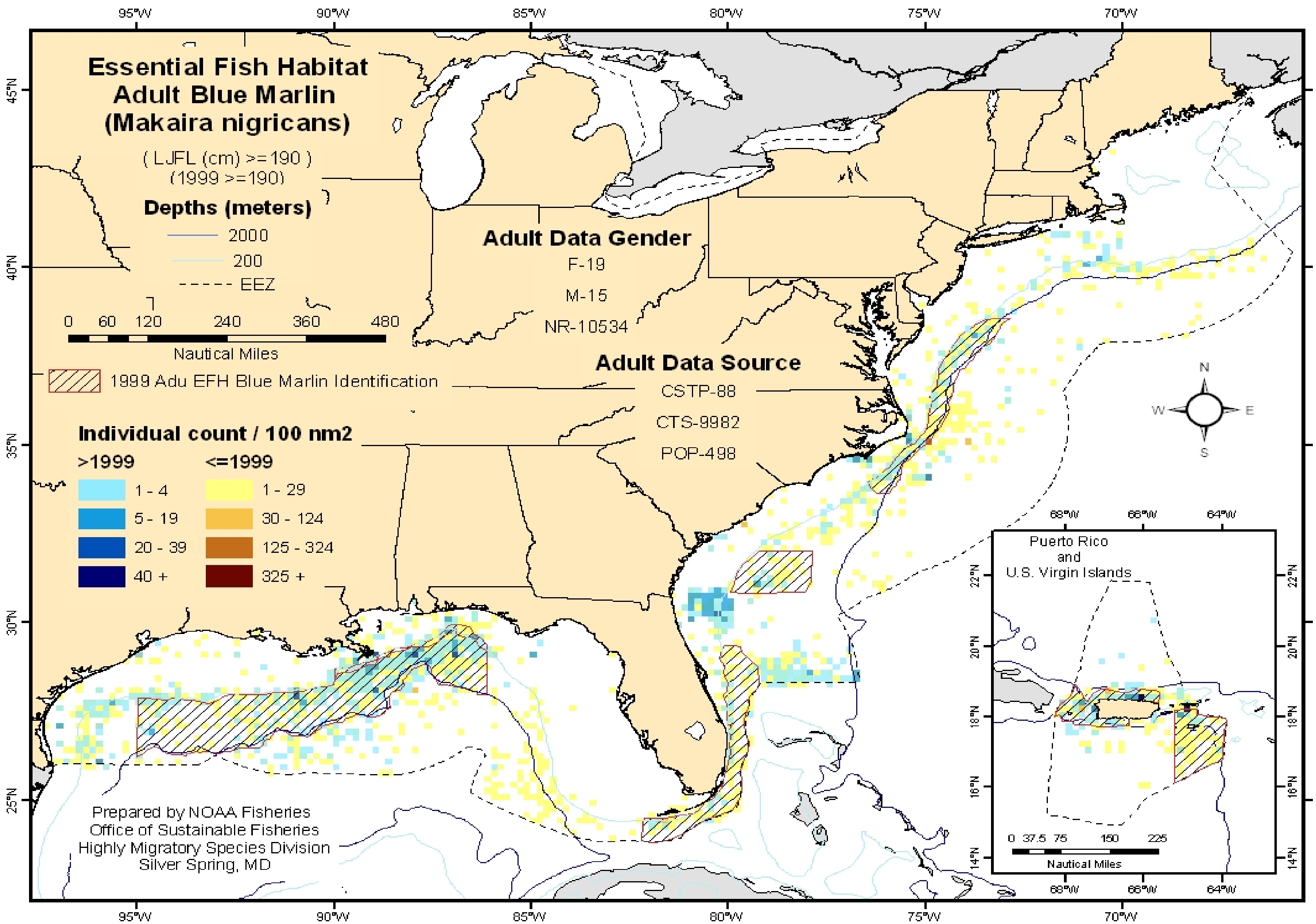

Figure B.21 **Blue Marlin: Adult.**

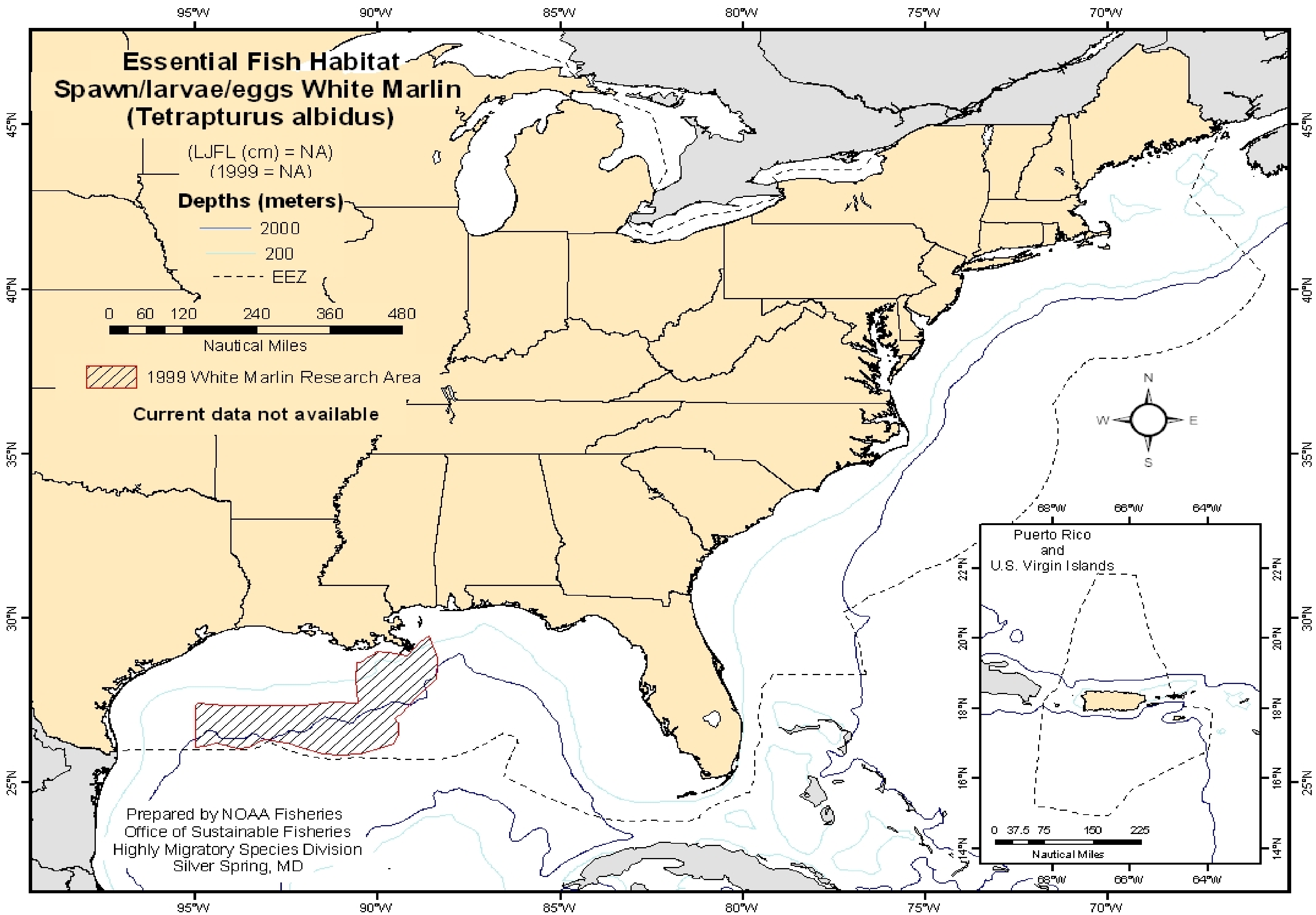

Figure B.22 **White Marlin: Spawning, Eggs, and larvae.**

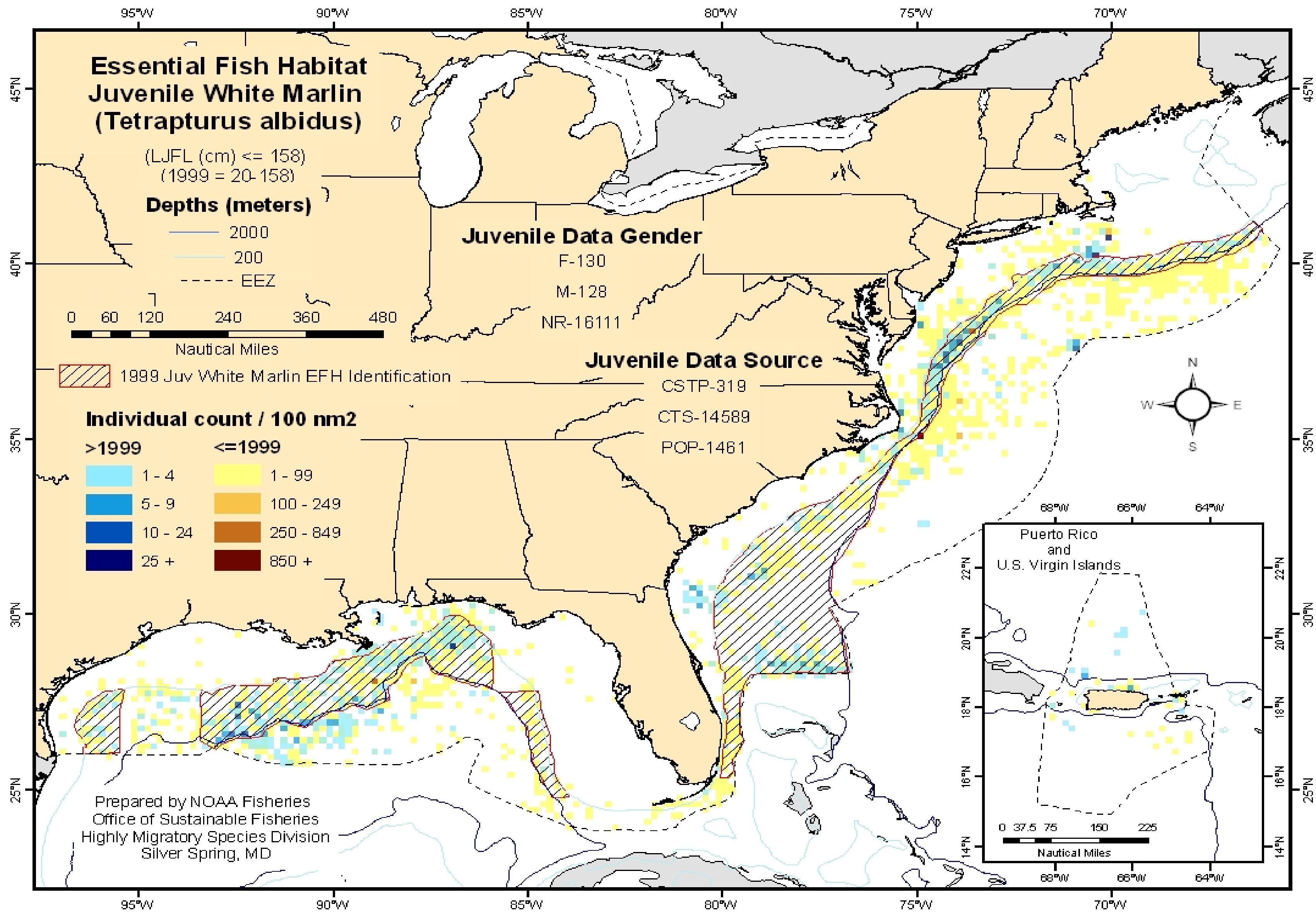

Figure B.23 White Marlin: Juvenile.

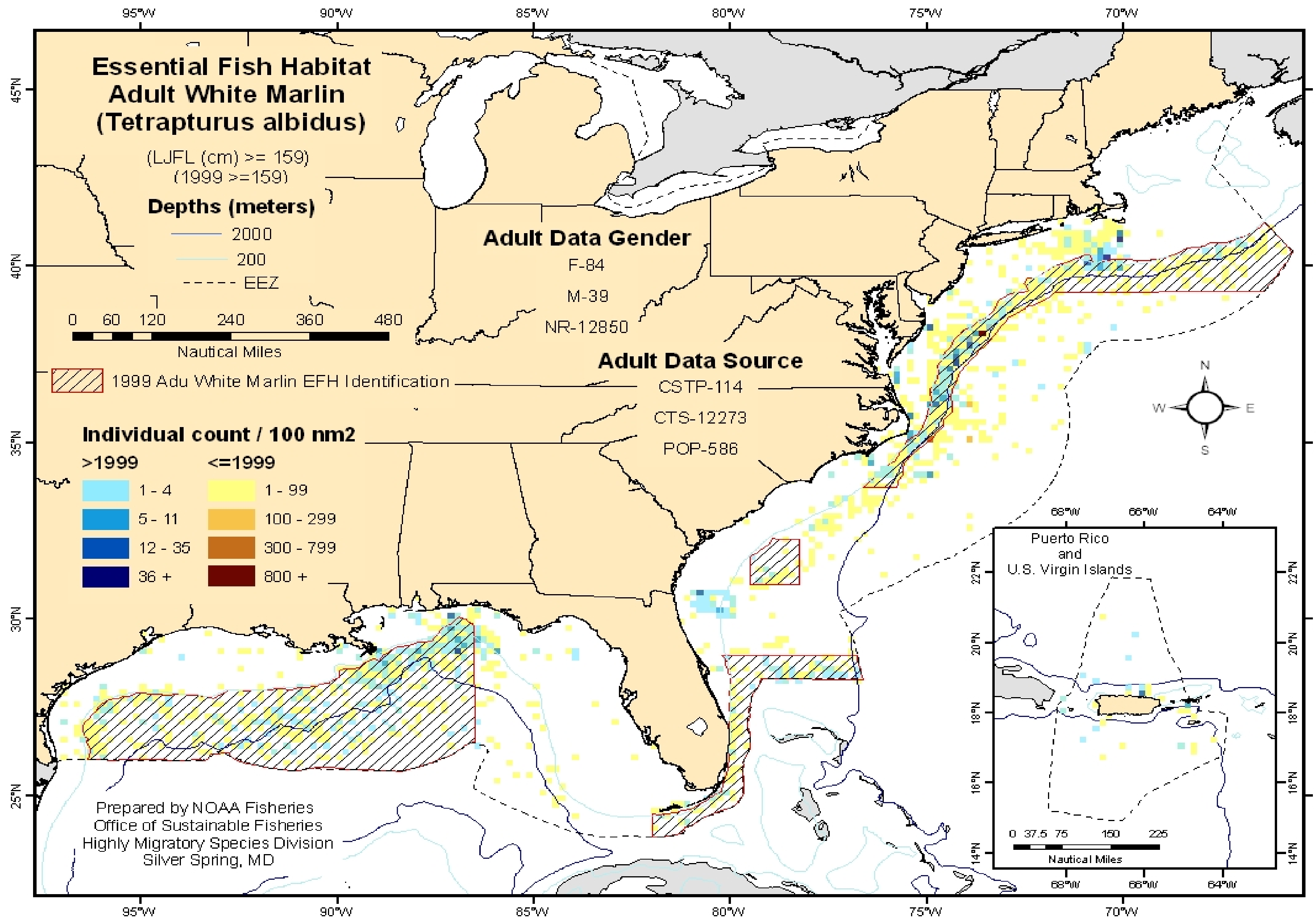

Figure B.24 White Marlin: Adult.

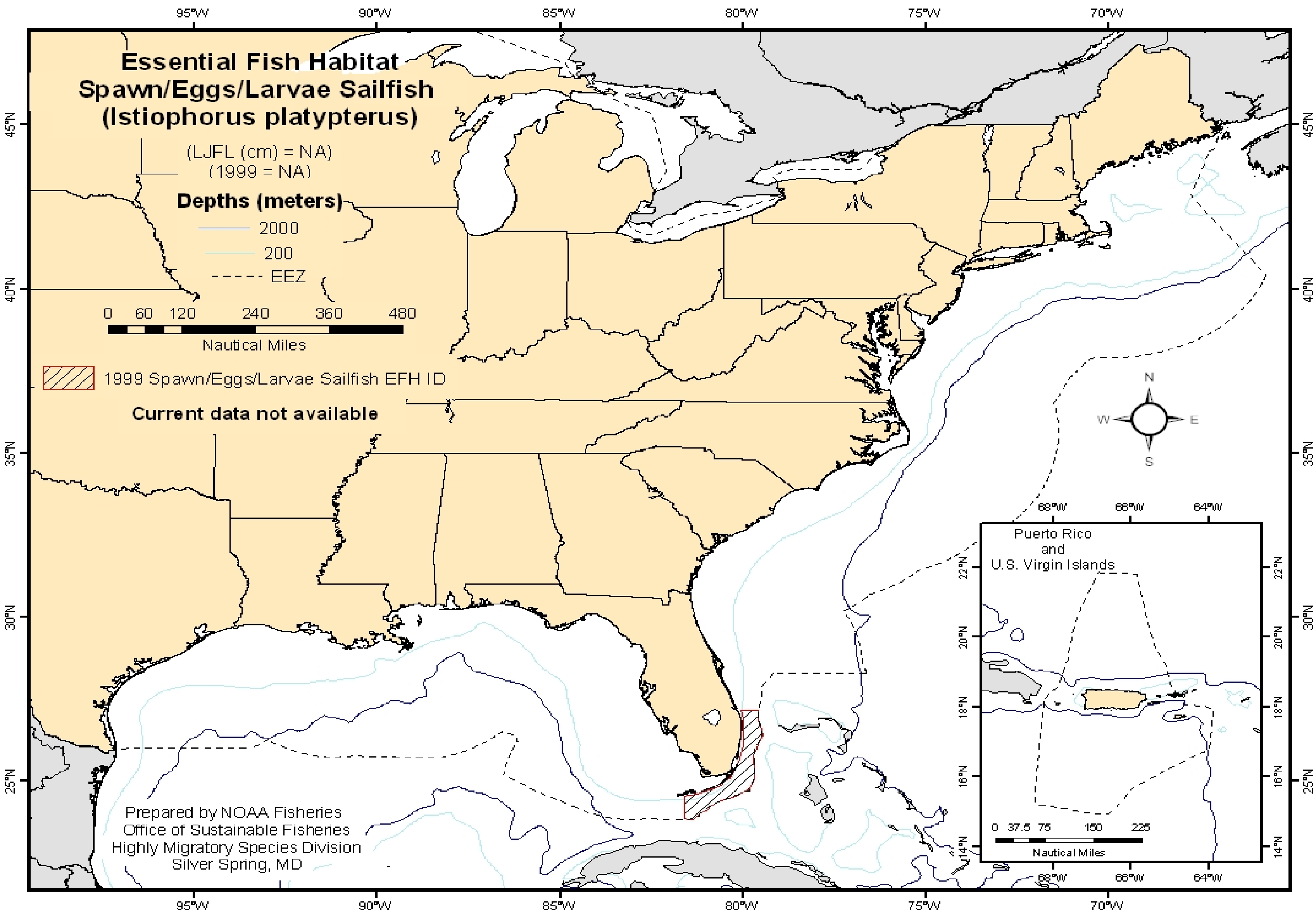

Figure B.25 **Sailfish: Spawning, Eggs, and Larvae.**

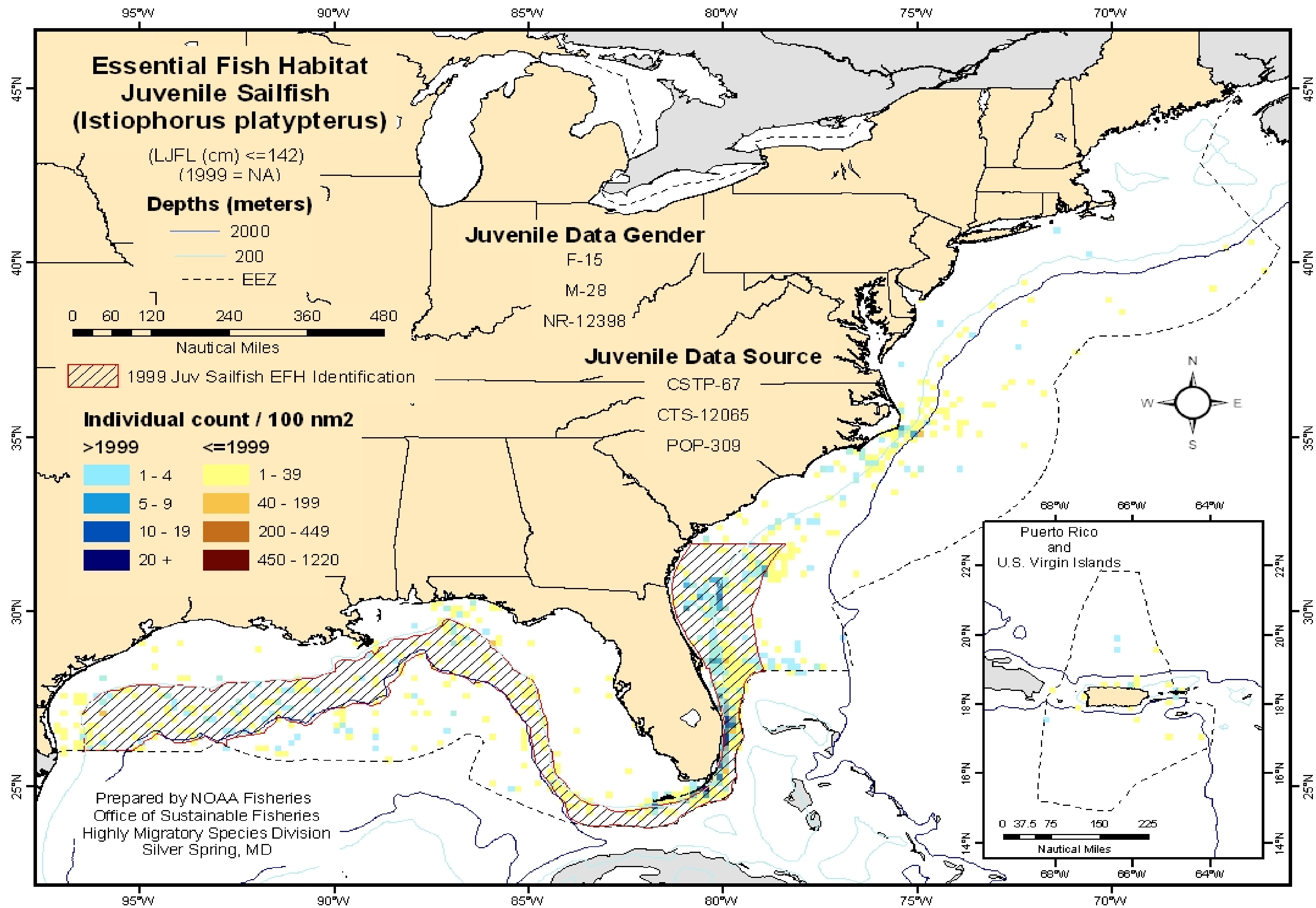

Figure B.26 **Sailfish: Juvenile.**

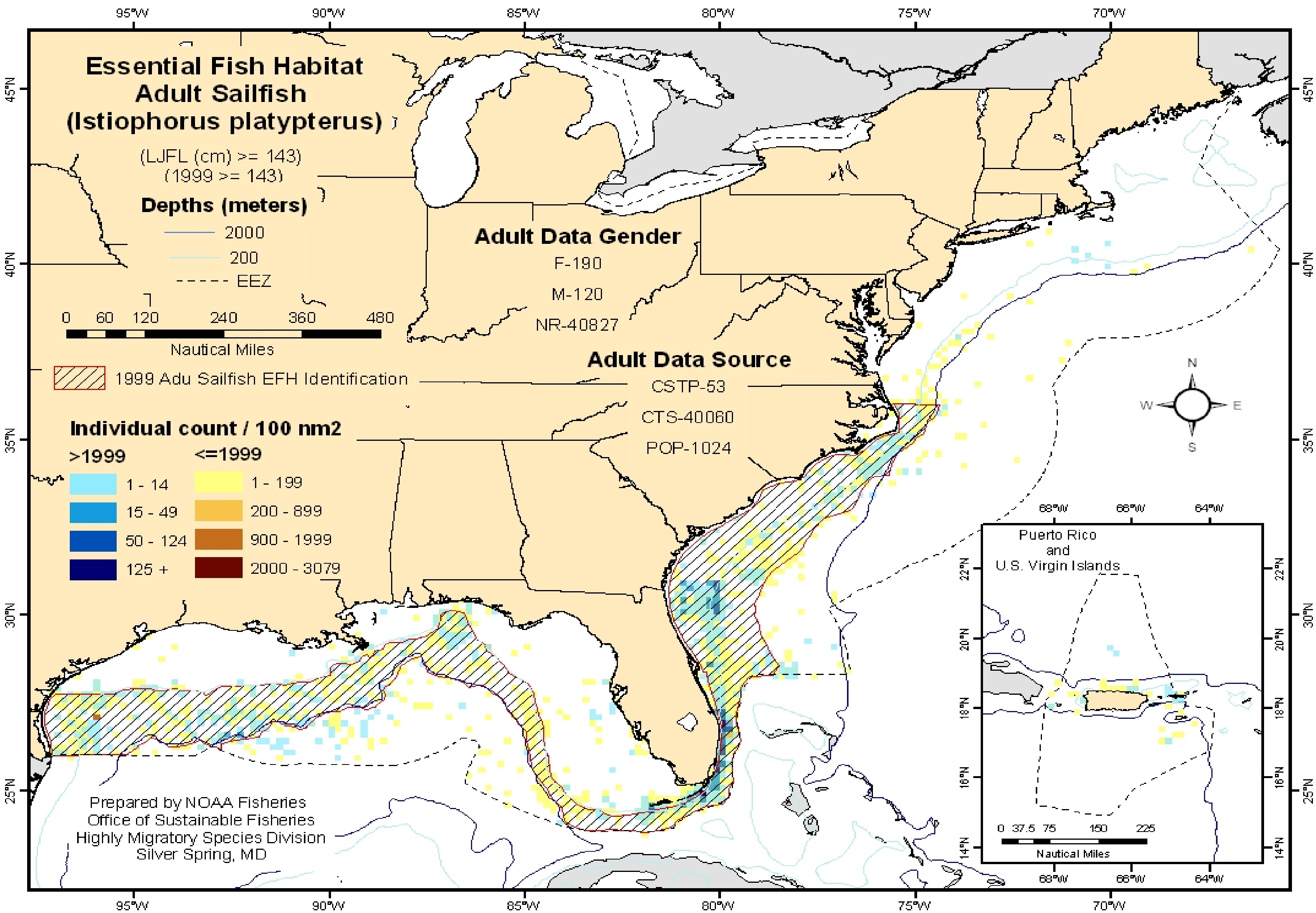

Figure B.27 **Sailfish: Adult.**

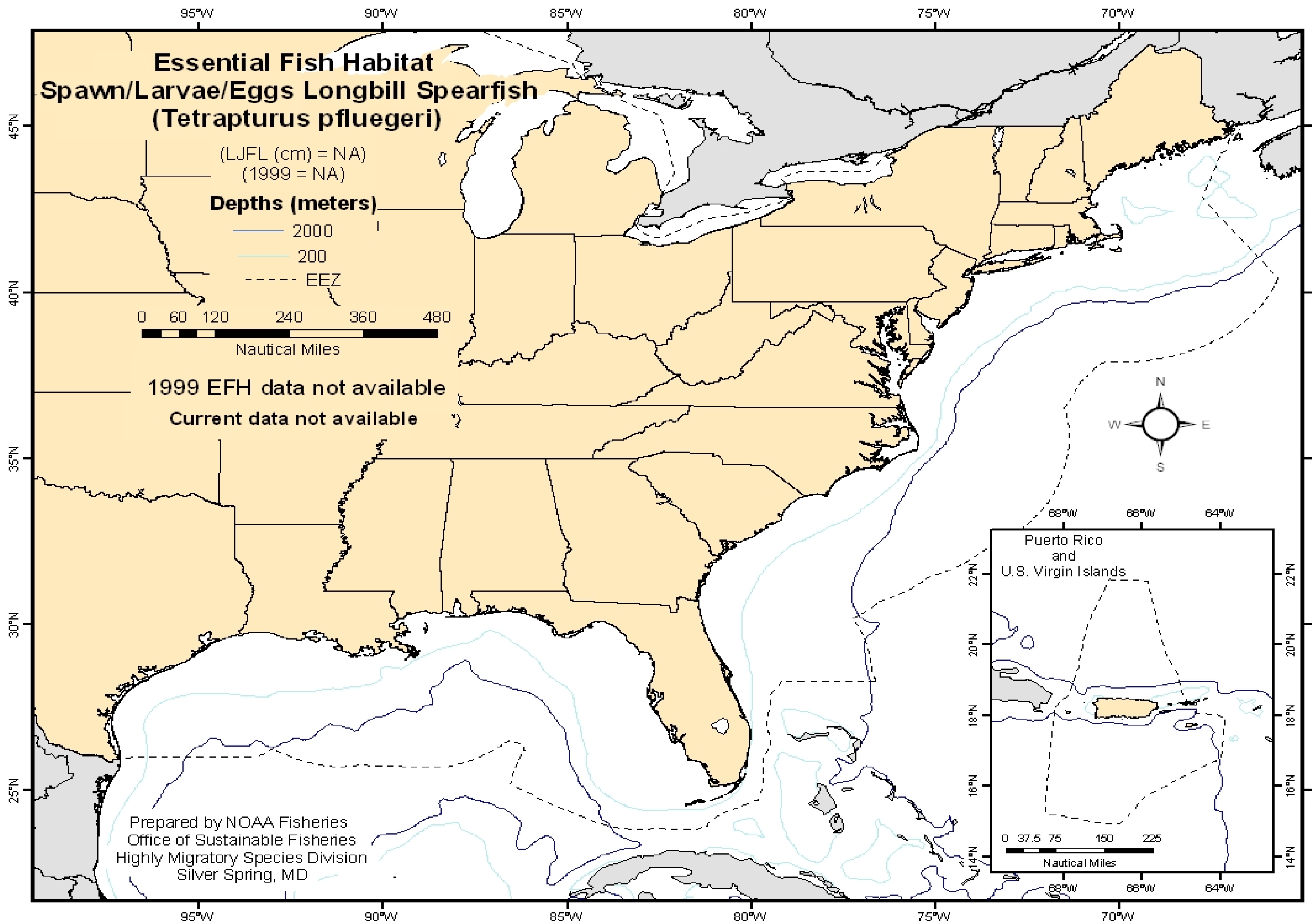

Figure B.28 Spearfish: Spawning, Eggs, and Larvae.

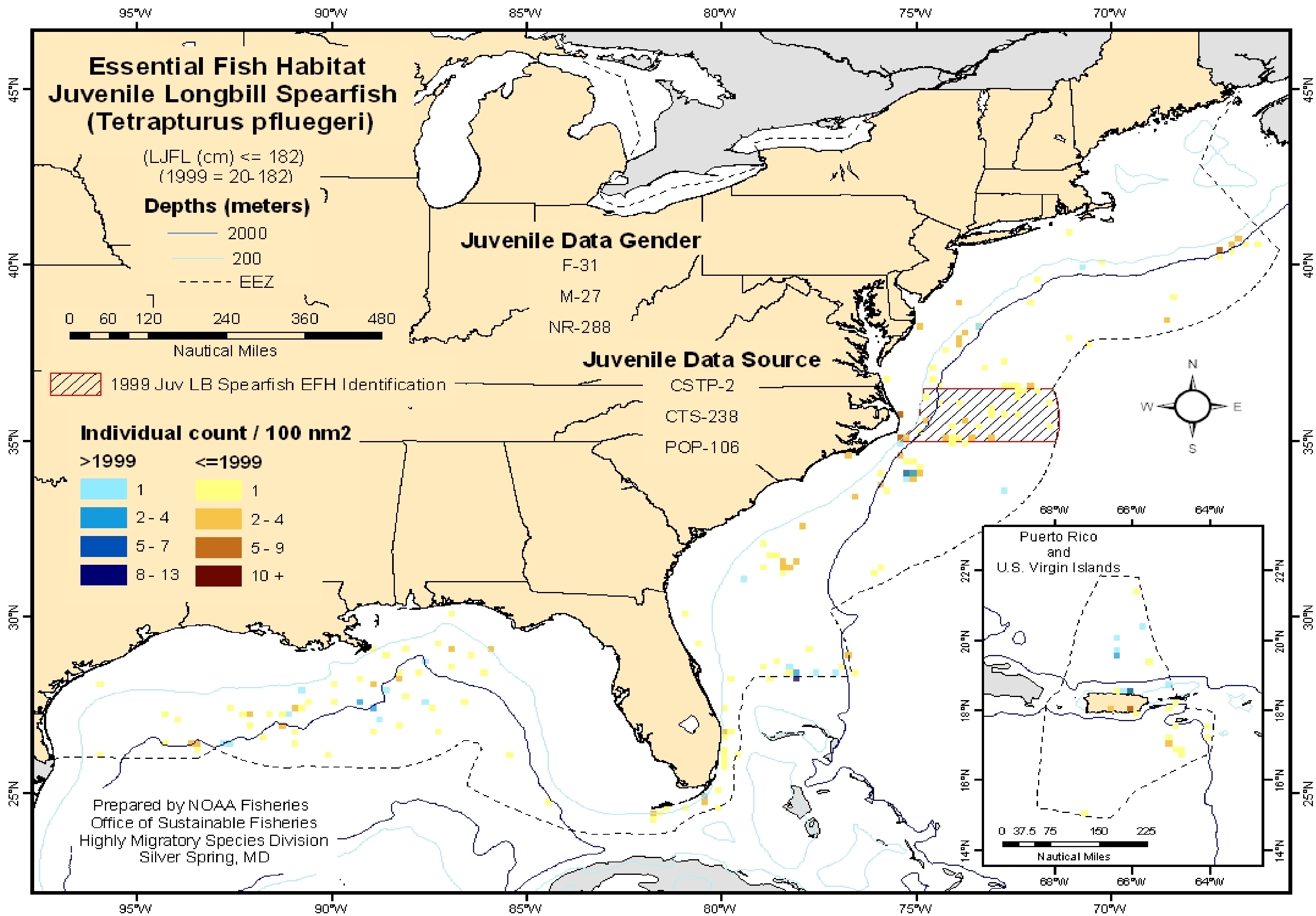

Figure B.29 Spearfish: Juvenile.

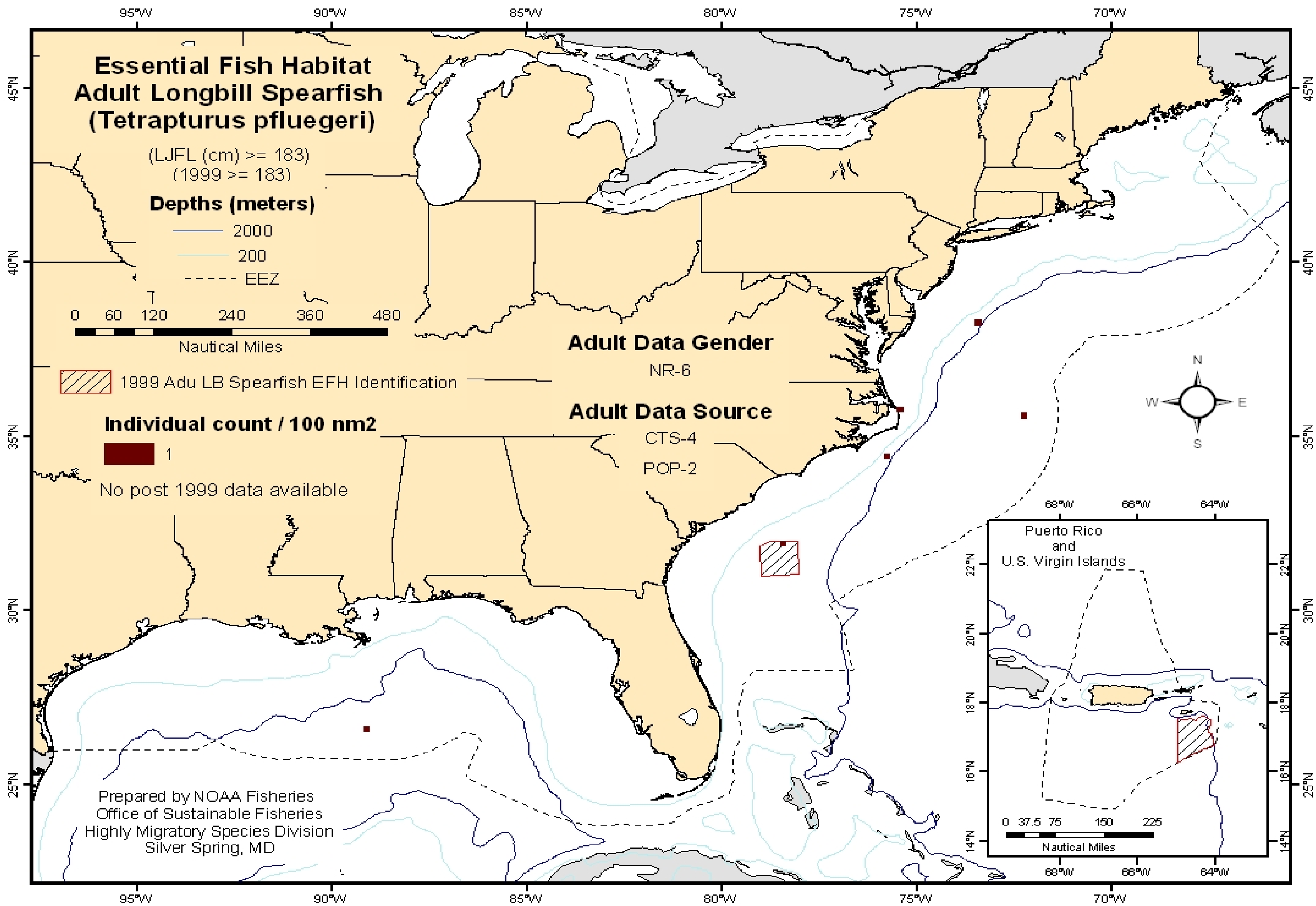

Figure B.30 Spearfish: Adult.

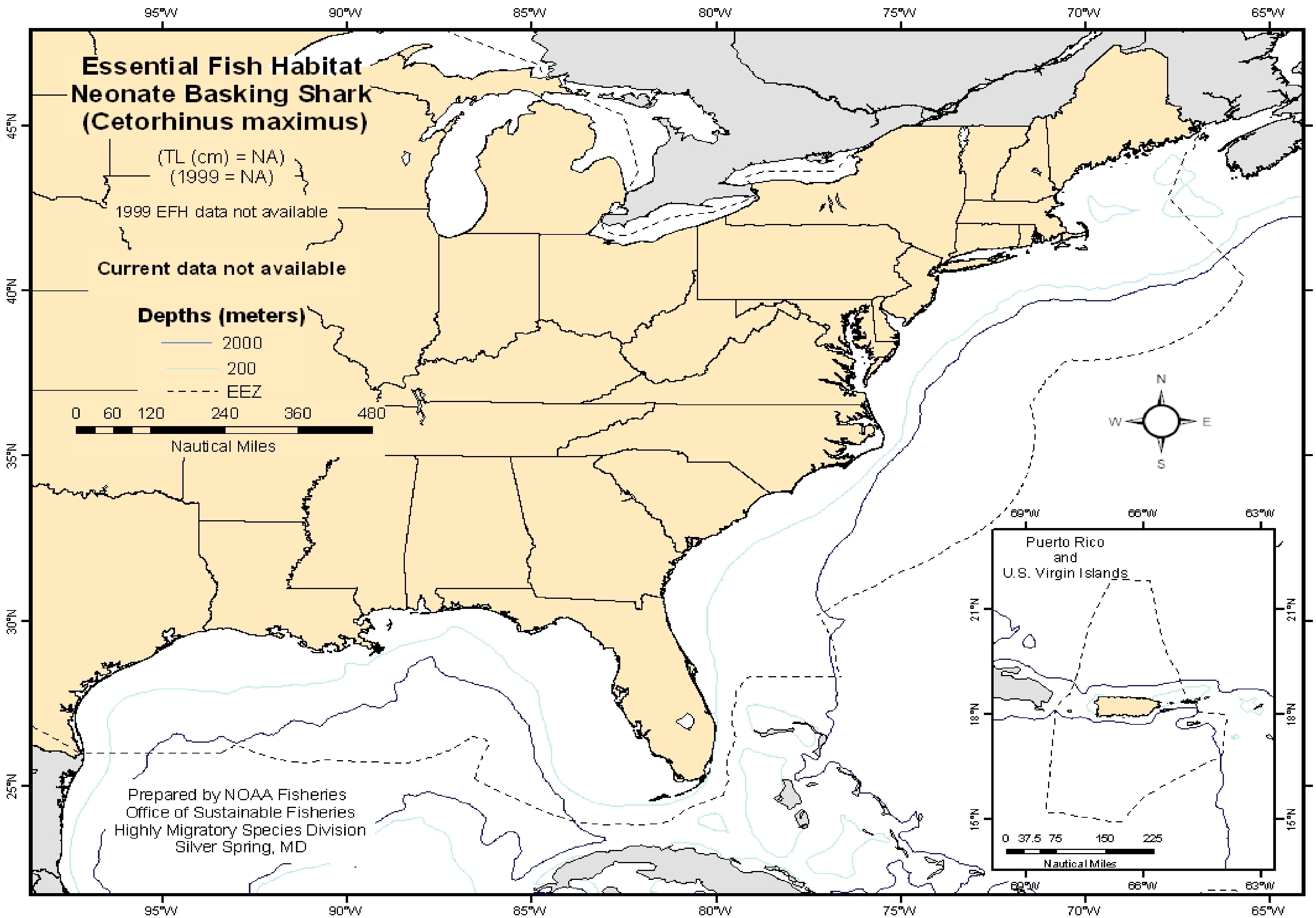

Figure B.31 **Basking Shark: Neonate.**

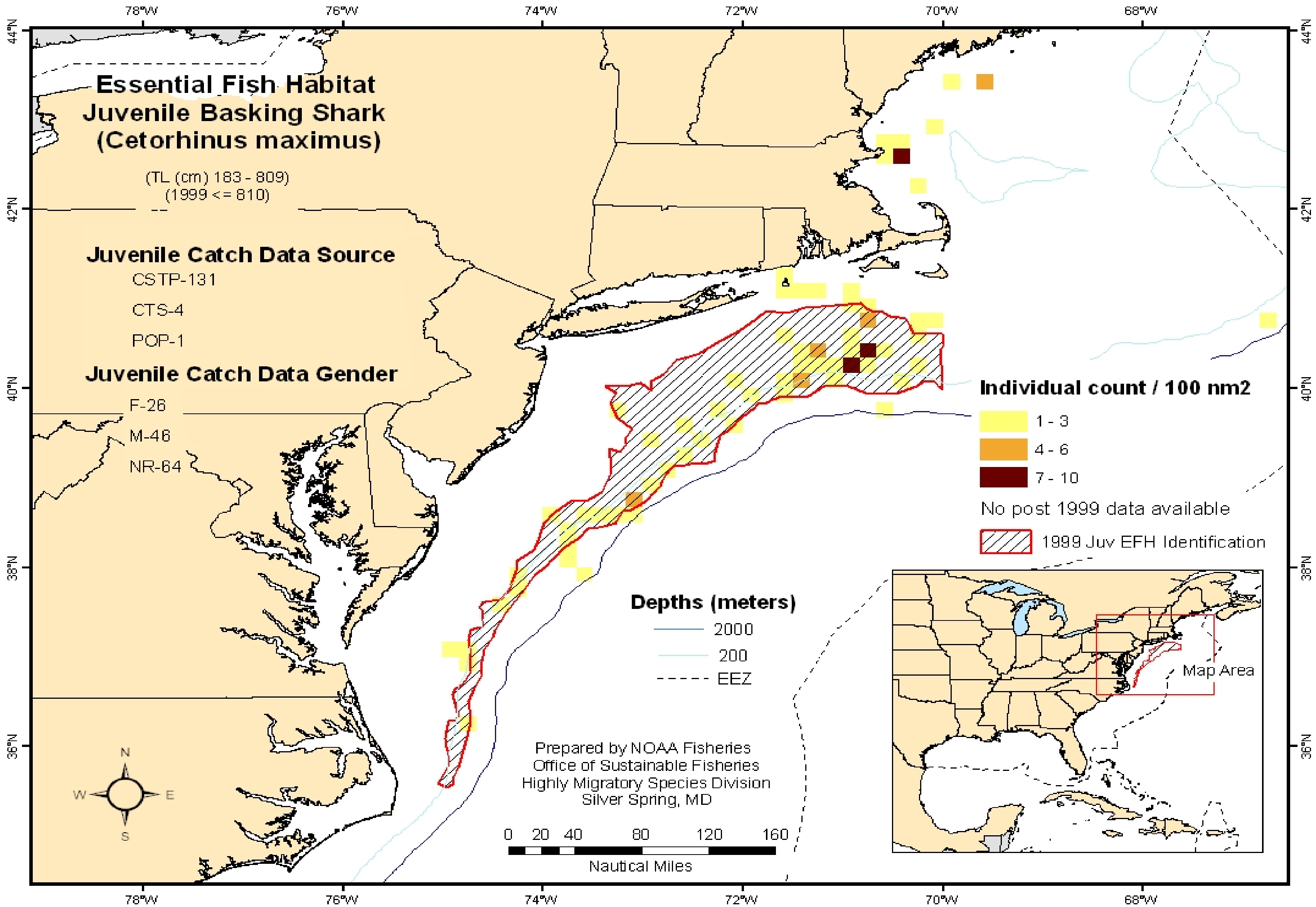

Figure B.32 **Basking Shark: Juvenile.**

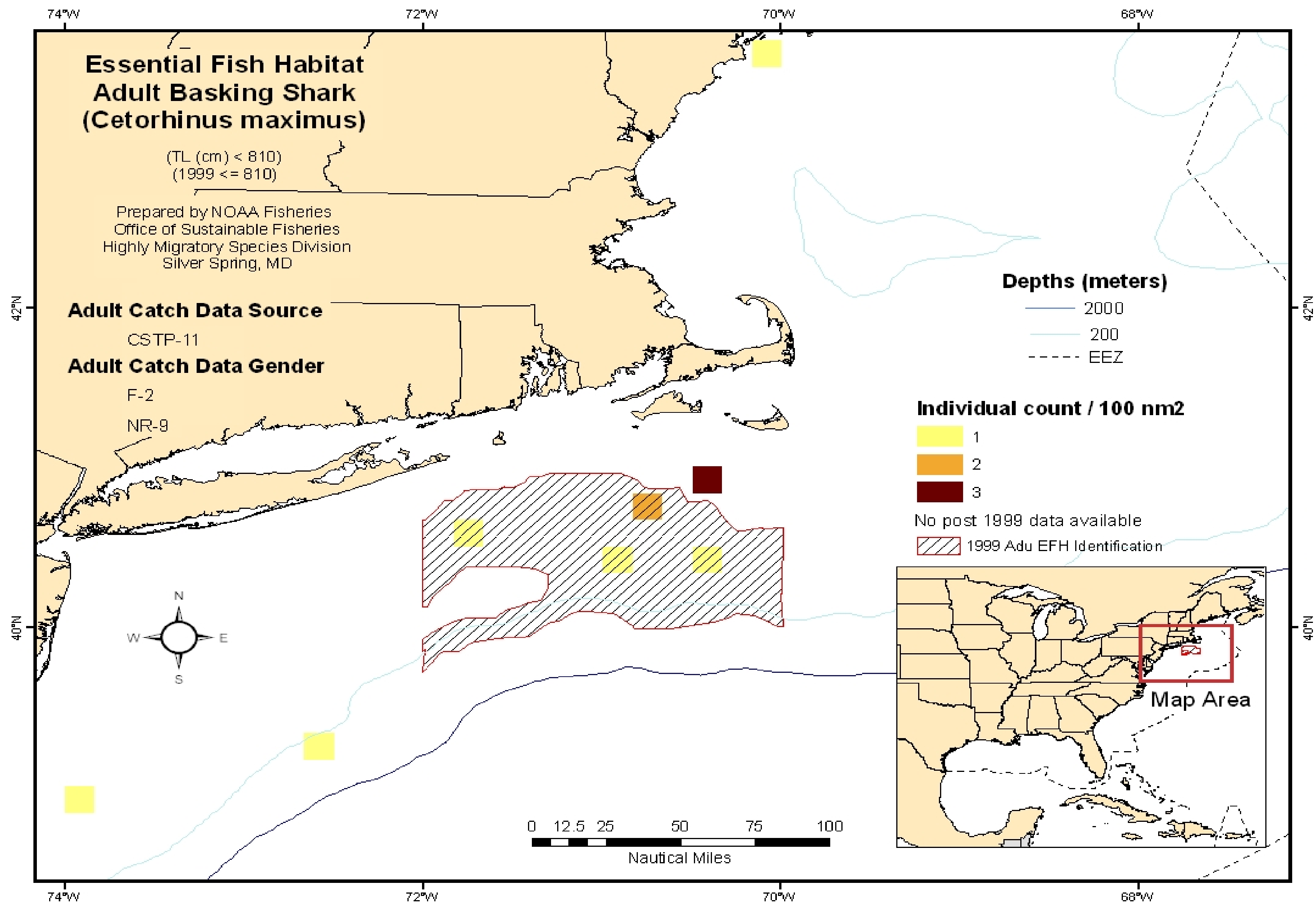

Figure B.33 Basking Shark: Adult.

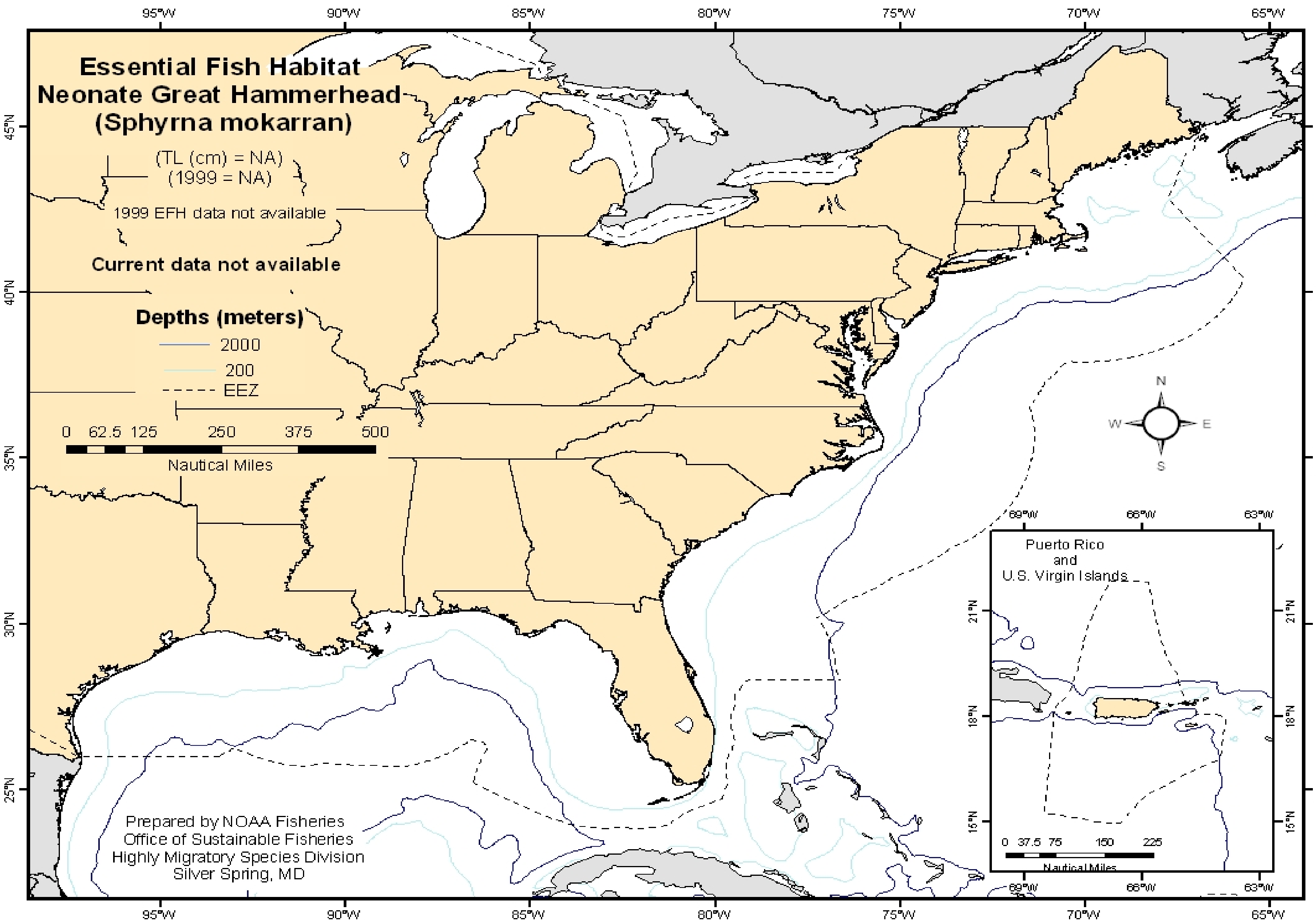

Figure B.34 Great Hammerhead: Neonate.

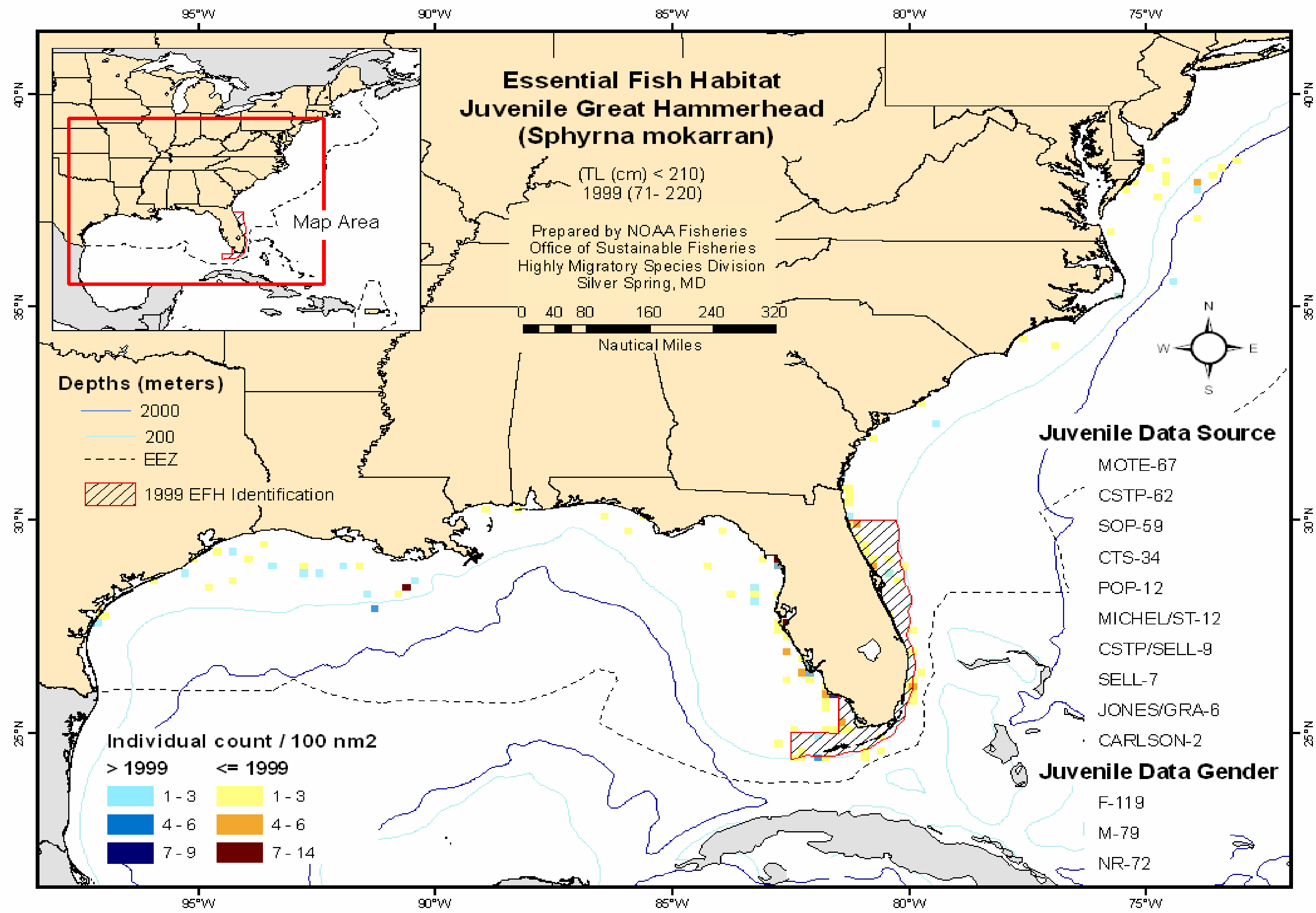

Figure B.35 Great Hammerhead: Juvenile.

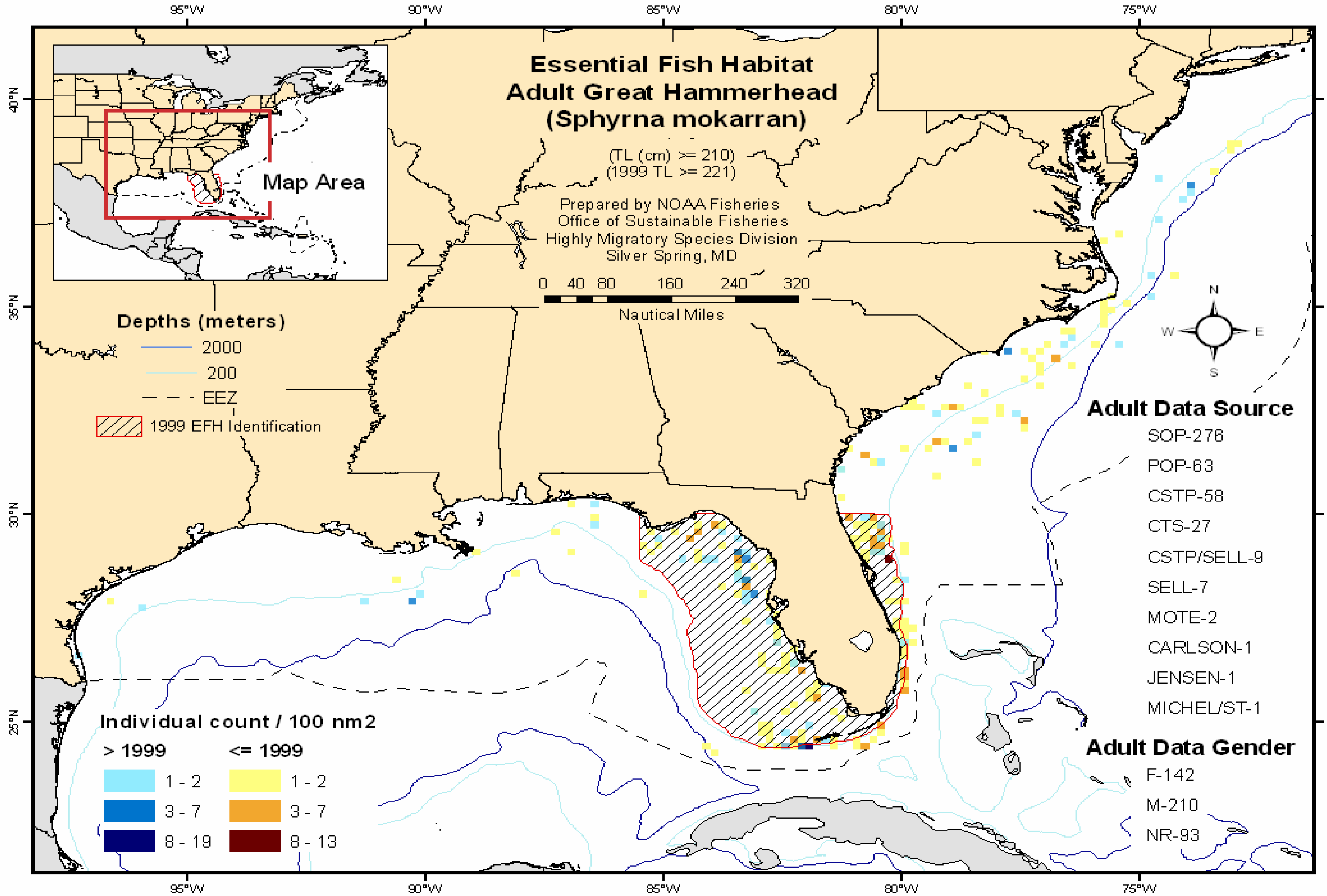

Figure B.36 Great Hammerhead: Adult.

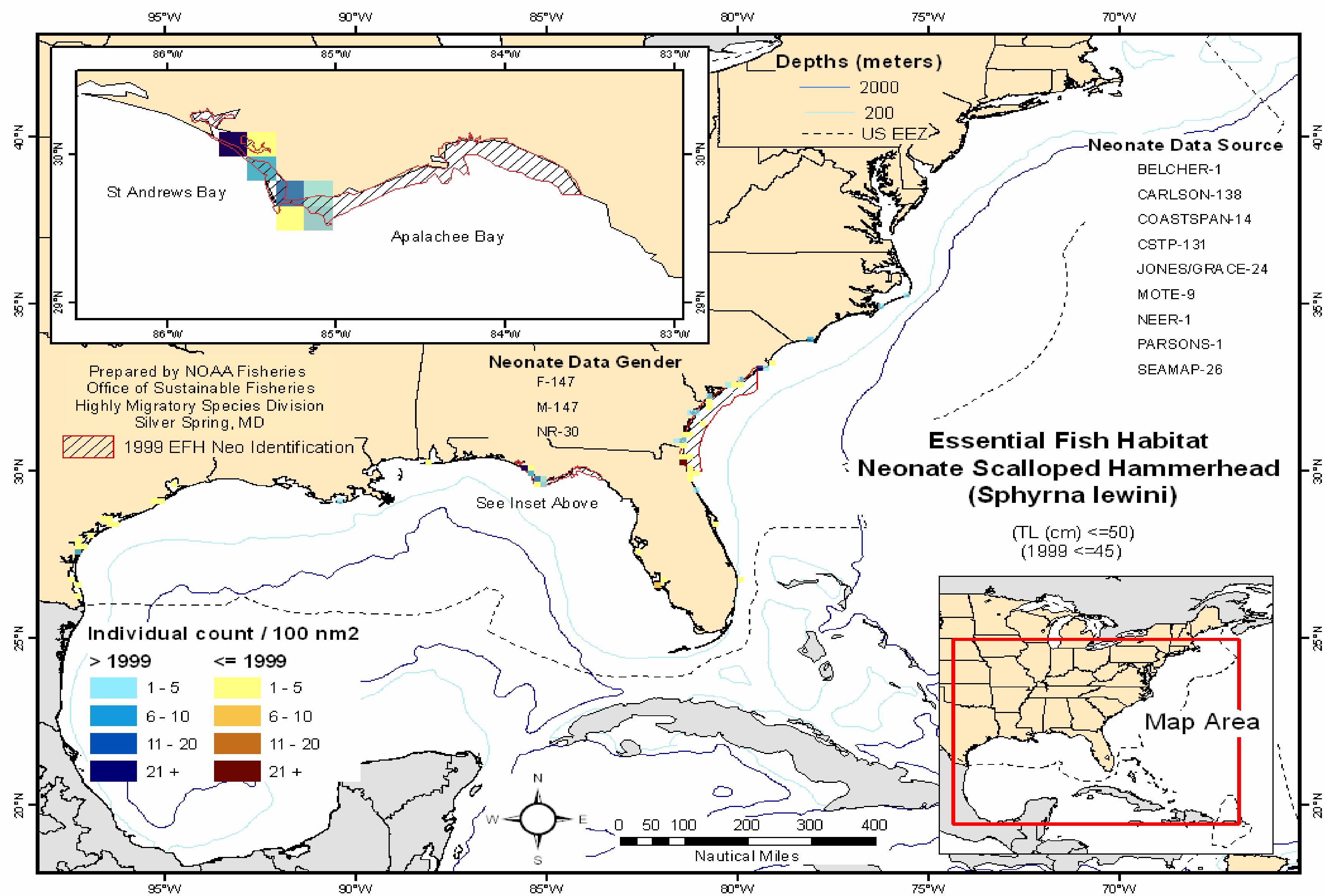

Figure B.37 **Scalloped Hammerhead: Neonate.**

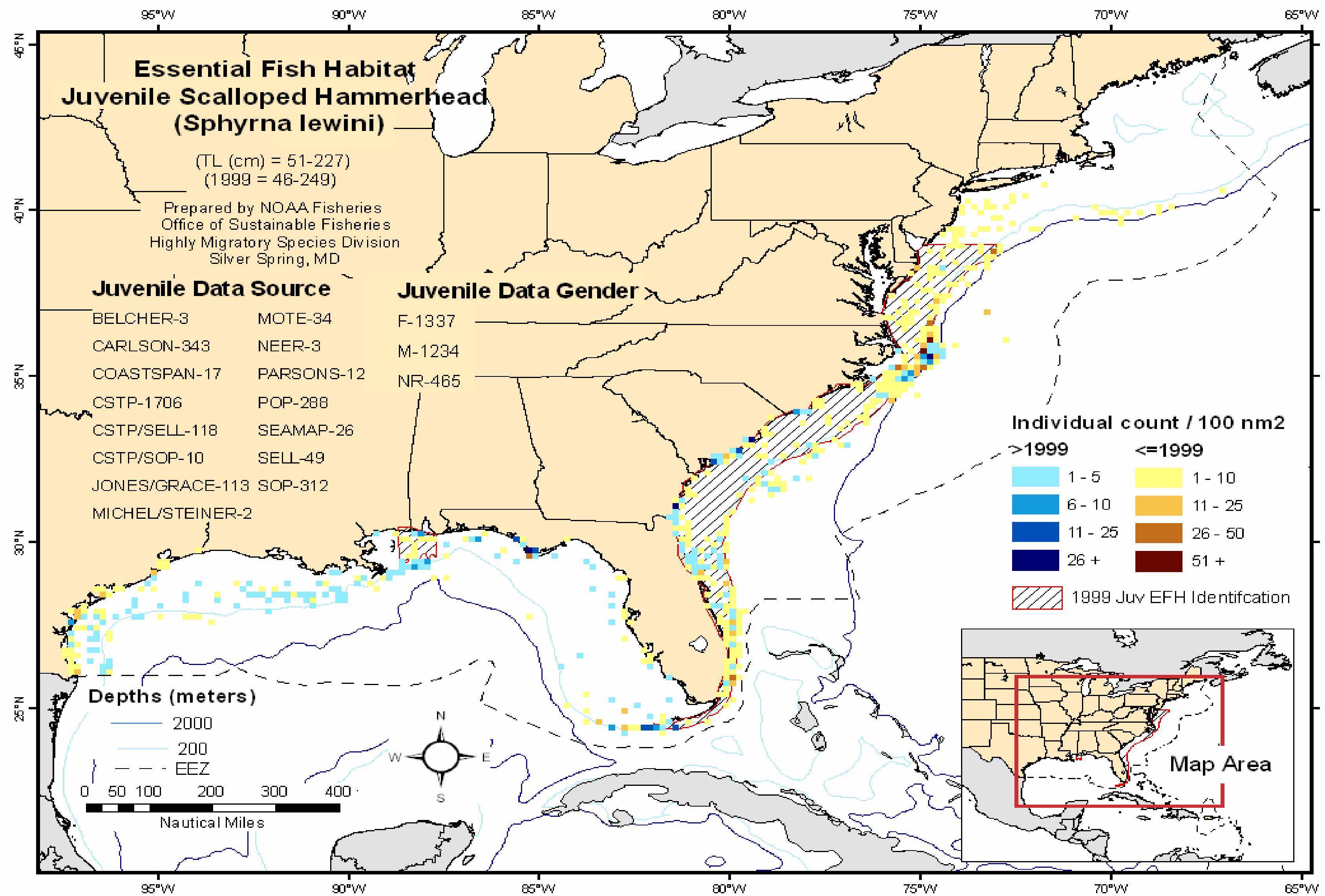

Figure B.38 Scalloped Hammerhead: Juvenile.

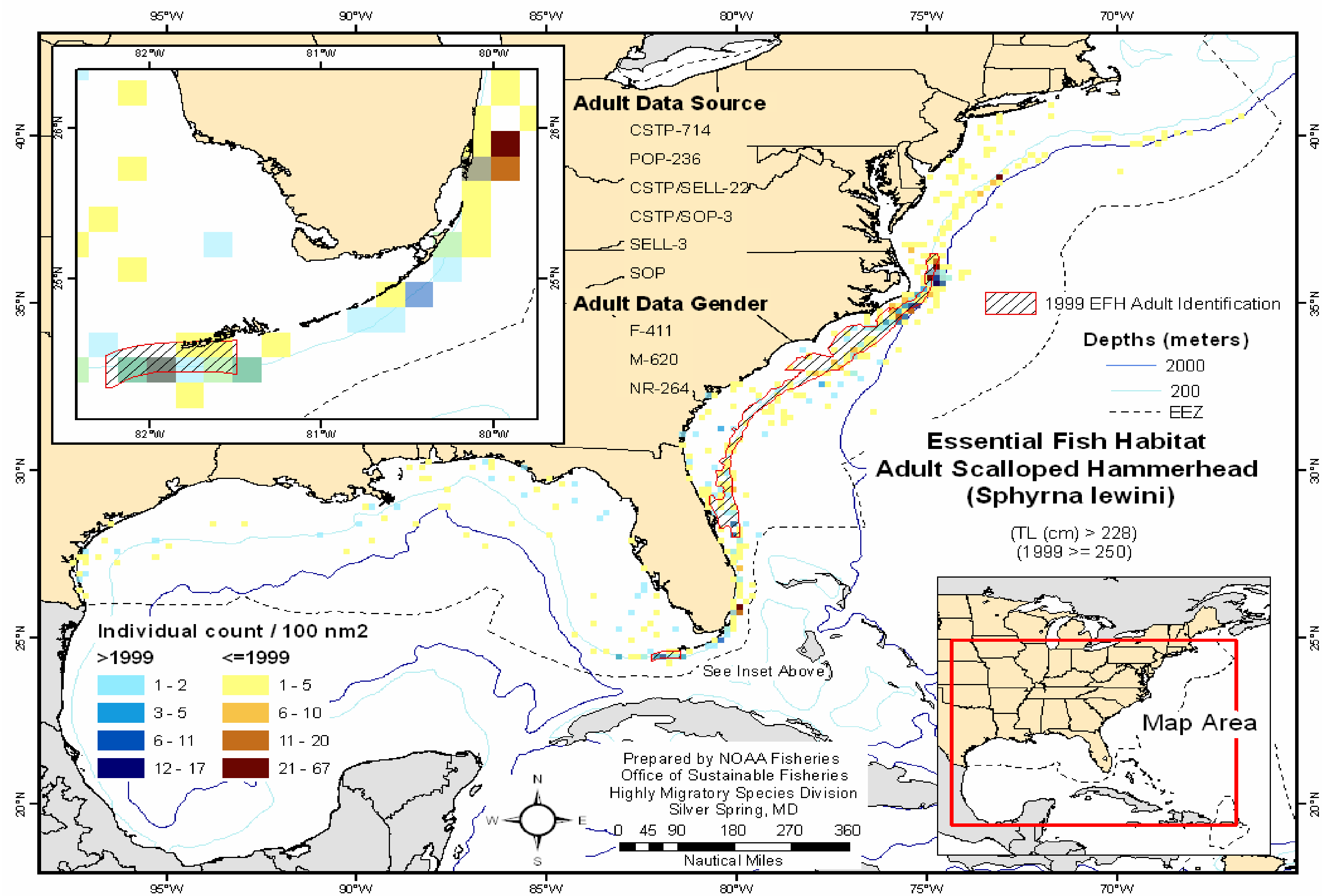

Figure B.39 **Scalloped Hammerhead: Adult.**

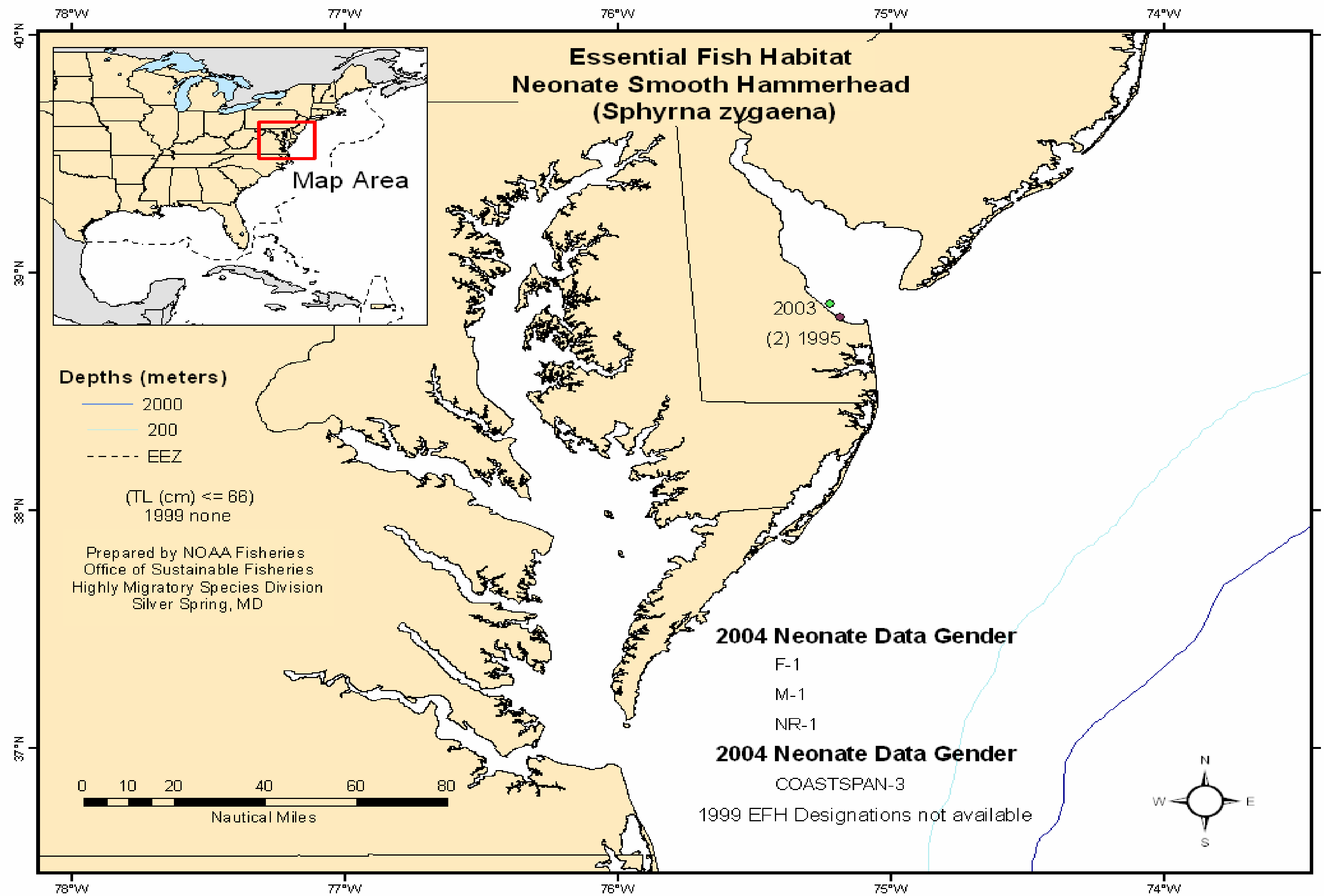

Figure B.40 Smooth Hammerhead: Neonate.

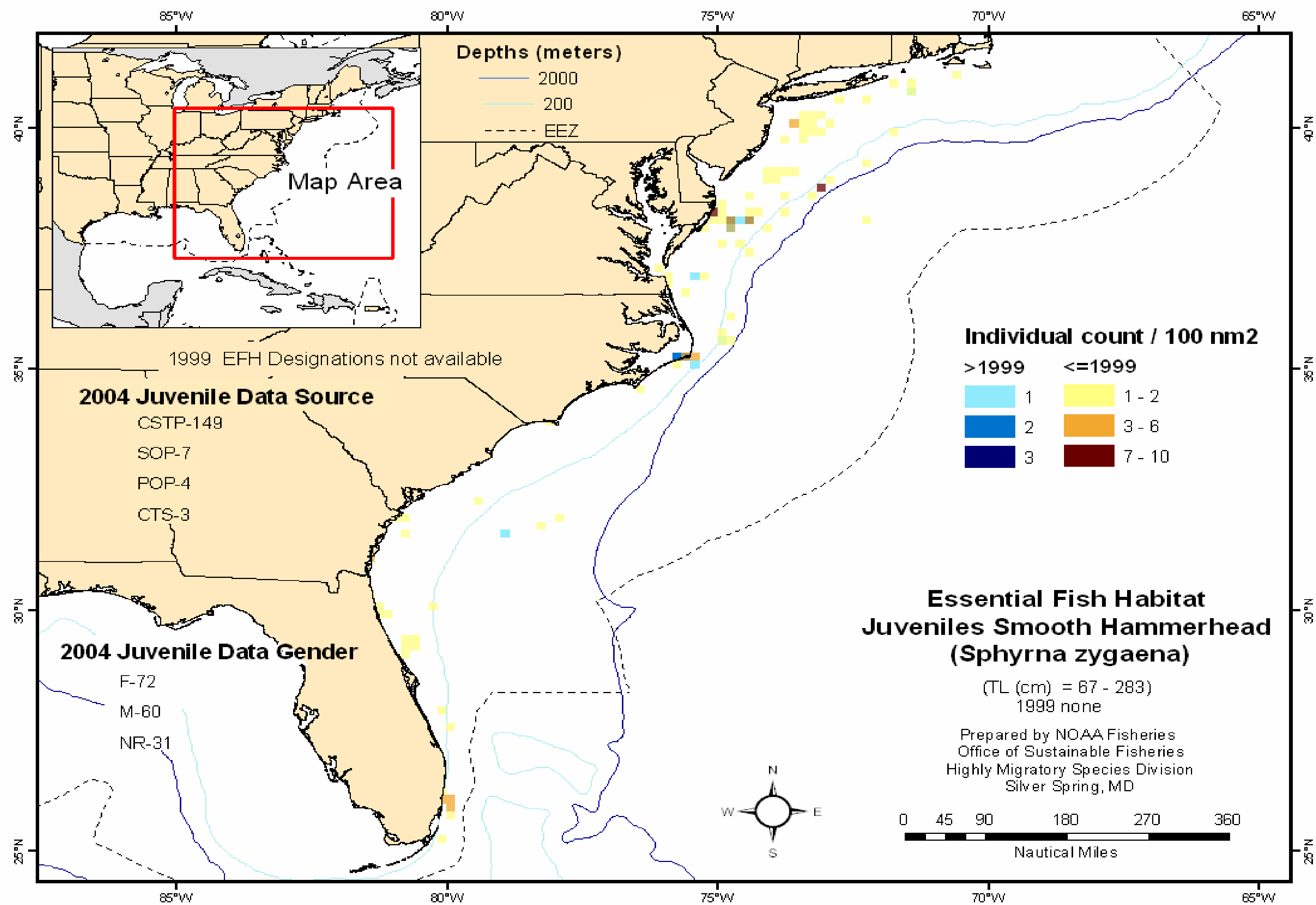

Figure B.41 **Smooth Hammerhead: Juvenile.**

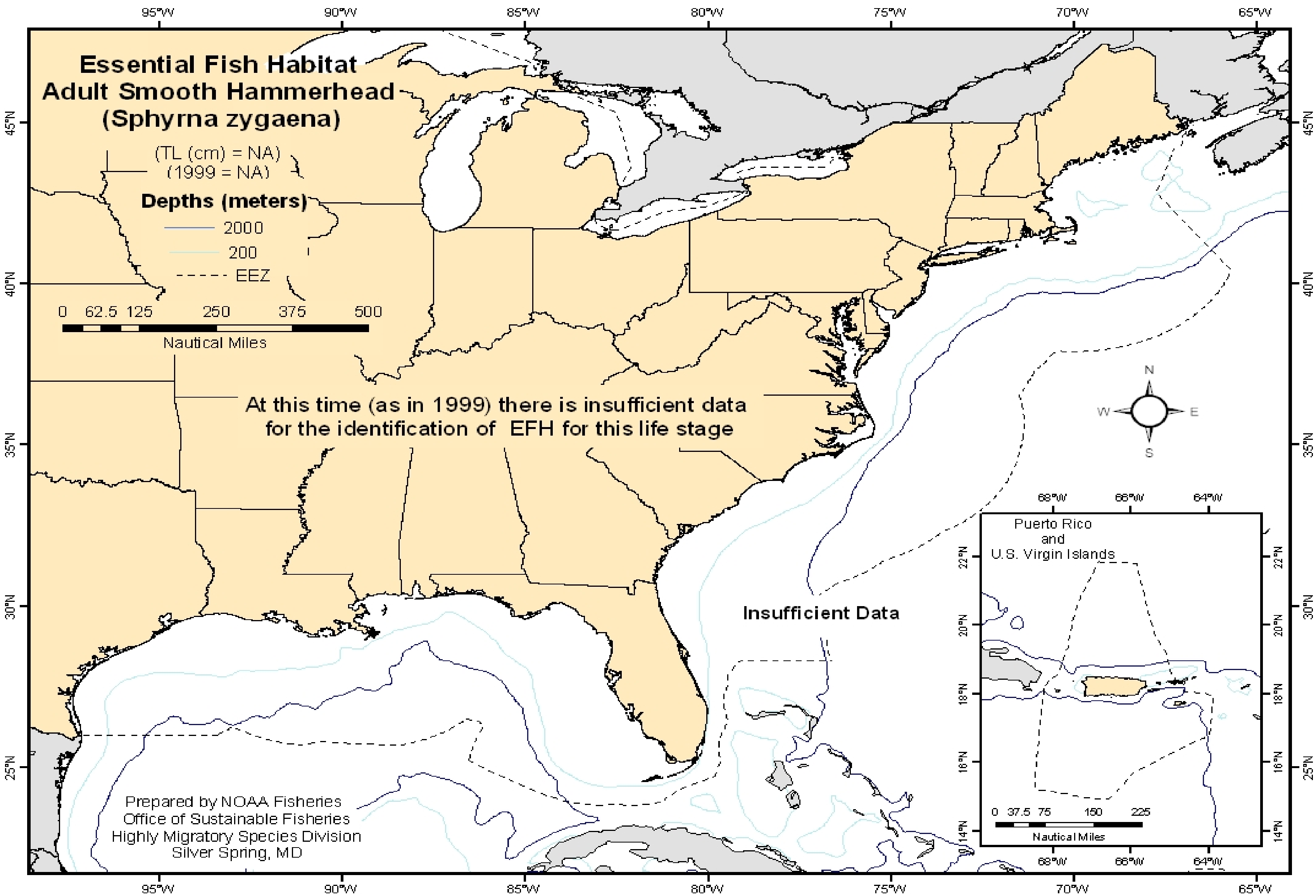

Figure B.42 Smooth Hammerhead: Adult.

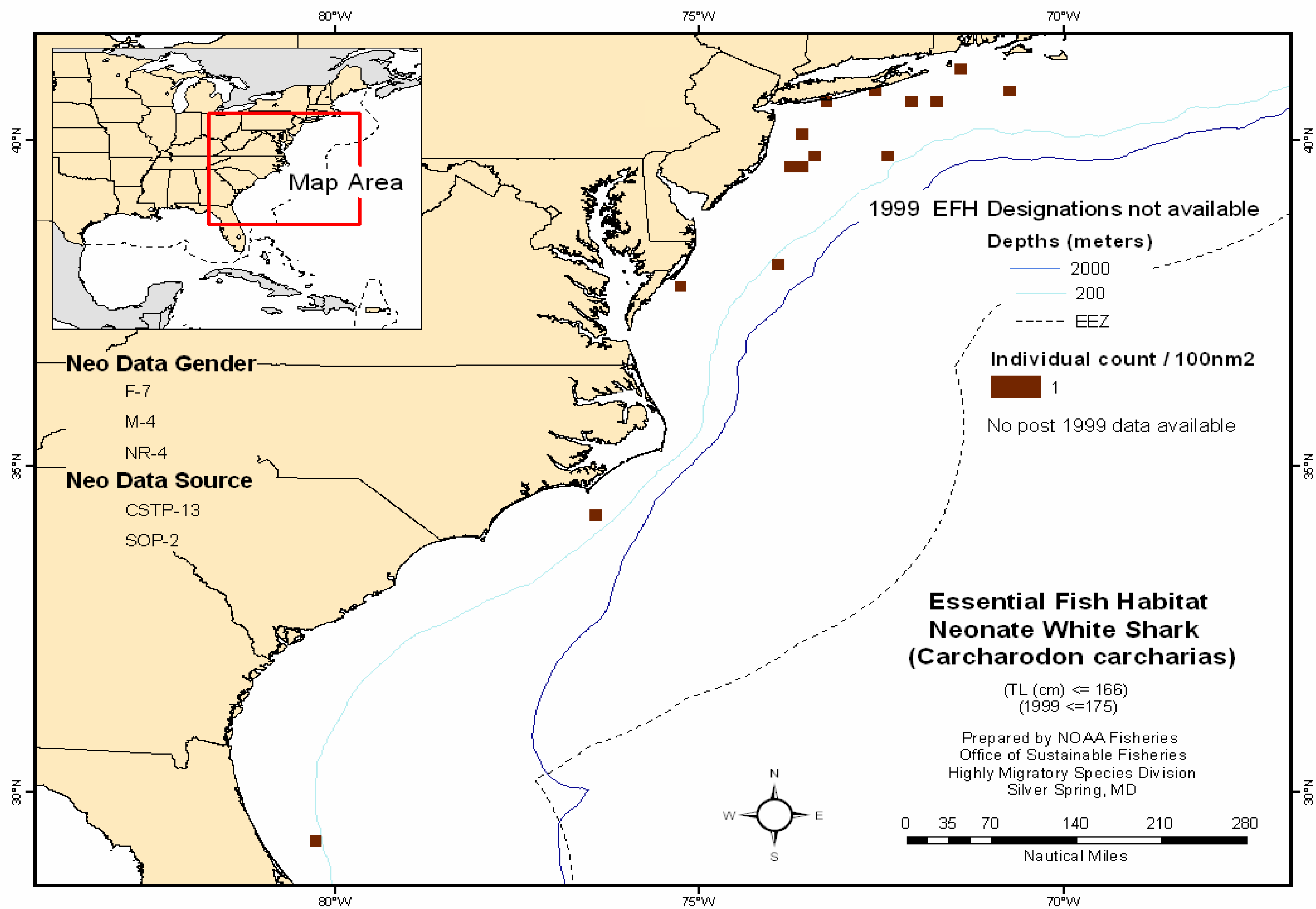

Figure B.43 **White Shark: Neonate.**

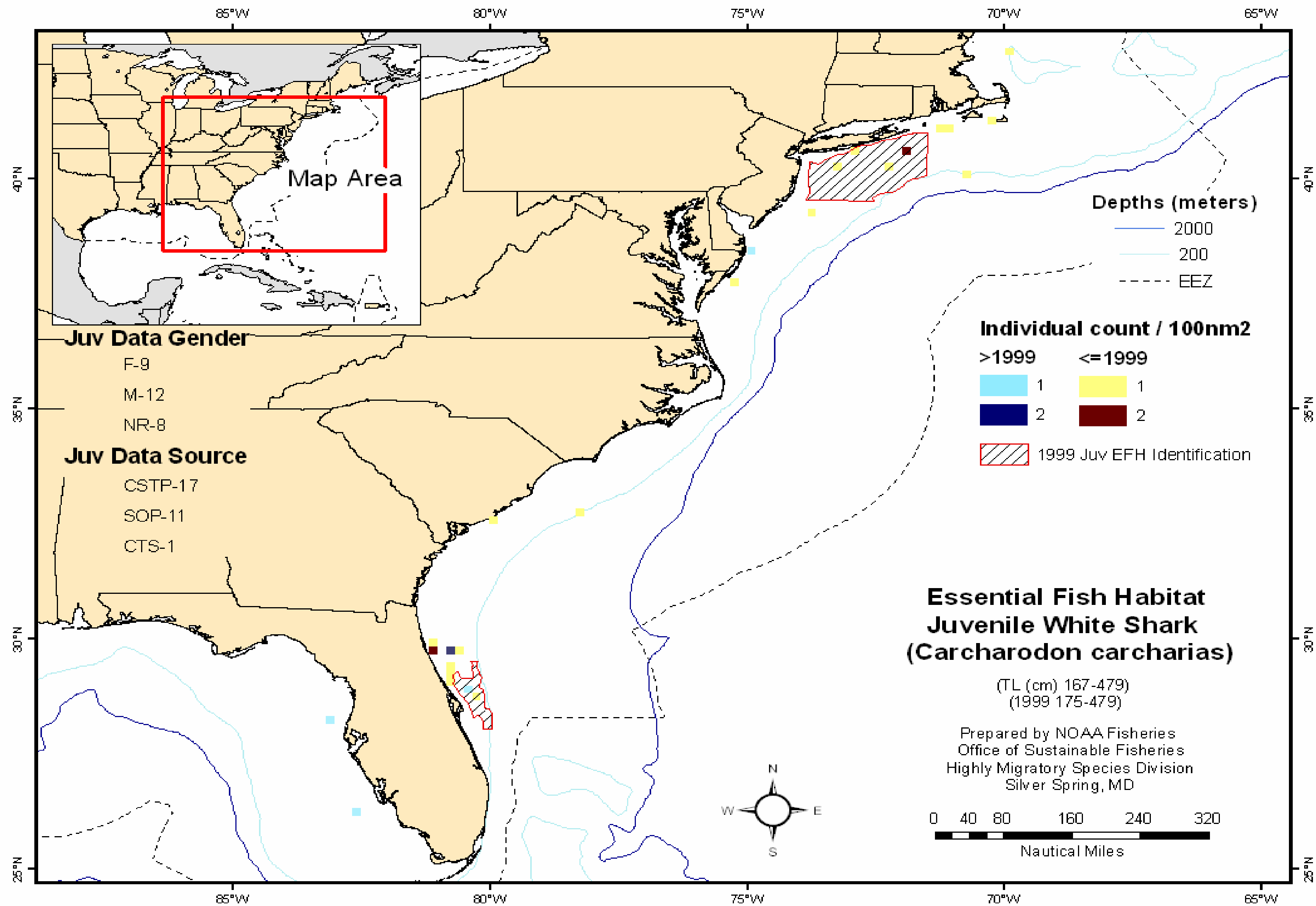

Figure B.44 White Shark: Juvenile.

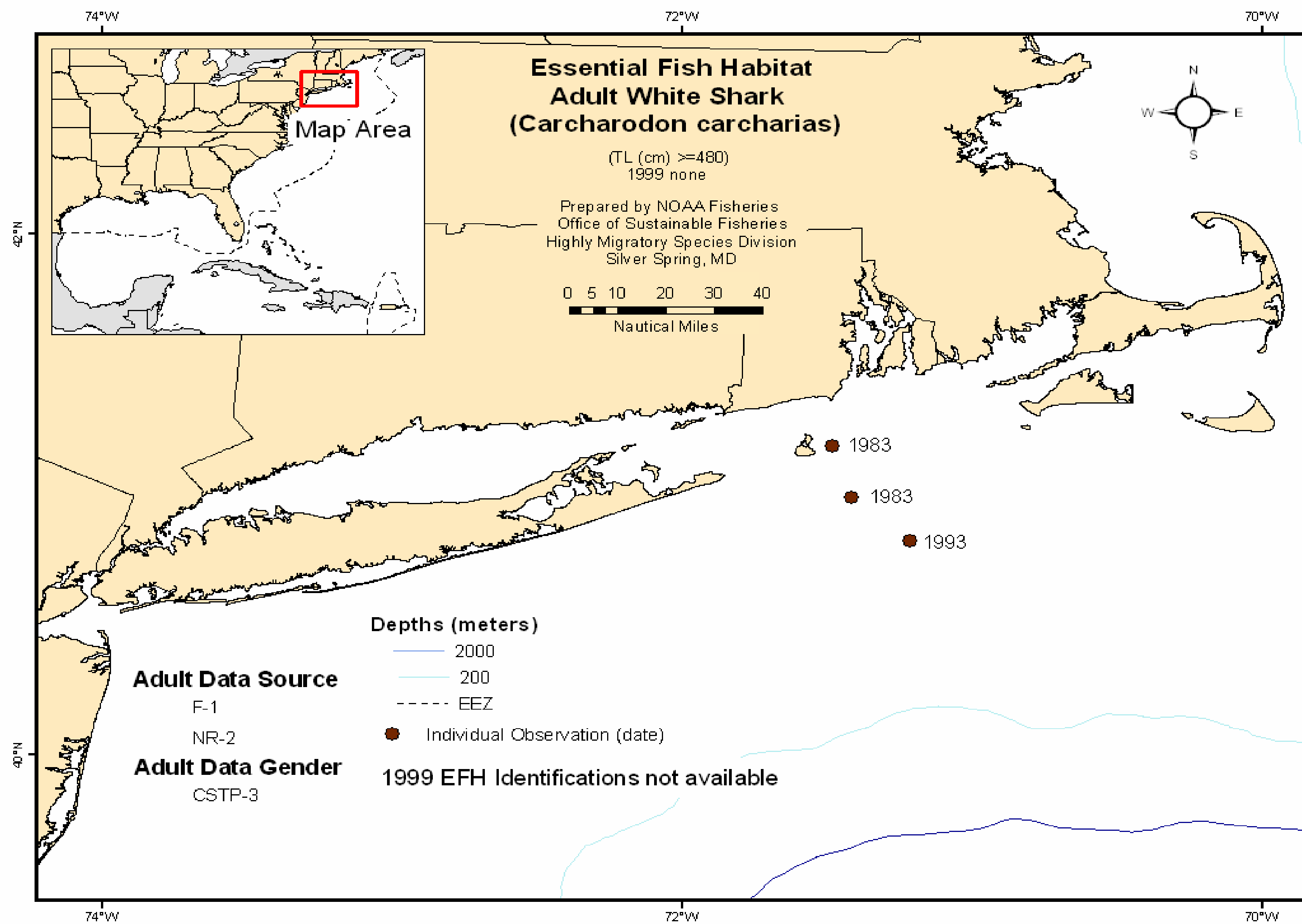

Figure B.45 White Shark: Adult.

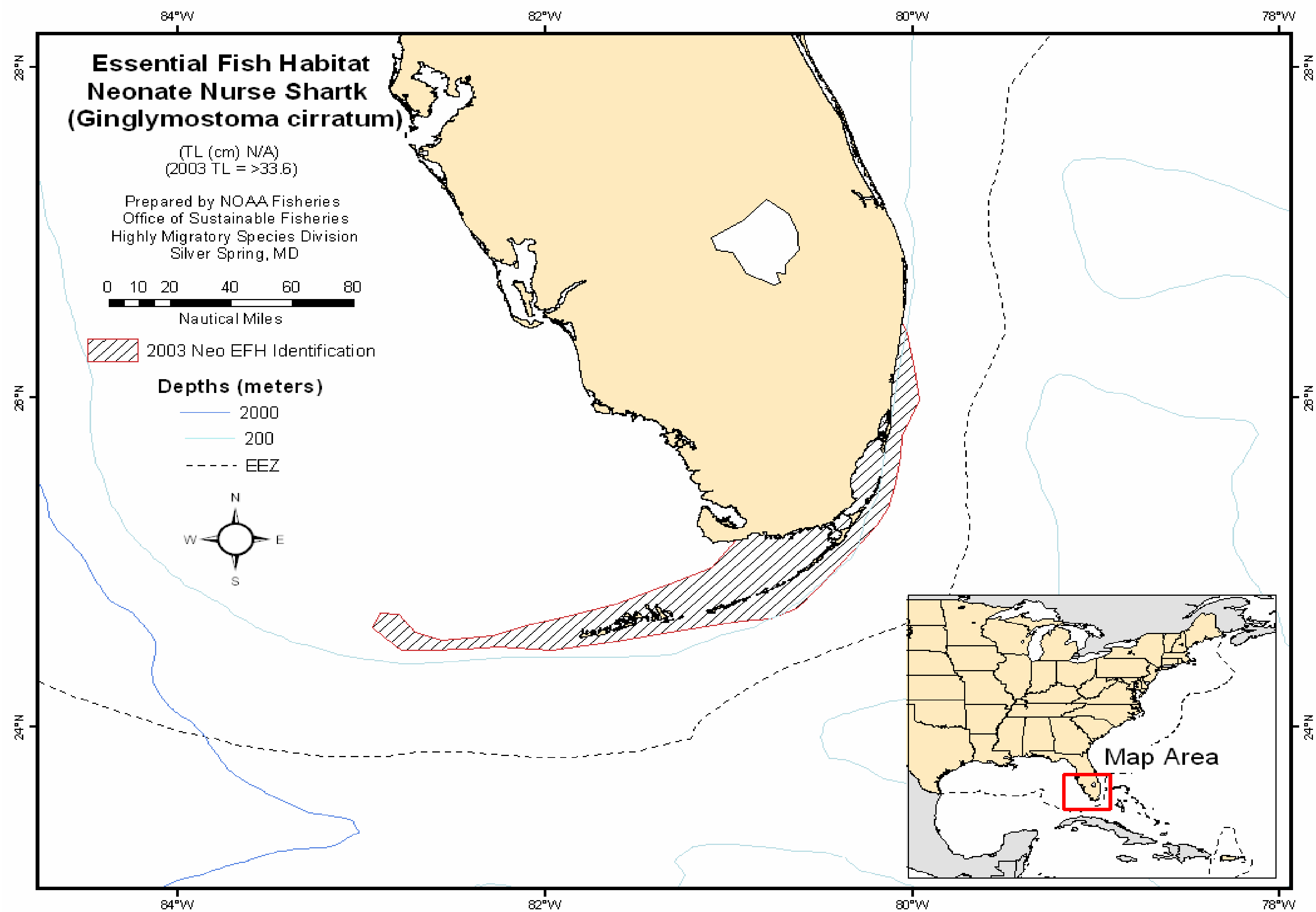

Figure B.46 **Nurse Shark: Neonate.**

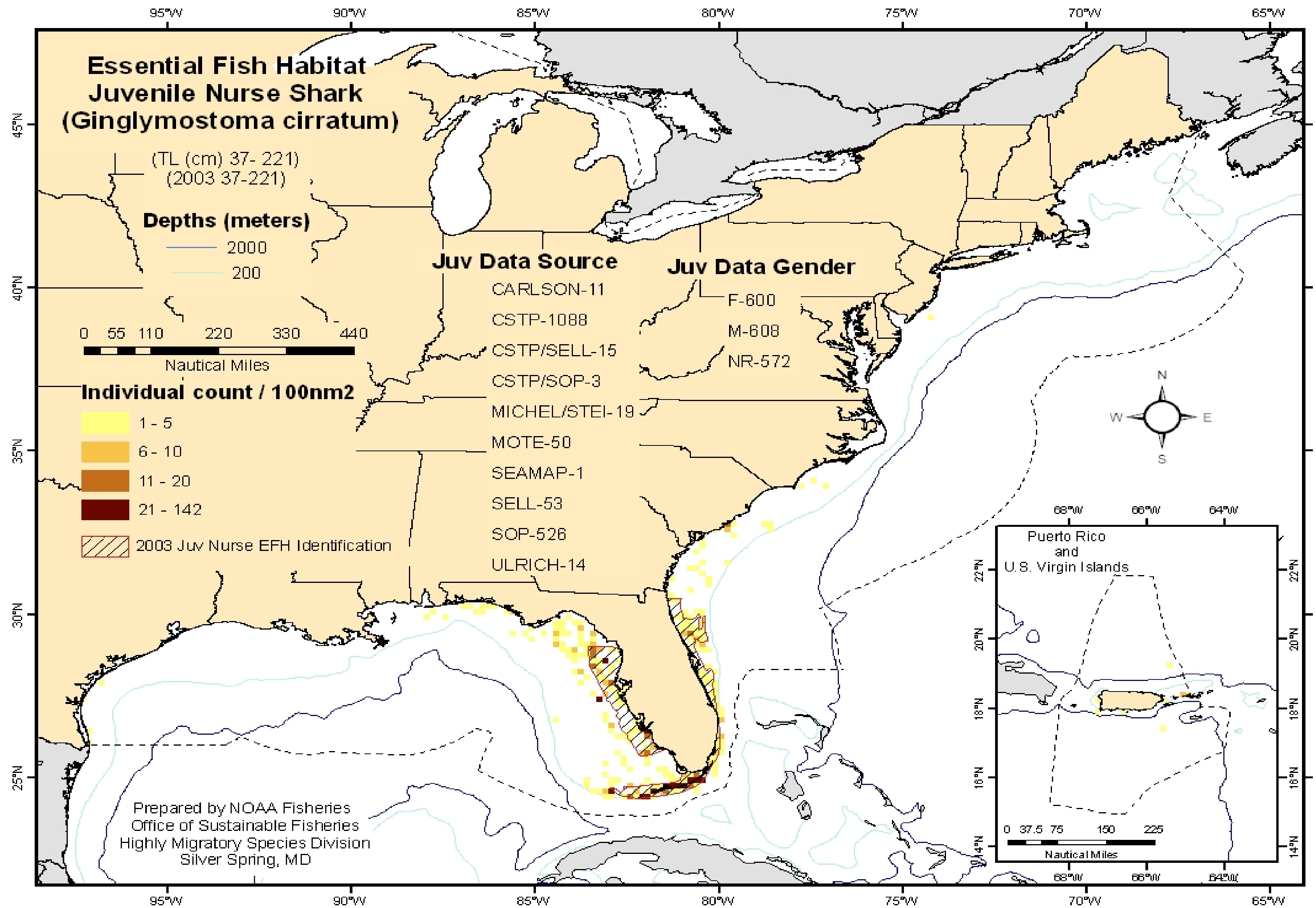

Figure B.47 Nurse Shark: Juvenile.

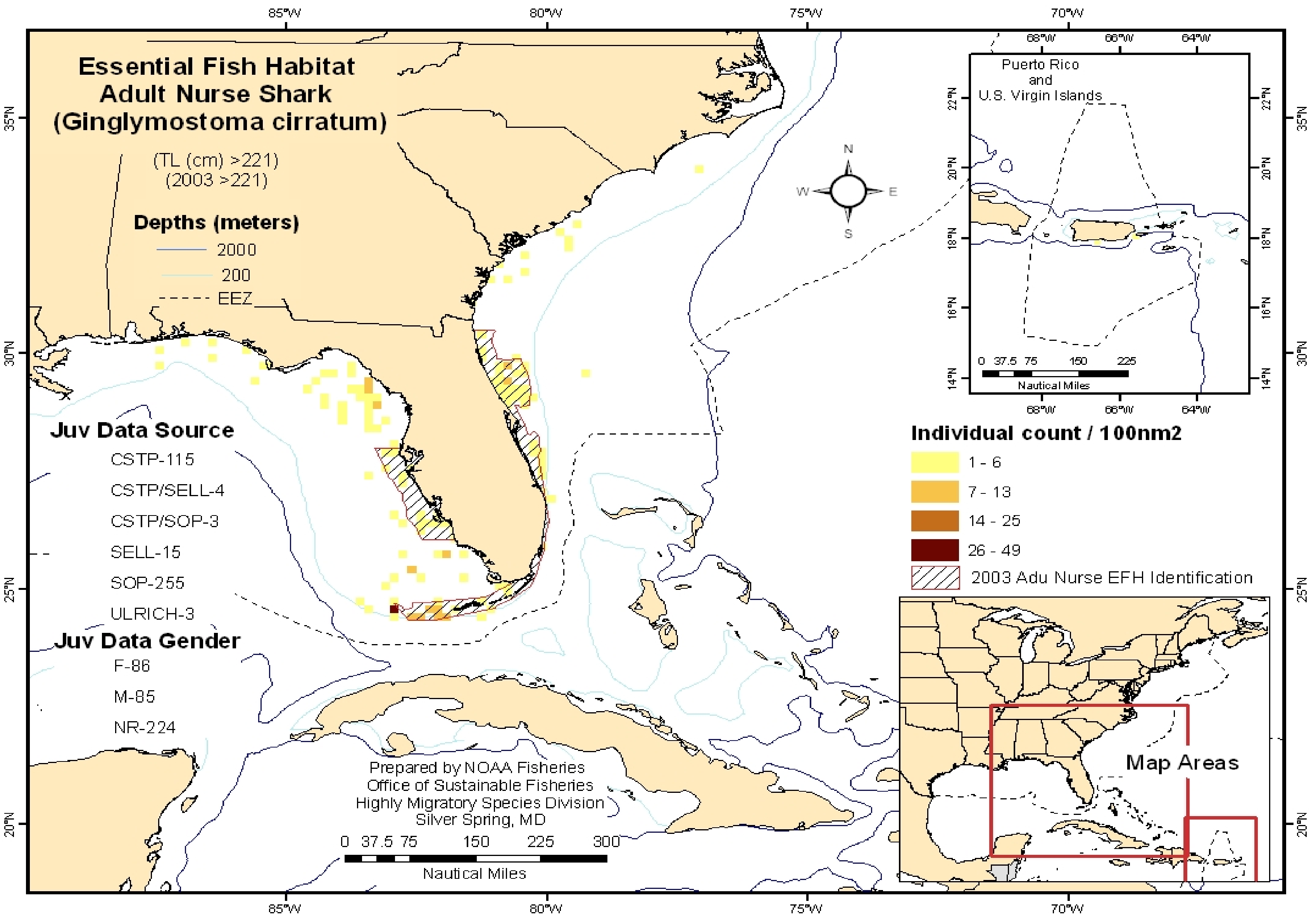

Figure B.48 Nurse Shark: Adult.

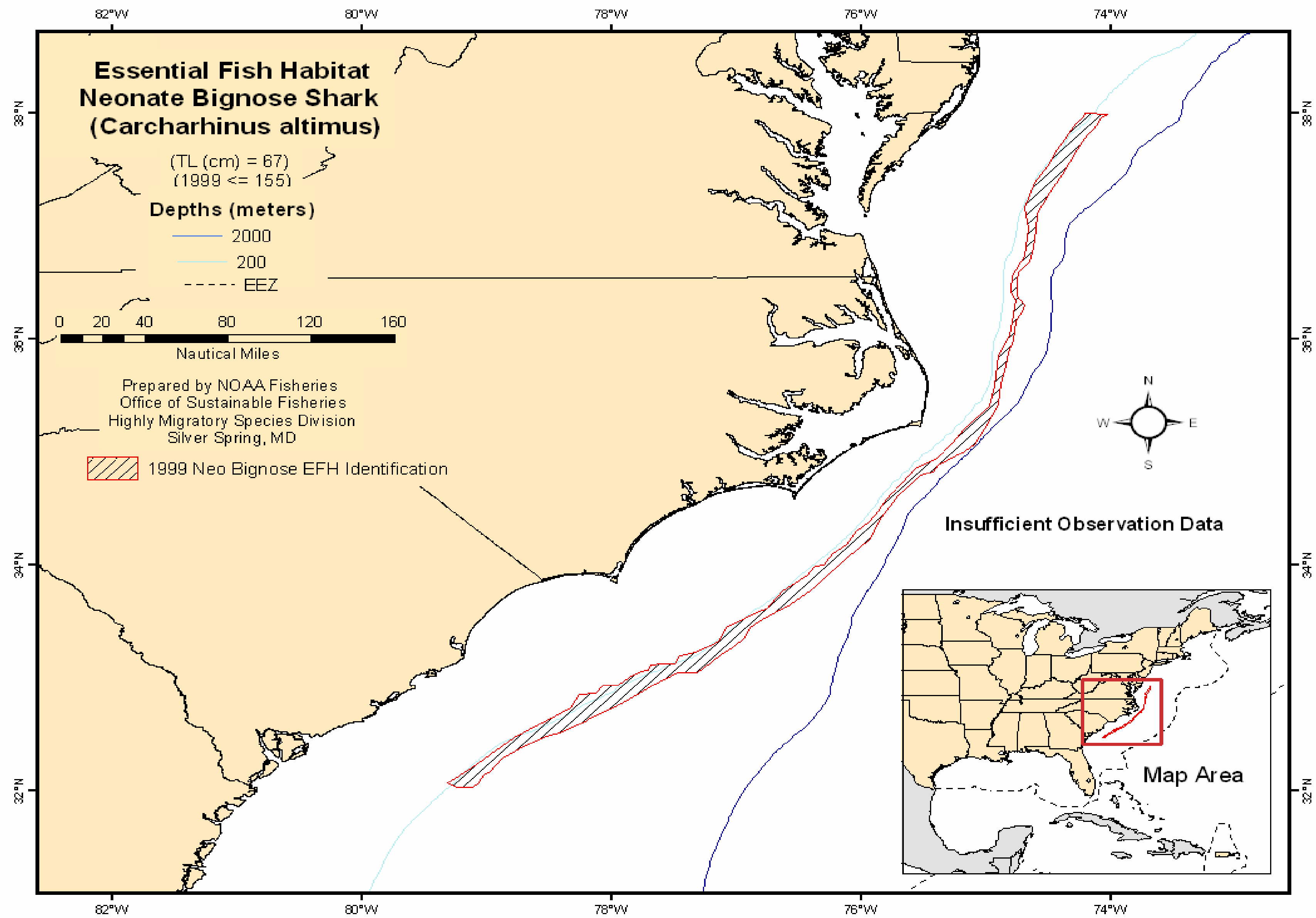

Figure B.49 **Bignose Shark: Neonate.**

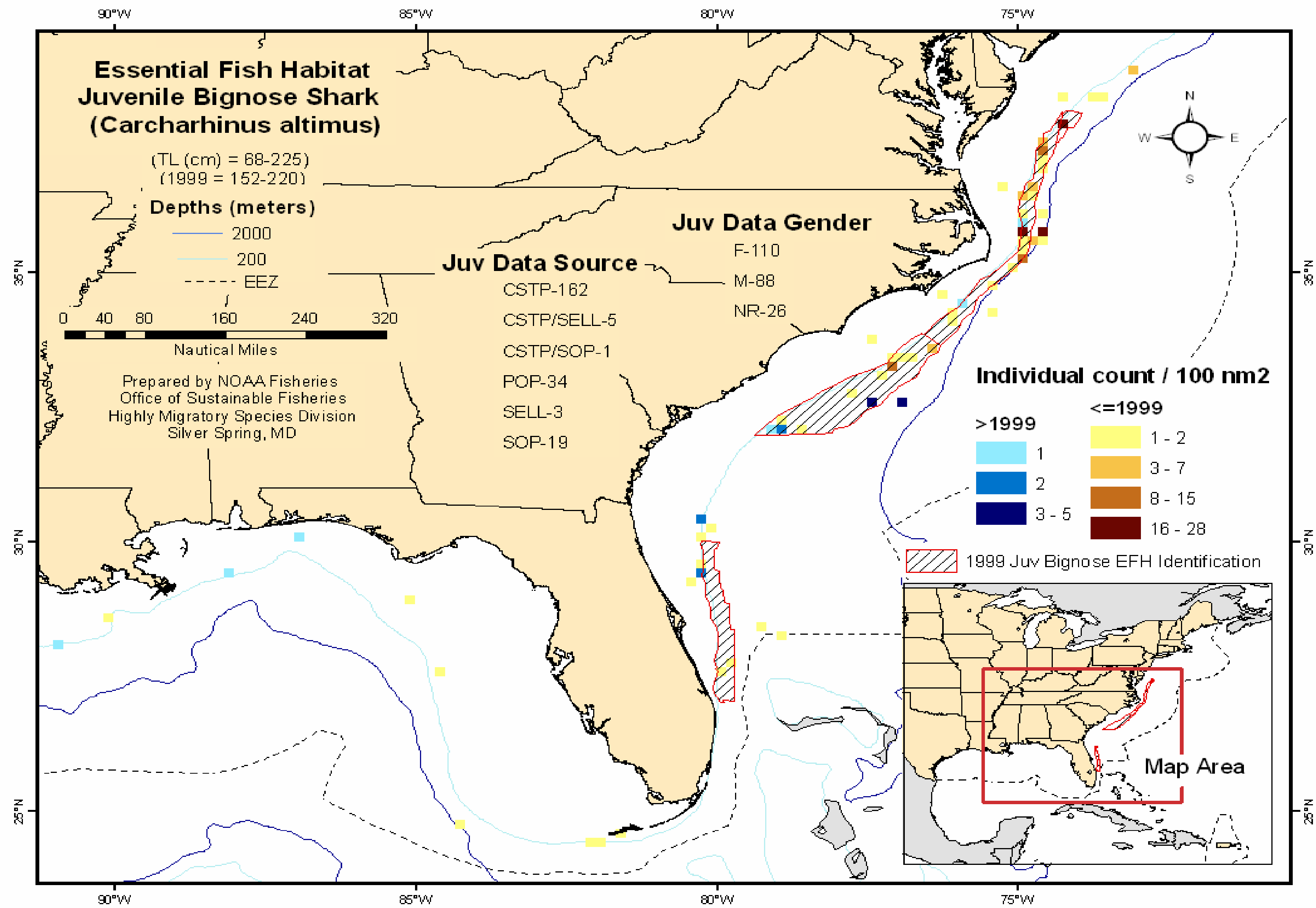

Figure B.50 Bignose Shark: Juvenile.

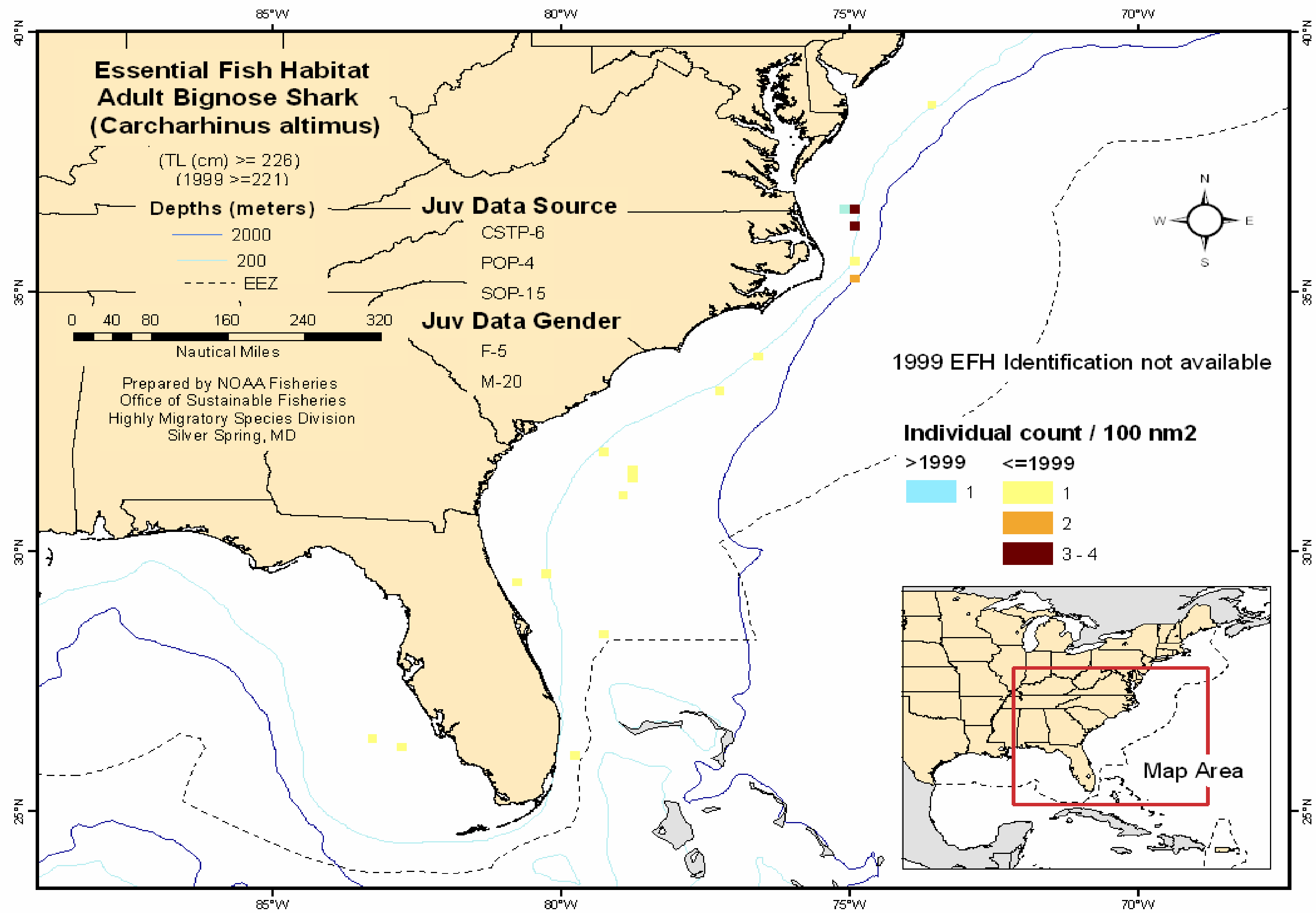

Figure B.51 **Bignose Shark: Adult.**

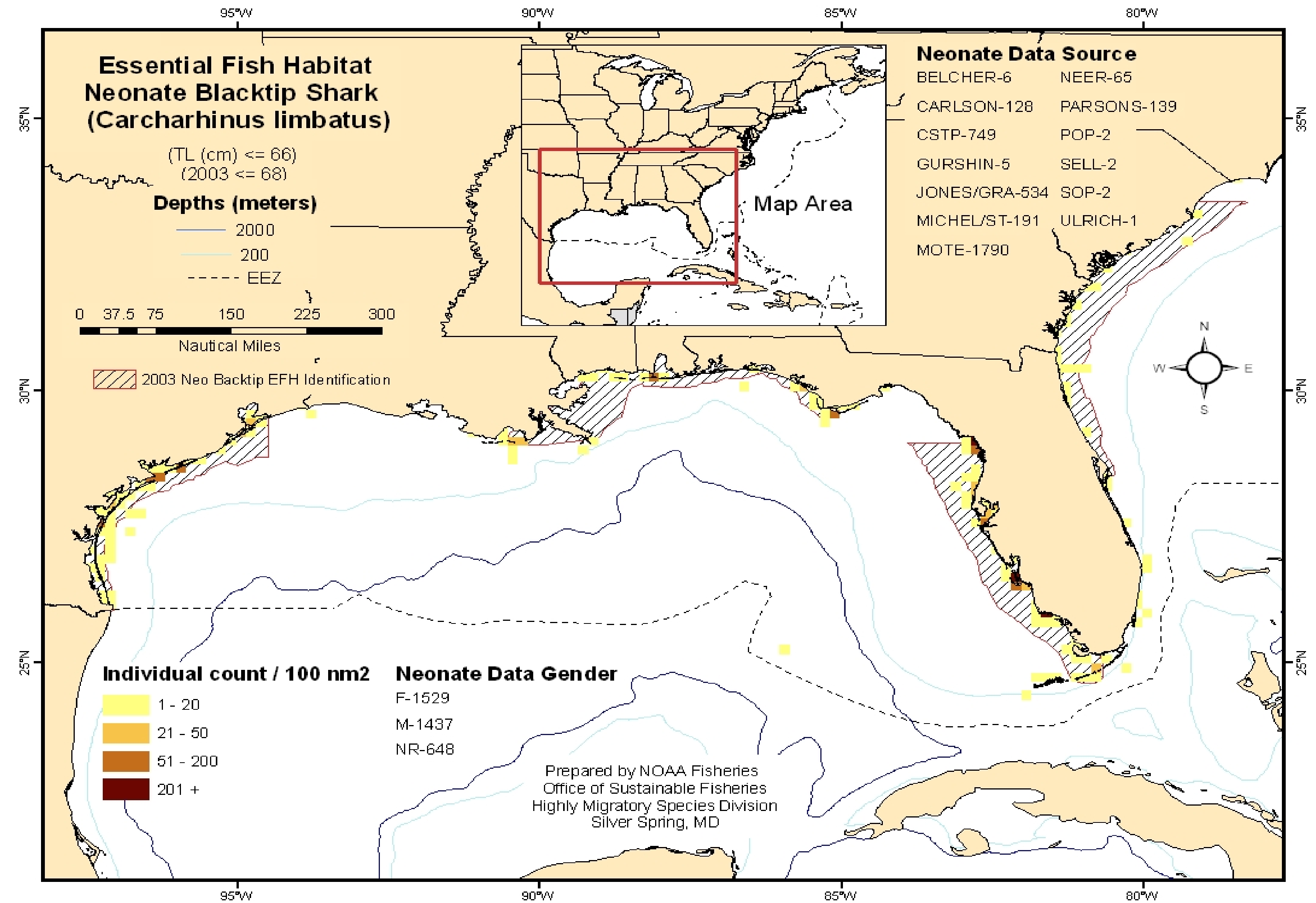

Figure B.52 **Blacktip Shark: Neonate.**

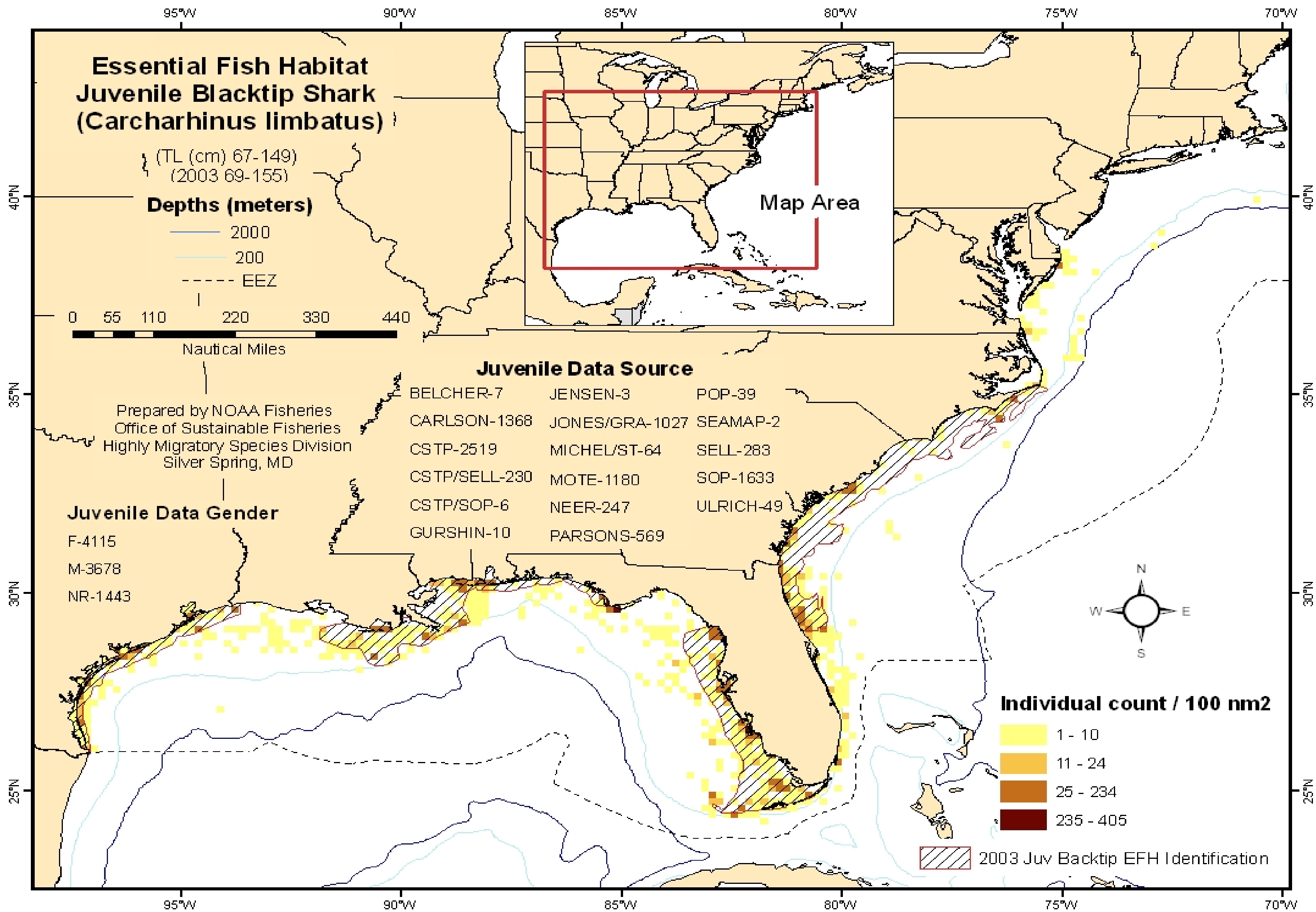

Figure B.53 **Blacktip Shark: Juvenile.**

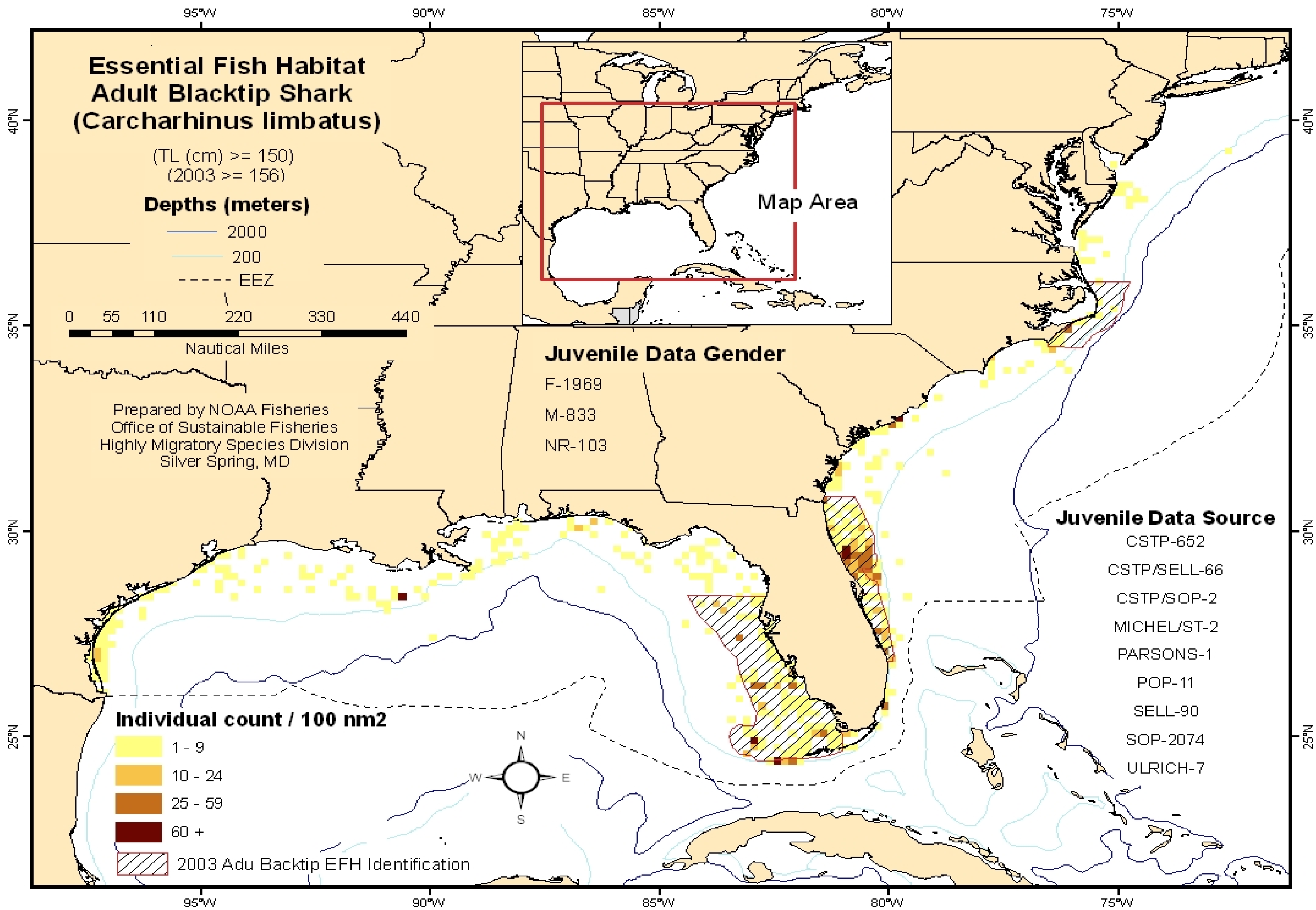

Figure B.54 Blacktip Shark: Adult.

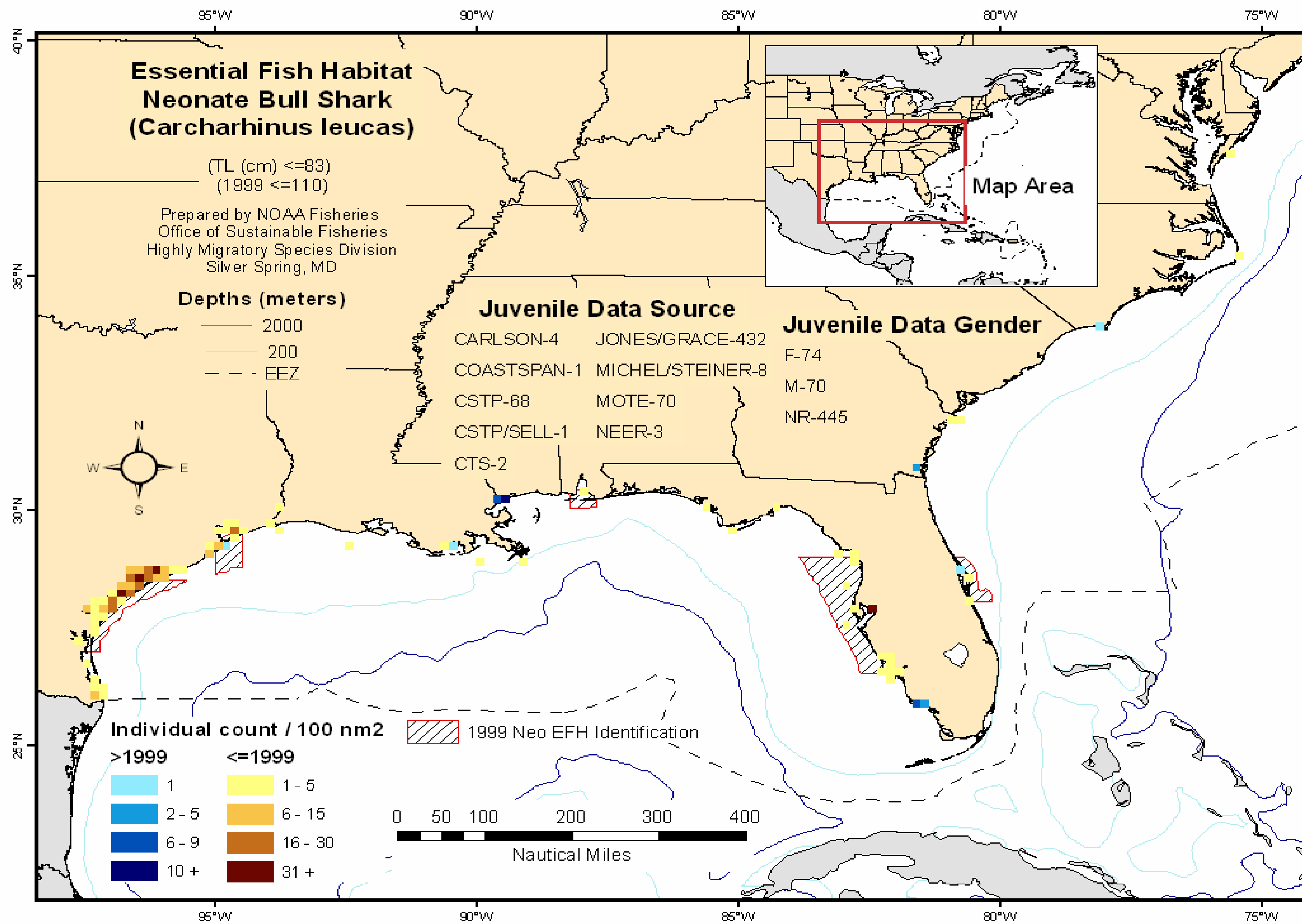

Figure B.55 **Bull Shark: Neonate.**

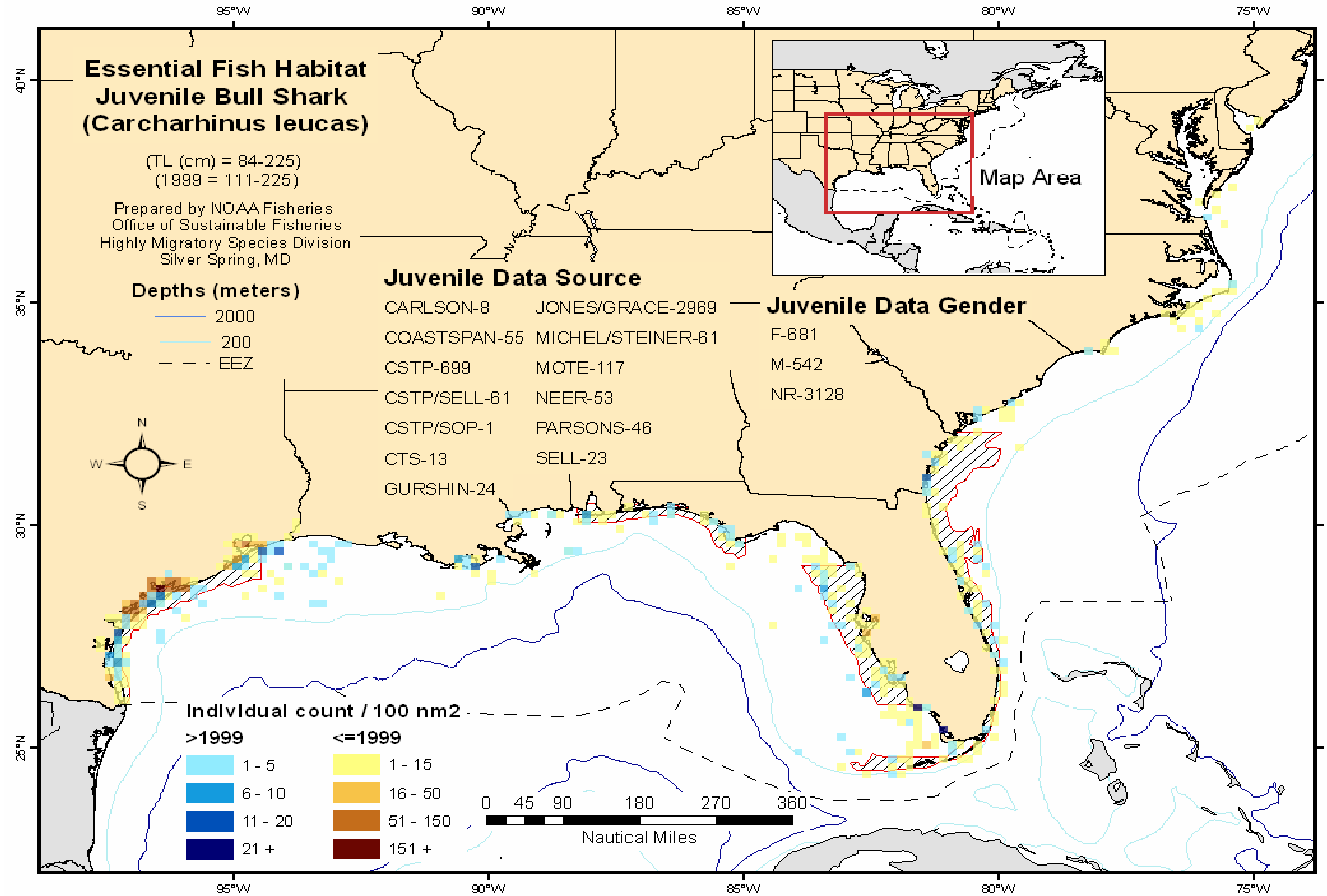

Figure B.56 **Bull Shark: Juvenile.**

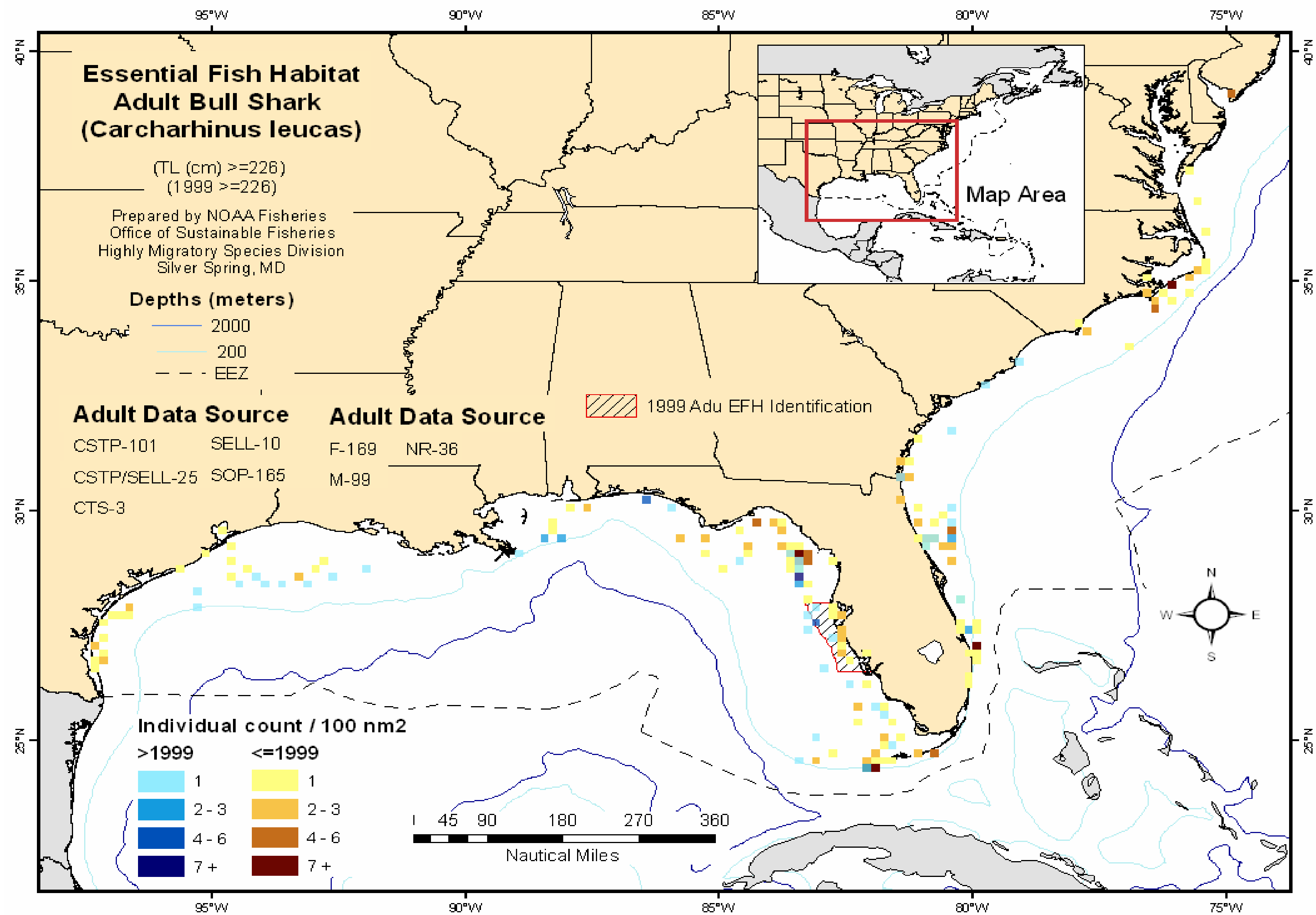

Figure B.57 Bull Shark: Adult.

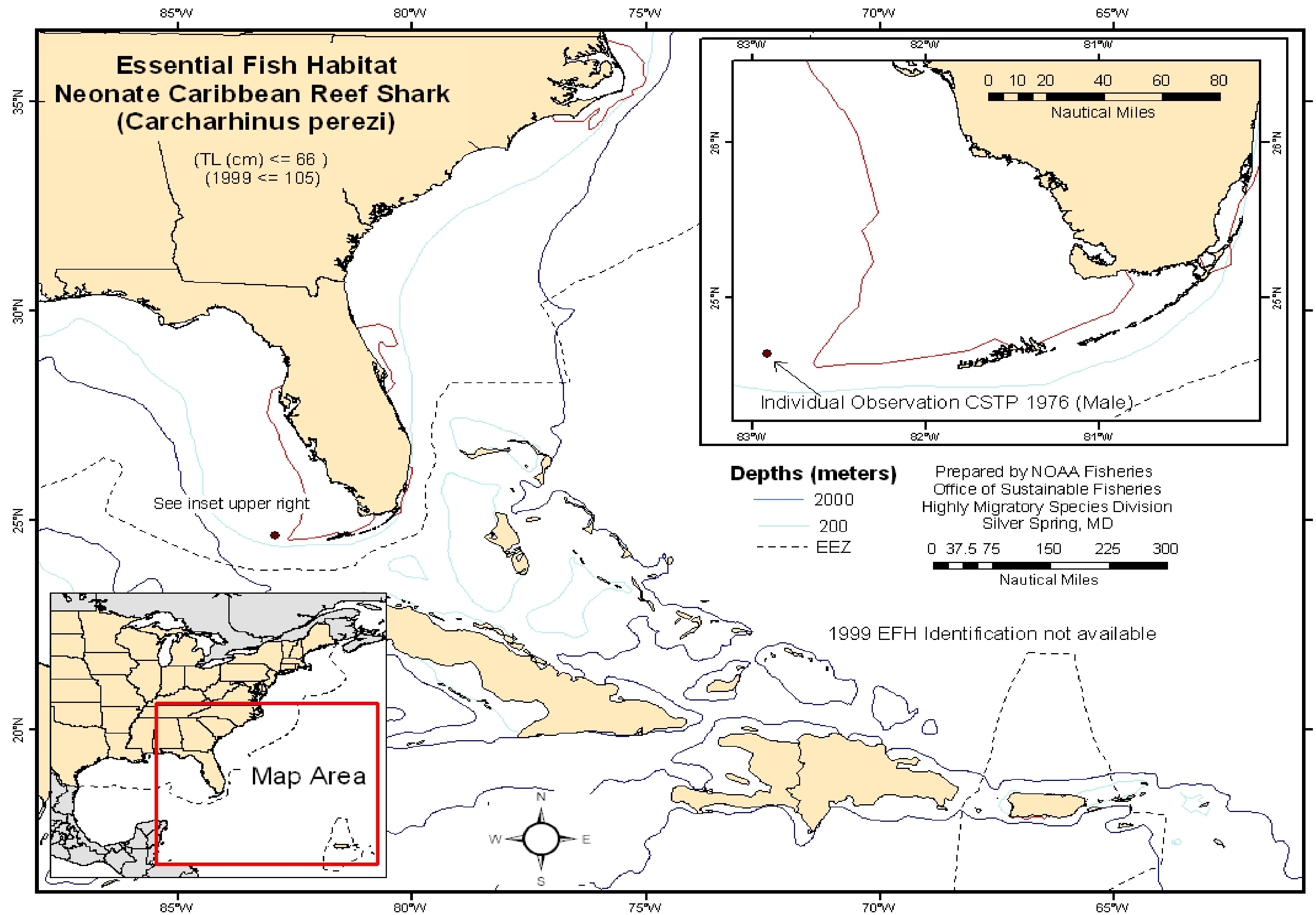

Figure B.58 Caribbean Reef Shark: Neonate.

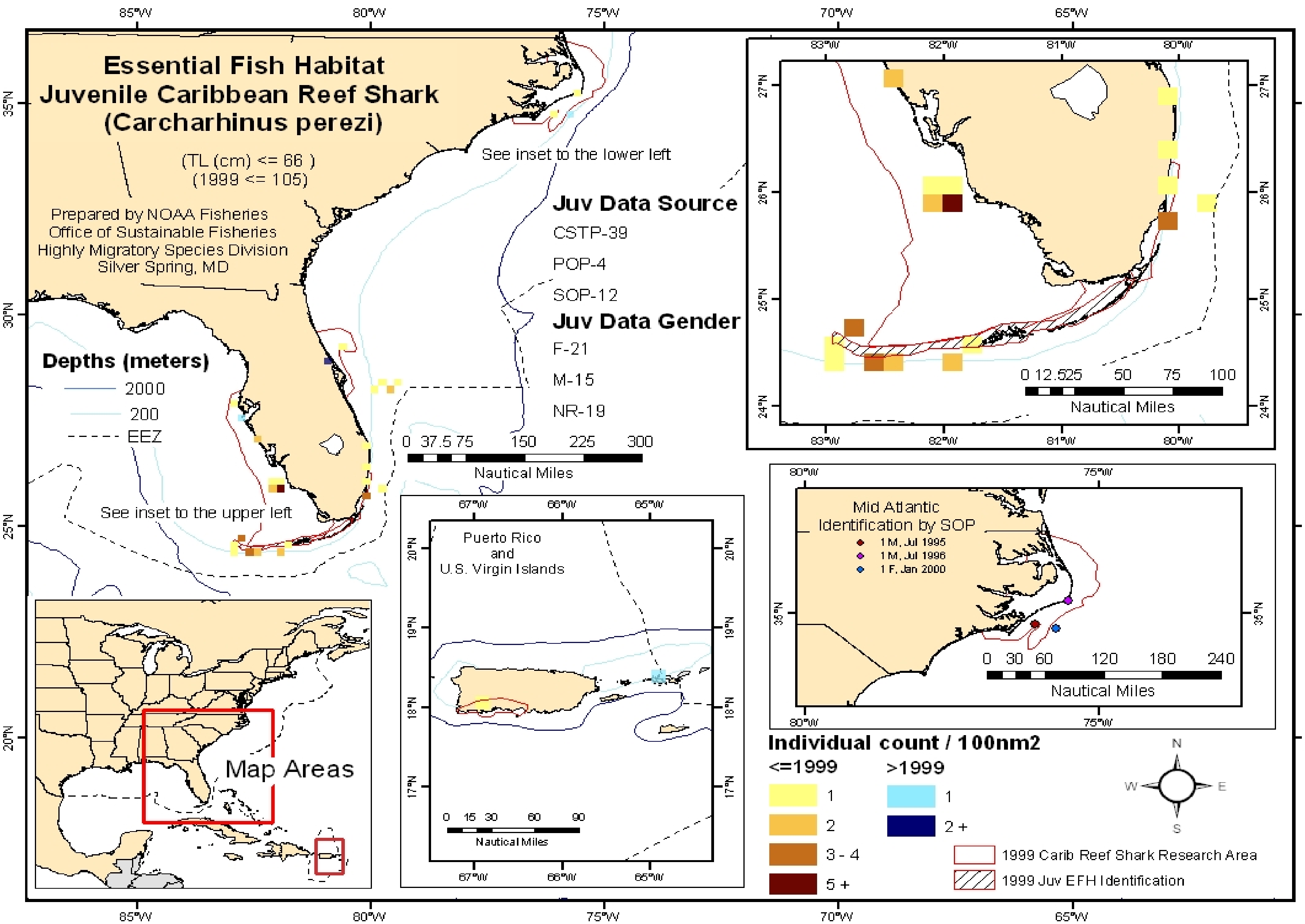

Figure B.59 Caribbean Reef Shark: Juvenile.

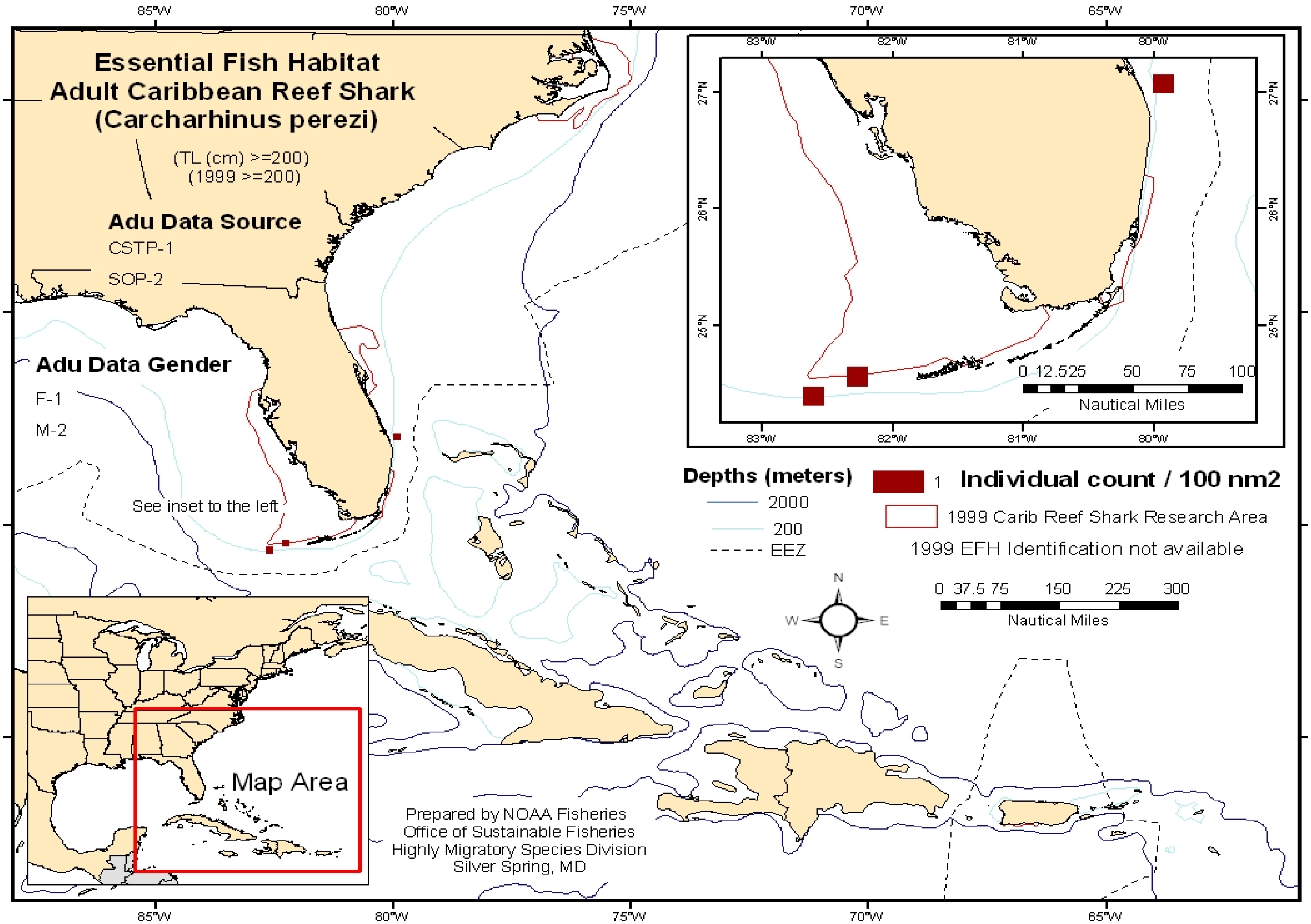

Figure B.60 Caribbean Reef Shark: Adult.

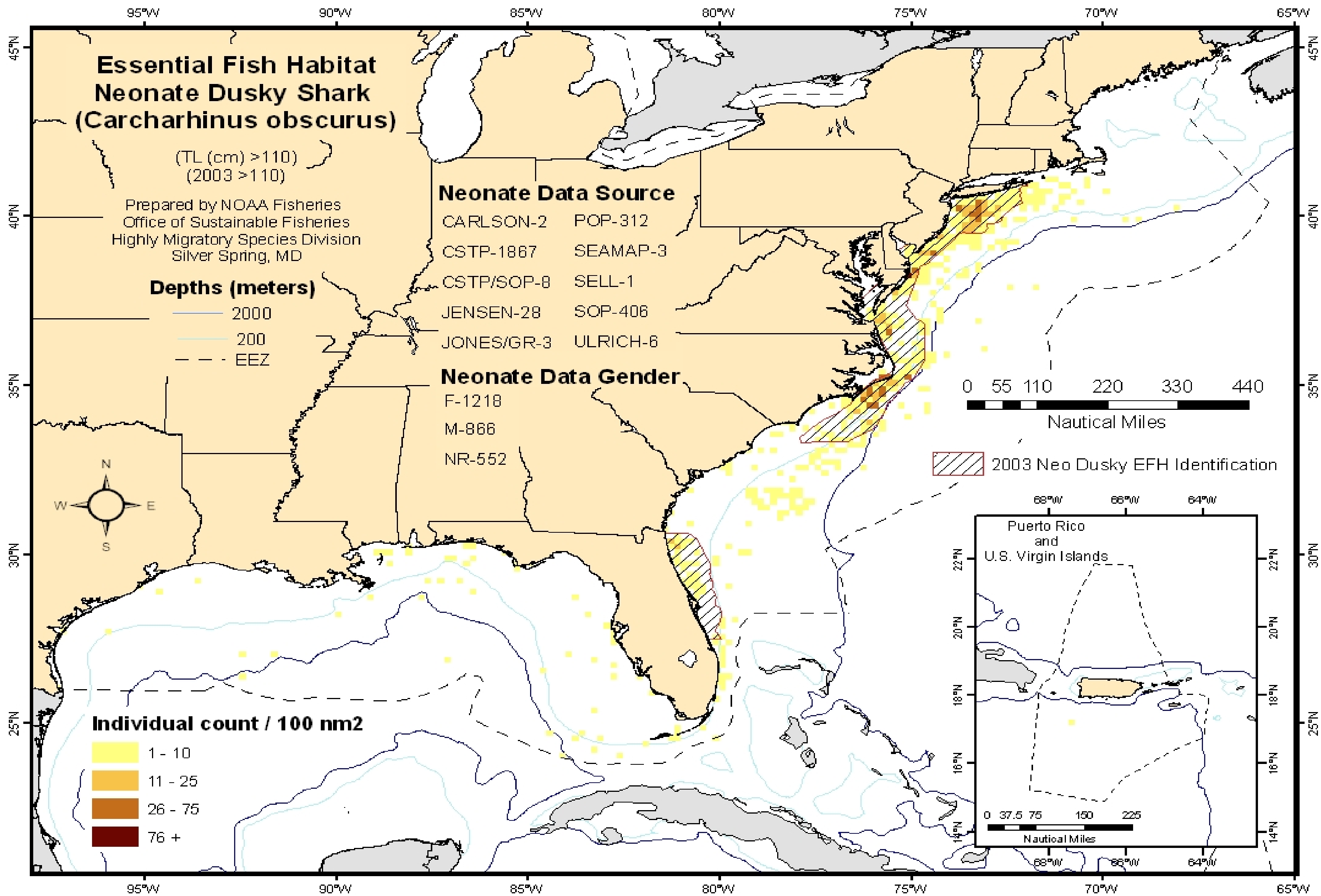

Figure B.61 Dusky Shark: Neonate.

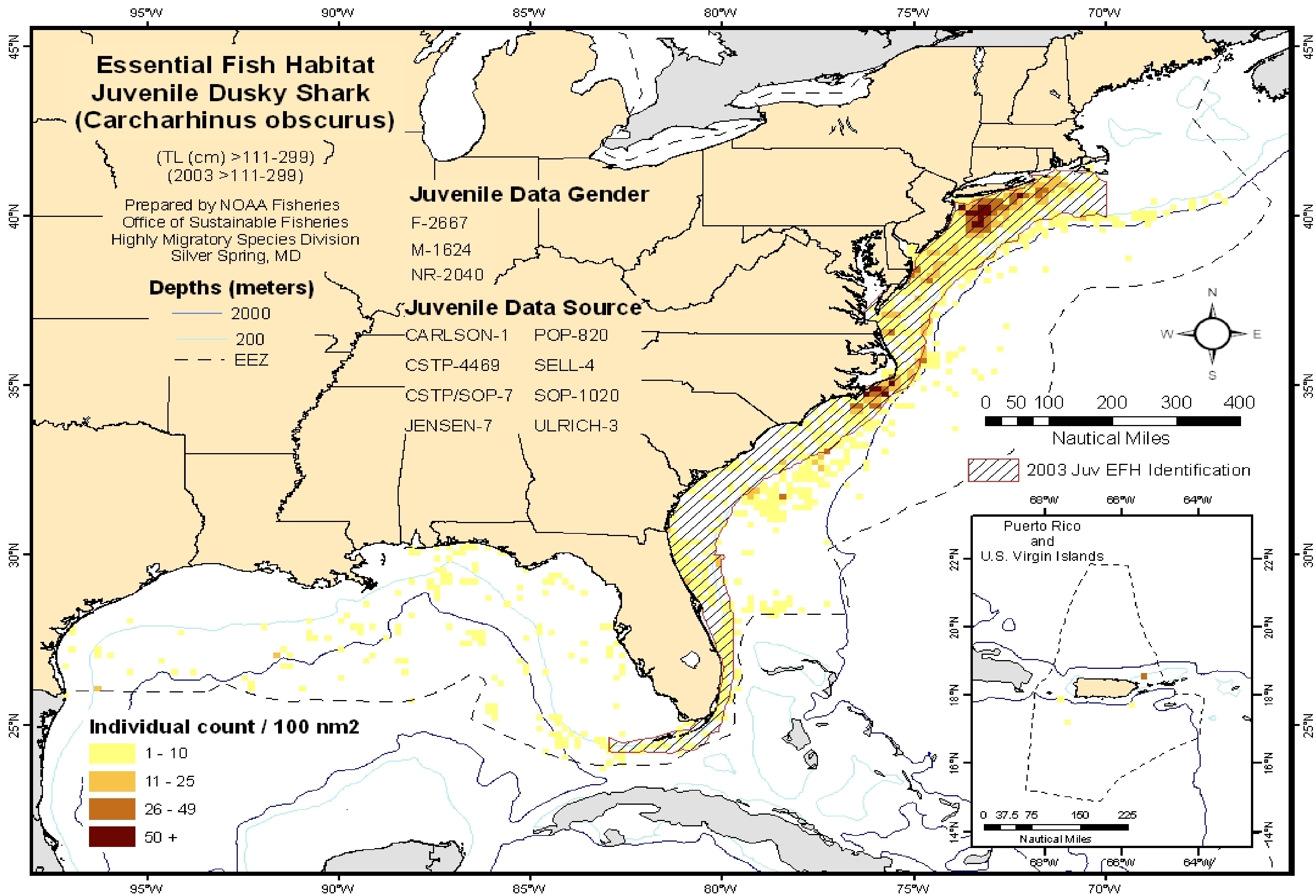

Figure B.62 Dusky Shark: Juvenile.

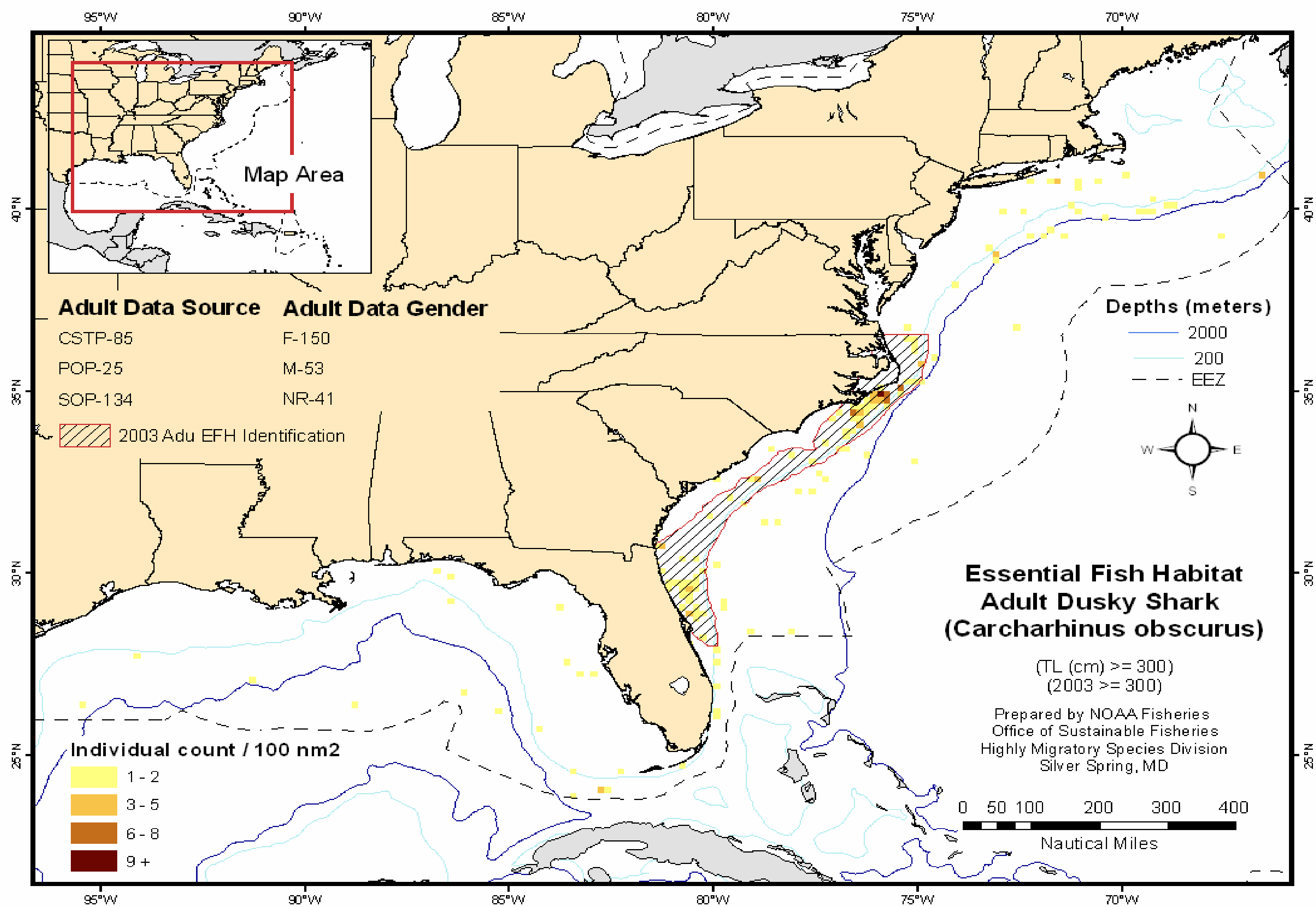

Figure B.63 Dusky Shark: Adult.

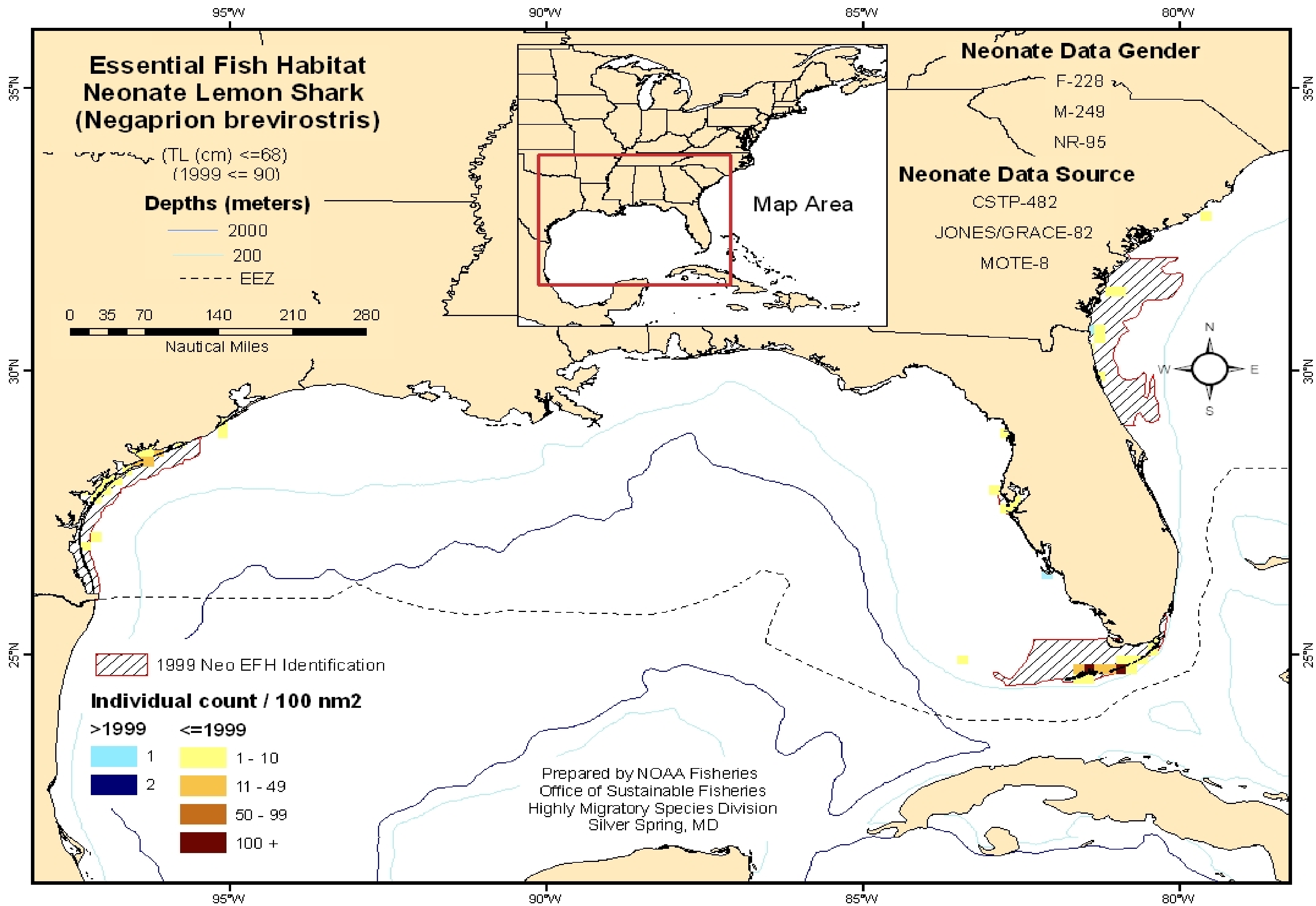

Figure B.64 **Lemon Shark: Neonate.**

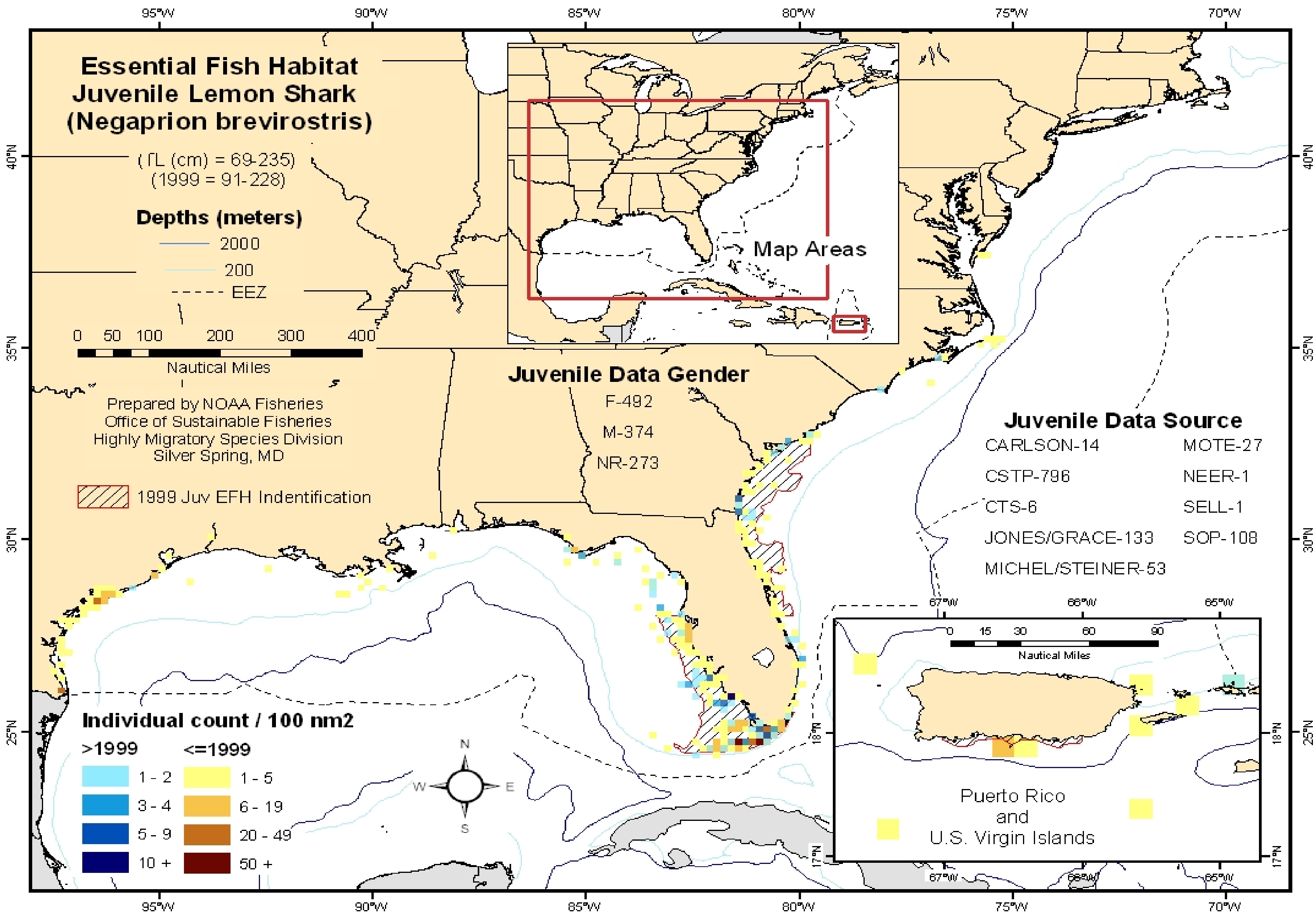

Figure B.65 Lemon Shark: Juvenile.

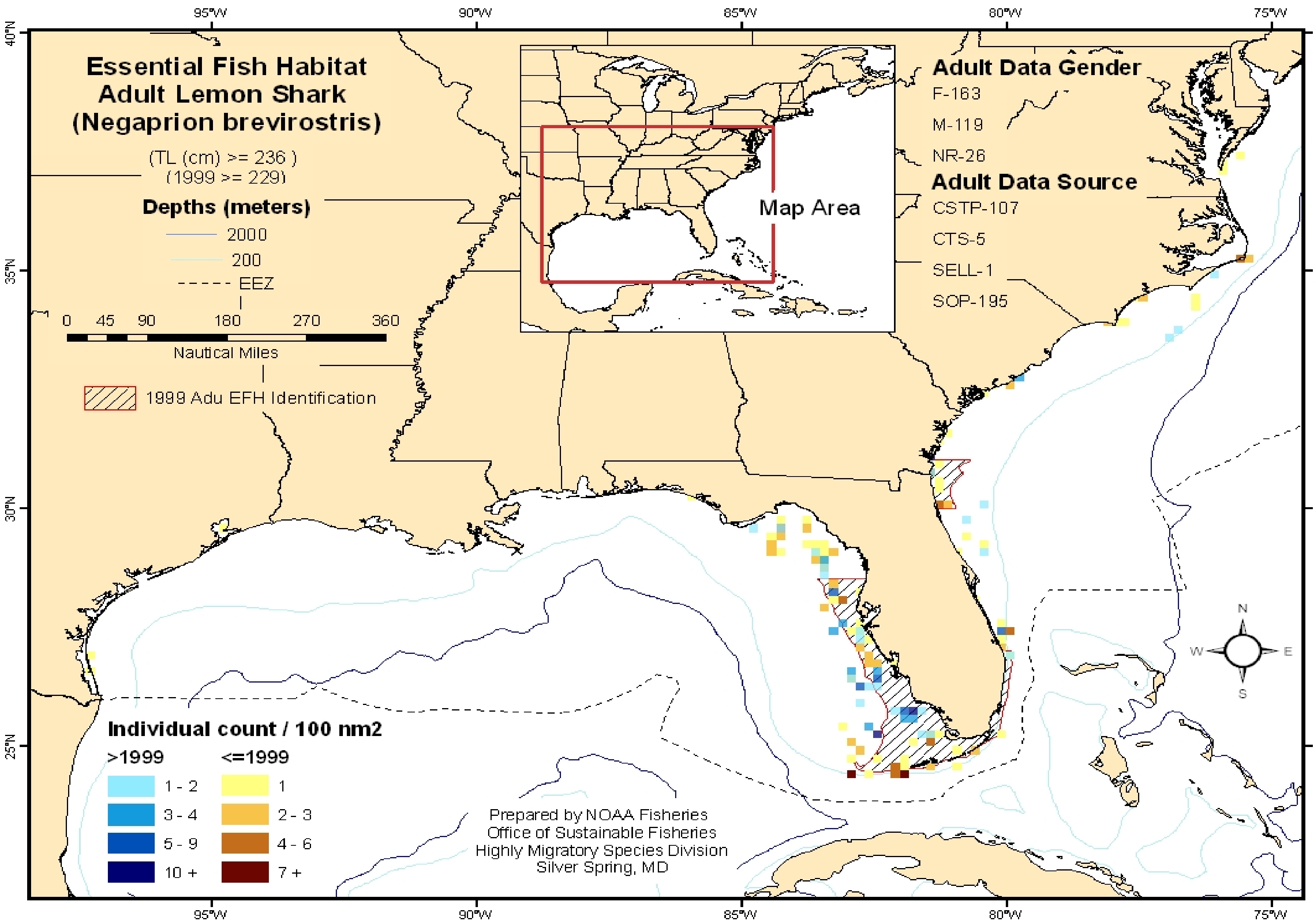

Figure B.66 Lemon Shark: Adult.

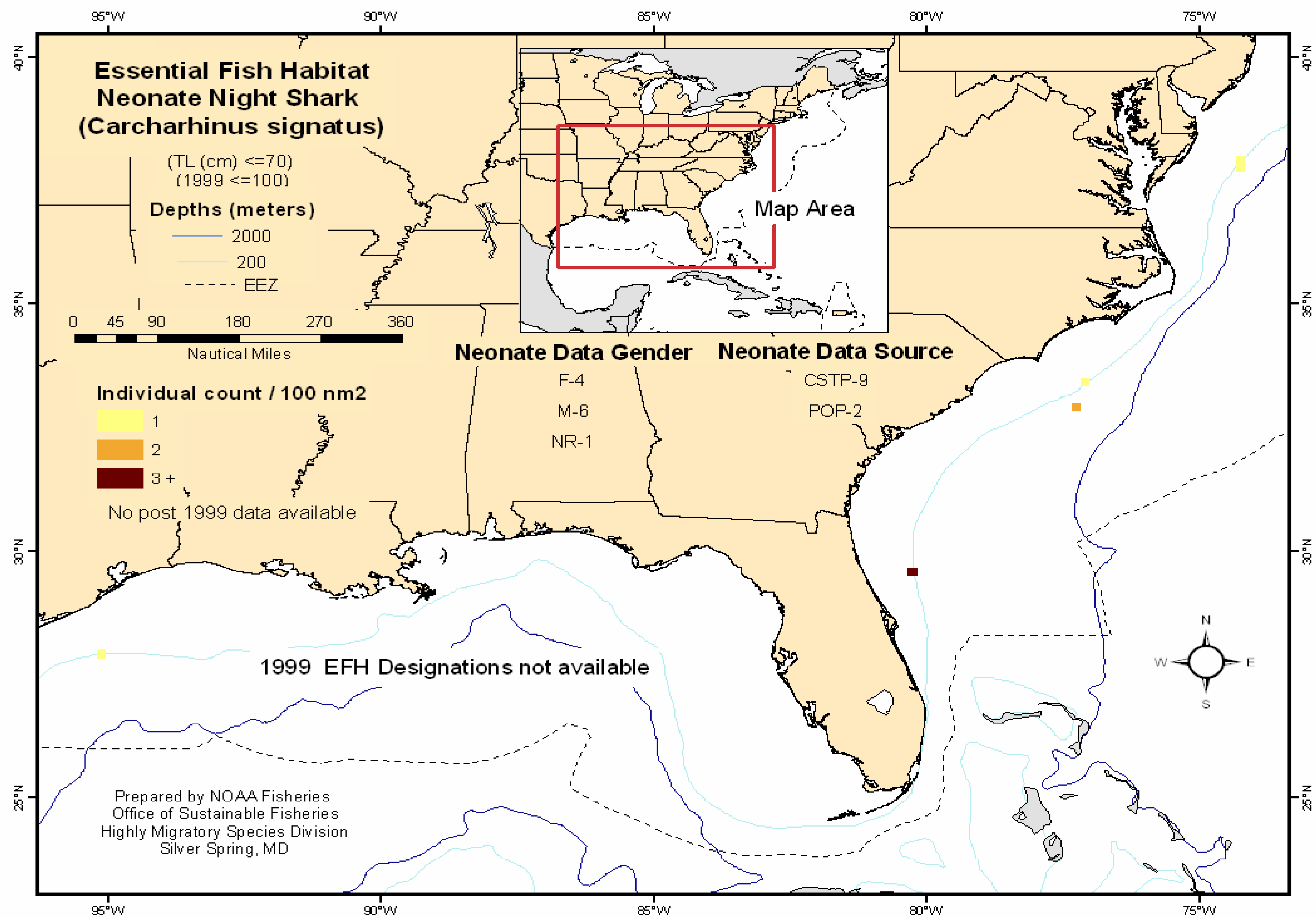

Figure B.67 Night Shark: Neonate.

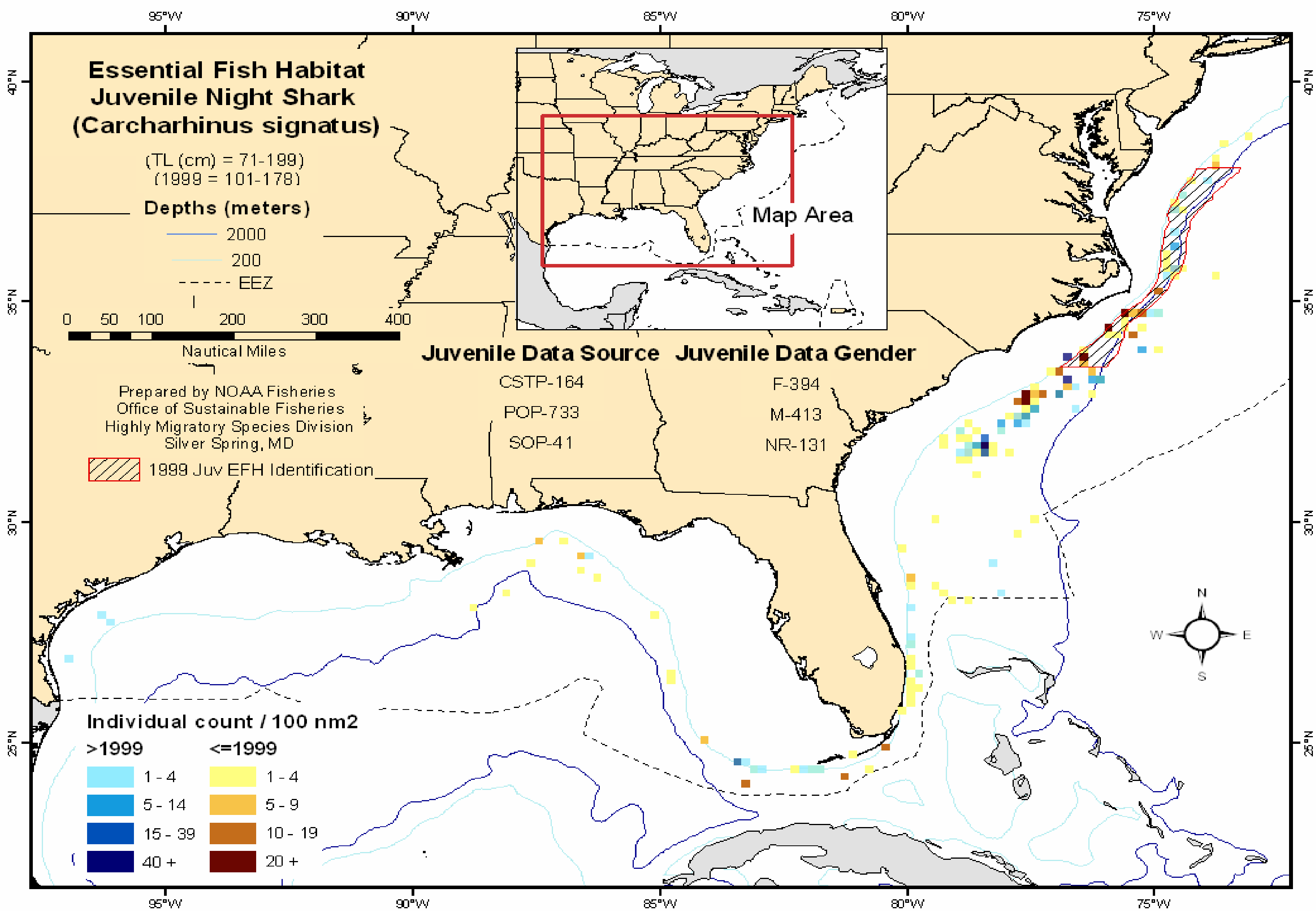

Figure B.68 Night Shark: Juvenile.

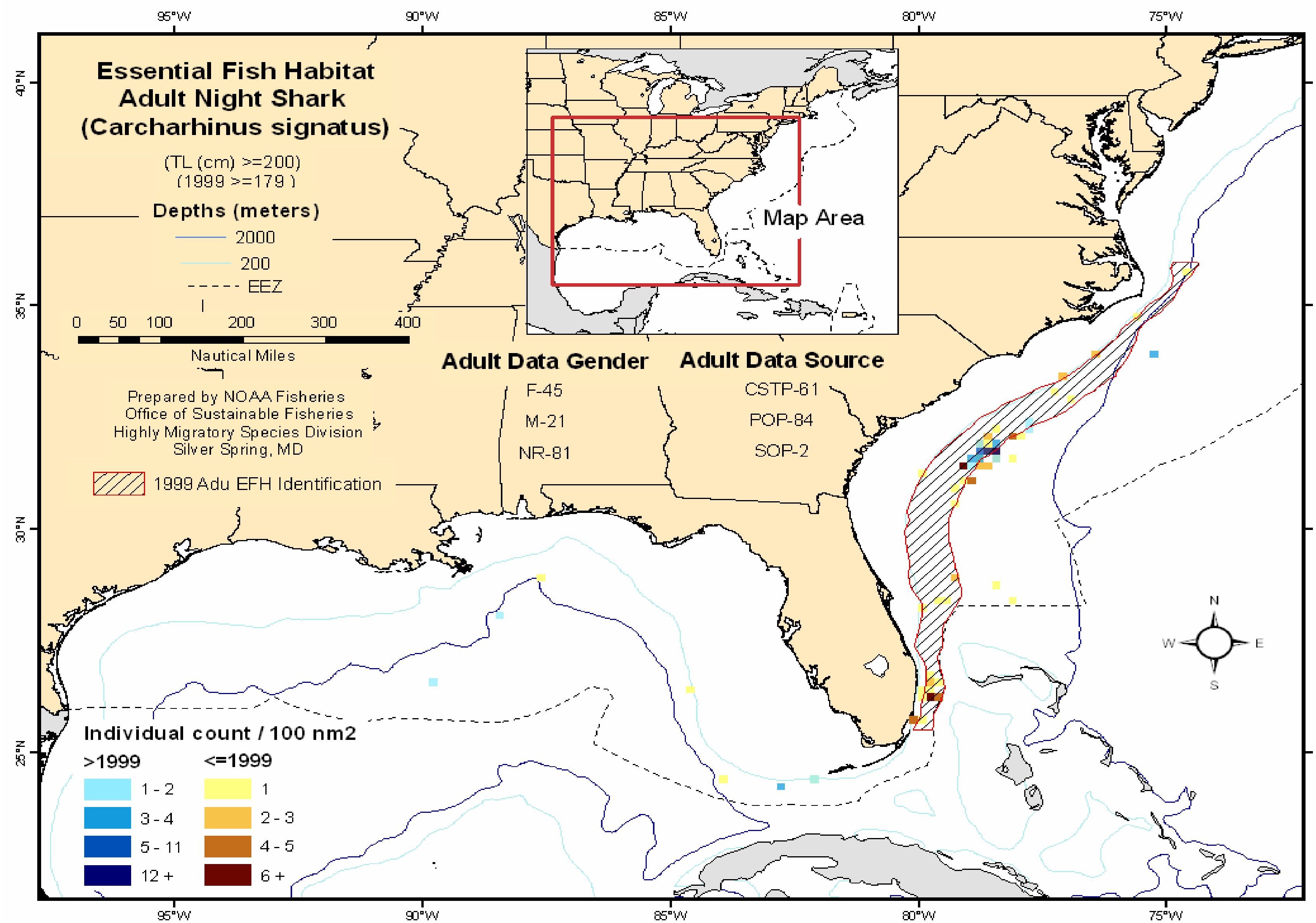

Figure B.69 **Night Shark: Adult.**

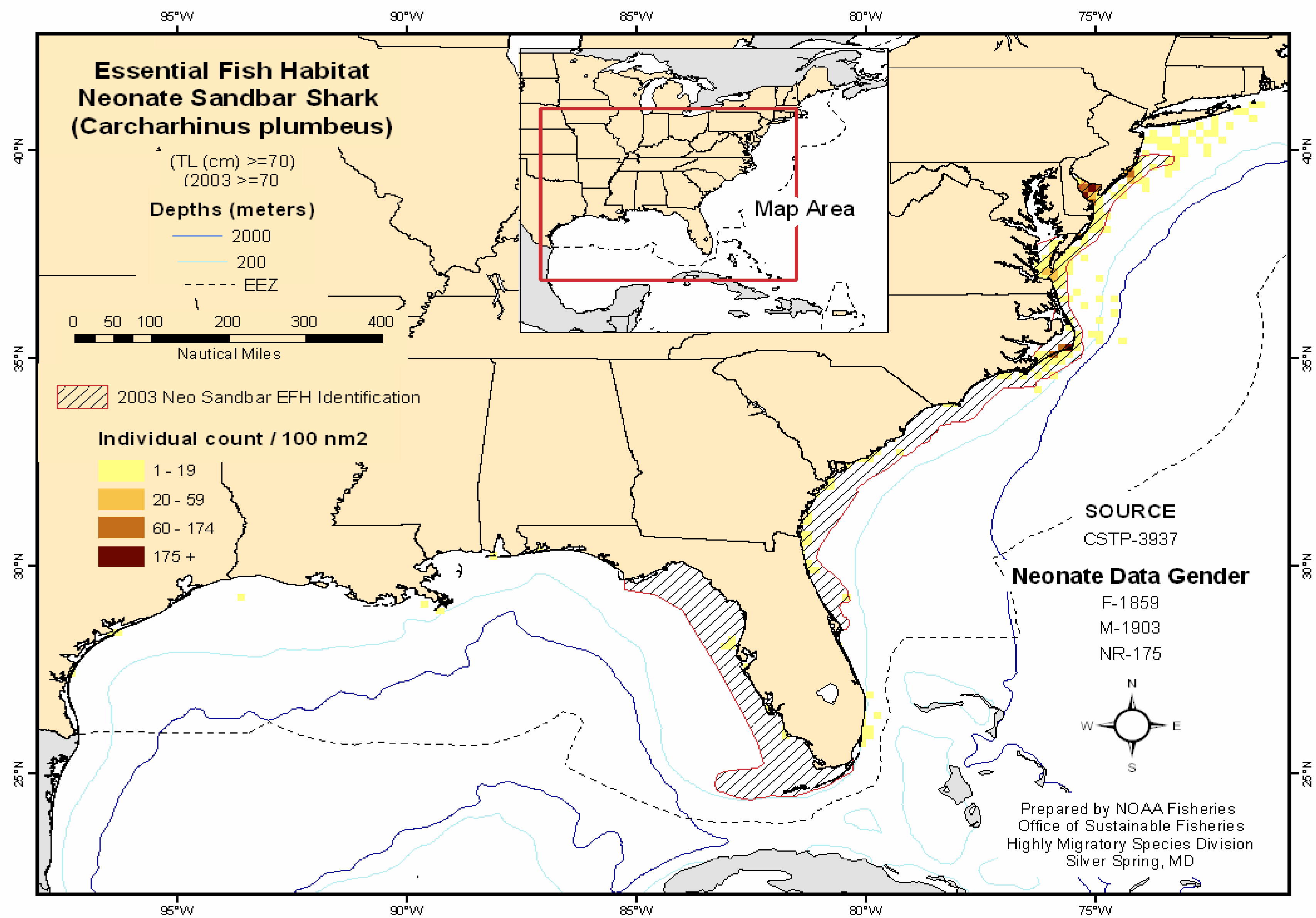

Figure B.70 Sandbar Shark: Neonate.

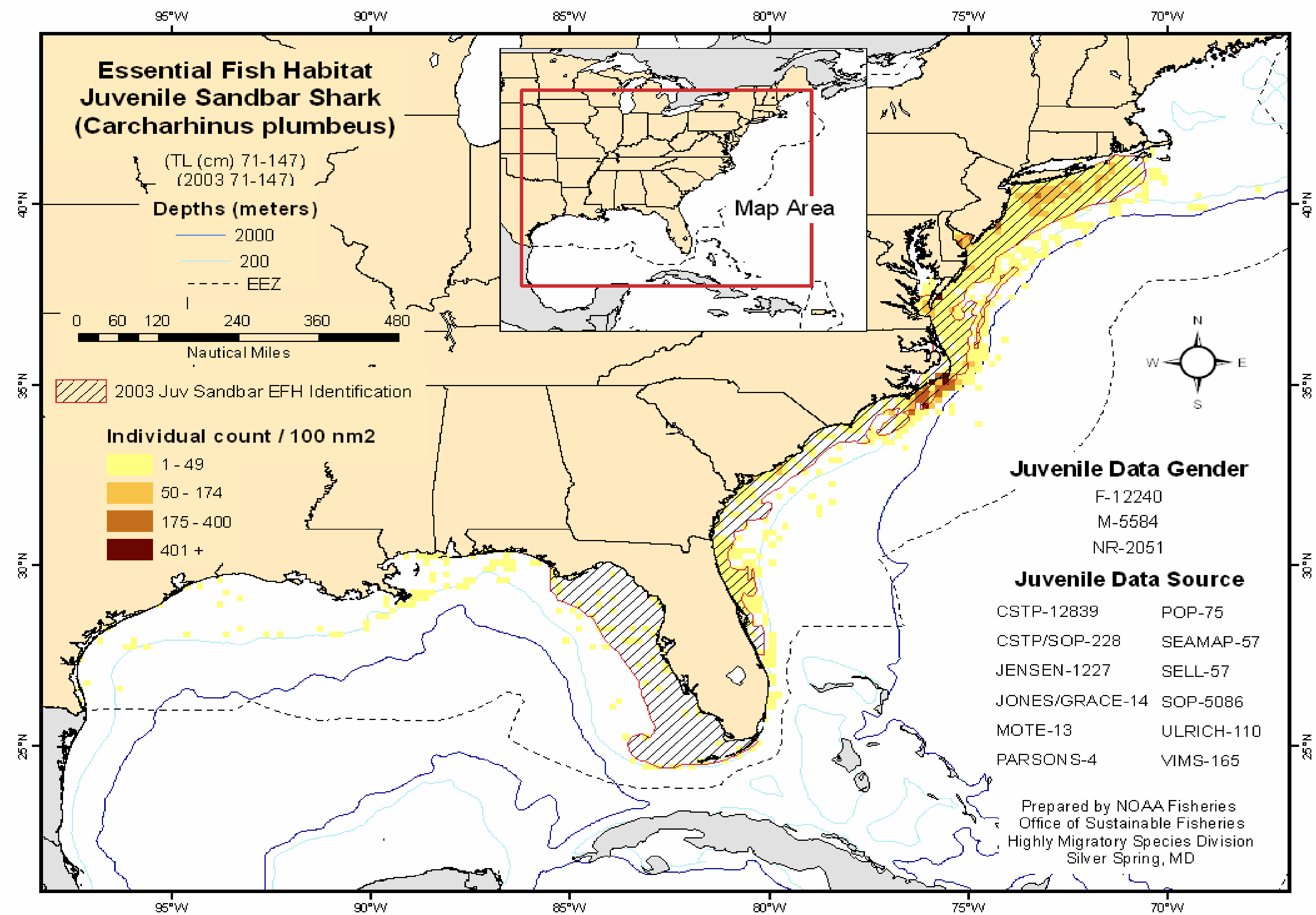

Figure B.71 **Sandbar Shark: Juvenile.**

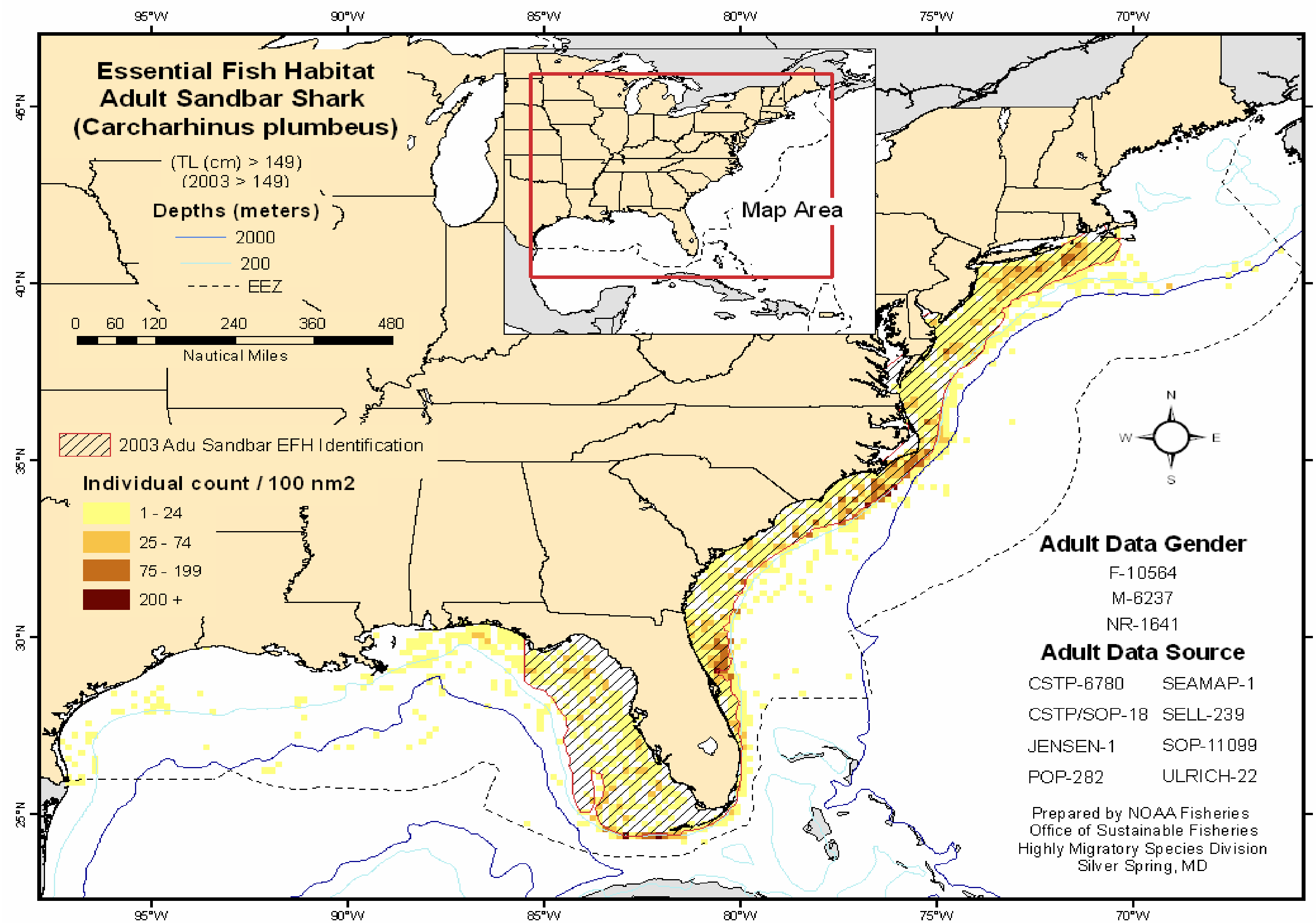

Figure B.72 **Sandbar Shark: Adult.**

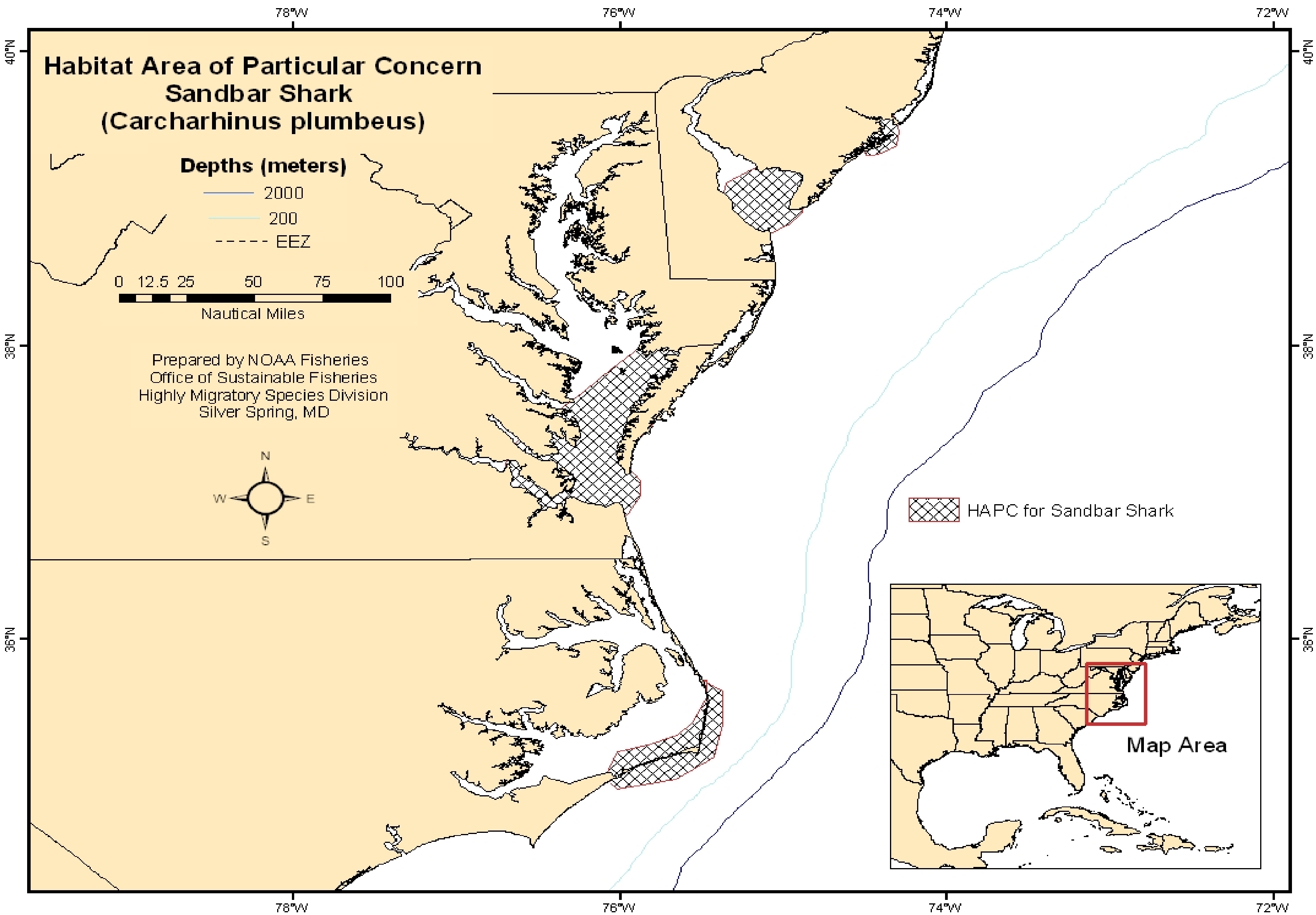

Figure B.73 **Sandbar Shark Habitat Area of Particular Concern.**

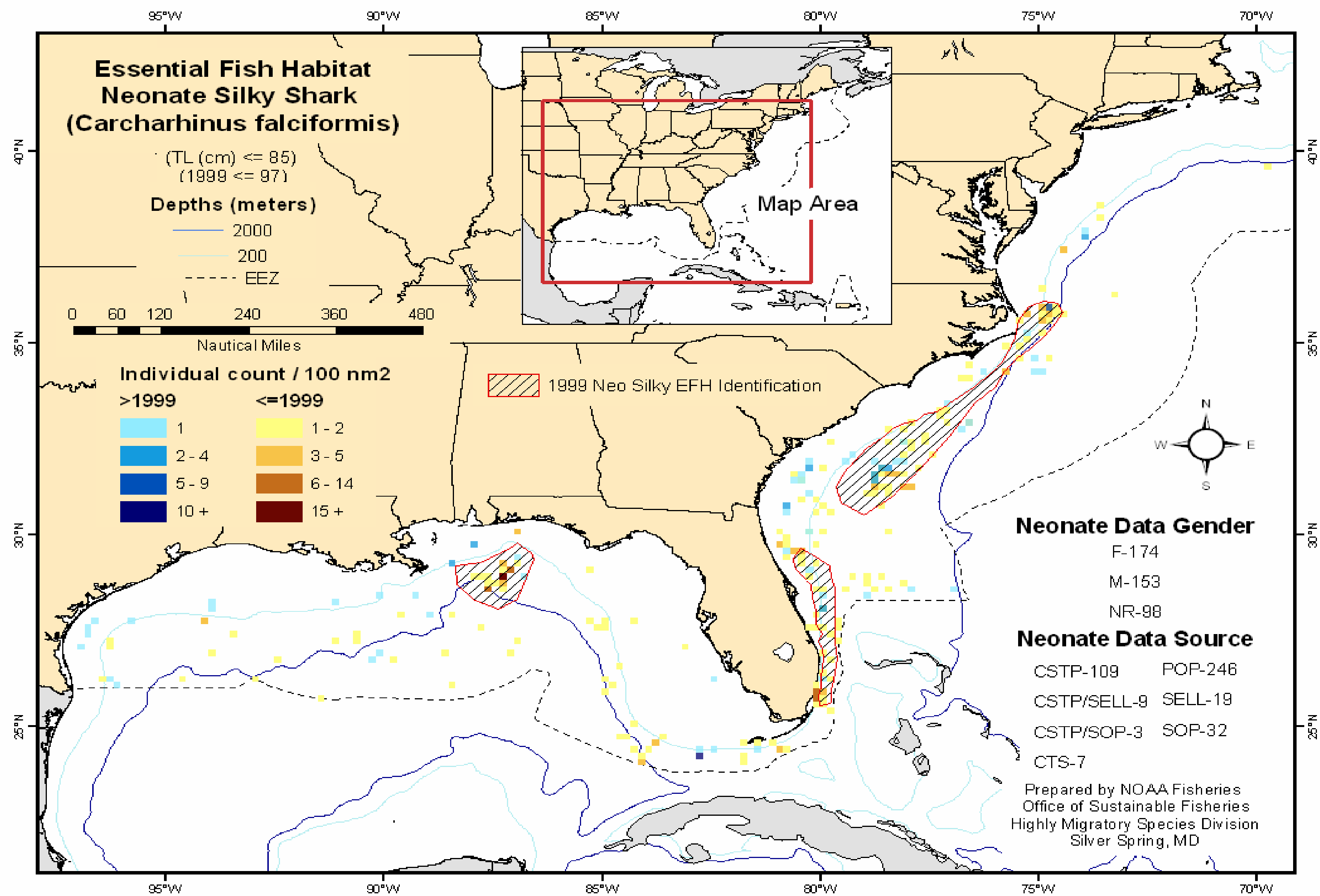

Figure B.74 Silky Shark: Neonate.

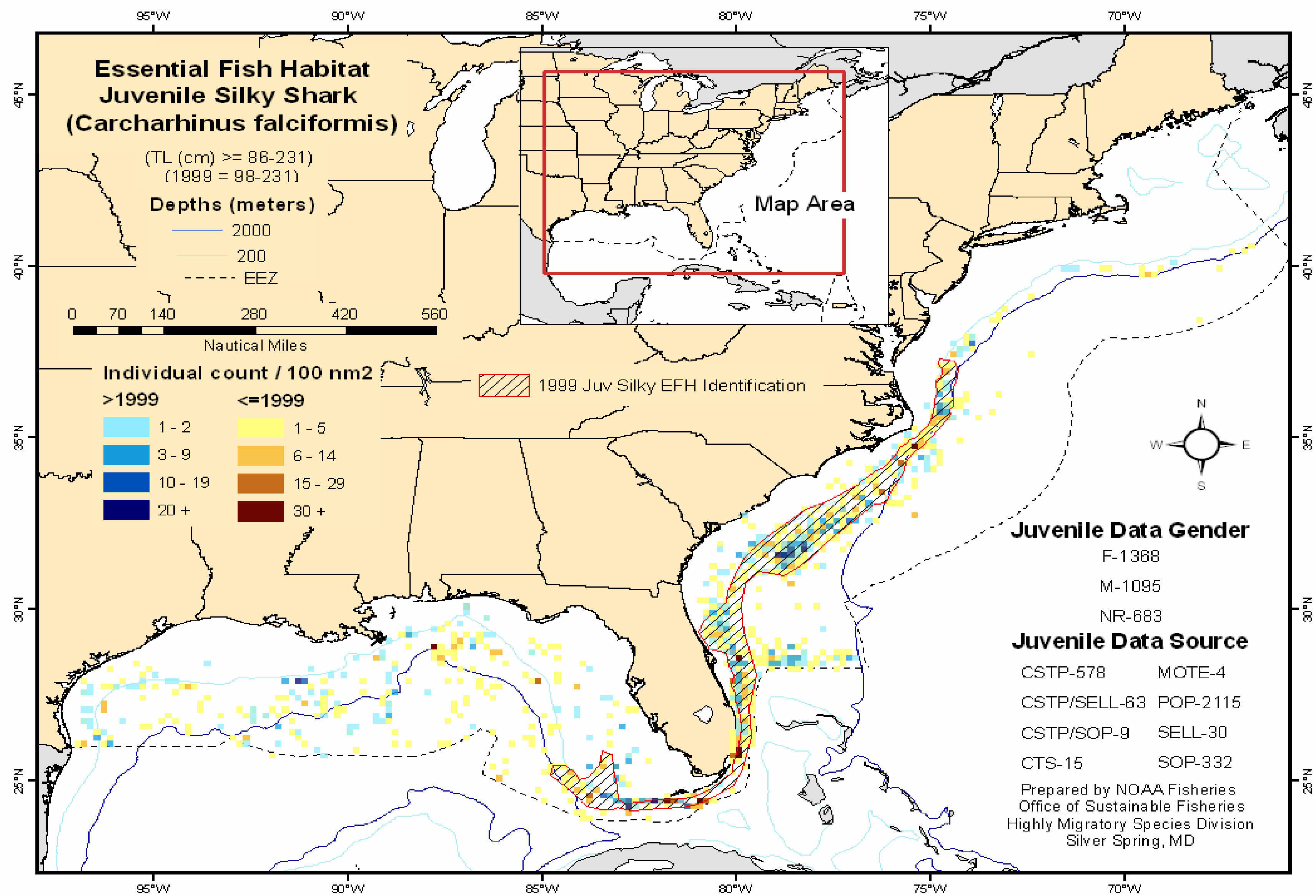

Figure B.75 Silky Shark: Juvenile.

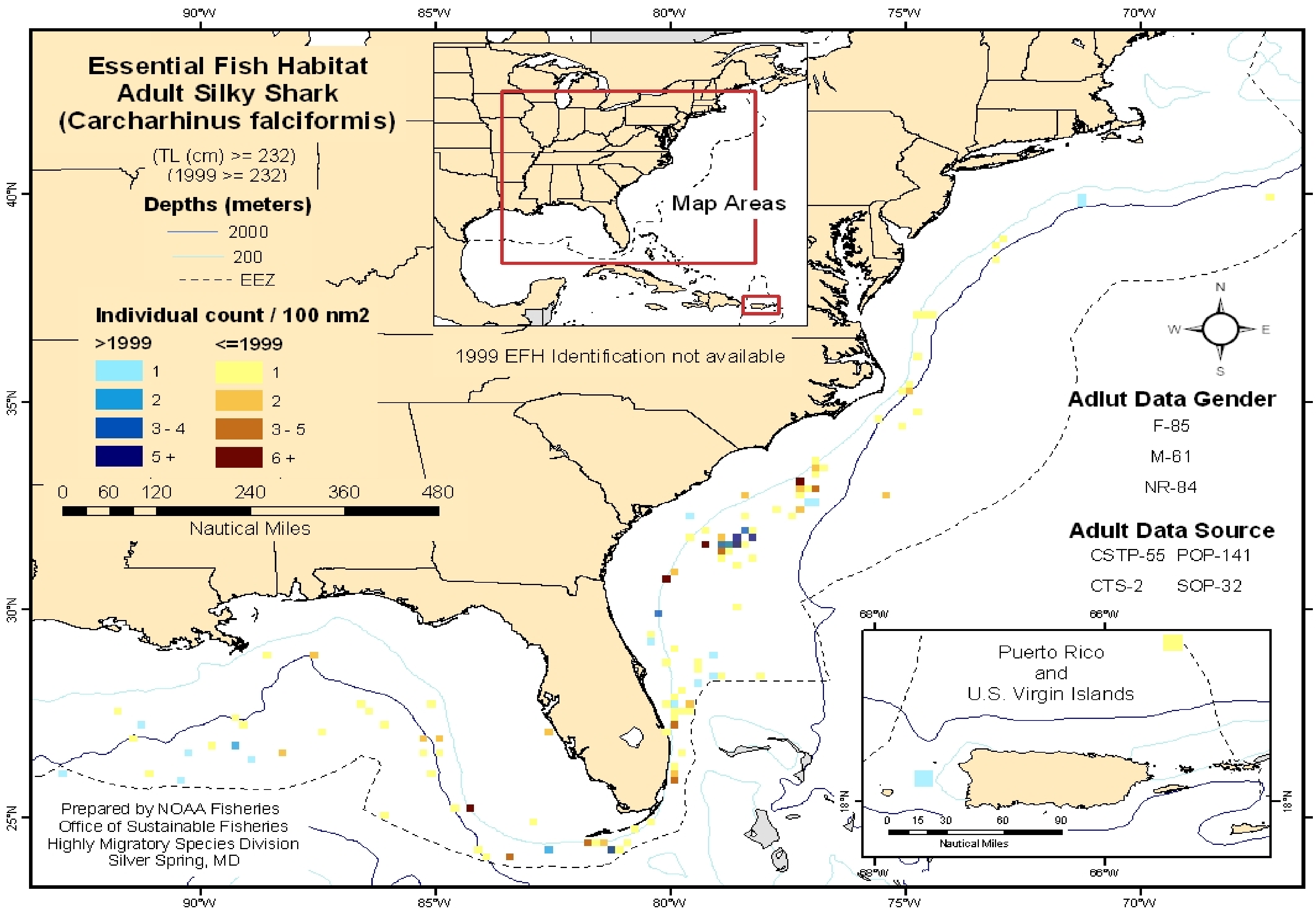

Figure B.76 Silky Shark: Adult.

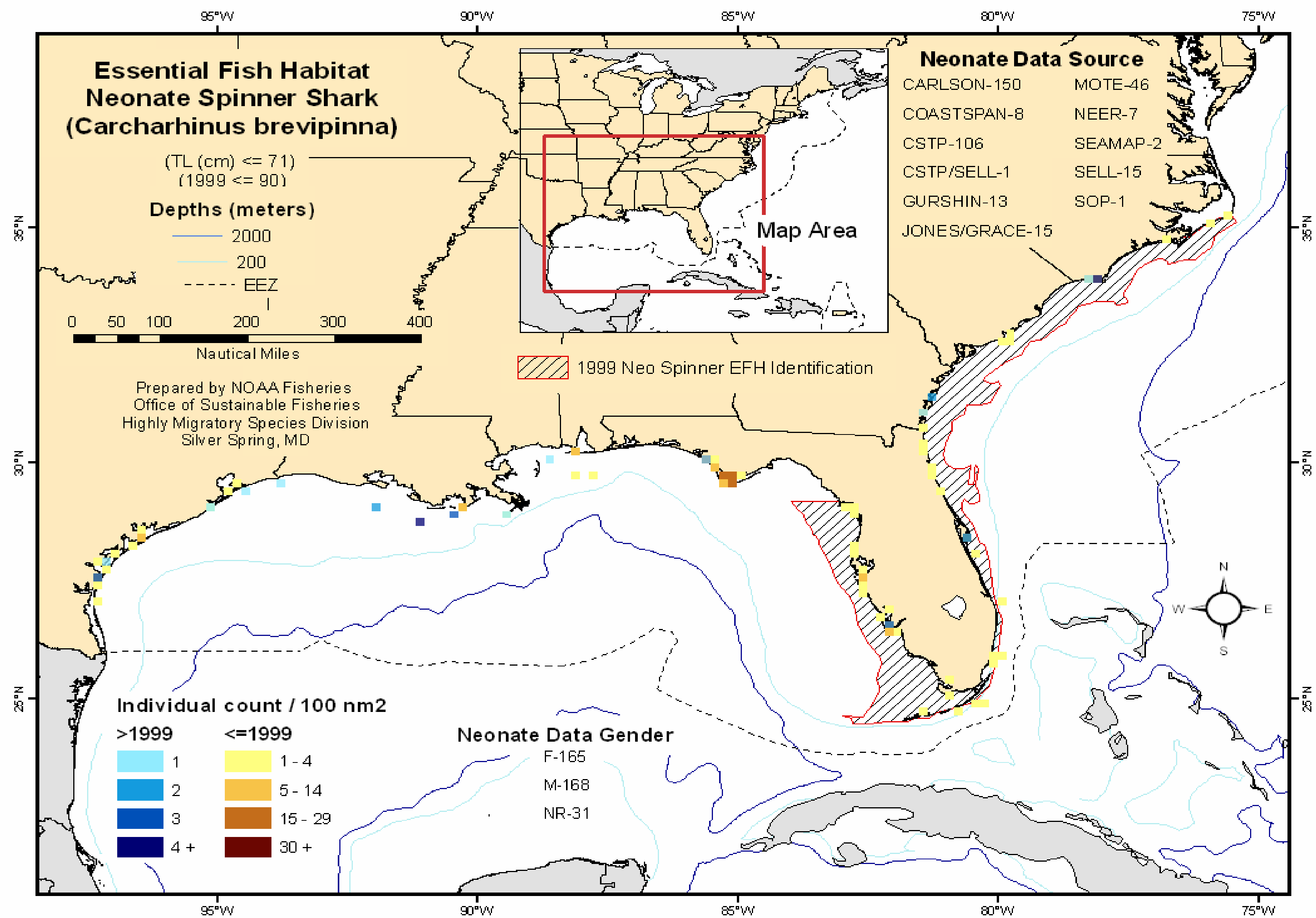

Figure B.77 Spinner Shark: Neonate.

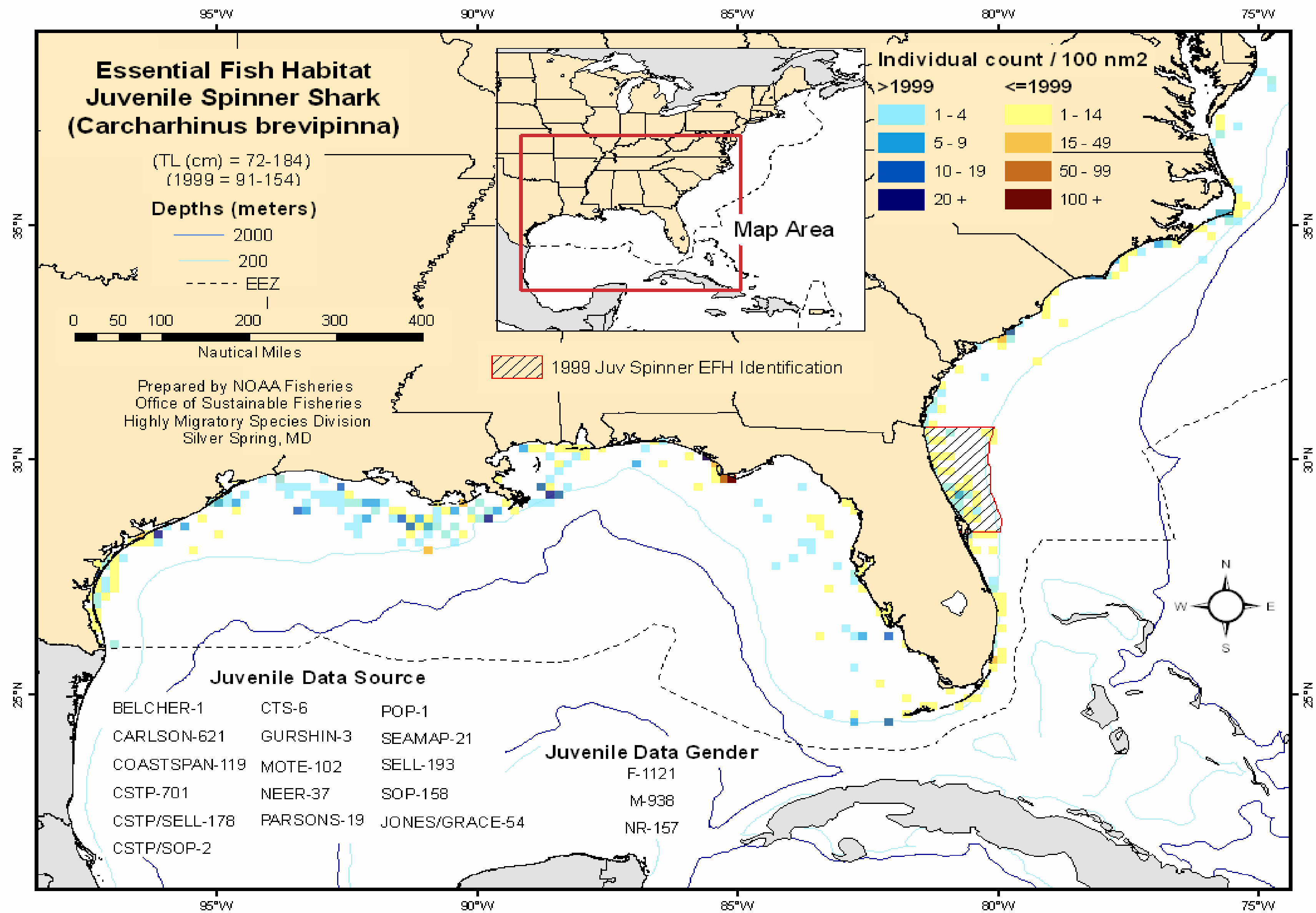

Figure B.78 Spinner Shark: Juvenile.

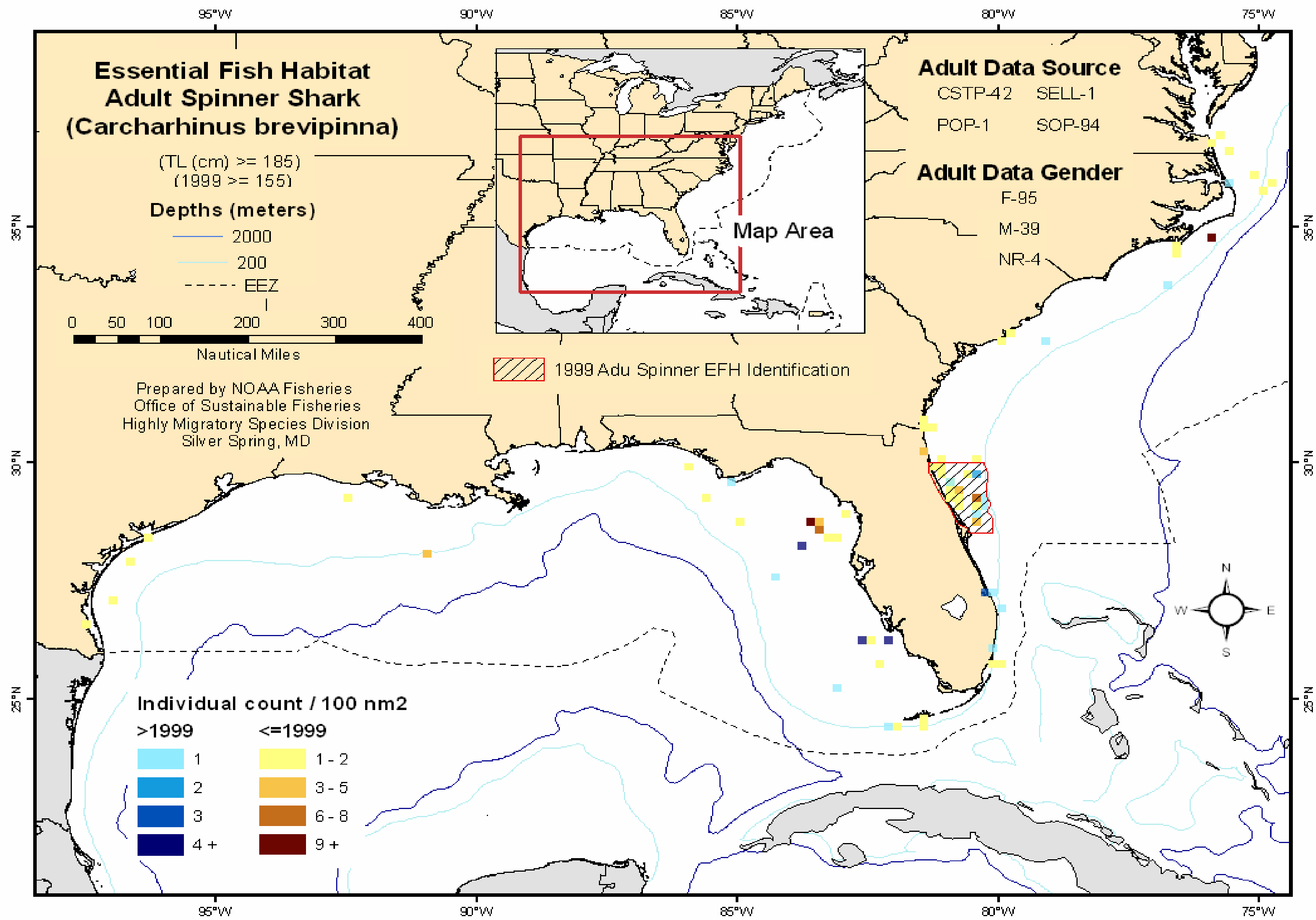

Figure B.79 Spinner Shark: Adult.

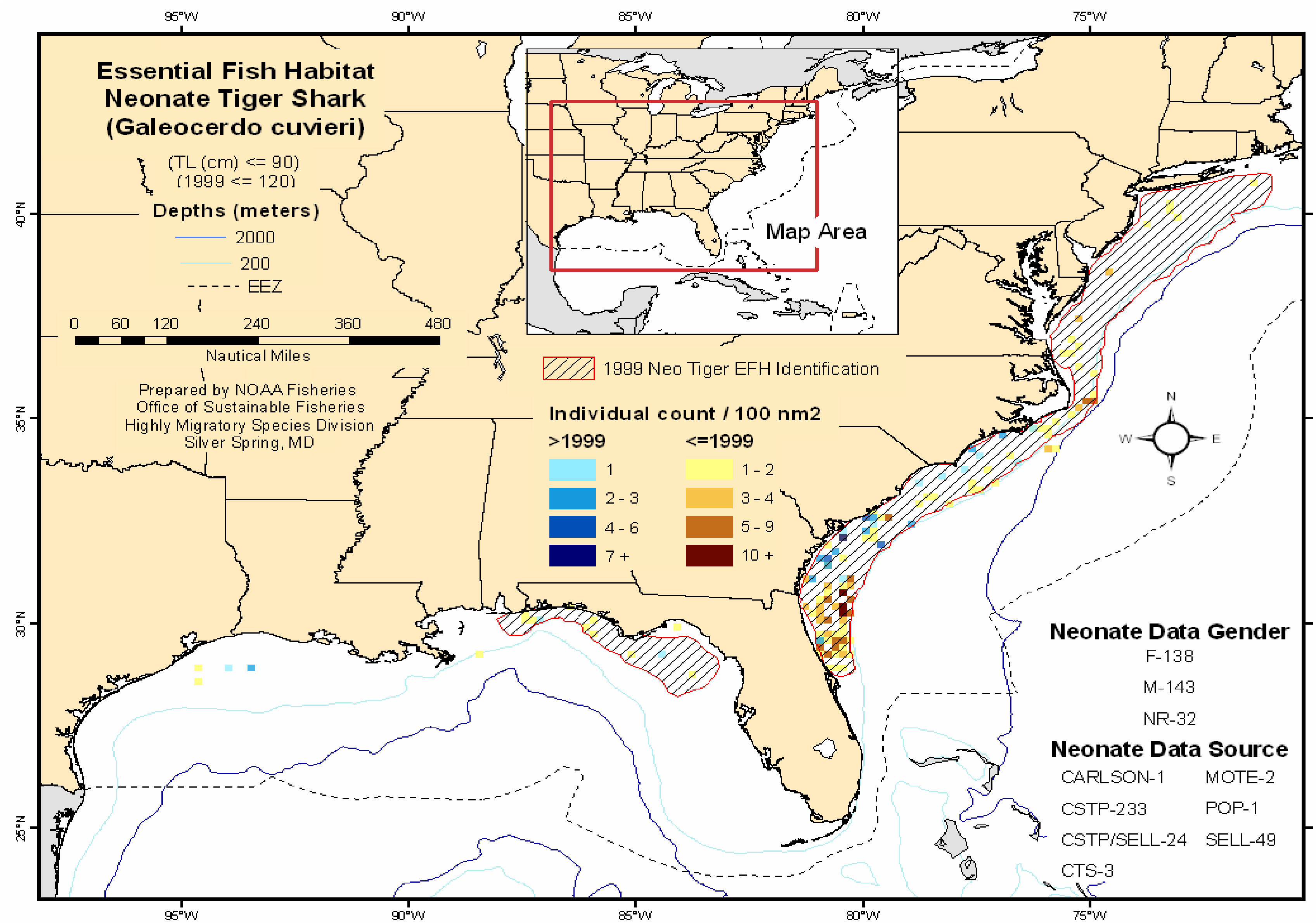

Figure B.80 **Tiger Shark: Neonate.**

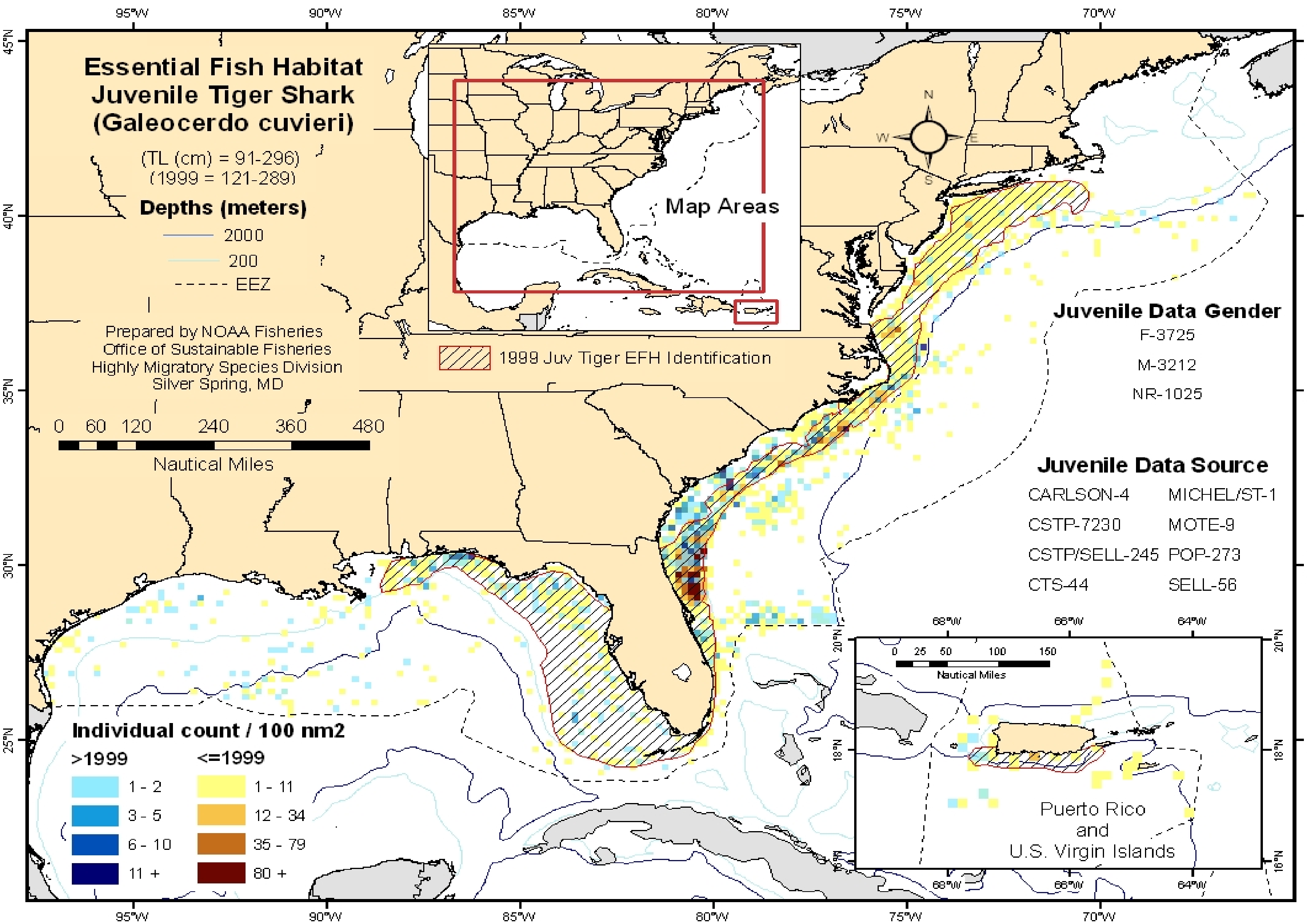

Figure B.81 Tiger Shark: Juvenile.

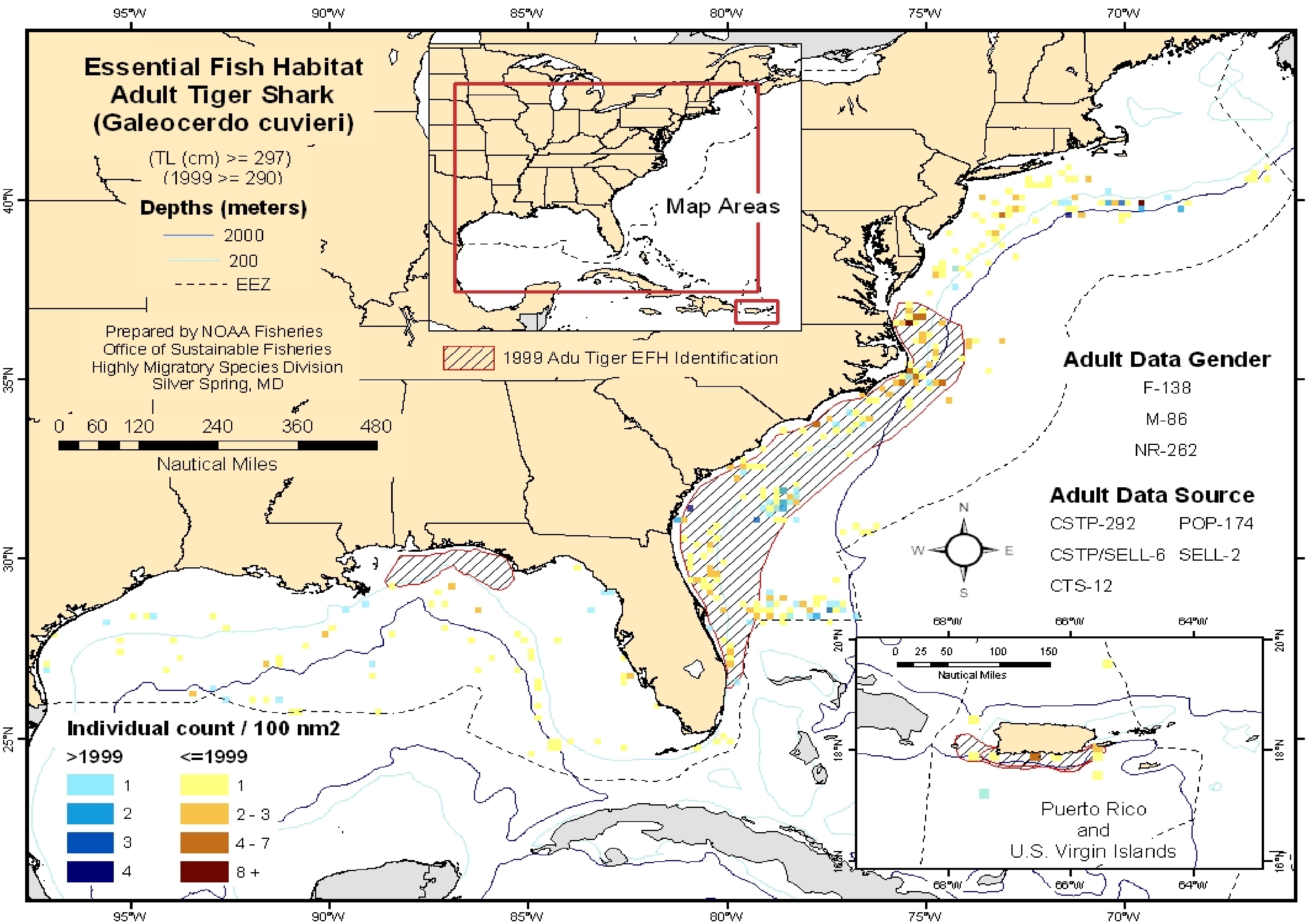

Figure B.82 Tiger Shark: Adult.

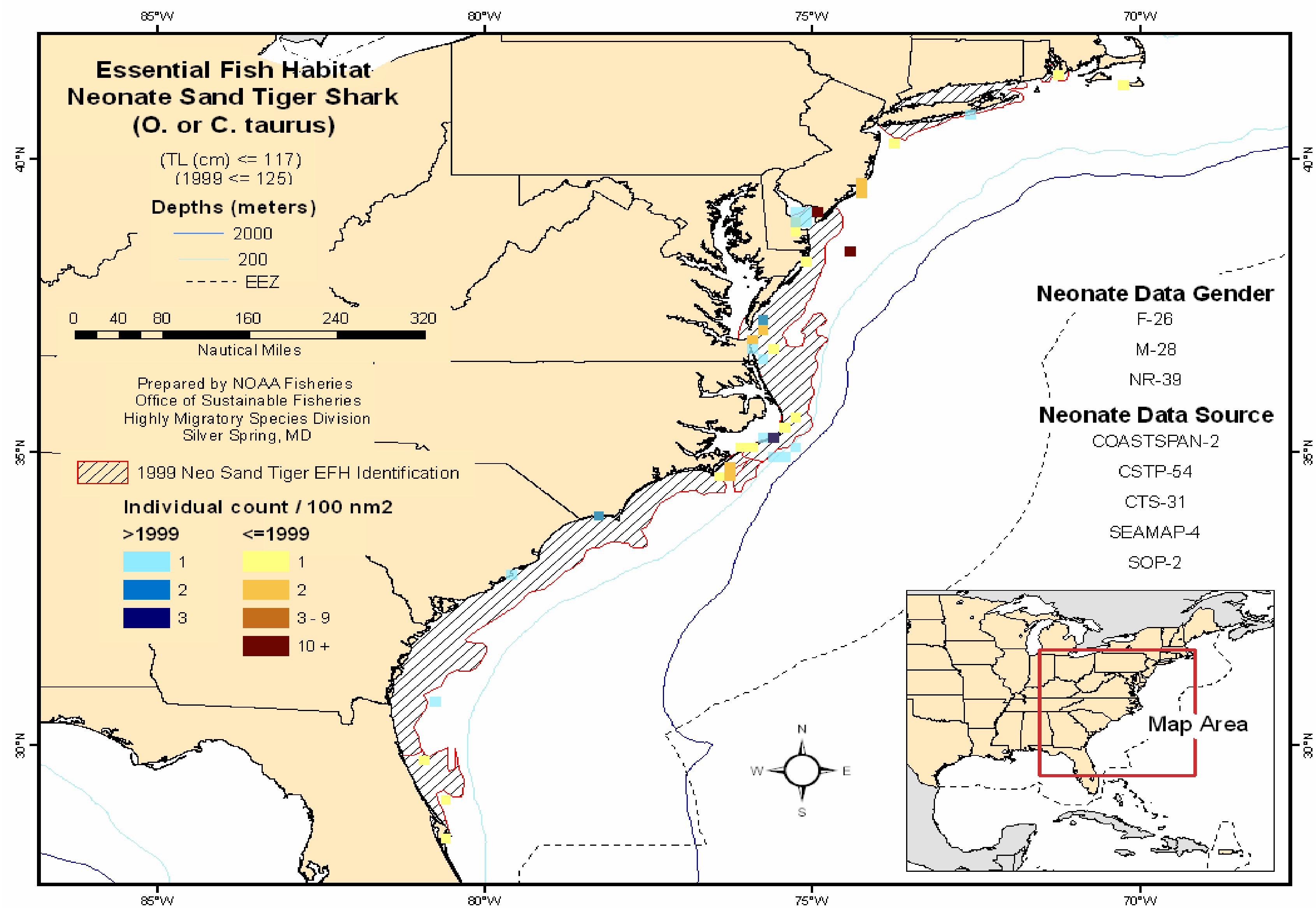

Figure B.83 **Sand Tiger Shark: Neonate.**

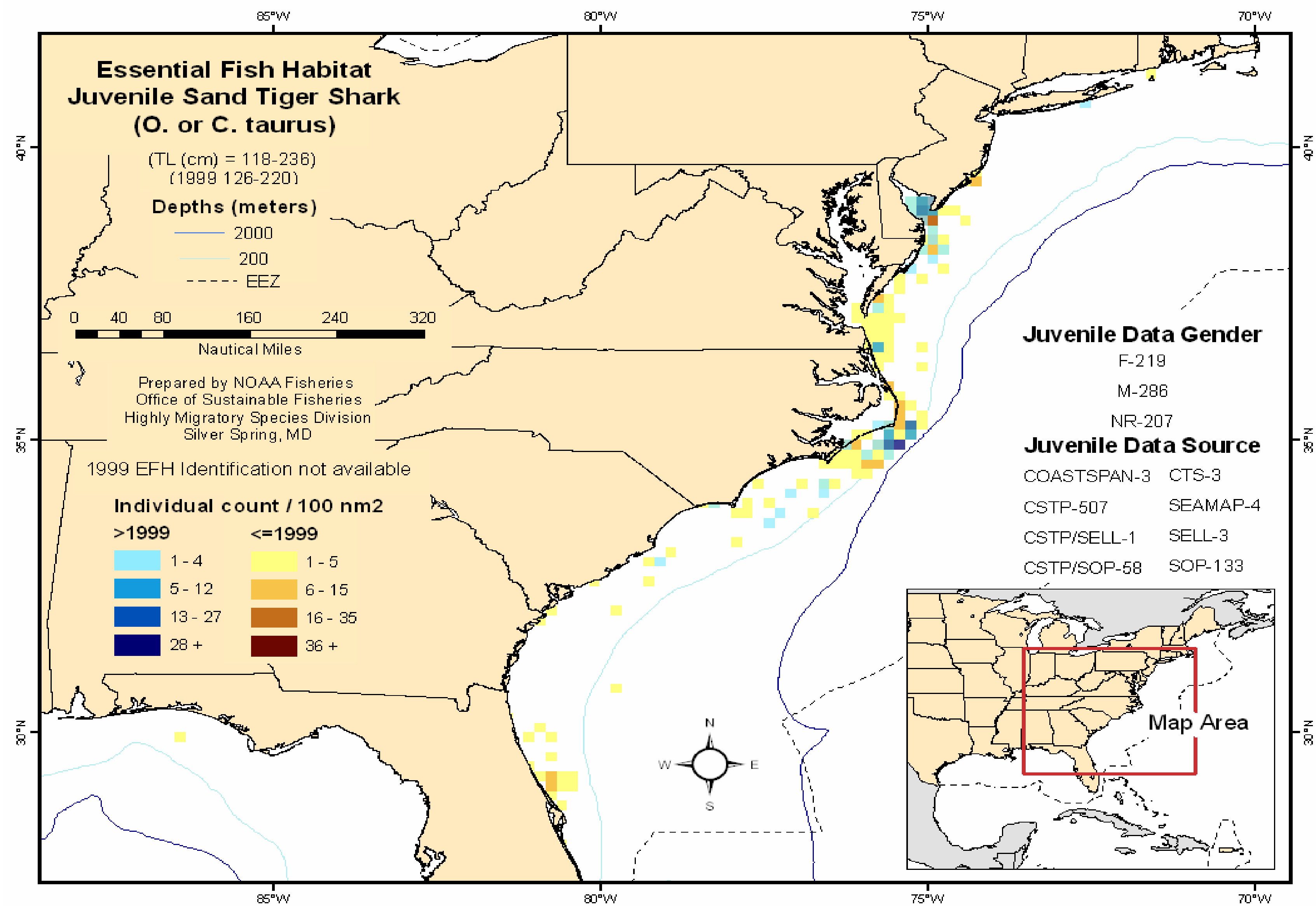

Figure B.84 Sand Tiger Shark: Juvenile.

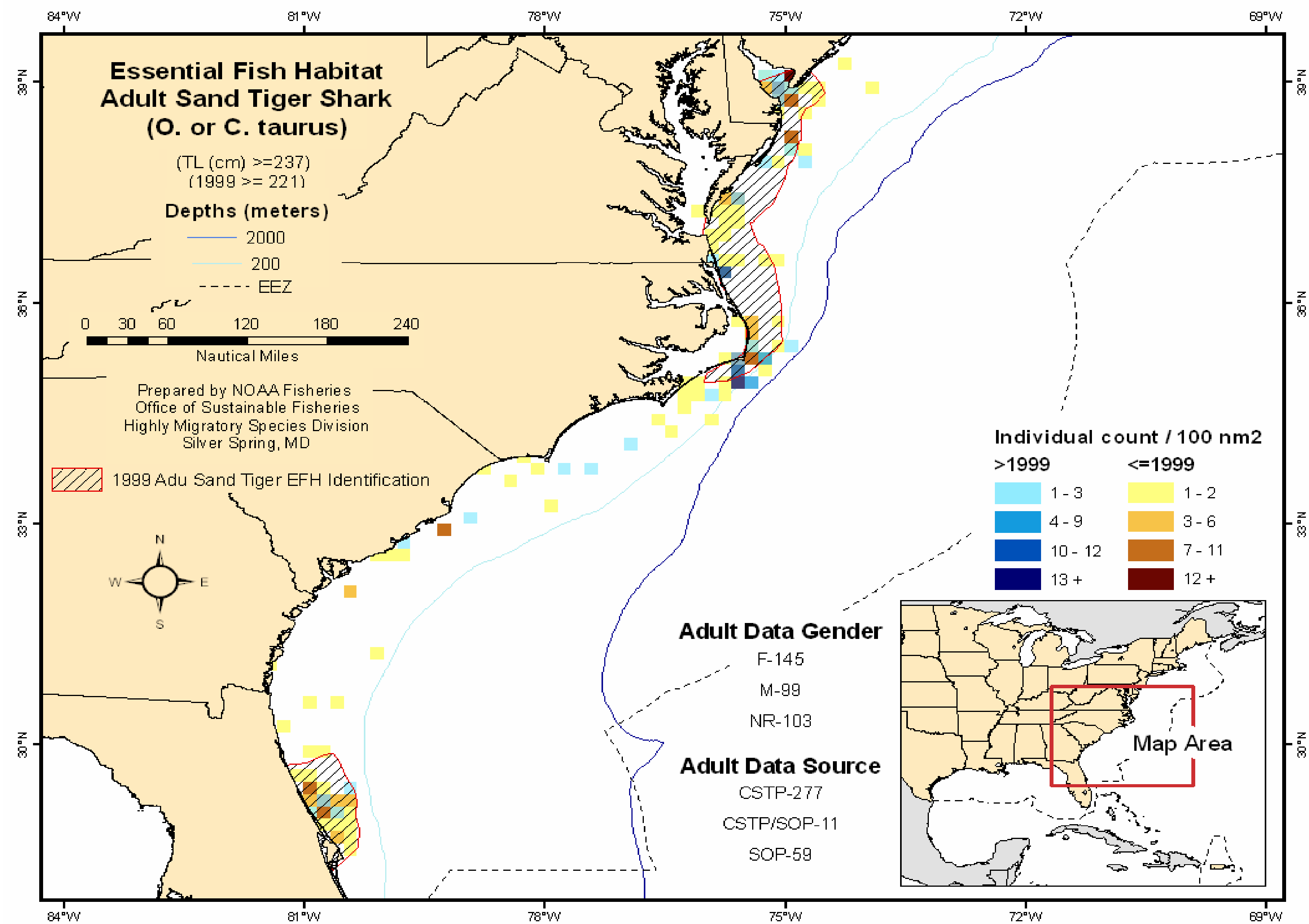

Figure B.85 Sand Tiger Shark: Adult.

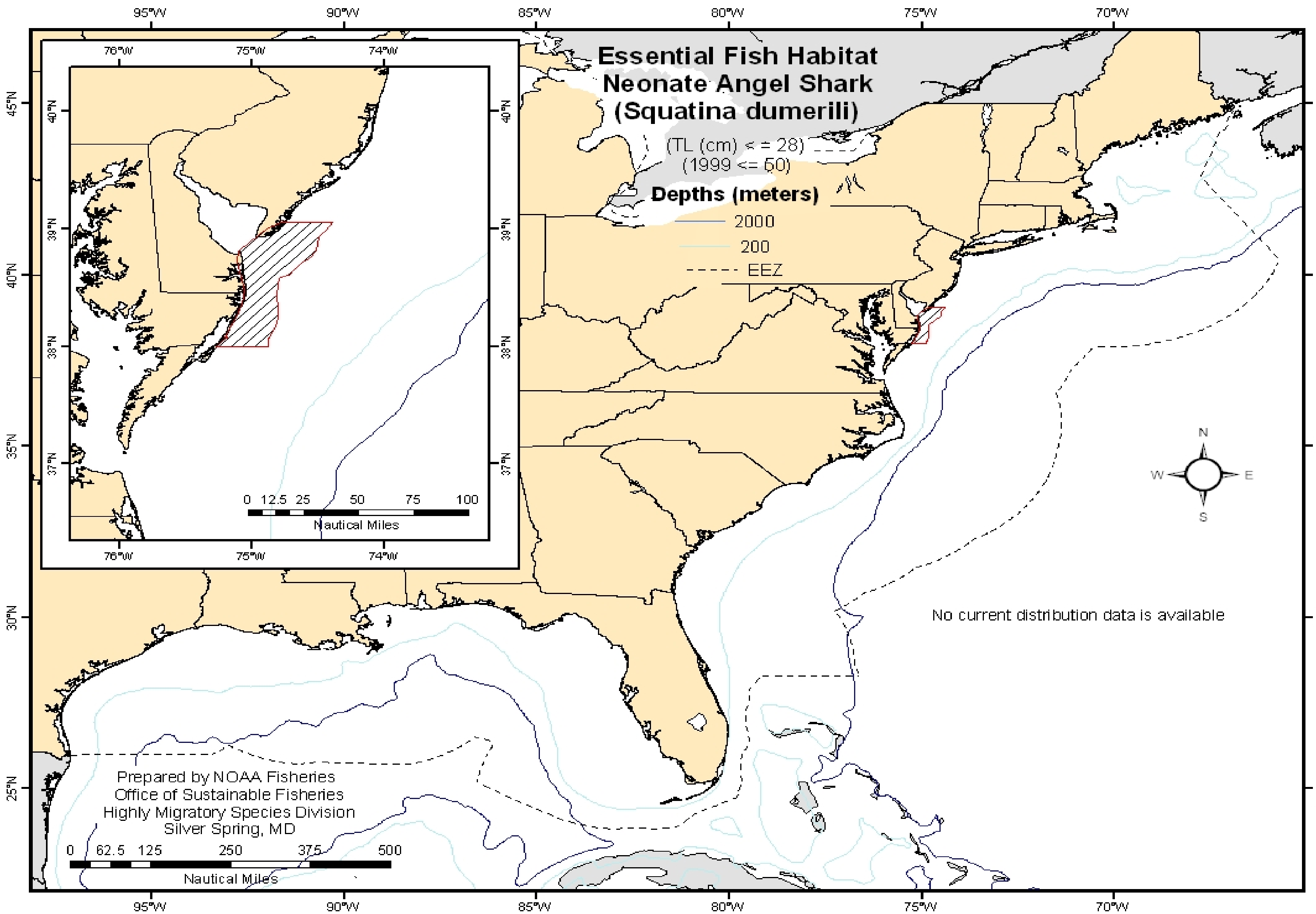

Figure B.86 Angel Shark: Neonate.

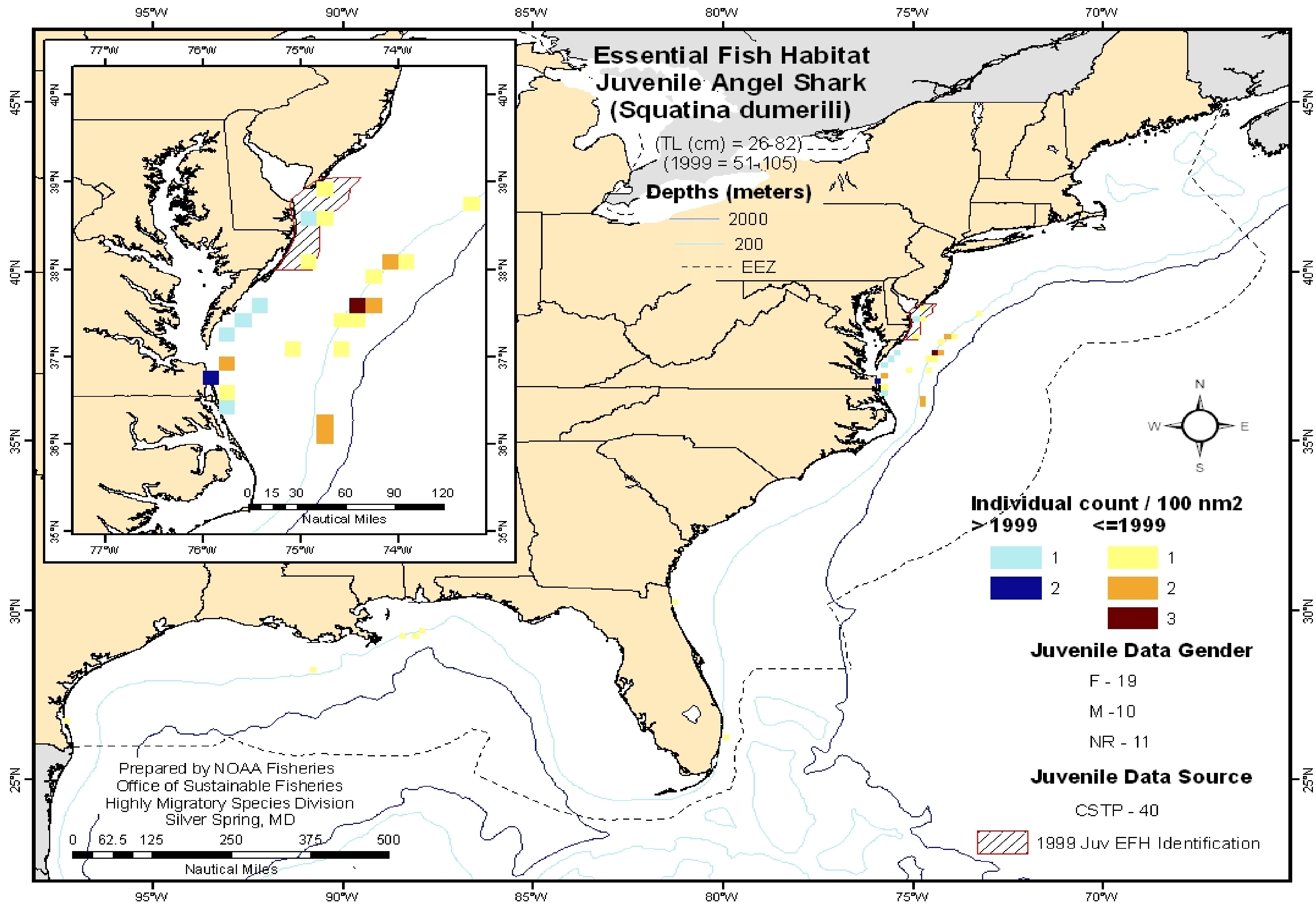

Figure B.87 Angel Shark: Juvenile.

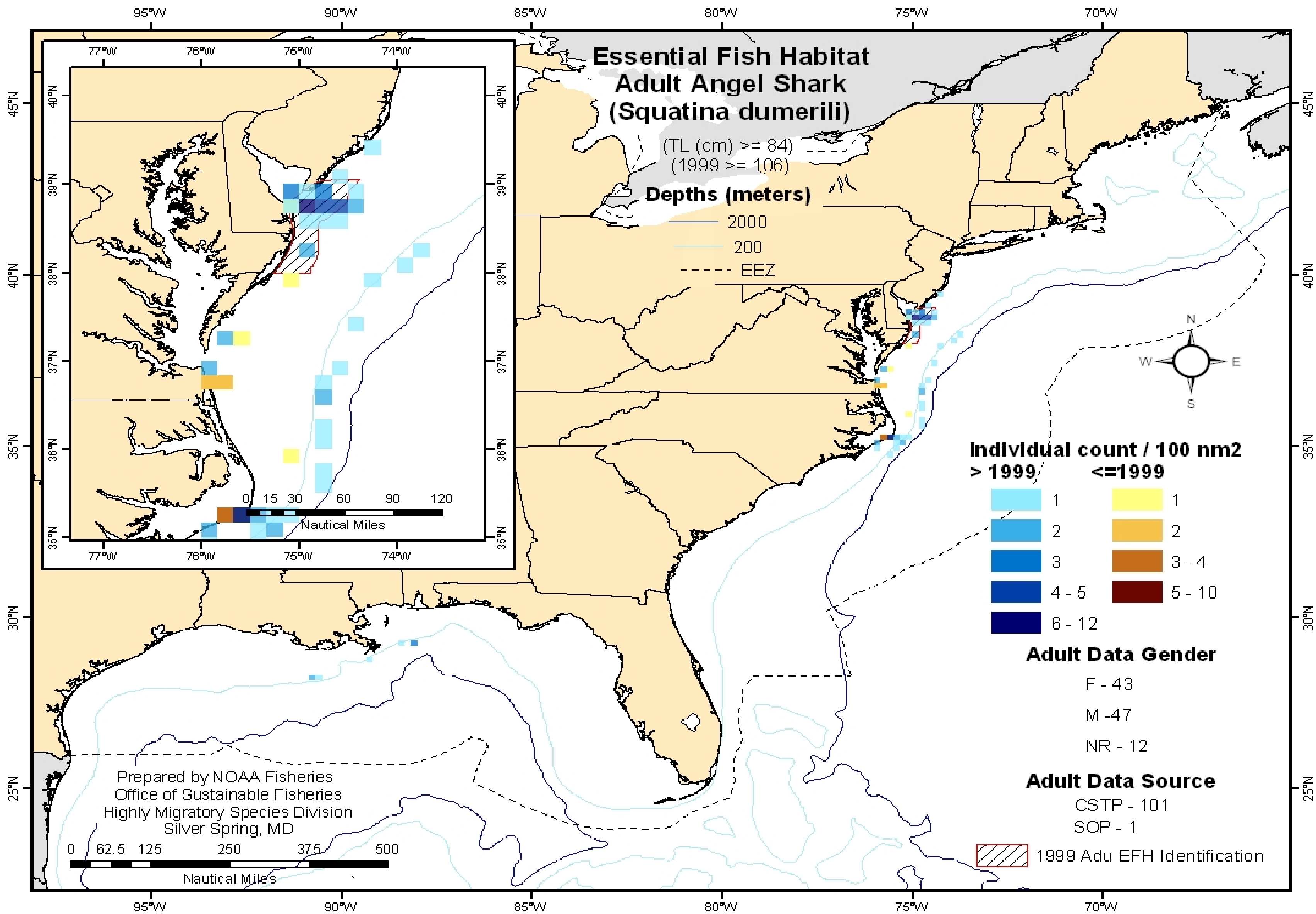

Figure B.88 Angel Shark: Adult.

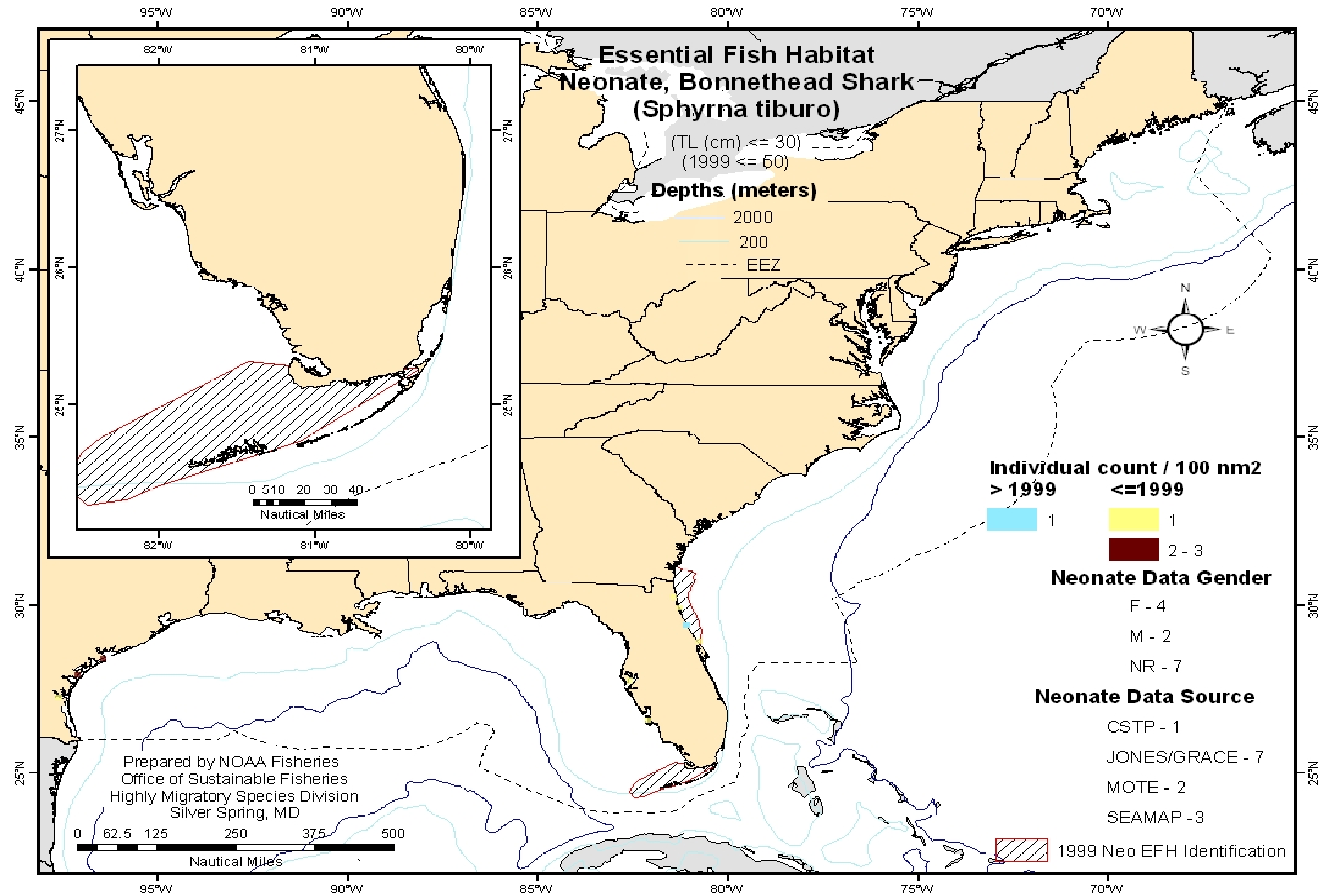

Figure B.89 Bonnethead Shark : Neonate.

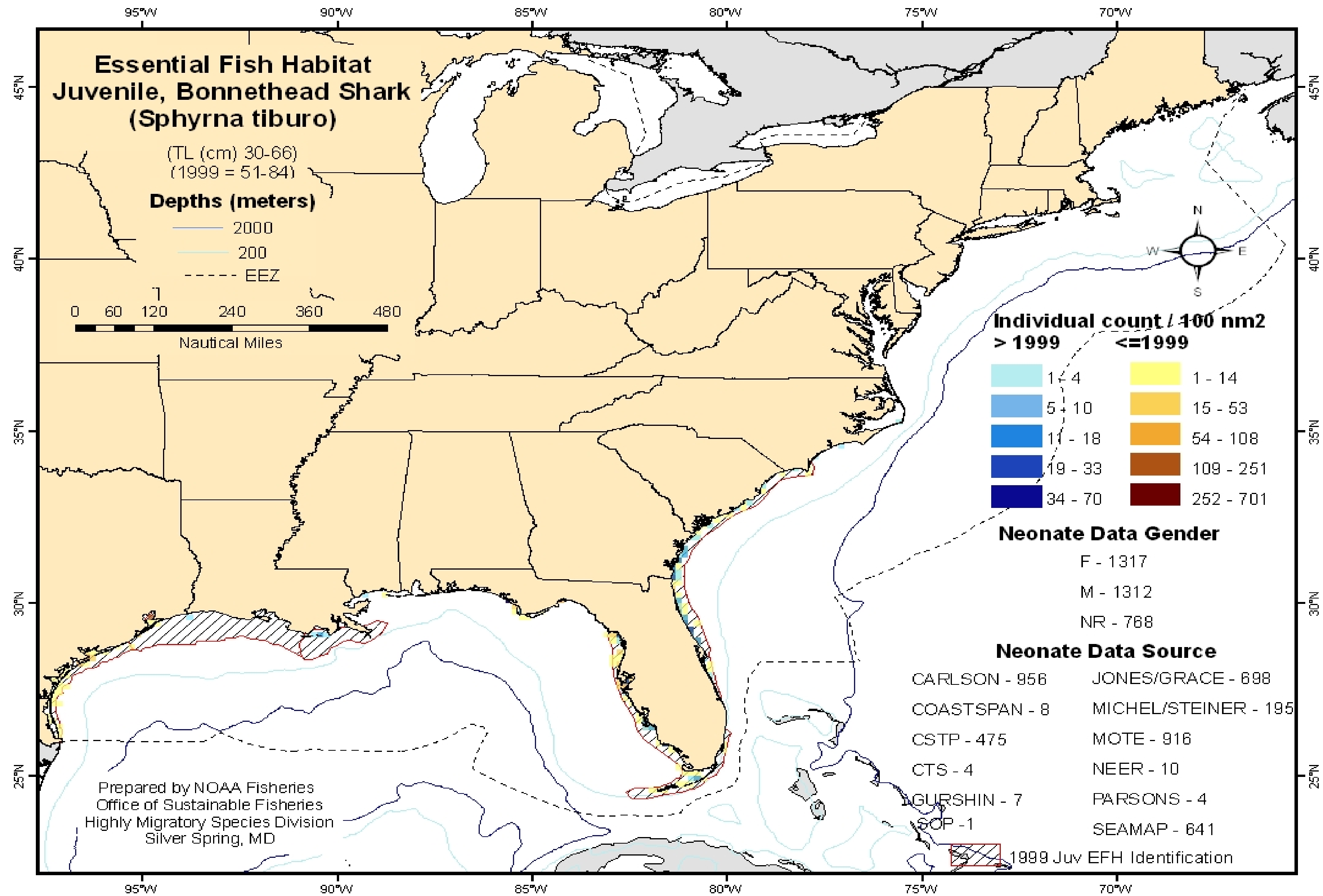

Figure B.90 **Bonnethead Shark: Juvenile.**

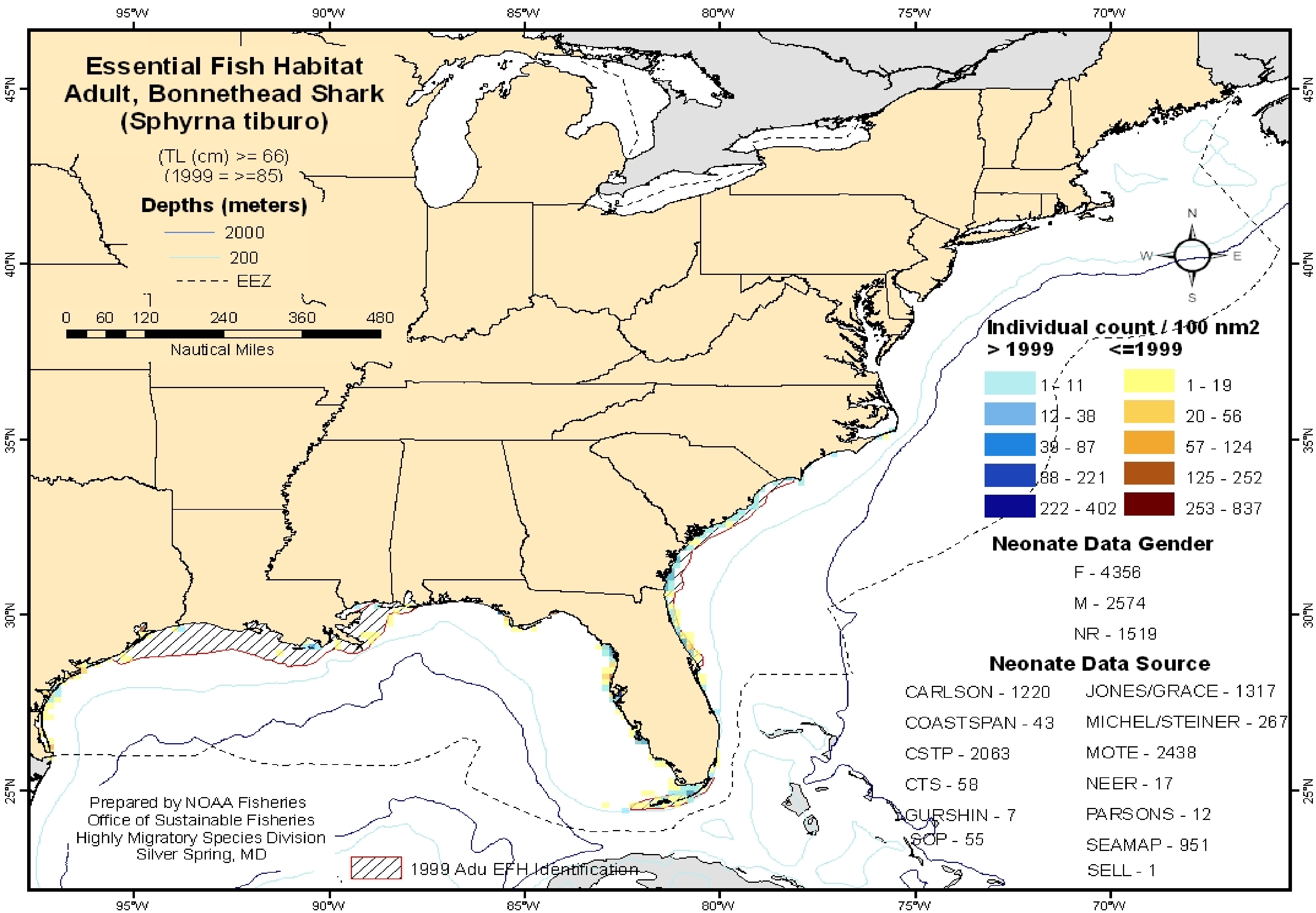

Figure B.91 Bonnethead Shark: Adult.

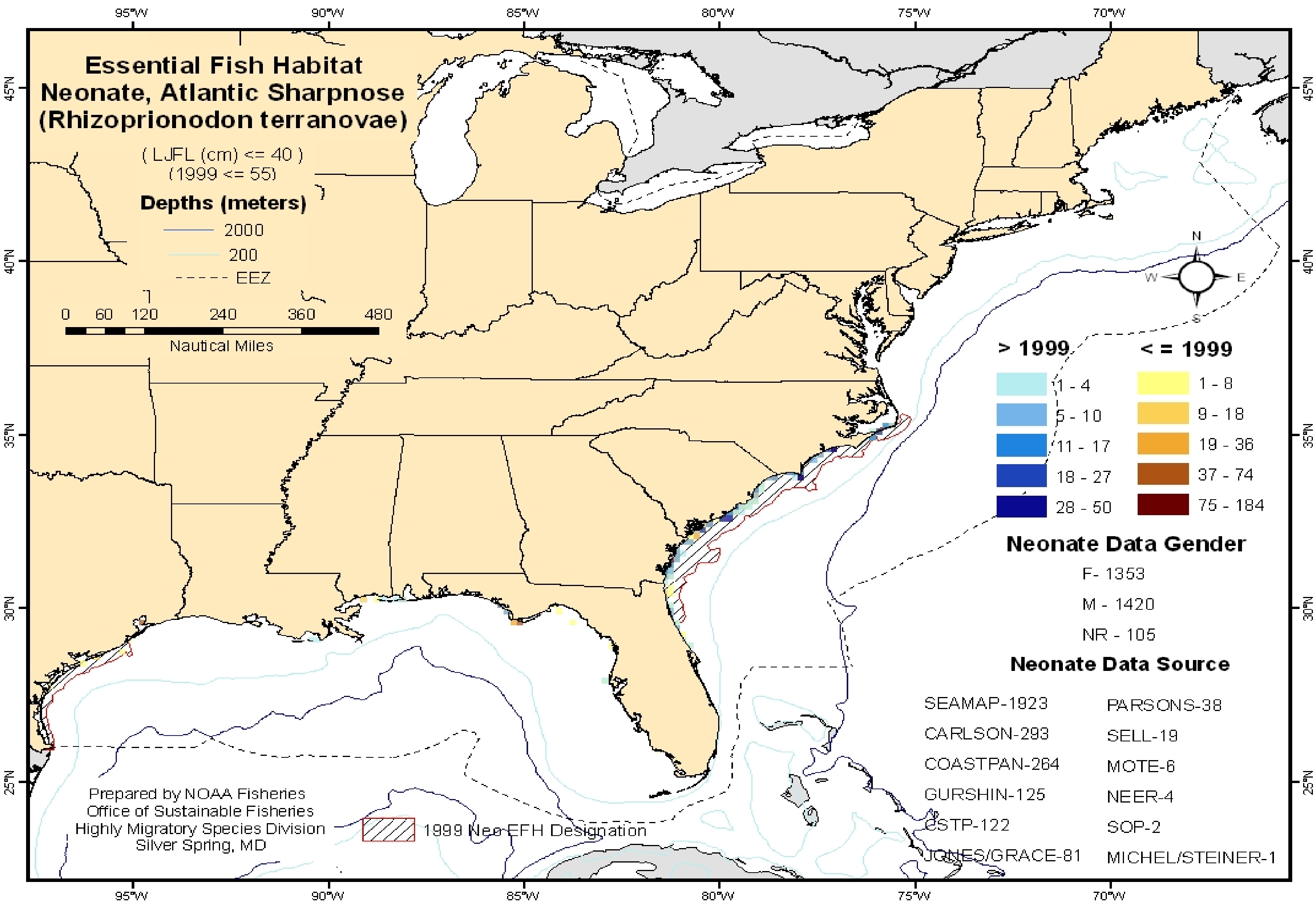

Figure B.92 **Altantic Sharpnose: Neonate.**

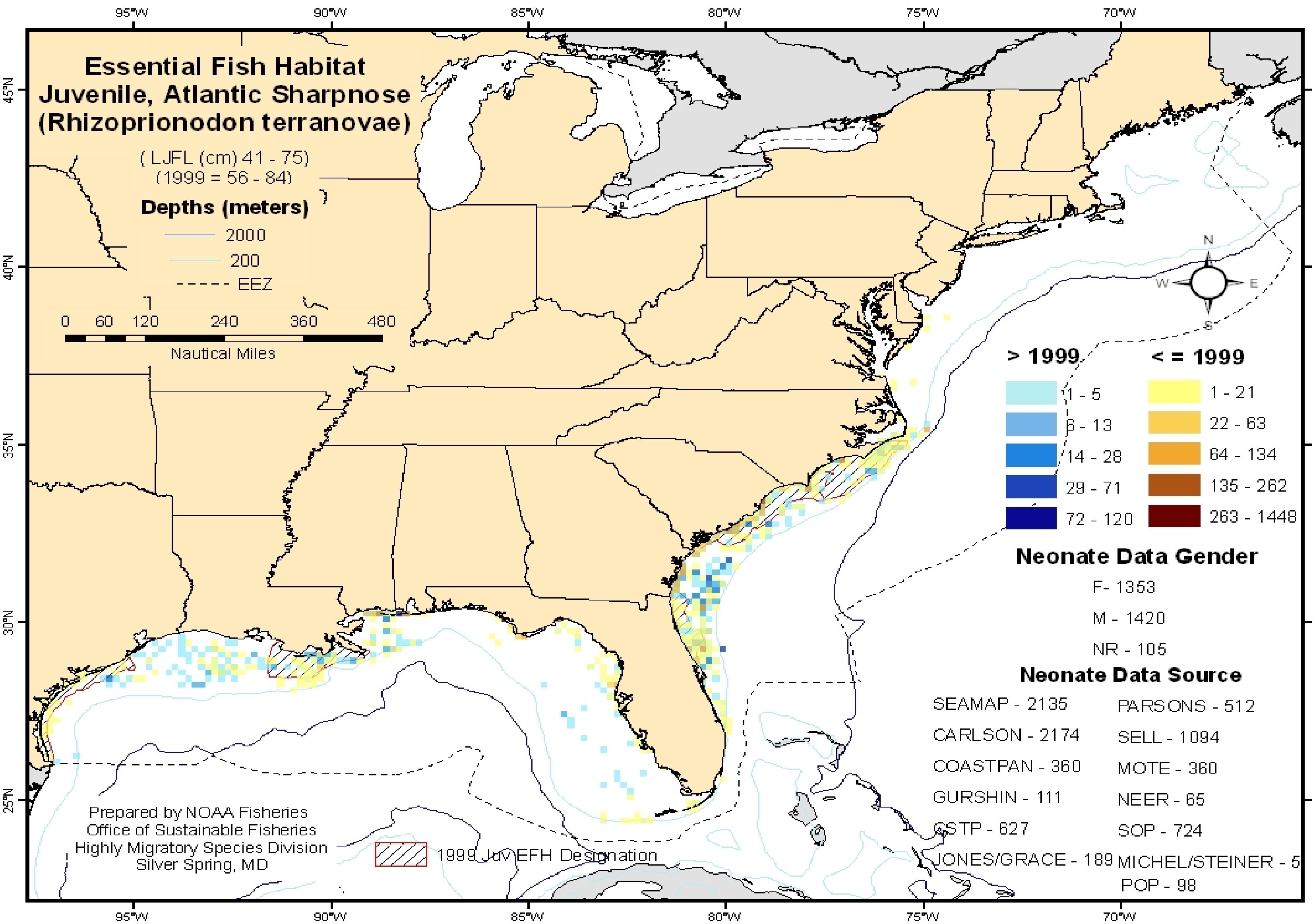

Figure B.93 Atlantic Sharpnose: Juvenile.

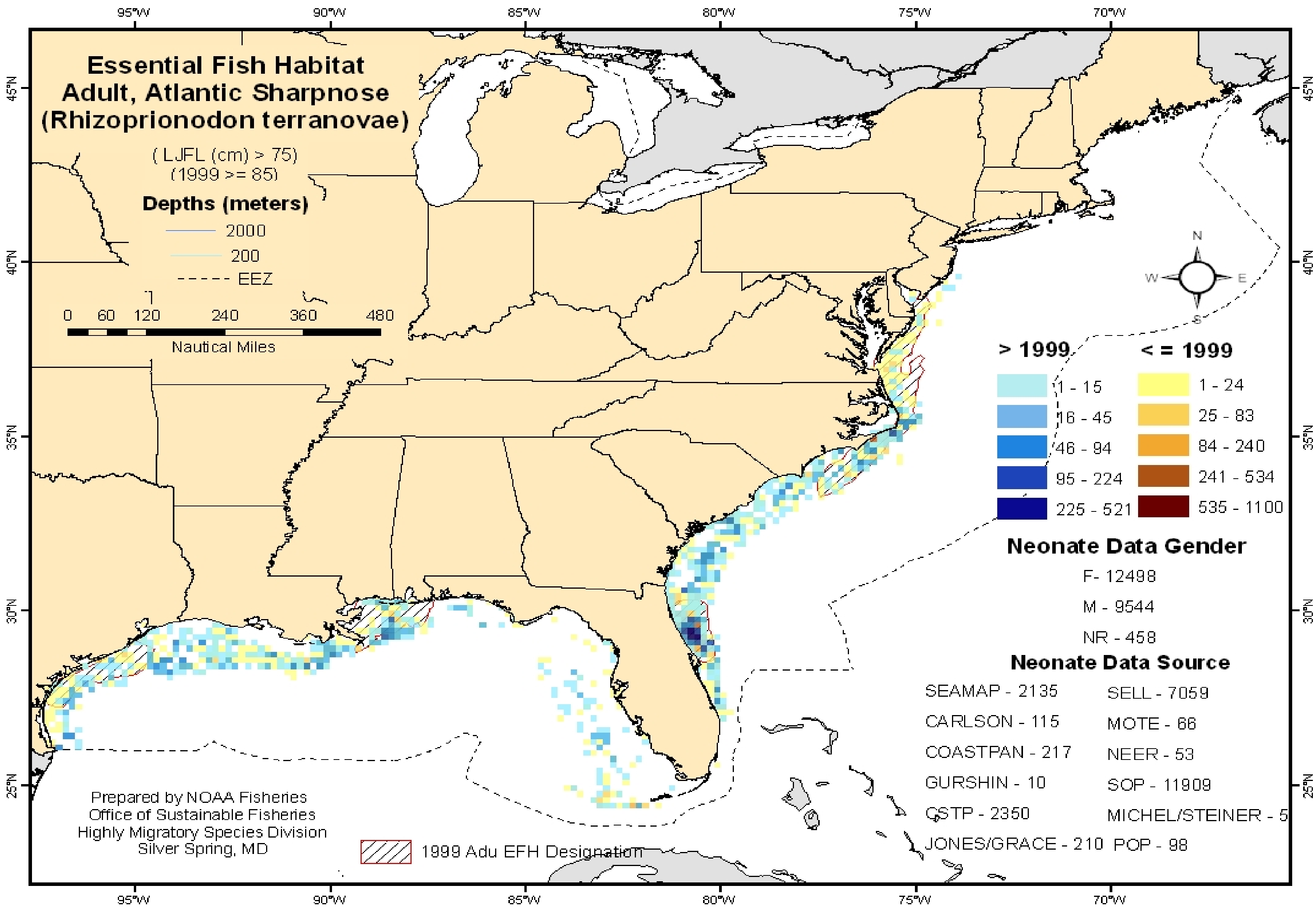

Figure B.94 **Atlantic Sharpnose Shark: Adult.**

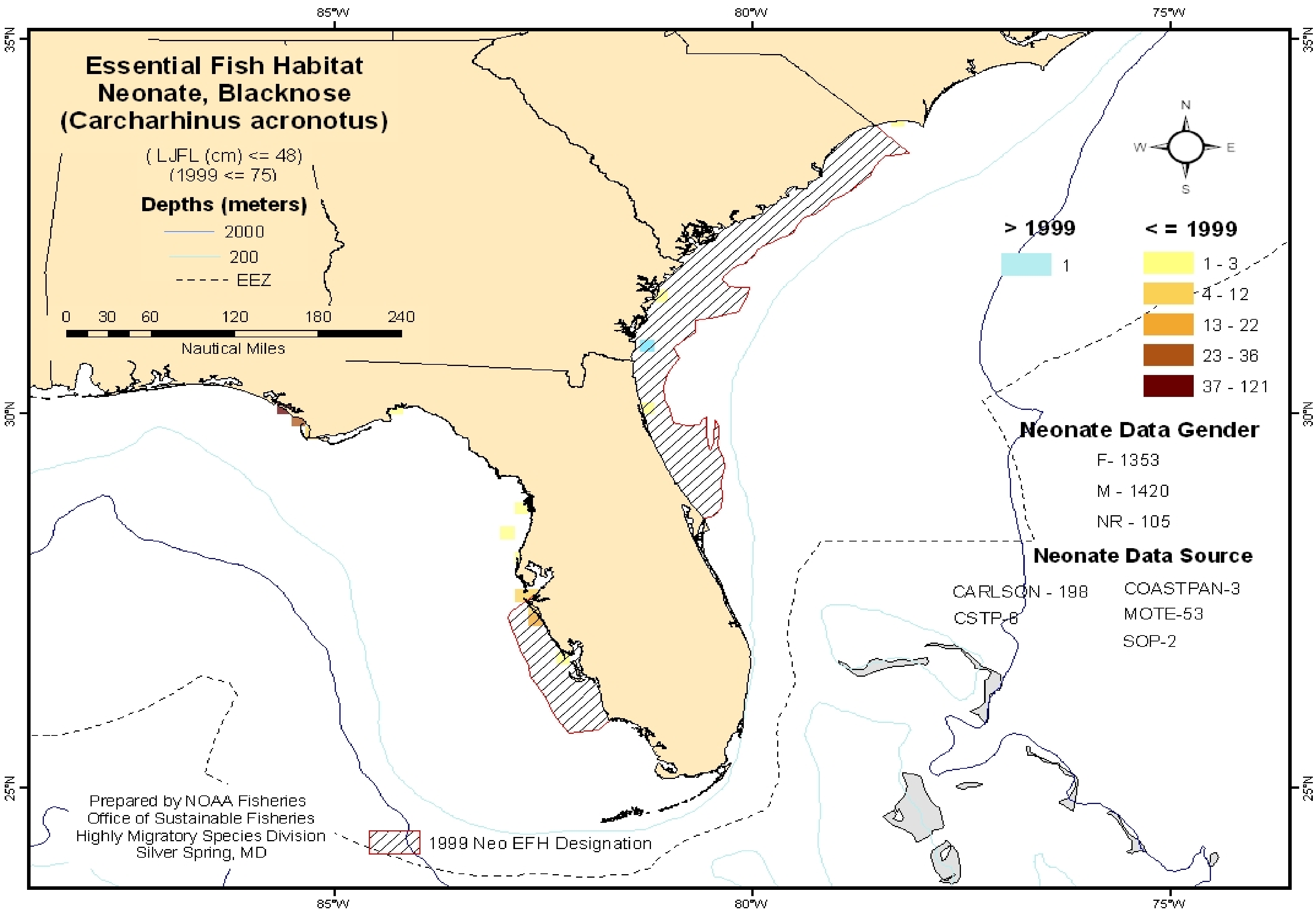

Figure B.95 Blacknose Shark: Neonoate.

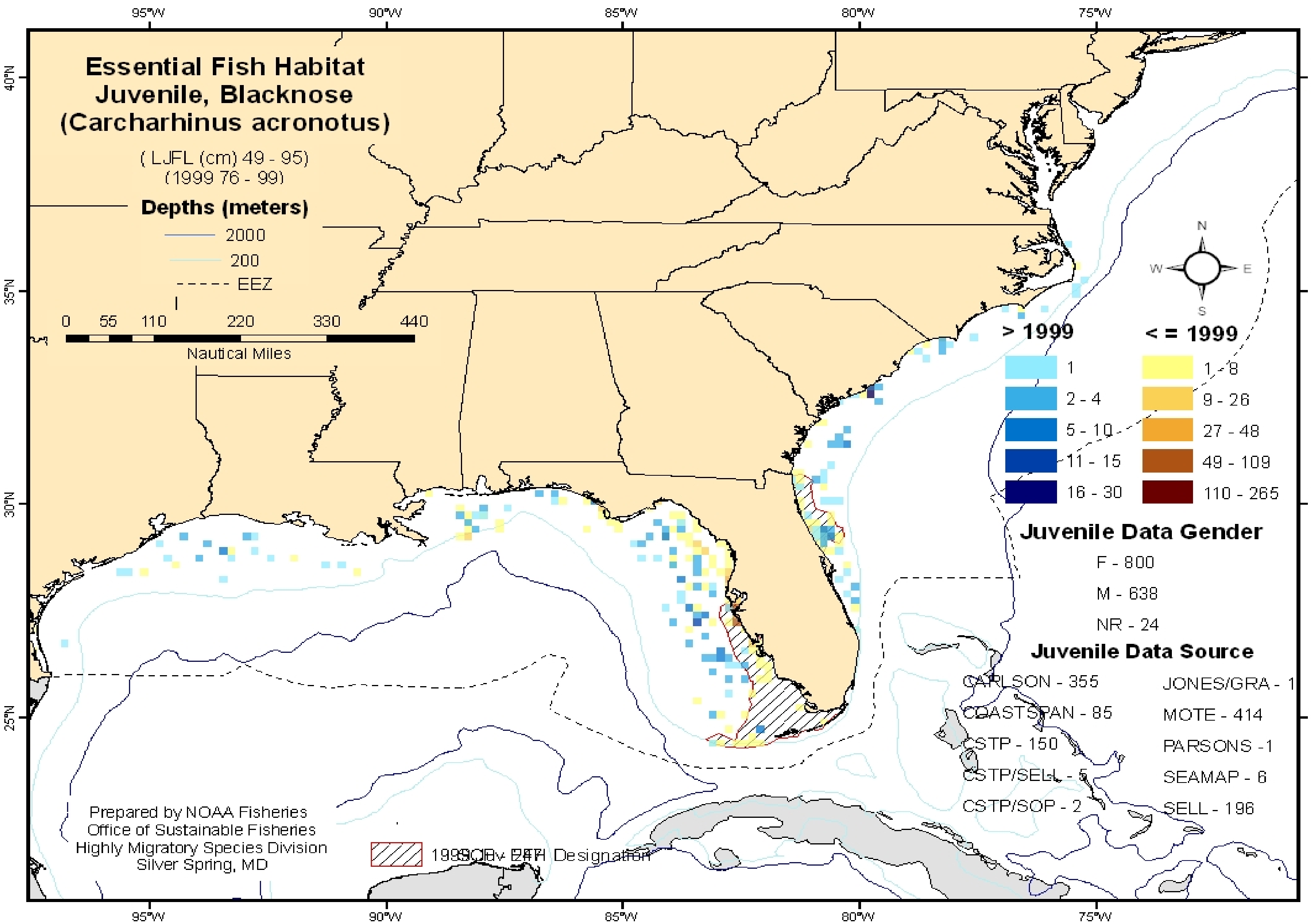

Figure B.96 **Blacknose Shark: Juvenile.**

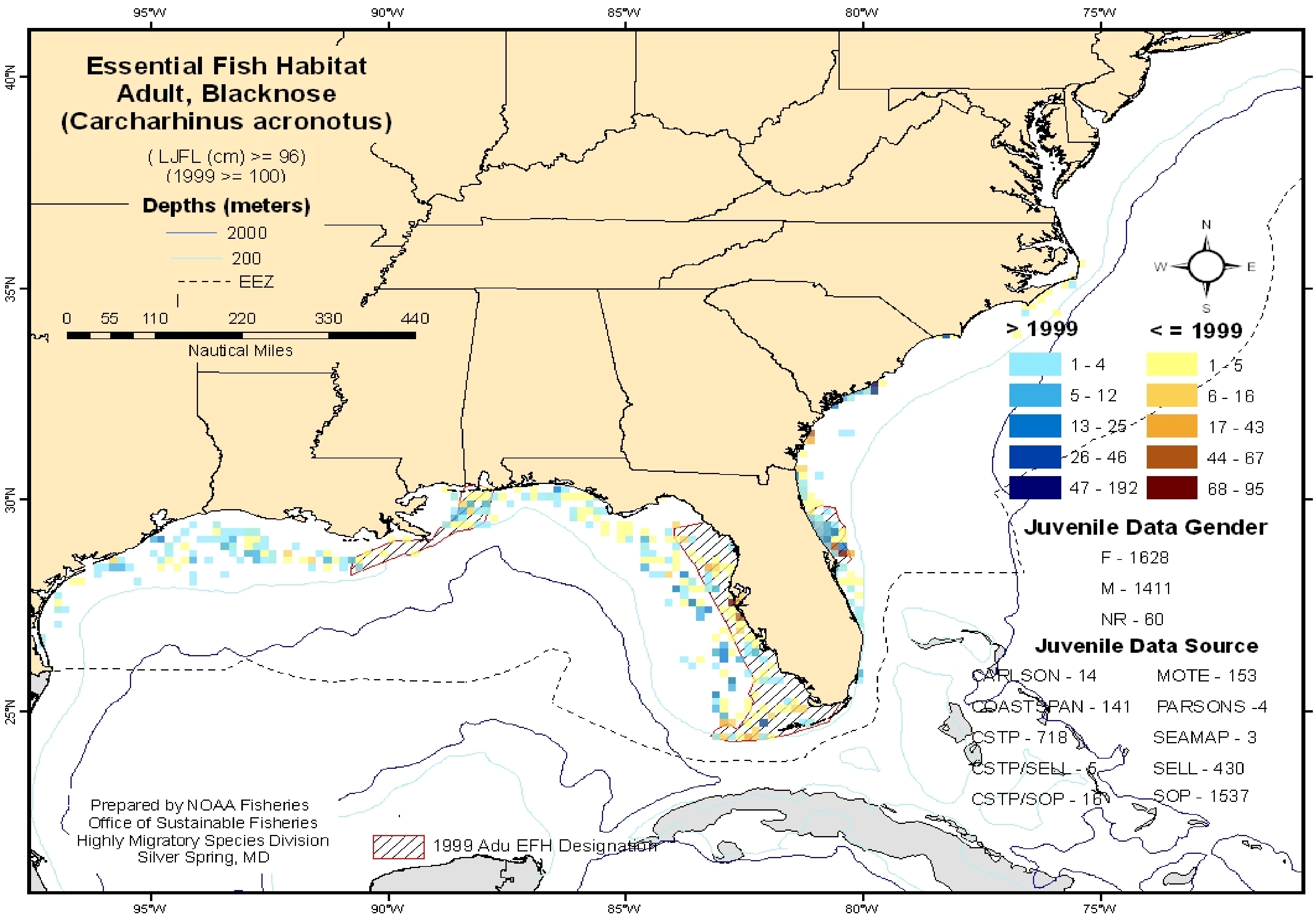

Figure B.97 **Blacknose Shark: Adult.**

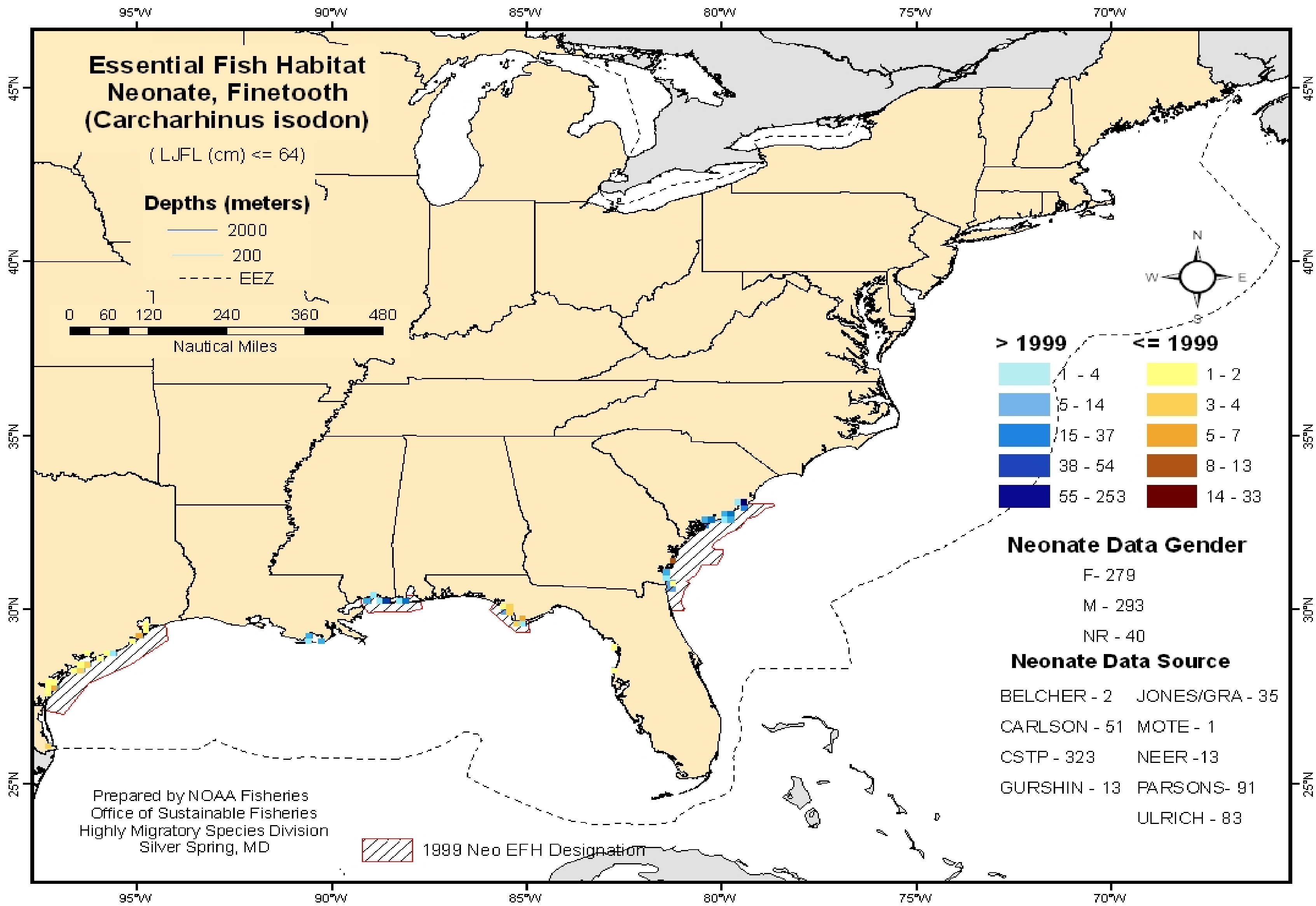

Figure B.98 Finetooth Shark: Neonate.

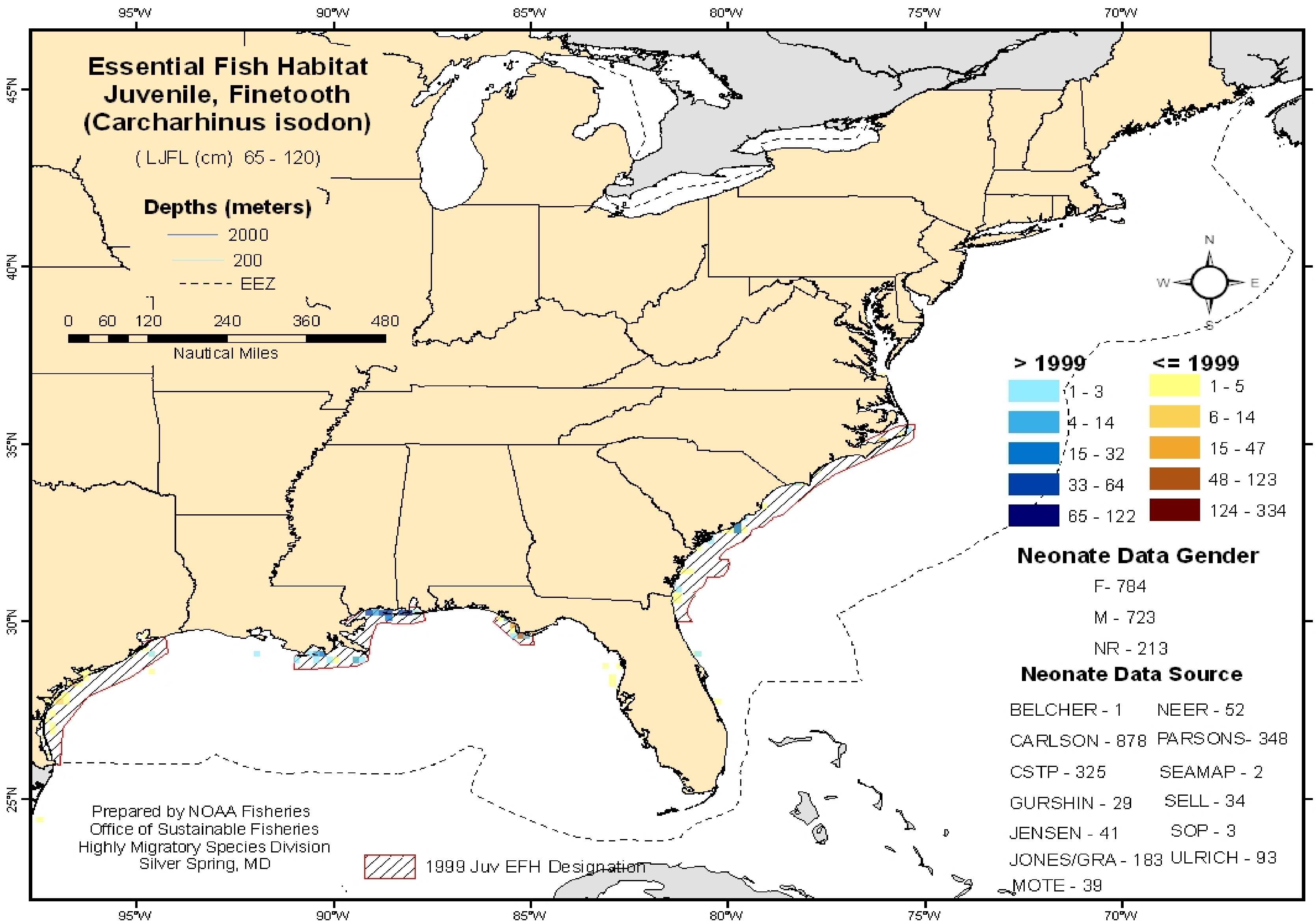

Figure B.99 Finetooth Shark: Juvenile.

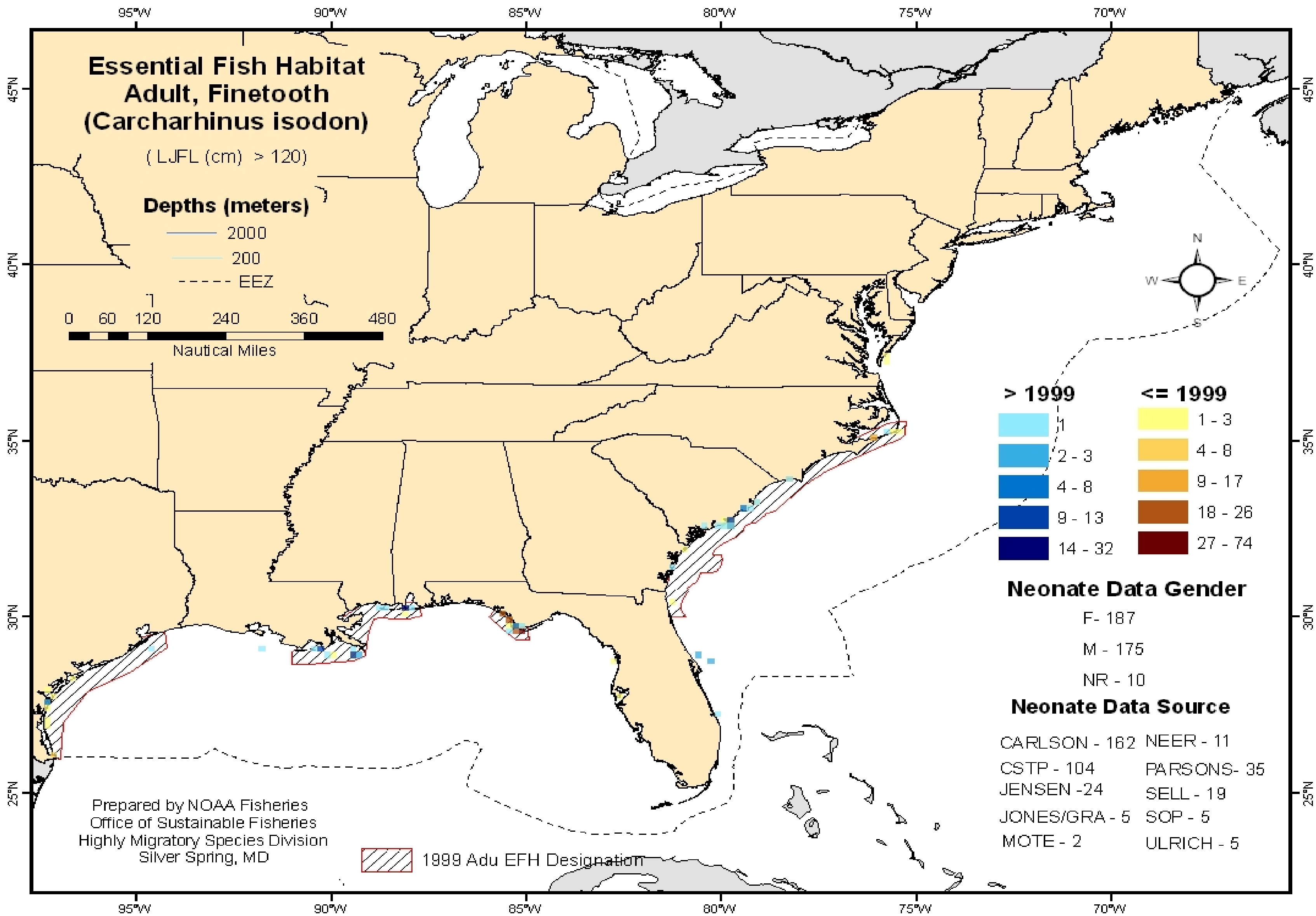

Figure B.100 Finetooth Shark: Adult.

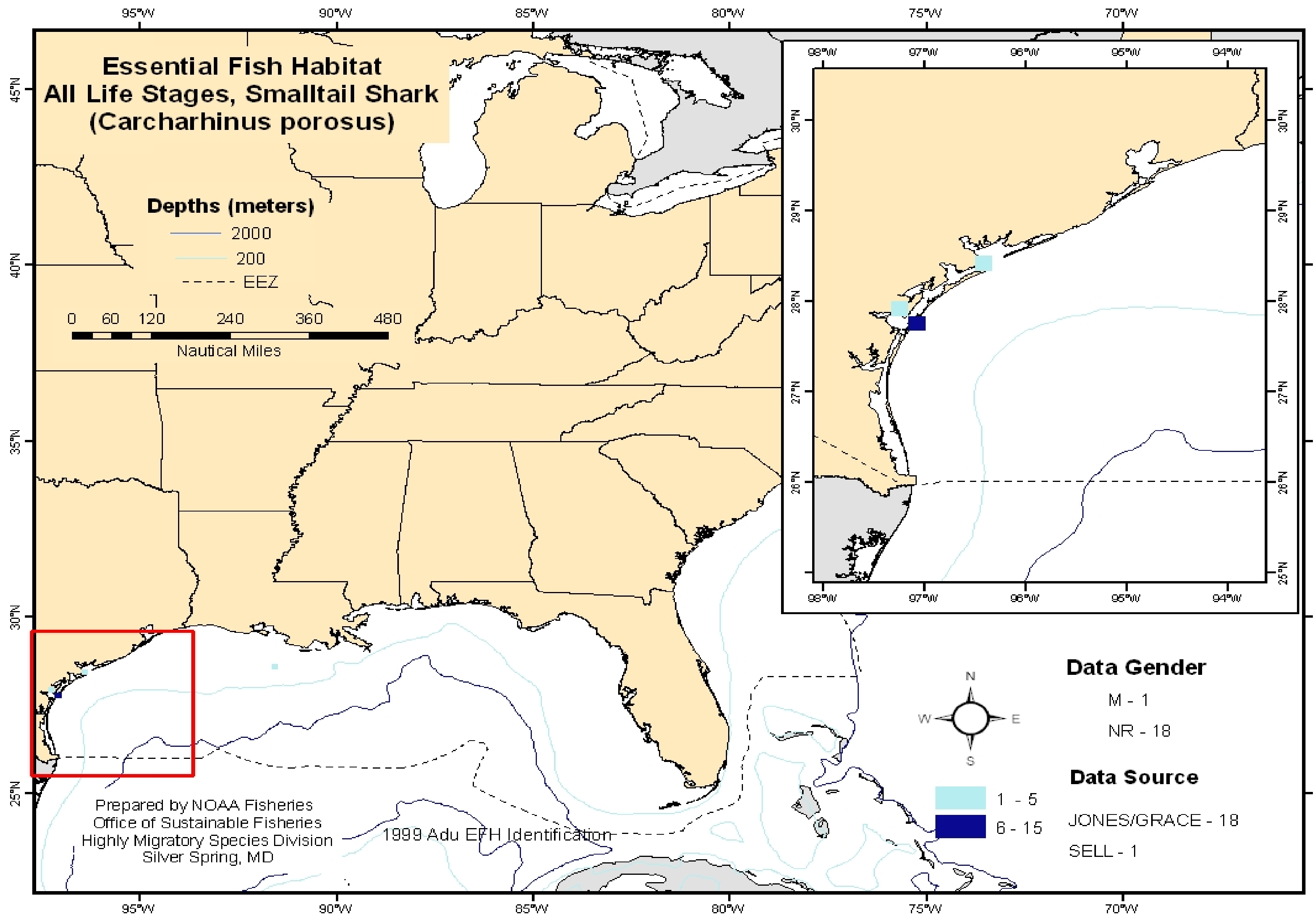

Figure B.101 Smalltail Shark: All Life Stages.

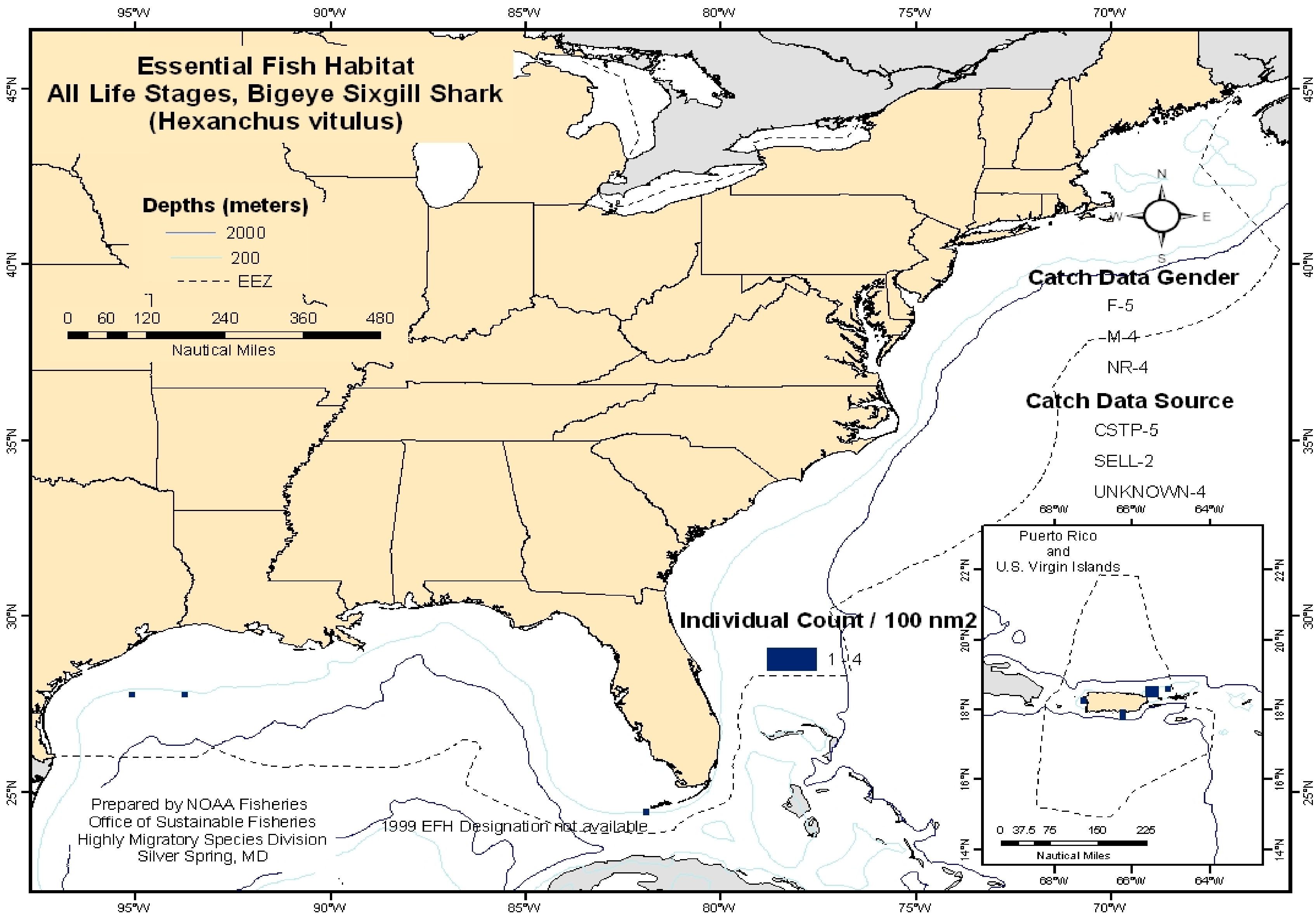

Figure B.102 Bigeye Sixgill Shark: All Life Stages.

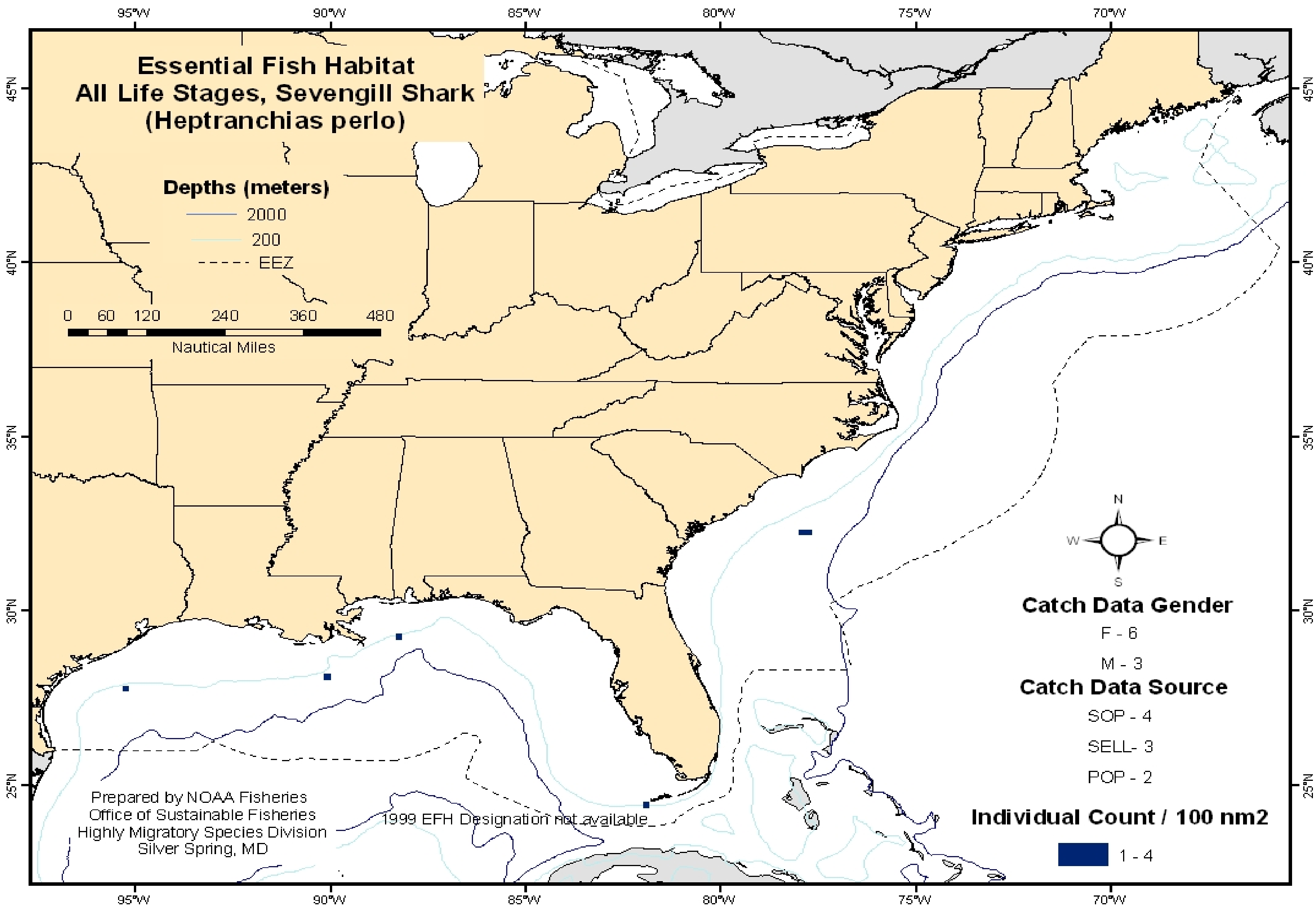

Figure B.103 **Sevengill Shark: All Life Stages.**

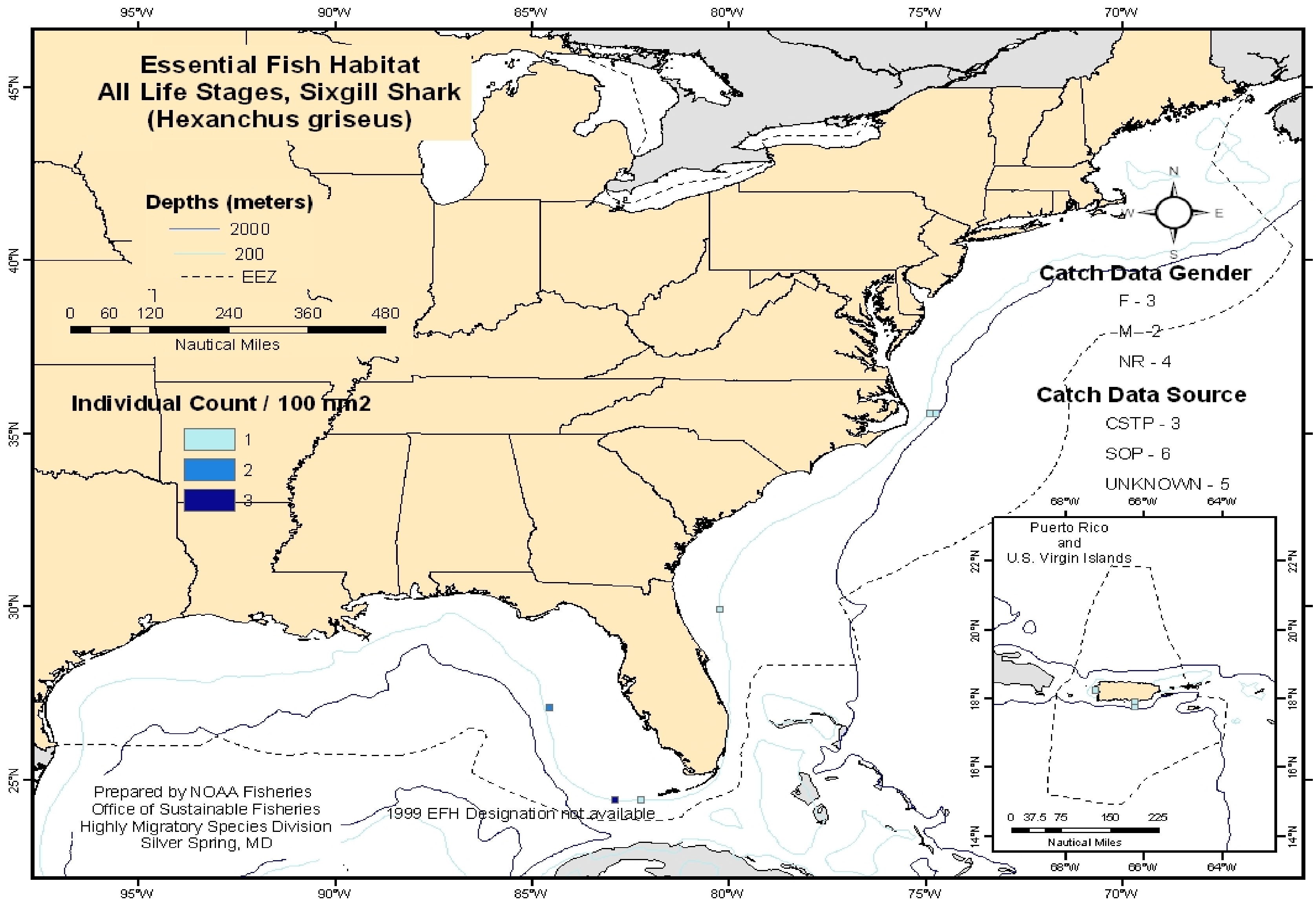

Figure B.104 **Sixgill Shark: All Life Stages.**

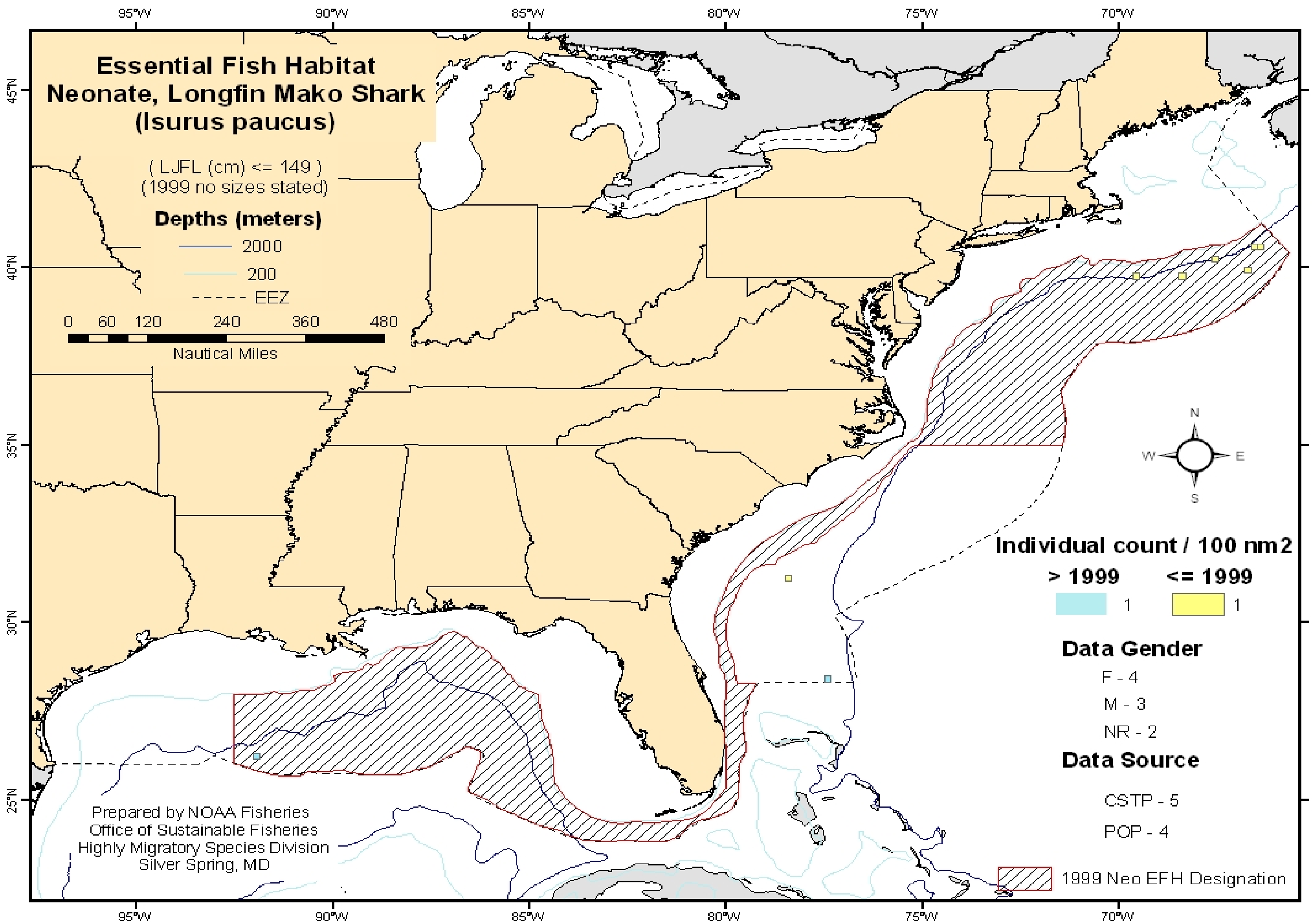

Figure B.105 Longfin Mako Shark: Neonate.

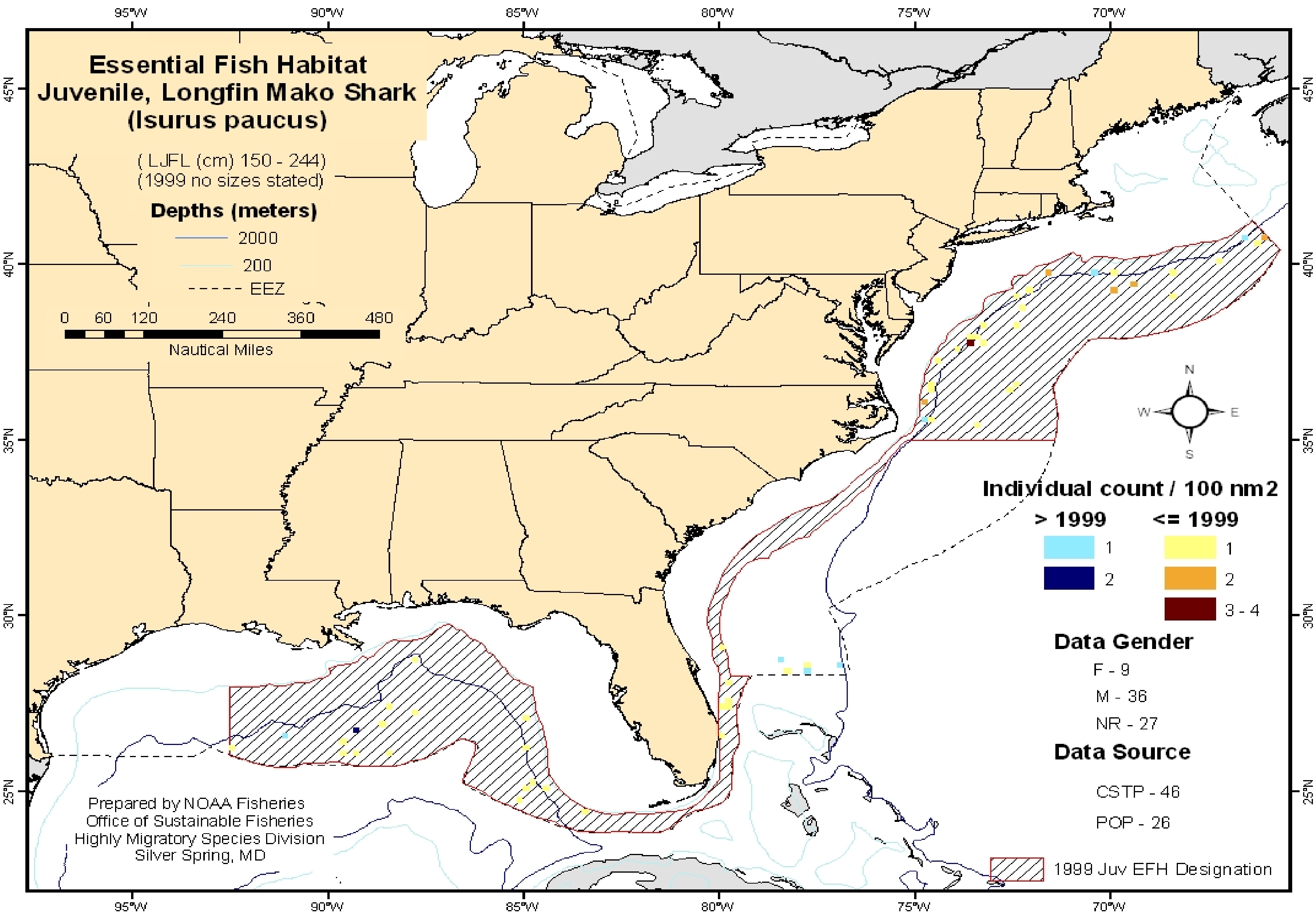

Figure B.106 Longfin Mako Shark : Juvenile.

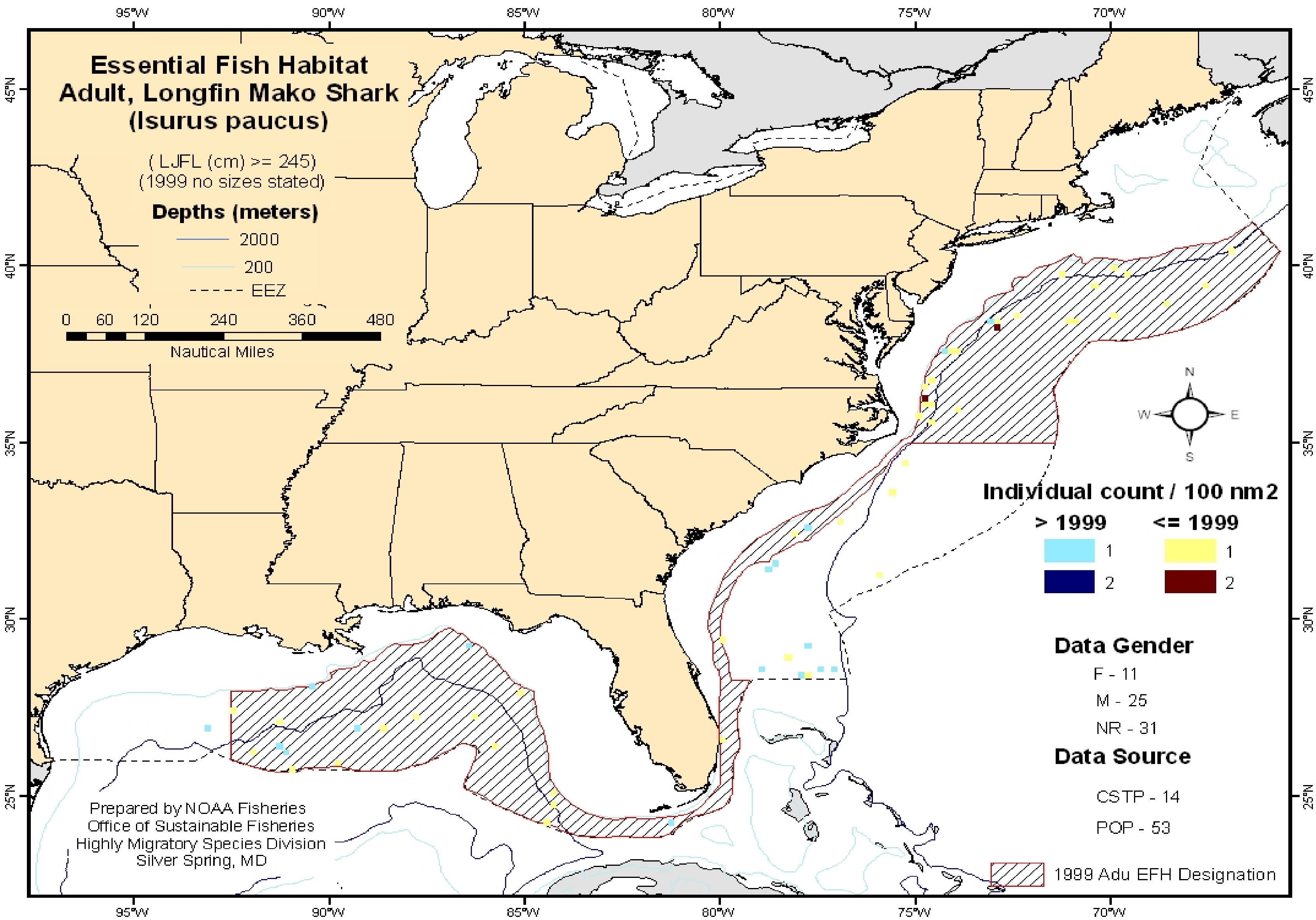

Figure B.107 Longfin Mako Shark: Adult.

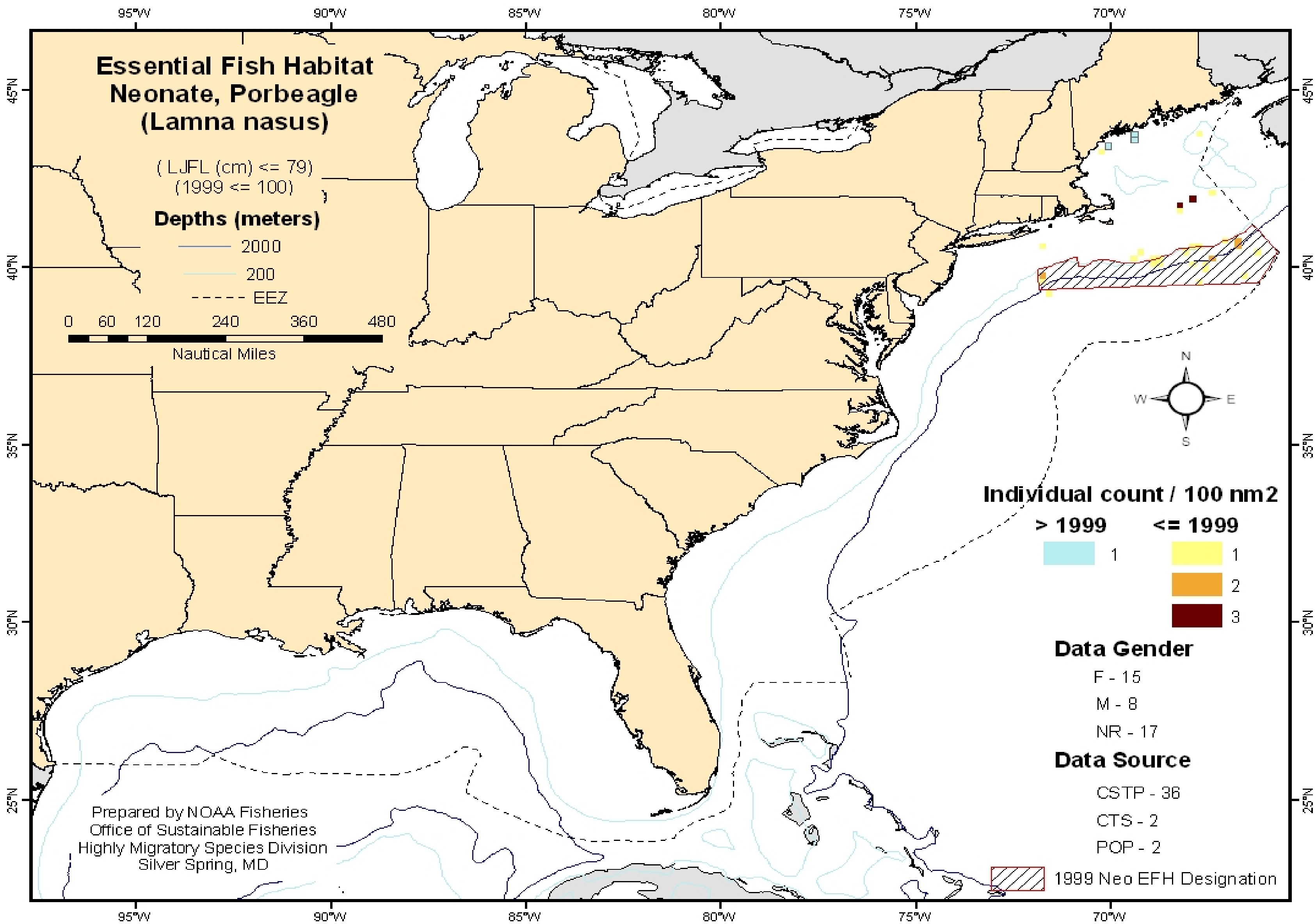

Figure B.108 **Porbeagle Shark: Neonate.**

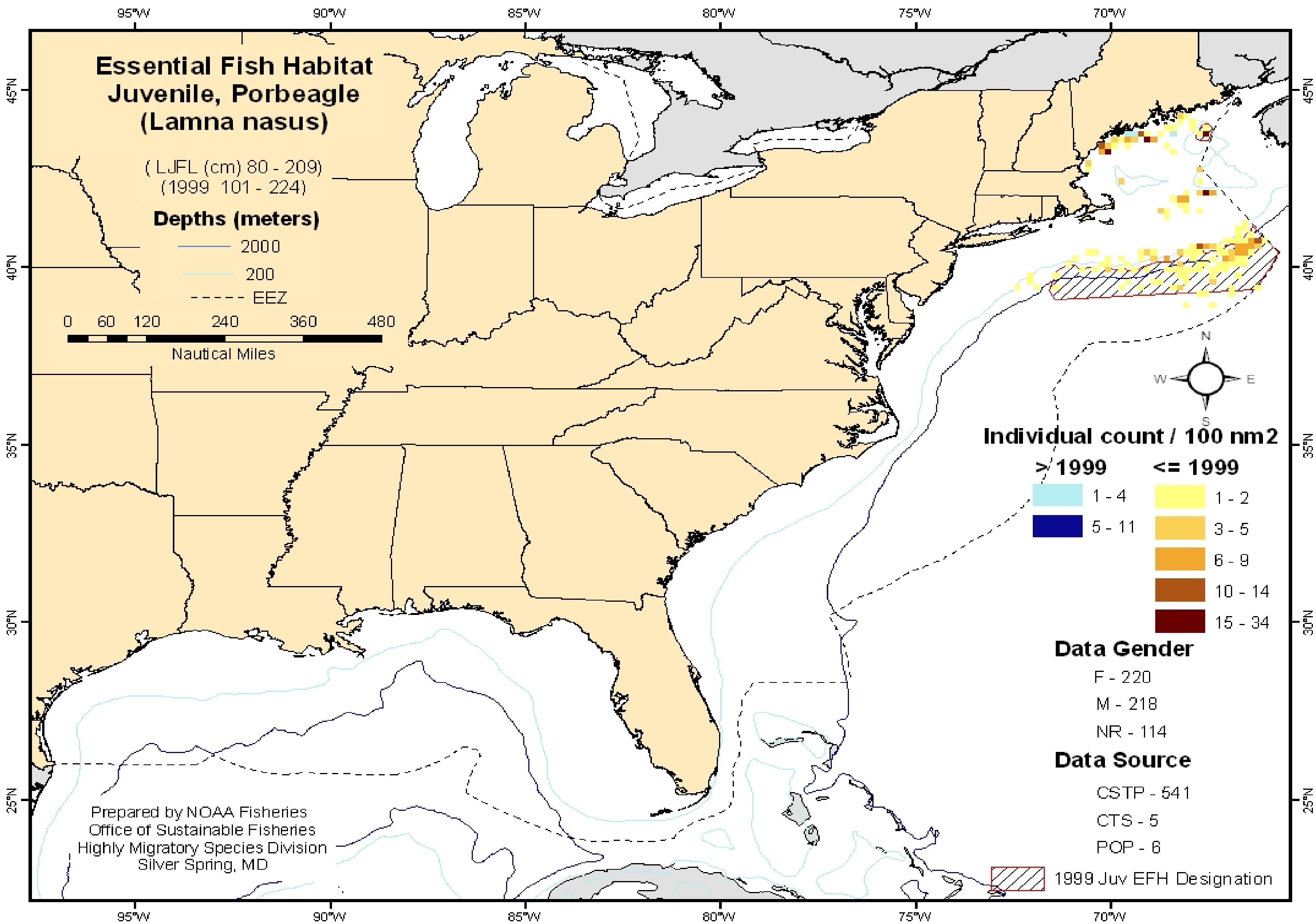

Figure B.109 Porbeagle Shark: Juvenile.

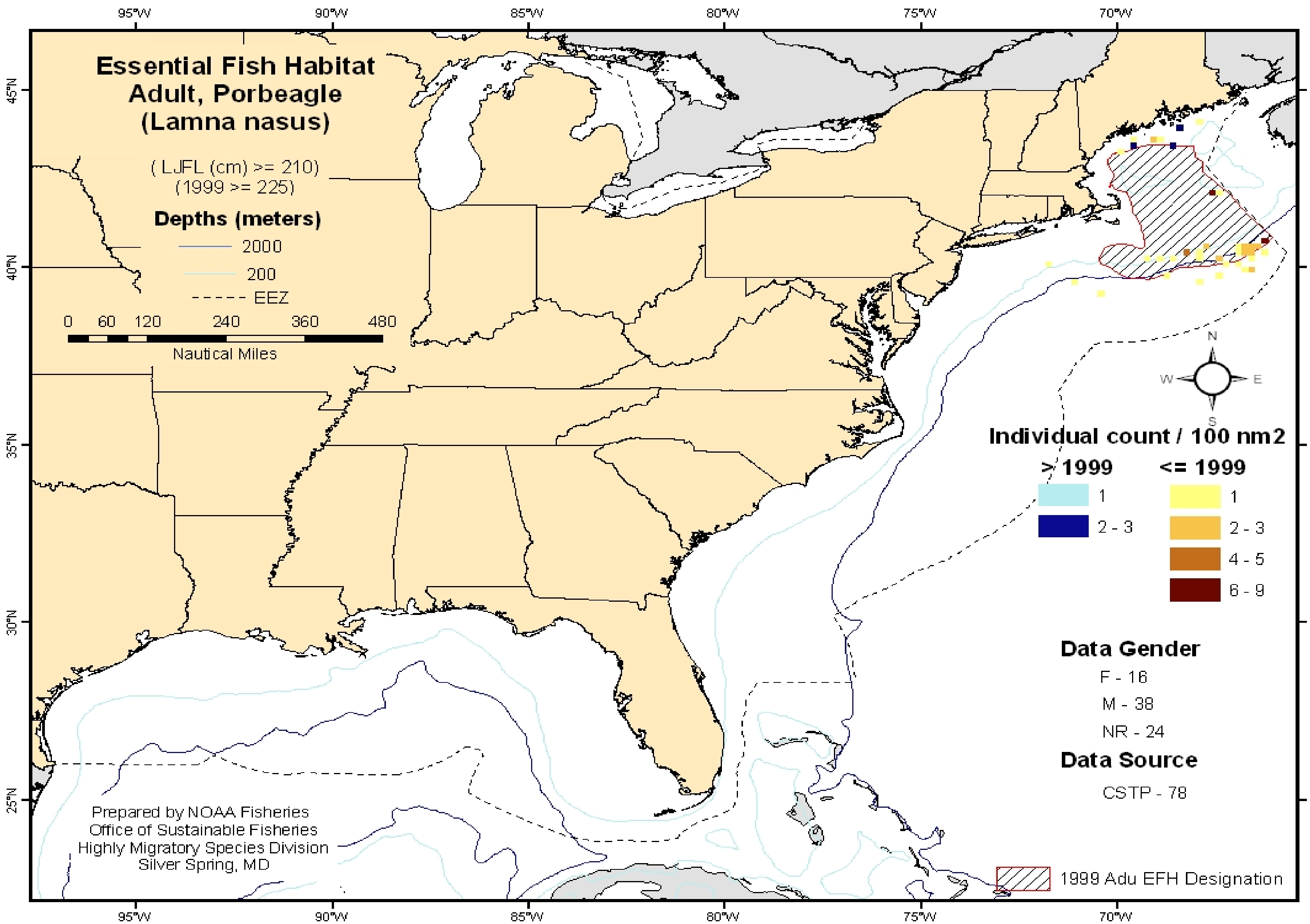

Figure B.110 **Porbeagle Shark: Adult.**

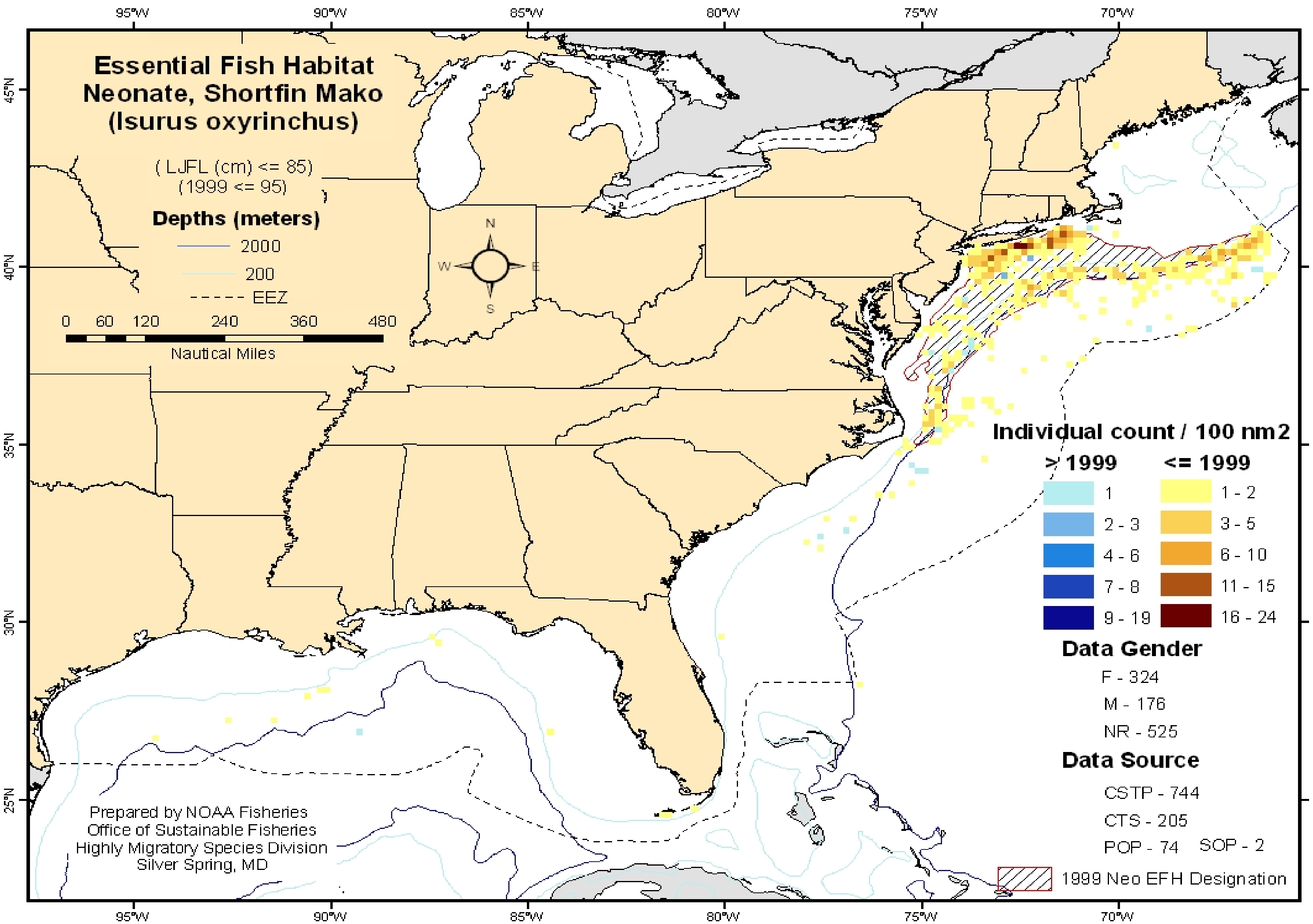

Figure B.111 **Shortfin Mako Shark: Neonate.**

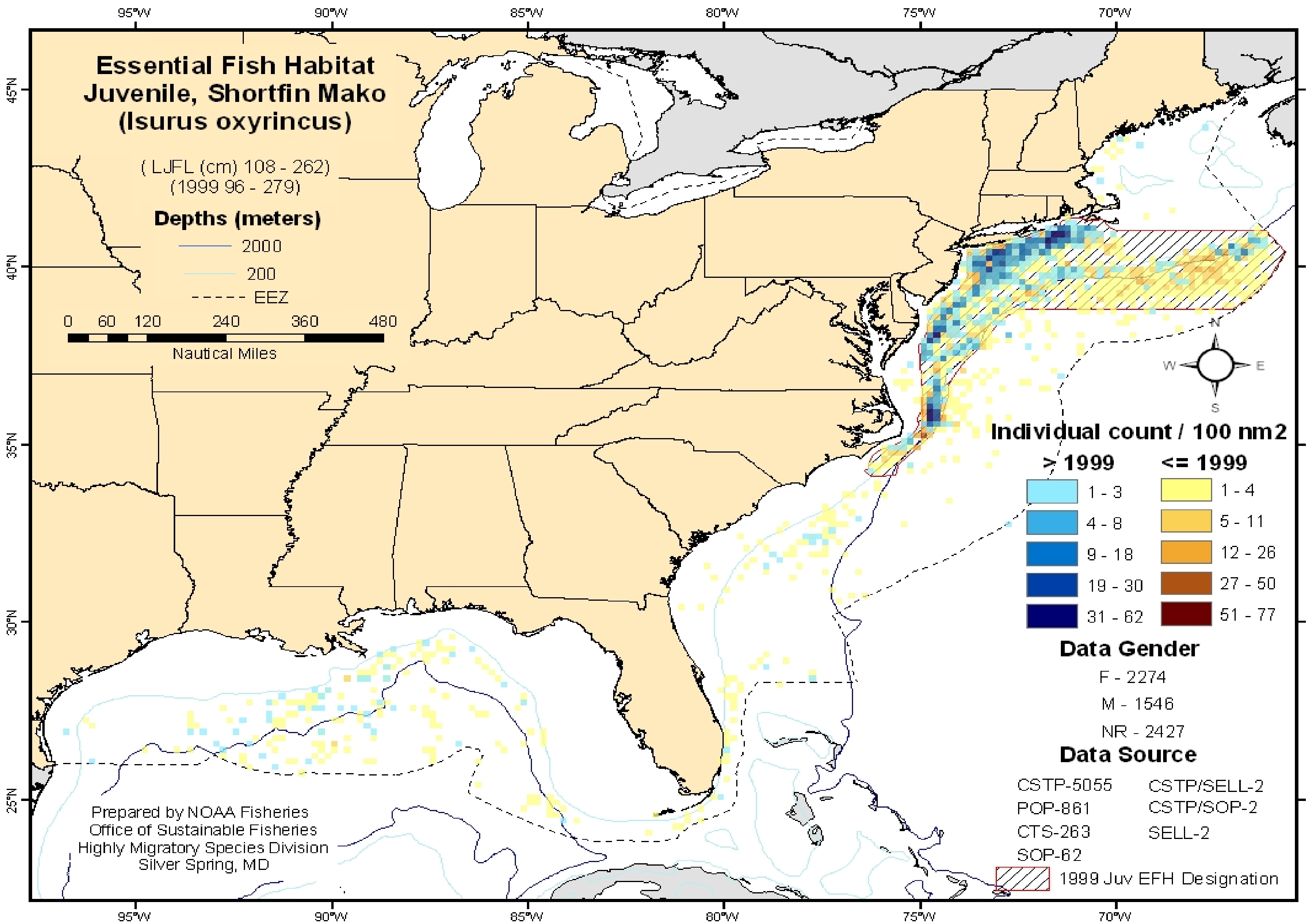

Figure B.112 Shortfin Mako Shark: Juvenile.

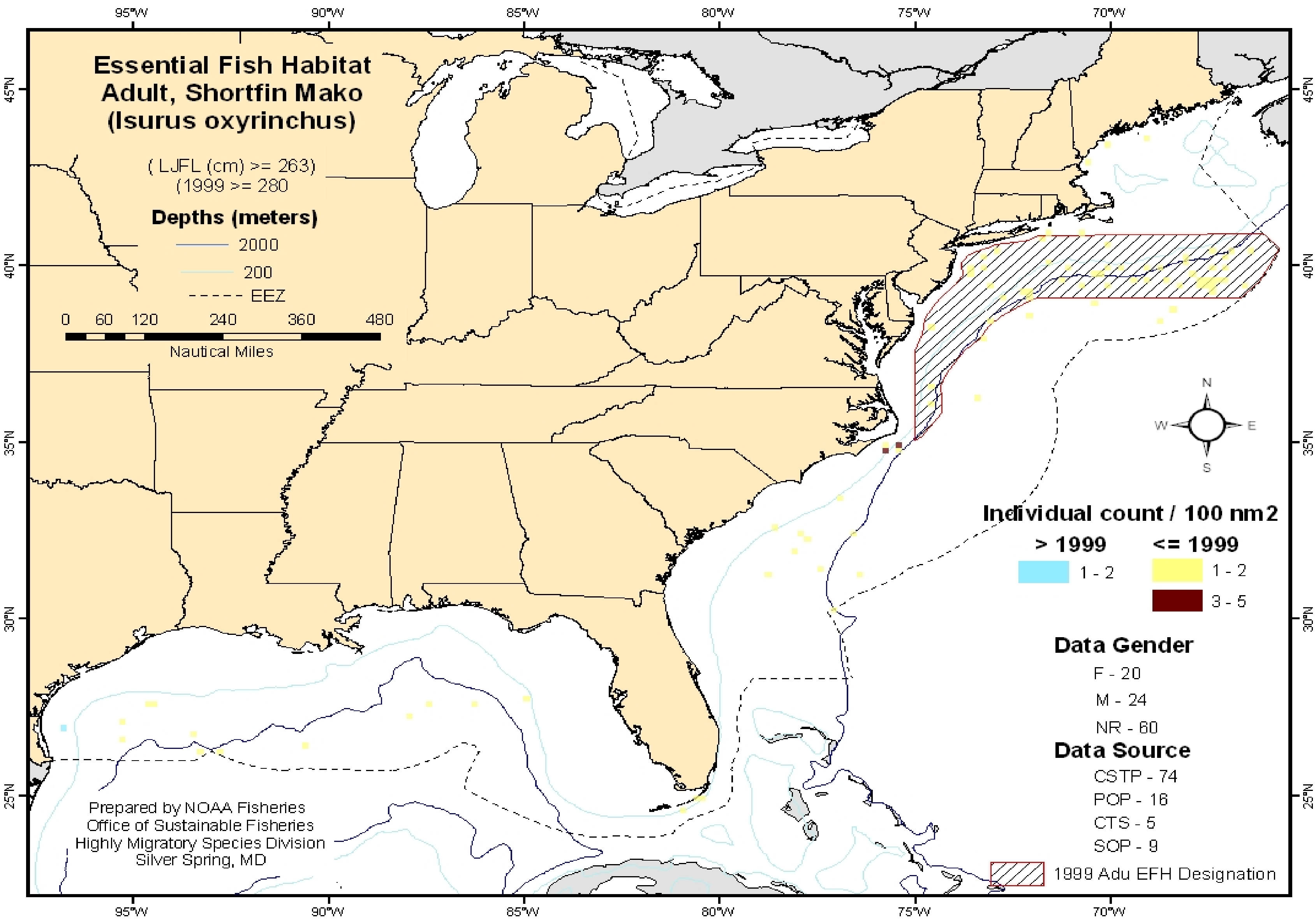

Figure B.113 Shortfin Mako Shark: Adult.

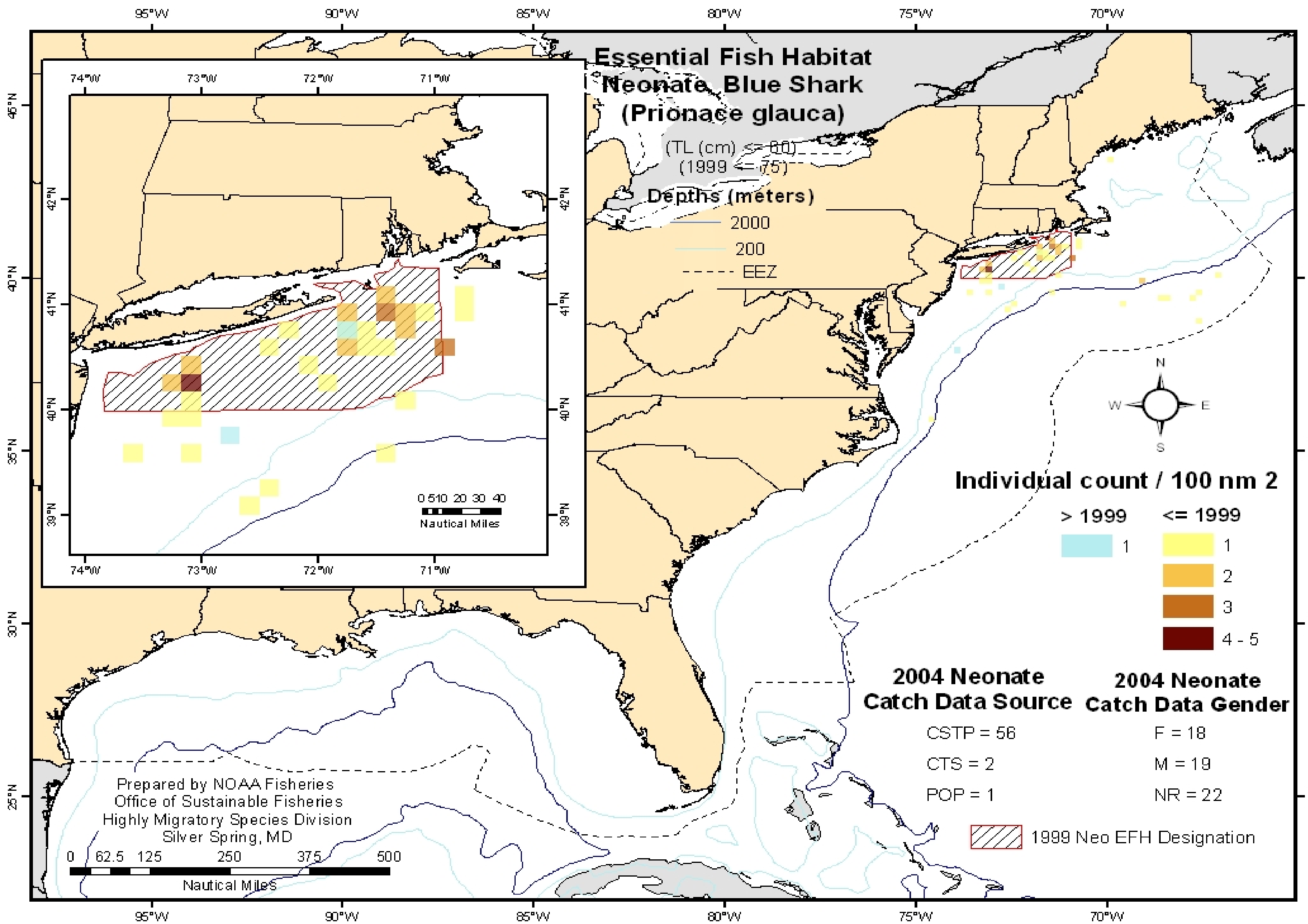

Figure B.114 **Blue Shark: Neonate.**

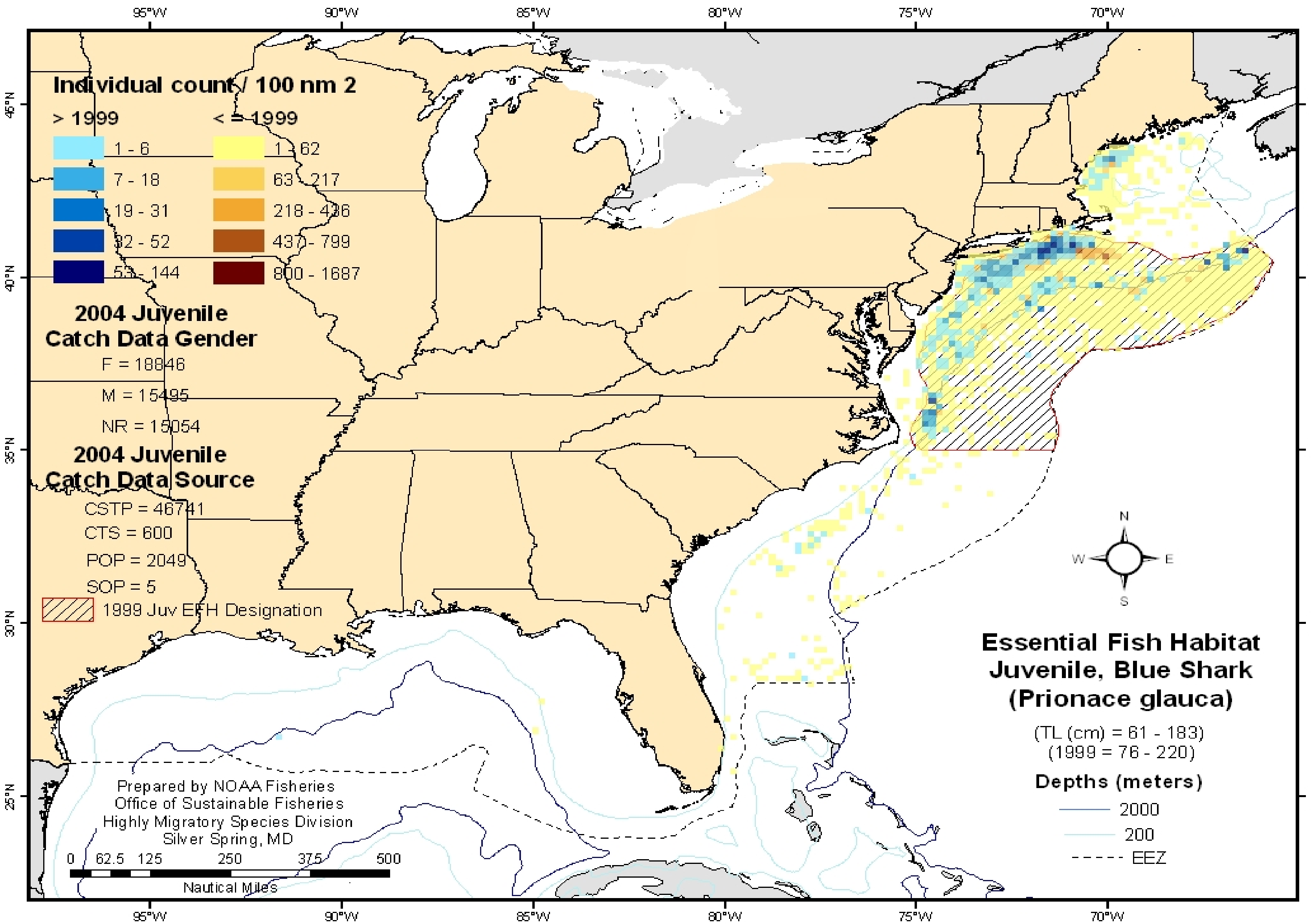

Figure B.115 **Blue Shark: Juvenile.**

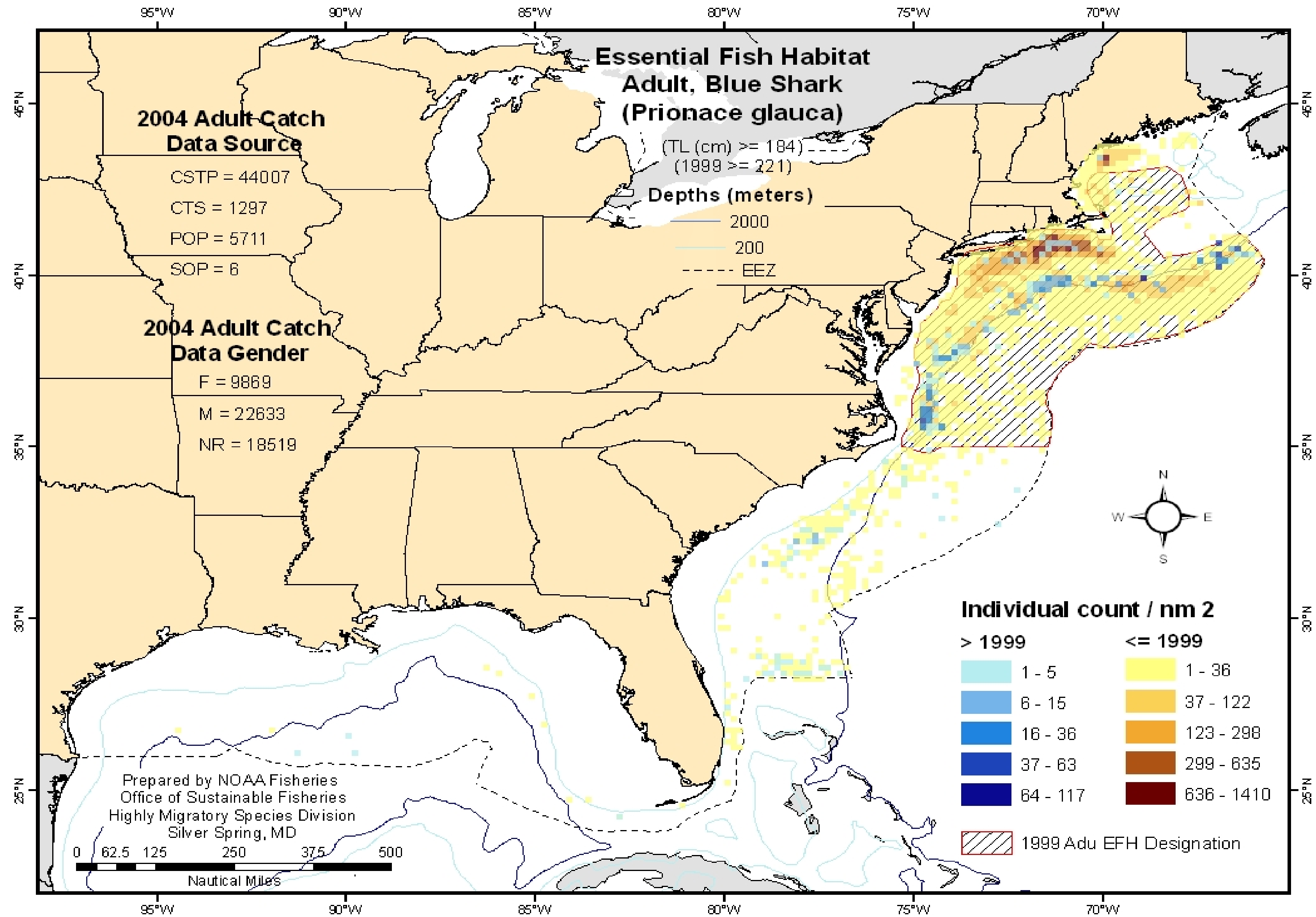

Figure B.116 **Blue Shark: Adult.**

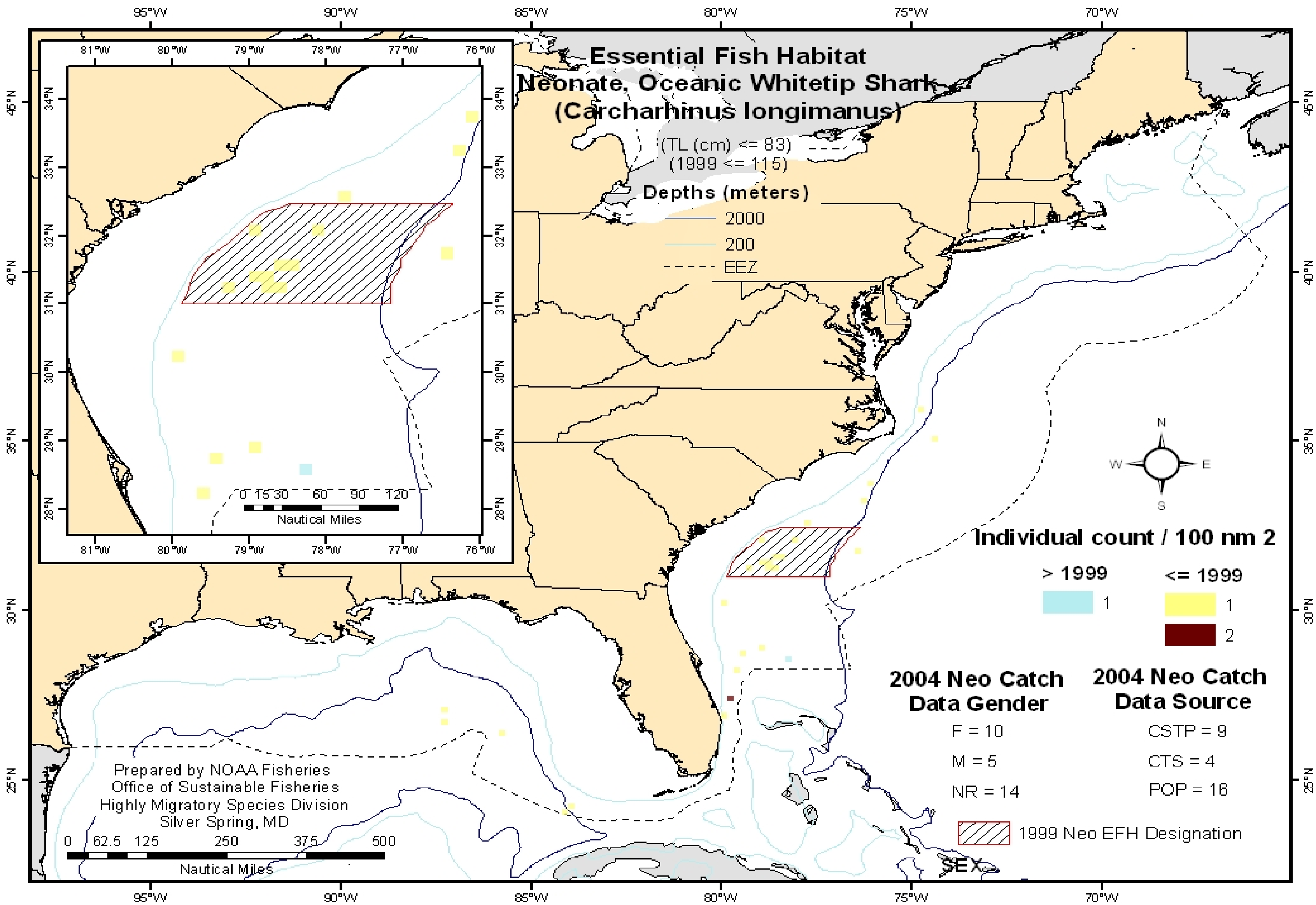

Figure B.117 Oceanic Whitetip Shark: Neonate.

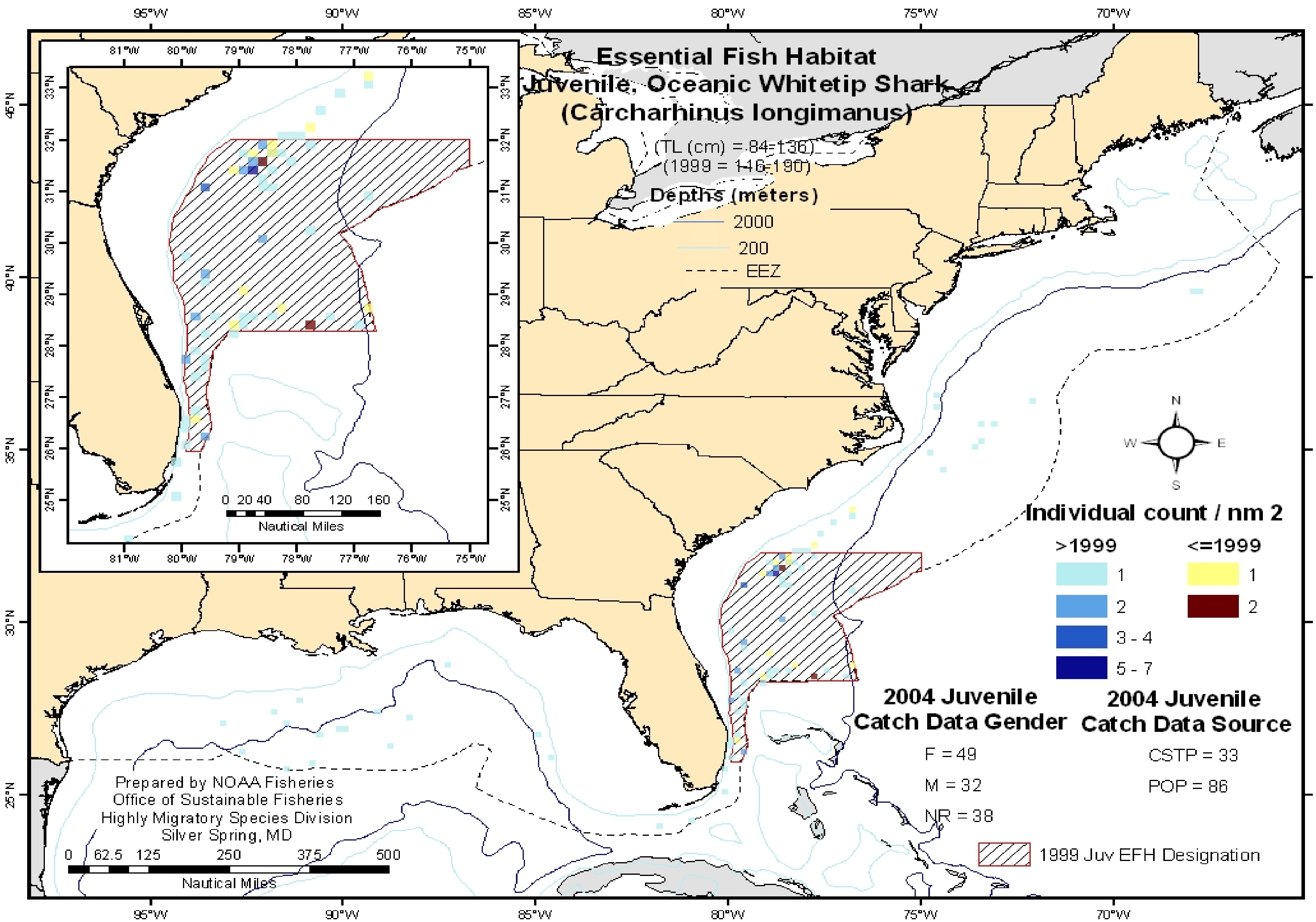

Figure B.118 Oceanic Whitetip Shark: Juvenile.

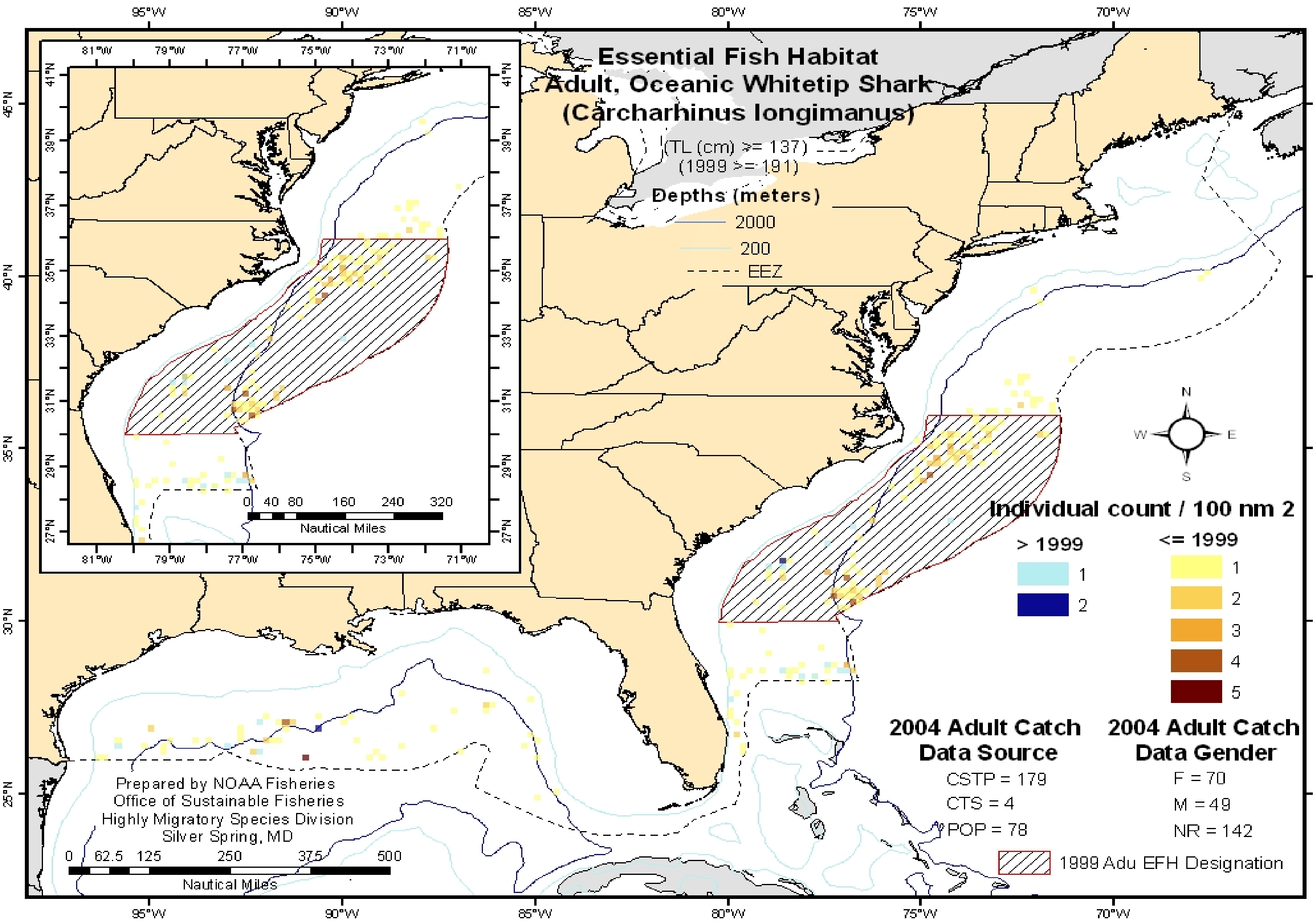

Figure B.119 **Oceanic Whitetip Shark: Adult.**

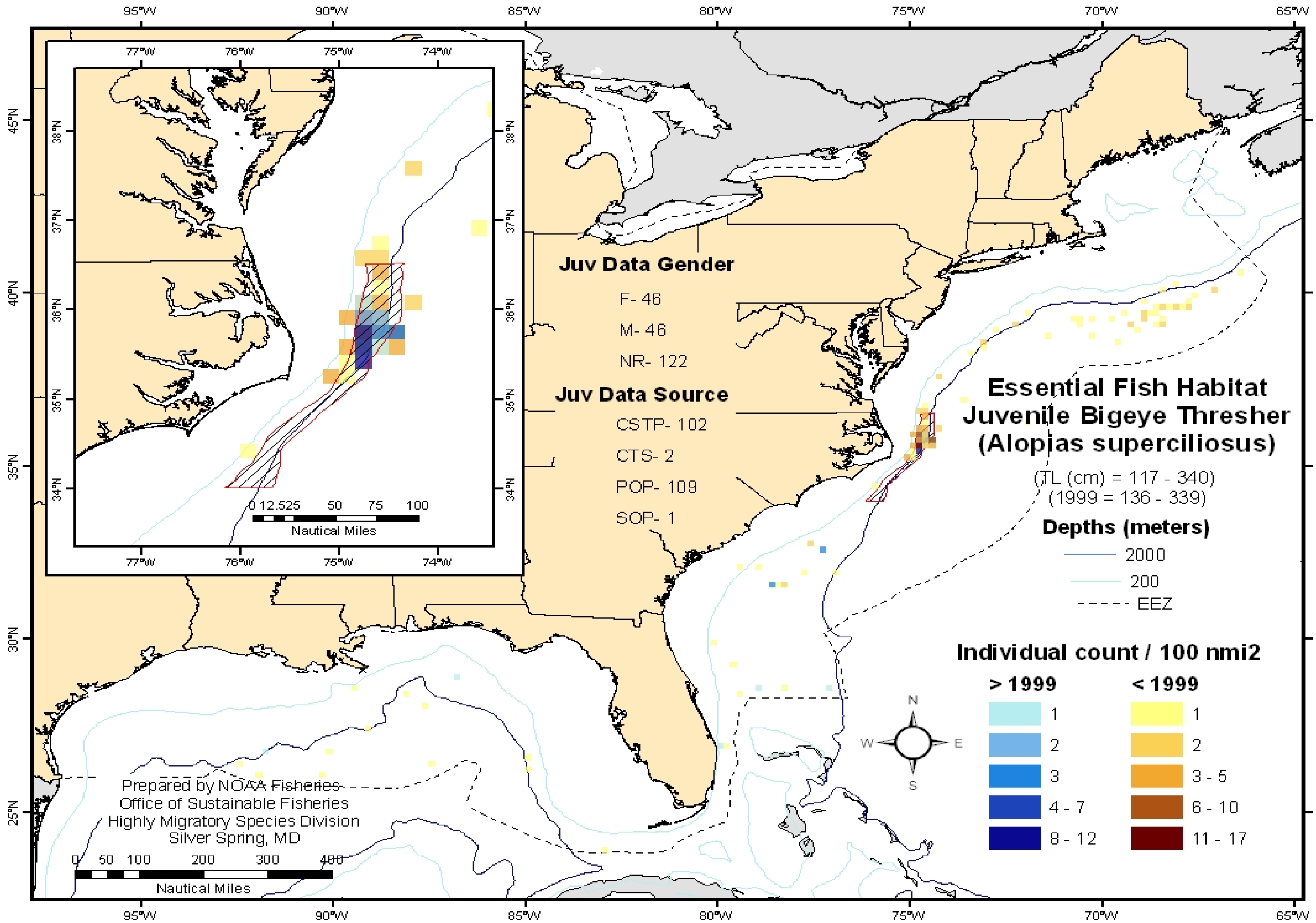

Figure B.120 Bigeye Thresher Shark: Juvenile.

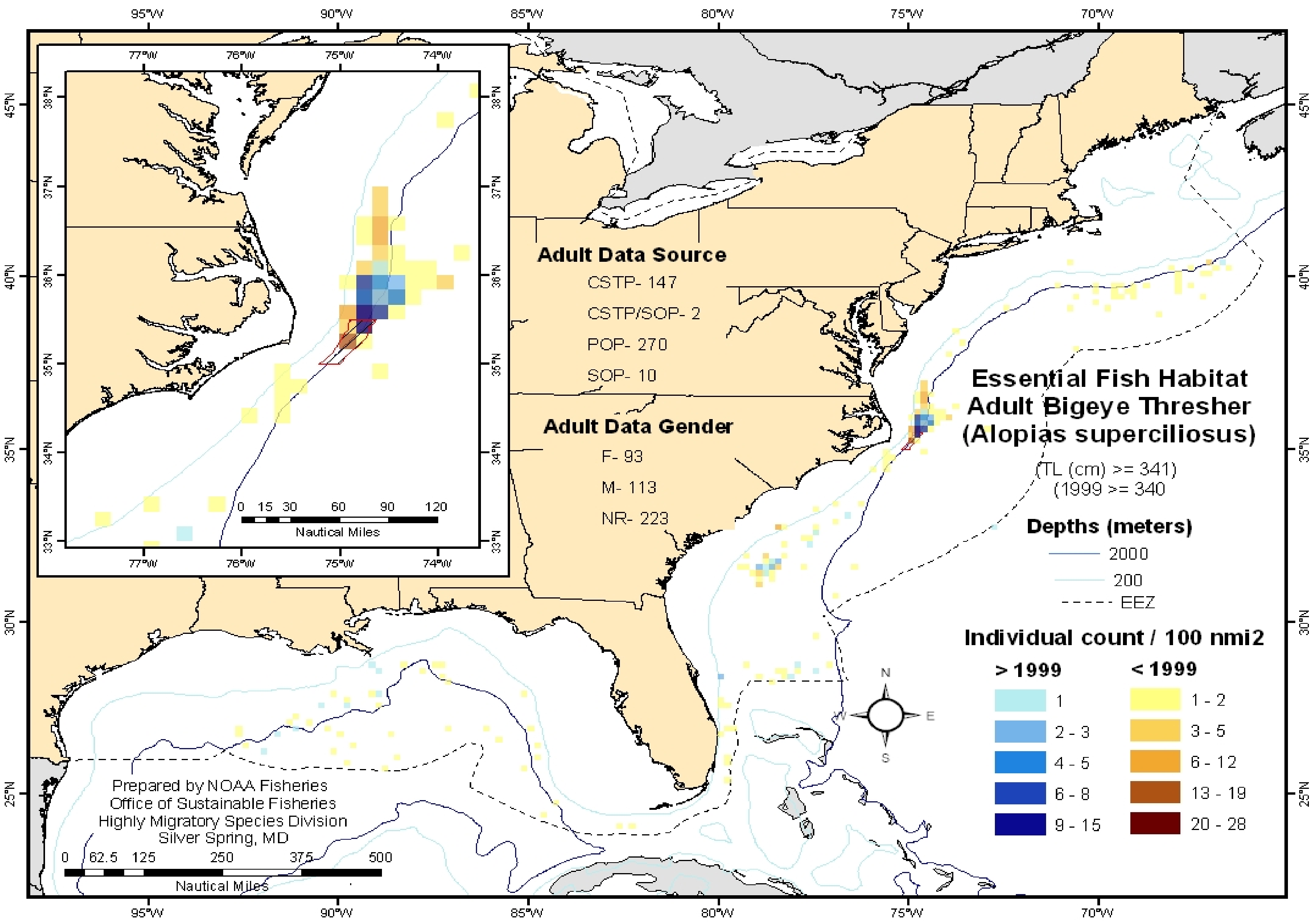

Figure B.121 Bigeye Thresher Shark: Adult.

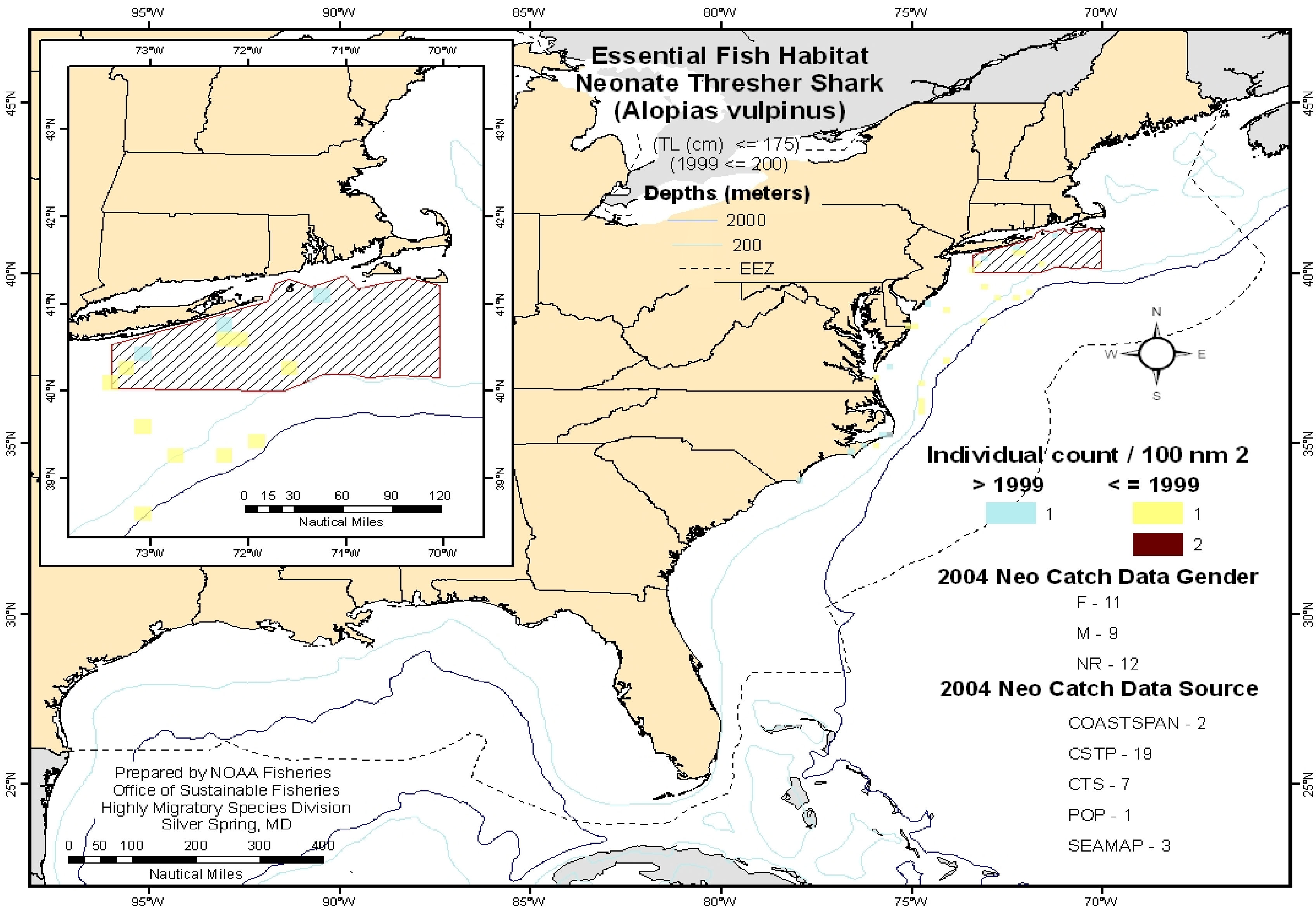

Figure B.122 Thresher Shark: Neonate.

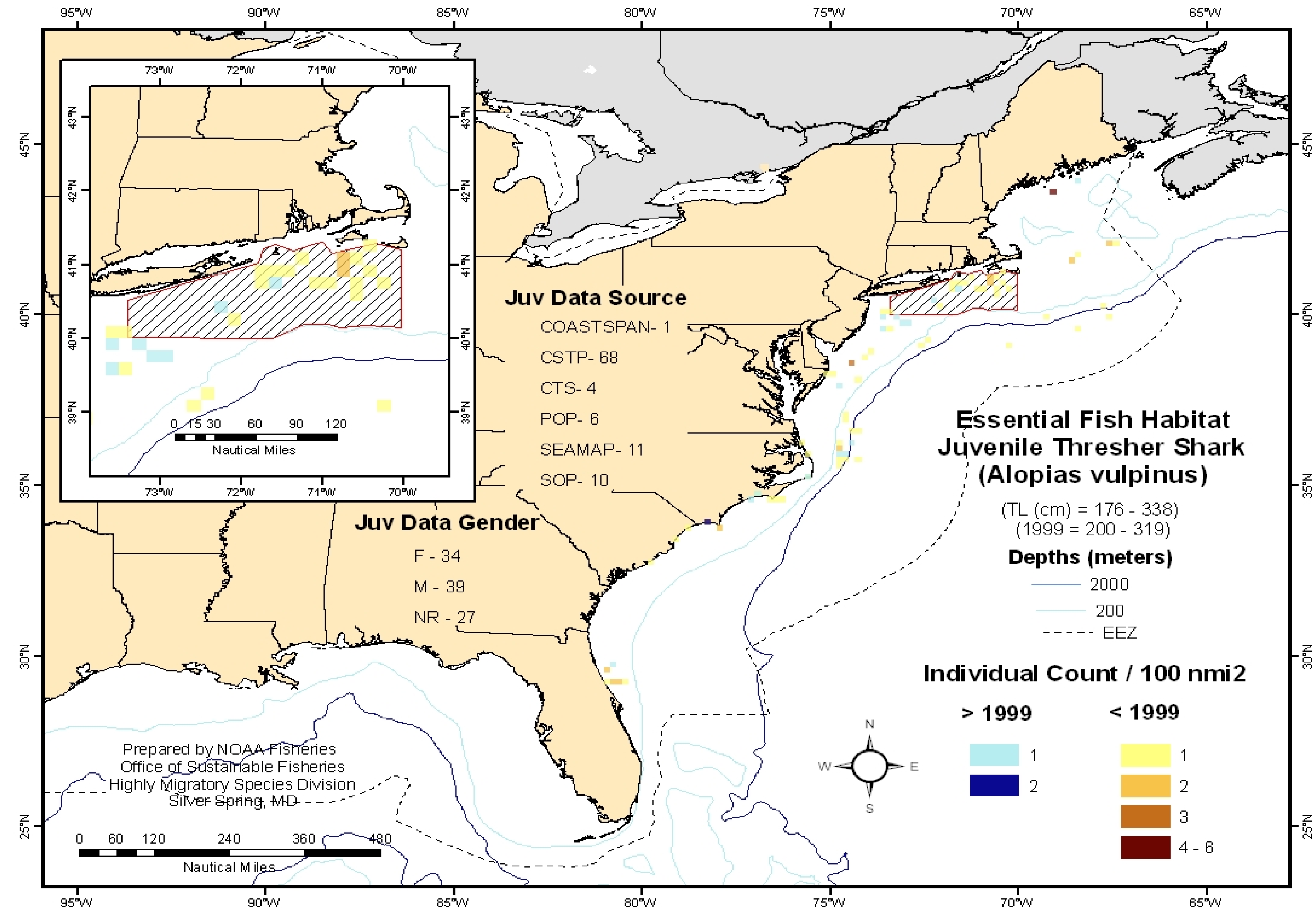

Figure B.123 Thresher Shark: Juvenile.

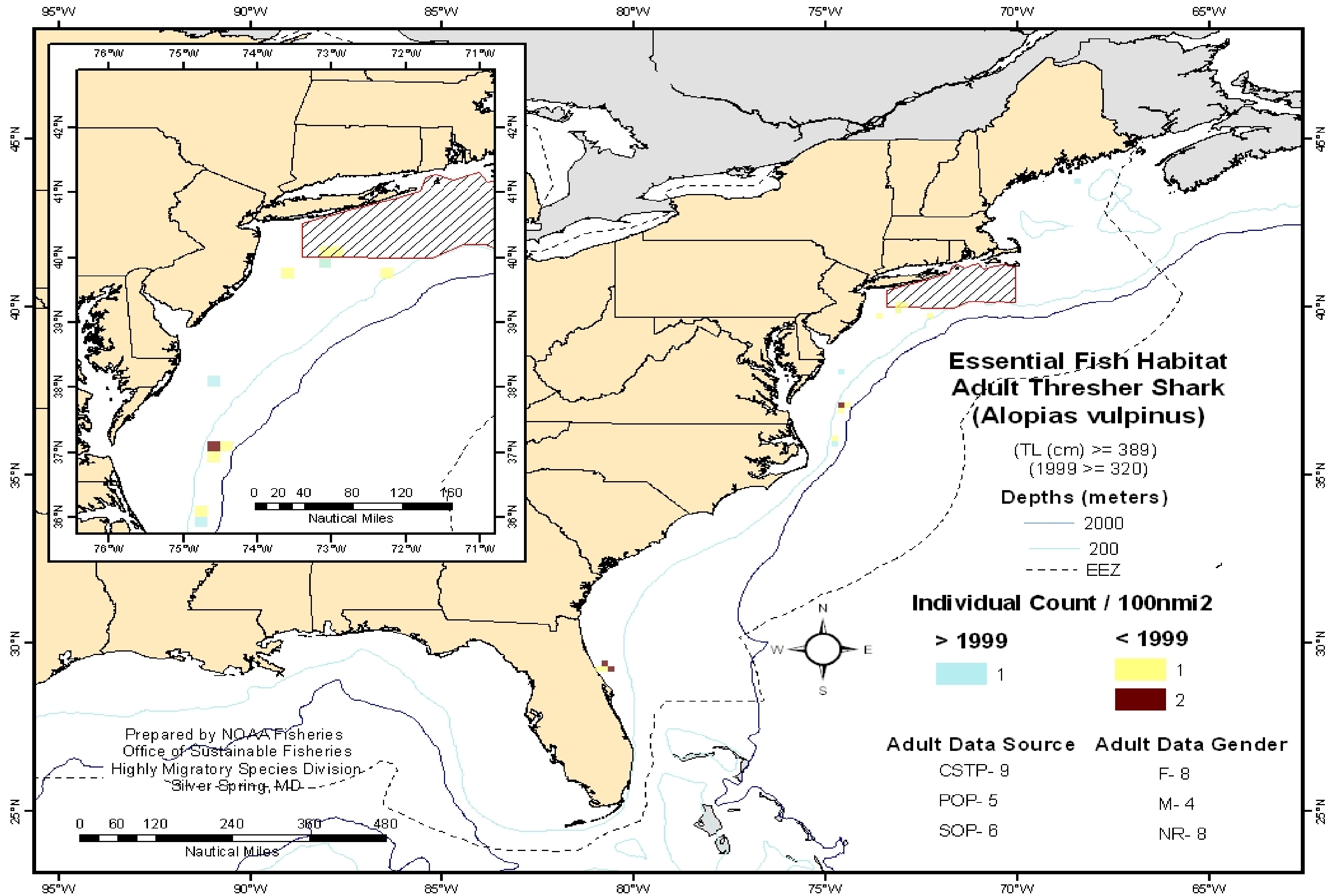

Figure B.124 **Thresher Shark: Adult.**

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