I. Application for an Individual Incidental Take Permit under the Endangered Species Act of 1973

II. Date: 10 January 2005

III. Applicant:

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IV. Species Affected:

The proposed activity may affect the endangered shortnose sturgeon, *Acipenser brevirostrum*, smalltooth sawfish, *Pristis pectinata*, and Atlantic salmon, *Salmo salar*, fish species, and the threatened loggerhead, *Caretta caretta*, and endangered Kemp's ridley, *Lepidochelys kempii*, green, *Chelonia mydas*, hawksbill, *Eretmochelys imbricata*, and leatherback, *Dermochelys coriacea*, sea turtles.

Shortnose sturgeon, *Acipenser brevirostrum*, occur along the east coast of North America from St. John River, New Brunswick, Canada, to St., John's River, Florida (Grunwald et al., 2002). They were listed as endangered on 11 March 1967. Shortnose sturgeon occur in mainstem rivers, estuaries, and nearshore marine habitats, the degree of marine habitat use depending on latitude (Kynard, 1997). In South Carolina and Georgia, they rarely occur in coastal waters (Collins et al., 1996). Their nearshore marine habitat may be associated with molluscs such as *Mya arenaria* (Dadswell et al., 1984). Spawning occurs from late winter to late spring, depending on latitude, in the freshwater reaches of rivers, while feeding and overwintering may occur in freshwater as well as saline portions (Dadswell et al., 1984). The species may be distributed into 19 distinct population segments representing each estuary where they occur, although genetic and tagging studies suggest a single population occurs in Delaware and Chesapeake Bays (Grunwald et al., 2002; Welsh et al., 2002). Juvenile shortnose sturgeon feed on crustaceans and insects, while adults feed primarily on molluscs (Murdy et al., 1997).

Smalltooth sawfish, *Pristis pectinata*, were listed as endangered 1 April 2003. They are distributed worldwide in tropical waters, but in the United States occur only on the east coast. Previously reported common in the Gulf of Mexico and in the Atlantic Ocean as far north as North Carolina, and rarely to New York, they are believed to be currently restricted to peninsular Florida (Federal Register, 2003). They occur on the Gulf of Mexico coast of Florida from Charlotte Harbor to Florida Bay, but are reported as extirpated from the Indian River lagoon system on the Atlantic coast (Snelson and Williams, 1981; Schmid et al., 1988; Seitz and Poulakis, 2002; Poulakis and Seitz, 2004). Smalltooth sawfish occur in shallow estuarine and nearshore coastal habitats over sandy or muddy bottom, feeding on benthic organisms by stirring the sediment with its rostrum, and on small schooling fishes by slashing at the schools with its rostrum (Murdy et al., 1997).

Atlantic salmon, *Salmo salar*, are an anadromous species occurring on both sides of the North Atlantic Ocean. In the United States, they historically ranged from Connecticut to the Canadian border, but are presently restricted to the Gulf of Maine. The Gulf of Maine distinct population segment was declared endangered 17 December 2000. Adults begin their spawning run from the Ocean from May to October, with spawning occurring from mid-October to mid-November (NMFS and USFWS, 2004). Some post-spawning adults move immediately back to the ocean, but the majority overwinter in freshwater, returning to the ocean in spring. Seaward migration of juveniles also occurs in spring (NMFS and USFWS, 2004). Their distribution in the northwest Atlantic Ocean is primarily from the Grand Banks to the Labrador Sea and western Greenland, and as far south as Cape Cod Bay (Bigelow and Schroeder, 1953; Reddin, 1986). Atlantic salmon are opportunistic feeders while at sea, although fish become more important in their diet as they age (Reddin, 1986; Kocik and Friedland, 2002).

Loggerhead sea turtles, *Caretta caretta*, are distributed worldwide, and occur from Newfoundland to Argentina in the western Atlantic Ocean (Marquez, 1990; Ernst et al., 1994). They were listed as threatened throughout their range on 28 July 1978. Loggerhead sea turtles inhabit coastal bays, lagoons, and estuaries as well as the nearshore ocean. Nesting on the Atlantic coast of the United States occurs during summer, primarily on the southern beaches of Florida and Georgia, and as far north as North Carolina. Immature and adult loggerhead sea turtles make seasonal foraging migrations in spring, dispersing throughout the Middle Atlantic Bight (TEWG, 1998). A southward migration occurs in the fall. At least four genetically distinct subpopulations occur in the western North Atlantic. The Northern and South Florida

Nesting Subpopulations comprise the majority of sea turtles along the Atlantic coast (TEWG, 2000), and are the most likely to be affected by the proposed activity. Loggerhead sea turtles feed primarily on crustaceans, horseshoe crabs and molluscs, as well as tunicates, sea pens, and fish (Plotkin et al., 1993; Lutcavage and Musick, 1985; Tomas et al., 2001).

Kemp's ridley sea turtles, *Lepidochelys kempii*, occur in the Atlantic ocean, and range from Nova Scotia to Venezuela and the Gulf of Mexico in the western Atlantic (Marquez, 1990; Ernst et al., 1994). They were listed as endangered on 2 December 1970. Kemp's ridley sea turtles inhabit coastal bays, lagoons, and estuaries as well as the nearshore ocean. Nesting primarily occurs in the western Gulf of Mexico. Adults are believed to be largely restricted to the nearshore waters of the Gulf of Mexico, while occurrences along the Atlantic coast are primarily juveniles (TEWG, 1998). Juveniles inhabit sounds and bays along the Atlantic coast from spring until fall, presumably to forage (Plotkin, 1995). Kemp's ridley sea turtles feed on crabs, shrimp, sea urchins, bivalves, gastropods, and fish (Marquez, 1990).

Green sea turtles, *Chelonia mydas*, occur in tropical and subtropical waters worldwide, and from Massachusetts to Argentina in the western Atlantic (Marquez, 1990; Ernst et al., 1994). Green sea turtles in the Atlantic Ocean may represent a subspecies, *C. m. mydas*. The Florida breeding population was listed as endangered on 28 July 1978, while elsewhere in U.S. waters green sea turtles were listed as threatened. Green sea turtles inhabit coastal bays, lagoons, and estuaries as well as the nearshore ocean. In the U.S., nesting occurs on the east coast of Florida, the U.S. Virgin Islands, and Puerto Rico. Critical habitat is designated as the waters around Isla Culebra, Puerto Rico and its associated keys (NMFS, 2002). Primary foraging habitat in the U.S. is in embayments and nearshore coastal waters of the Gulf of Mexico and Atlantic coast of Florida. Adult green sea turtles feed largely on vegetation, including algae, seagrasses and mangroves, but juveniles also feed on bivalves, squid, crabs, and fish (Bjorndal, 1980; Mendonca, 1983; Ernst et al., 1994; Limpus and Limpus, 2000).

Hawksbill sea turtles, *Eretmochelys imbricata*, are distributed worldwide, primarily in the tropics (Marquez, 1990; Ernst et al., 1994). A possible subspecies, *E. i. imbricata*, occurs in the western Atlantic from Massachusetts to Brazil. Hawksbill sea turtles are considered uncommon north of Florida (Plotkin, 1995). They were listed as endangered in 1970. Hawksbill sea turtles inhabit coral reefs and rocky shores, as well as estuaries and lagoons. Nesting occurs on the Yucatan Peninsula, in Central America and in the Caribbean, as well as southeastern Florida (NMFS and USFWS, 1993). Critical habitat is designated as the waters around Mona and Monito Islands, Puerto Rico (NMFS, 2002). Adult and subadult foraging habitat consists mostly of coral reefs, but also other hard-bottom substrate as well as mangrove swamps. Hawksbill sea turtles' diets consist largely of sponges (Meylan, 1988; Leon and Bjorndal, 2002).

Leatherback sea turtles, *Dermochelys coriacea*, occur worldwide, and are distributed from Labrador to Argentina and the Gulf of Mexico in the western Atlantic (Marquez, 1990; Ernst et al., 1994). Leatherback sea turtles were listed as endangered on 2 June 1970. Leatherback sea turtles are typical found in the open ocean, but occasionally enter shallow coastal waters. In the Atlantic Ocean, nesting occurs on the South and Central American coasts of the Caribbean, as well as on islands throughout the Caribbean including the U.S. Virgin Islands and Puerto Rico. Nesting also occurs on the Atlantic coast of Florida and possibly Georgia (NMFS and USFWS, 1992). Critical habitat is listed as the waters adjacent to Sandy Point, St. Croix, U. S. Virgin Islands (NMFS, 2002). Adults may undertake routine migrations between nesting and foraging areas (Plotkin, 1995). Peak sightings in May off South Carolina and in August and September in Cape Cod Bay off Massachusetts (Plotkin, 1995) suggest a northward dispersal along the coast to forage during summer. Leatherback sea turtles feed mostly on jellyfish, but also sea urchins, octopus, squid, snails, bivalves, tunicates, and fish (Ernst et al., 1994).

V. Proposed activity:

Status of the problem

The horseshoe crab, *Limulus polyphemus*, is an ecologically, economically and medically important species on the east coast of the United States (Berkson and Shuster, 1999). Horseshoe crabs occur from Maine to Florida and the eastern Gulf of Mexico, with the center of abundance between New Jersey and Virginia (Shuster, 1982; Botton and Ropes, 1987). In the mid-Atlantic region, horseshoe crabs spawn primarily during full and new moon periods in May and June (Shuster and Botton, 1985). Coincident with horseshoe crab spawning, over 50% of the western hemisphere flyway populations of red knots, *Calidris canutus*, ruddy turnstones, *Arenaria interpres*, and semipalmated sandpipers, *C. pusilla*, stop over in the Delaware Bay area to feed (Myers, 1986; Castro and Myers, 1993; Clark et al., 1993; USFWS, 2003). The horseshoe crab spawning event has historically provided the birds with a reliable, abundant food source in the form of crab eggs (Wander and Dunne, 1981; Shuster and Botton, 1985). Shorebirds arrive in the Delaware Bay with little or no fat reserves after flights of up to 12,000 km and must forage intensely, often doubling their body weights during the two to three week stopover, before departing for their Arctic breeding grounds (Myers, 1986; Harrington, 1996). Horseshoe crabs are also commercially harvested as bait for the American eel (*Anguilla rostrata*) and channeled whelk (*Busycotypus canaliculatus*) fisheries (ASMFC, 1998a). Finally, biomedical companies catch horseshoe crabs for their blood, from which they produce Limulus Amebocyte Lysate (LAL) (Novitsky, 1984; ASMFC, 1998a). LAL is used to detect contamination of injectable drugs and implantable devices by Gram-negative bacteria, and is the most sensitive means available for detecting endotoxins (Novitsky, 1984). The horseshoe crab resource, in terms of ecotourism associated with the annual bird migration, the eel and whelk fisheries and the biomedical industry, contributes a combined $93 to $123 million to regional economies, and at least $175 million to the national economy (Manion et al., 2000).

Despite supporting a fishery for over 100 years, horseshoe crabs have largely been ignored by fisheries managers until recently, when concerns arose regarding the possible overexploitation of the population (Berkson and Shuster, 1999; Walls et al., 2002). Perceived declines in horseshoe crab abundance have been accompanied by perceived declines in the shorebird populations that depend on them (USFWS, 2003). As increasing commercial landings raised concerns about the resource's status, the Atlantic States Marine Fisheries Commission (ASMFC) implemented a fishery management plan to regulate the harvest (ASMFC, 1998a).

Proper management of any species requires that specific management goals and objectives be established, and those goals depend on the resource users involved (Quinn and Deriso, 1999). Horseshoe crabs present a distinct resource management challenge because they are important to a diverse set of users (Berkson and Shuster, 1999). The goal of the fishery management plan is to ensure a sustainable population level to support the continued use by all these diverse interests (ASMFC, 1998a). Unfortunately, management policies have been hampered by a lack of scientific data needed to attain that goal (Berkson and Shuster, 1999; Walls et al., 2002). In order to properly manage the horseshoe crab fishery, accurate information on abundance levels and trends is necessary. Fishery-independent monitoring surveys are generally relied upon to provide abundance information (Hilborn and Walters, 1992; Gunderson, 1993). However, most state and federal survey programs programs are conducted to monitor finfish resources, and the data they provide for horseshoe crabs are uninformative. Because of the lack of adequate information, the Atlantic States Marine Fisheries Commission determined that a trawl survey which specifically targeted horseshoe crabs was the highest priority for the information it would provide for stock assessment.

The activity

The proposed research activity will consist of annual horseshoe crab abundance monitoring surveys and associated studies to evaluate survey methodology. The annual trawl surveys will provide abundance, distribution and demographic information in support of the horseshoe crab Fishery Management Plan of the Atlantic States Marine Fisheries Commission. The surveys will be conducted under the sanction and advisement of the Horseshoe Crab Management Board of the ASMFC. The surveys will be conducted from Cape Cod, Massachusetts to the Georgia-Florida border. Proposed sampling gears will consist of flounder and whelk trawls. The proposed sampling gears are intended to capture horseshoe crabs for examination and enumeration, especially large adults. The gears must therefore be operated without modifications such as turtle excluder devices (TEDs) which reduce the capture of large objects. It is anticipated that fish and sea turtles will be captured by the unmodified gears.

The horseshoe crab abundance monitoring survey in the middle Atlantic region (Cape Cod to Cape Charles, Virginia) will be conducted from chartered commercial stern trawlers utilizing a flounder trawl. The net will consist of 15.2-cm stretched mesh in the body, and double-yarn 14.0-cm stretched mesh in the bag, which will be equipped with chafing gear. The trawl will have a 18.3-m head rope and 24.4-m footrope equipped with a Texas sweep (Hata and Berkson, 2003). The net will be fished with 82.3 or 91.4-m ground cables, and towed at 4.6-5.6

km/h for 15 minutes (bottom time). The survey will use a stratified-random sampling design, with stratification by distance from shore and bottom topography (Hata and Berkson, 2004). Sampling is expected to be conducted at night, when horseshoe crabs are more susceptible to the gear.

Survey activity in the south Atlantic (South Carolina to Georgia) will be conducted from one or more chartered shrimp trawlers, using whelk trawls. Specifications of this gear have not yet been determined, and will depend on the capabilities of the vessel as well as state and federal restrictions. The gear will probably consist of two nets (one on either side of the boat) of approximately 13.7-m footrope, with 10.1-cm stretched mesh in the body and bag. The nets will be fished using tickler chains, and will be attached directly to the trawl doors. The nets will be towed at 4.6-5.6 km/h for 15 minutes (bottom time). The survey will use a stratified-random sampling design, with stratification by distance from shore. Sampling is expected to be conducted at night, when horseshoe crabs are more susceptible to the gear. Limited studies have indicated that use of TEDs reduces the catch of whelks and horseshoe crabs in whelk trawls of similar dimensions (Belcher et al., 2001).

Additional research activity in the south Atlantic will be conducted to calibrate catches from the flounder and whelk trawls. Chartered fishing vessels will use the above mentioned nets and protocols at randomly determined locations.

A. Anticipated dates and durations

The proposed research activities are anticipated to be conducted annually from approximately mid-August to approximately mid-November, 2005 through 2011. Middle Atlantic research activity is expected to consist of approximately 28 days at sea between mid-

August and mid-October. South Atlantic survey activity is expected to consist of approximately 10 days at sea between mid-October and mid-November. Additional activity to calibrate catches from the whelk and flounder trawls will be conducted in the south Atlantic region over approximately 10 days at sea between mid-September and mid-November. Specific dates and actual activity duration will depend on vessel availability, weather, and funding.

B. Specific location of activity

The proposed research activity will be conducted in Atlantic Ocean waters seaward of the territorial sea demarcation line, and out 20 nautical miles from shore. Activities in the middle Atlantic region will be conducted from Cape Cod, Massachusetts (west of Monomoy Island), along the southern coasts of Massachusetts and Rhode Island eastward to approximately 71° 51' W, thence along the southern coast of Long Island, New York to the entrance to New York Harbor, thence southward along the coast to Cape Charles, Virginia. Activities in the south Atlantic region will be conducted from Cape Romain, SC to the Georgia-Florida state border. The proposed activity will specifically exclude Long Island Sound and all coastal embayments landward of the territorial sea demarcation line. Specific locations for each sample will be determined randomly and are presently unavailable.

VI. Conservation Plan:

A. Anticipated impact on listed species:

Shortnose sturgeon occur all along the Atlantic coast of the United States, and adults occasionally move into nearshore marine waters associated with molluscs (Dadswell et al., 1984). However, they are not known to make coastal migrations, and their occurrence in nearshore coastal habitats is not well documented (NMFS, 1998). Net fisheries may represent a significant mortality source for both shortnose and Atlantic sturgeon (*A. oxyrinchus*): about 16% of sturgeon caught in gillnets die, and 20% are injured (Collins et al., 1996; 2000). Trawl mortality of Atlantic sturgeons is believed to be low: of 15 juveniles tagged in the Delaware River and recaptured in trawls, all were released alive (ASMFC, 1998b). However, subsequent mortality from injuries is unknown. Of 551 tagged shortnose sturgeon in the Altamaha River, Georgia, only one (0.2%) was recaptured by a trawl fishery, and 2.7% (41 of 1,534) of tagged Atlantic sturgeon were recaptured by trawl fisheries (Collins et al., 1996). Few, if any, shortnose sturgeons are likely to be caught, and the survivability of those caught is likely to be near 100%.

In the United States, Atlantic salmon presently occur only in the Gulf of Maine. Their marine distribution in the northwestern Atlantic Ocean is believed to be primarily north of the Grand Banks, but also as far south as Cape Cod Bay (Bigelow and Schroeder, 1953; Reddin, 1986). Mortality likelihoods for Atlantic salmon are unknown, but they are unlikely to be encountered.

The northeast multispecies fisheries comprise approximately 3,700 vessels operating over 50,000 days at sea (NMFS, 2001). Despite the level of effort, these fisheries were not considered likely to have an adverse impact on shortnose sturgeon or Atlantic salmon (NMFS, 2001). In addition, the shrimp trawl fishery expended about 37,696 days of effort in the south Atlantic Ocean and 13,408 days in south Atlantic inshore waters between March and November 2001 (Epperly et al., 2002). NMFS determined that the impact of the south Atlantic shrimp trawl fisheries on shortnose sturgeon was discountable (NMFS, 2002). In contrast, the proposed activity will consist of approximately 240 tows over an estimated 48 days at sea. In comparison to the number of participants and the amount of fishing effort expended by the aforementioned commercial fisheries, and given the impacts of those fisheries on these species expected by

NMFS, we believe the proposed level of research activity is relatively insignificant, with a correspondingly small impact on those species.

Smalltooth sawfish occur worldwide in tropical waters, but in the United States are believed to occur only on peninsular Florida. Entanglement in fishing nets by the rostrum is a significant source of mortality (Simpfendorfer, 2000). Elasmobranchs caught in Australian shrimp trawls suffer mortality rates around 56% (Stobutzki et al., 2002), so a similar rate should be expected for smalltooth sawfish here. However, the proposed activity area is north of the current known range, so the probability of encountering smalltooth sawfish, and the anticipated impact of the activity, is considered to be very small.

The proposed activity has the potential to impact all five sea turtle species that occur in the western North Atlantic. Interactions with hawksbill sea turtles are unlikely, because they are uncommon in the proposed activity area. However, it is highly likely that loggerhead and Kemp's ridley sea turtles, and to a lesser extent green and leatherback sea turtles, would be affected, because of their habitats and feeding ecologies. Loggerhead, Kemp's ridley, and green sea turtles, in descending order of occurrence, are the most commonly encountered species in east coast trawl fisheries (Henwood and Stuntz, 1987; Epperly et al., 1995). The proposed activity would use nets without TEDs, so the capture rate of sea turtles per hour fished would be higher than in fisheries that employ them. However, this higher catch rate will be offset by a much lower tow duration than typically used in commercial trawl fisheries (see section VI.C. Proposed Mitigation and Monitoring, below).

The proposed activity will consist of approximately 240 tows over an estimated 48 days at sea. Assuming a catch rate of 17 turtles per 100 trawl net hours in the summer flounder winter trawl fishery (Epperly et al., 1995) applied to the entire study region, and a 30 minute "soak time" (from when the net mouth enters the water until the net mouth exits the water), the 120 trawl net hours may result in 20 sea turtle captures. A catchability coefficient of 0.65 for sea turtles in this fishery suggests a total of 11 to 31 sea turtles would be disturbed (Musick et al., 1991). Data from the south Atlantic shrimp trawl fishery operating from March to November in the ocean (Epperly et al., 2002) indicate that one leatherback, two hawksbill, 61 loggerhead, and 20 Kemp's ridley sea turtles may be encountered in 48 days of sampling. At a catch rate of 65%, 40 loggerhead, 13 Kemp's ridley, and one green sea turtle would be captured. In contrast, results from other shrimp trawl fishery studies suggest a total catch of 3 to 6 sea turtles (Henwood and Stuntz, 1987; Poiner et al., 1990; Robins, 1995).

Sea turtle mortality rate estimates range from 17 to 29% in the Gulf of Mexico and South Atlantic shrimp fisheries and summer flounder winter trawl fishery (Henwood and Stuntz, 1987; Epperly et al., 1995). True rates may be three times as high as these estimates (NRC, 1990). However, Poiner et al. (1990) reported no sea turtle mortality for tows less than 90 minutes in the Australian prawn fishery, and Henwood and Stuntz (1987) reported less than 1% mortality for tows less than 60 minutes.

Epperly et al. (1995) stated that the sea turtle mortality rate in the summer flounder winter trawl fishery is 0.25 turtles per day regardless of tow duration, indicating a total of 12 turtles would be killed by this study. Other catch and mortality rates given above indicate from none to 47 sea turtles would be killed. These mortality estimates assume that all of the proposed activity is conducted in areas where sea turtles are relatively abundant, which is not the case. In consideration of the proposed activity areas and tow durations (see section VI.C. Proposed Mitigation and Monitoring, below), we anticipate that the actual number killed during the activity would be much lower than the estimates. In comparison, the National Marine Fisheries

Service estimated that two sea turtles of all species would be killed in the northeast multispecies fishery annually, and the south Atlantic shrimp trawl fishery would result in over 9,000 mortalities of all sea turtle species annually (NMFS, 2001; 2002).

B. Anticipated impact on habitat:

Significant short-term impact on the bottom is anticipated. Horseshoe crabs frequently burrow in the bottom sediment, and the intended sampling gears are designed to dig into the bottom to remove the crabs. The research activity will result in the temporary suspension of fine sediments which will reduce visual foraging. Some benthic fauna will be damaged and exposed even if not captured by the gear, and after examination the catch and bycatch will be returned to the water, so short-term impacts may make food items available to sea turtles that would otherwise not be accessible. Over the long term, trawling and dredging can also reduce habitat structural complexity, epifaunal species diversity, and species richness (NRC, 2002). Such effects may persist for two years or more (Kaiser et al., 2002; NRC, 2002). However, low levels of trawling activity, as proposed, have a similar effect on bottom habitat as natural bioturbation (Kaiser et al., 2002). Total trawl survey effort is expected to be about 120 net hours soak time, or 60 hours bottom time, in comparison with approximately 46,525 annual net hours in the summer flounder winter trawl fishery (Epperly et al., 1995), and 704,376 annual net hours in the south Atlantic shrimp trawl fishery (Henwood and Stuntz, 1987), excluding other directed and general trawl fisheries in the mid and south Atlantic. Over 1000 vessels participate in the mid Atlantic mixed species trawl fishery, about 448 vessels participate in Gulf of Maine and mid-Atlantic sea scallop dredge and trawl fisheries, and about 2,400 vessels participate in south Atlantic and Gulf of Mexico shrimp trawl fisheries (NMFS, 2002; Federal Register, 2003a).

Although immediate and long lasting effects on bottom habitat are possible, the total amount of effort expended by the research activities will be small and diffuse relative to ongoing commercial fishing activities.

Certain habitats such as coral or rock areas and submerged aquatic vegetation, important feeding areas for hawksbill and green sea turtles, will be avoided because of the potentially destructive nature of the proposed sampling gear and possible impacts on sea turtles. The sampling gear was chosen, in part, because other effective gear such as hydraulic clam dredges were considered as damaging or more damaging to the environment.

Critical habitat has been designated for green, hawksbill, and leatherback sea turtles. However, these are all outside the proposed area and would not be impacted by the activities. No critical habitat has been designated for loggerhead or Kemp's ridley sea turtles.

C. Proposed monitoring and mitigation:

In order to reduce the potential impact of the proposed research on listed species the amount of effort has been limited to the minimum believed necessary for statistically valid results. Additional experimental sampling with more efficient gear, and exploratory sampling in additional locations have also been eliminated from the original study plan.

The proposed activities will avoid coral and rock habitats associated with hawksbill sea turtle feeding because of the nature of the gear. The proposed activities will avoid areas of submerged aquatic vegetation, due to sampling vessel depth requirements as well as the destructive nature of the sampling gear, so interactions with feeding adult green sea turtles are unlikely. Horseshoe crabs have been a principal forage item for loggerhead sea turtles in Chesapeake Bay (Lutcavage and Musick, 1985), so surveys targeting horseshoe crabs are likely to disrupt feeding where sea turtles and horseshoe crabs co-occur. The habitats and diets of loggerhead and Kemp's ridley, and possibly juvenile green sea turtles, as well as their reported scavenging habits, indicate that they are the most likely to be negatively impacted during the research activities. Loggerhead and Kemp's ridley sea turtles are also the most abundant species in the proposed research area, and most likely to be encountered. Loggerhead, Kemp's ridley, and green sea turtles are the most commonly encountered species in east coast trawl fisheries (Henwood and Stuntz, 1987; Epperly et al., 1995). Therefore, research activities will be tailored to reduce detrimental effects, including using minimal tow durations and avoiding areas of high fishing vessel activity which may attract foraging sea turtles.

Loggerhead sea turtles submerge for an average of 16.1 minutes, but averages range from 4.2 minutes in summer to 171.7 minutes in winter (Lutcavage and Lutz, 1991; Renaud and Carpenter, 1994). Reported average submergence durations for Kemp's ridley sea turtles range from 18.1 to 63.2 minutes (Byles, 1989; Gitschlag, 1996). In captivity, average submergence times for Kemp's ridley and large loggerhead turtles averaged less than 5 minutes (Lutz and Bentley, 1985). Submergence times are generally greater at night when resting, so the probability of encounter may be higher than indicated in the studies above. Sea turtles are physiologically stressed during involuntary submergence, as when caught in trawls, and the stress is exacerbated by repeated involuntary submergence (Lutcavage and Lutz, 1991). Substantial acidosis occurs in involuntary submergences less than 30 minutes, and repeated captures may cause mortality when sea turtles are unable to compensate for the stress (Lutcavage et al., 1997).

Research tows using all gears will be limited to 15 minutes bottom time to minimize adverse impacts on sea turtles. At tow durations less than 15 minutes variability in the time the gear starts and stops fishing becomes significant relative to tow duration, and resulting information is of little value (Pennington and Volstad, 1991). In the Gulf of Mexico and south Atlantic shrimp trawl fisheries sea turtle mortality rates were less than 1% in tows less than 60 minutes, and no sea turtle mortality was observed in tows less than 90 minutes in the Australian prawn fishery (Henwood and Stuntz, 1987; Poiner et al., 1990). The National Research Council recommended limiting tow durations to 40 minutes in the summer and 60 minutes in the winter (NRC, 1990). While reducing the impacts on captured sea turtles, this tow duration will also minimize the likelihood of encountering any of the above listed fish species.

Both loggerhead and Kemp's ridley sea turtles feed on fishing vessel discards (Shaver, 1991; Tomas et al., 2001), which may make them especially susceptible to capture or recapture in areas of heavy trawling activity. To avoid capturing sea turtles that may be feeding on fishing vessel discards, and to avoid capturing sea turtles that may have been recently caught and stressed, the proposed research activities will avoid known areas of active or recent high fishing effort.

All activities will be conducted under the direct supervision of scientific parties from Virginia Tech. Sampling will not be conducted when sea turtles are observed in the area. If a sea turtle is captured, all efforts will be made to release the turtle as quickly as possible with minimal trauma. If necessary, resuscitation will be attempted following published guidelines (Federal Register, 2001). Scientific parties will be familiarized with resuscitation techniques prior to surveys, and a copy of the resuscitation guidelines will be carried aboard the vessel during survey activities. In the event resuscitation is unsuccessful, the sea turtle will be transferred to the sea turtle stranding network of the appropriate jurisdiction. Other monitoring or mitigation actions will be undertaken as required.

The proposed research activity is funded through an appropriation by the United States Congress to The Virginia Polytechnic Institute and State University through the Northeast Regional Office of the National Marine Fisheries Service to conduct horseshoe crab research. Remediation funds would derive from that appropriation.

D. Alternatives to the proposed activity:

As an alternative to conducting the proposed research, no action could be taken. Horseshoe crab management would rely on current state and federal finfish monitoring programs. Those programs are inefficient for sampling horseshoe crabs, are of limited geographical scope, and are insensitive to population changes. A decline in the horseshoe crab population of 70% or more over five years would be required for existing programs to detect any decline, compared to a 12% decline in five years detectable by the proposed research (ASMFC, 2004). The no-action alternative would be least damaging to protected species, but may have a significant impact on horseshoe crabs.

Another alternative to the proposed research is to conduct the activities elsewhere. The Atlantic species of horseshoe crab, *Limulus polyphemus*, occurs along the Atlantic coast from Maine to Florida, along the Florida coast of the Gulf of Mexico, and on the Yucatan Peninsula. The proposed activity area encompasses the areas of highest species abundance and greatest economic and ecological value. The Horseshoe Crab Management Board of the Atlantic States Marine Fisheries Commission has requested that the proposed research be conducted in the proposed areas because they are the most important and relevant areas for the population. Conducting the proposed activities in other locations would impose similar impacts on other species, protected species, and the environment as the proposed locations, although different species may be affected or the affects could be of different magnitudes. For example, sampling within embayments could have a greater chance of shortnose sturgeon mortality than sampling on the continental shelf, and sampling in coastal waters of Maine would increase the chance of mortality to Atlantic salmon. However, sampling in other locations would not provide the critical management information for the largest and most significant segment of the horseshoe crab population, possibly leading to greater negative impacts on the population than it currently endures. Conducting the proposed activities in other areas would have the same impact on horseshoe crabs as the no-action alternative.

Further, the proposed activities could be conducted with alternative sampling methods. Hydraulic clam dredges and scallop dredges (e.g. New Bedford type) may be effective for sampling horseshoe crabs, but both require specialized vessels and large crews, and would be cost-prohibitive. Both dredge types also impose similar bycatch, bycatch mortality, protected resource, and habitat concerns as the proposed gear (DuPaul et al., 1995; NRC, 2002). Hydroacoustic survey techniques rely on density differences between air bladders in fishes and the surrounding water for detection. They would not be effective for horseshoe crabs, which lack air bladders. They would also not be able to reliably detect horseshoe crabs on or within the substrate. Diving and remotely-operated vehicles would be prohibitively time consuming and expensive and diving would introduce additional hazards regarding diver safety. Horseshoe crabs generally burrow in the bottom and may not be easily or positively detectable by divers or remotely-operated vehicles. Furthermore, hydroacoustic techniques and remotely-operated vehicles would not distinguish sex or maturity, characteristics critical for management. Horseshoe crabs have not been shown to be effectively captured by traps or other passive sampling gear, and the amount of survey area to be covered, and the labor and time required to sample that area would make such research activities impractical. The set times required to collect a relatively sedentary species such as horseshoe crabs would increase the hazard of entanglement, which represents a source of mortality for sea turtles (NRC, 1990) and marine mammals. In addition, passive gears such as gillnets would also likely impose a much greater mortality on bycatch and protected species such as shortnose sturgeon.

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