Compatibility Determination
Eastern Massachusetts National Wildlife Refuge Complex

Background: The National Wildlife Refuge System Improvement Act (NWRSIA) of 1997, codified at 16 U.S.C. § 668dd-ee, amends the National Wildlife Refuge System Administration Act (NWRSAA) of 1966. The NWRSIA clearly establishes wildlife conservation as the singular National Wildlife Refuge System mission. In addition, it provides a mechanism for refuge planning, gives guidance for management, and gives refuge managers uniform direction and procedures for making decisions regarding wildlife conservation and uses of the National Wildlife Refuge System. The NWRSIA required, at 16 U.S.C. § 668dd(d)(3)(B), that the Secretary of the Interior issue new regulations for the process of determining whether a use on a national wildlife refuge is compatible, including re-evaluation of existing uses and opportunities for public comment. The Notice of the Final Compatibility Policy 65 F.R. § 62482 and the Final Compatibility Regulations published on the same date at 65 F.R. § 62458, are both effective as of November 17, 2000.

In 1994, a compatibility determination for harvesting horseshoe crabs (*Limulus polyphemus*) for biomedical use on Monomoy NWR was written under the old regulations, which have been recently amended (50 C.F.R parts 25, 26, and 29), pursuant to the 1997 amendments to the NWRSAA. In 50 C.F.R. § 25.12 (g) it states that " . . . we will re-evaluate compatibility determinations for all existing uses other than wildlife dependent recreational uses when conditions under which the use is permitted change significantly, or if there is significant new information regarding the effects of the use . . . In addition, a refuge manager always may re-evaluate the compatibility of a use at any time." At 50 C.F.R. § 25.12 (i) it states that during re-evaluation, " . . . we will take a fresh look at the use and prepare a new compatibility determination following the procedure outlined in 50 C.F.R. § 26.41." This compatibility determination is warranted because conditions under which the use was permitted have changed and there is new information relative to the effects of the use that were not considered during the compatibility determination in 1994.

Use: Horseshoe Crab Harvesting

Refuge Name: Monomoy National Wildlife Refuge (Monomoy NWR or Refuge)

Establishing and Acquisition Authority (ies):

- 16 USC §715d - Migratory Bird Conservation Act
- Public Law 91-504, 16 USC § 1132(c) - An Act to Designate Certain Lands as Wilderness

Refuge Purpose(s):

- for use as an inviolate sanctuary, or for other management purpose, for migratory birds (Migratory Bird Conservation Act)
- to preserve the wilderness character of the Monomoy Islands (An Act to Designate Certain Lands as Wilderness)

National Wildlife Refuge System Mission: To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (NWRSAA as amended by16 U.S.C. § 668dd-ee).

Description of Use and Background: The proposed use is harvesting of live horseshoe crabs from Monomoy NWR for: 1) use as bait (either sold or in personal fishing pots) in commercial fisheries (generally for whelk [*Busycon* spp.] or American eel [*Anguilla rostrata*]), 2) bleeding at a biomedical facility and subsequent return to Monomoy NWR waters, and 3) any other collecting of live horseshoe crabs. None of these uses are priority public uses and, at present, harvesting of horseshoe crabs is largely for commercial uses. This compatibility determination will consider the effects of live harvest anywhere on Monomoy NWR (intertidal and subtidal areas) for any use.

Horseshoe crab harvesting for bleeding and bait has been taking place on Monomoy NWR for many years (AR, 3C, 161-163)[1]. Both types of harvesters generally collect horseshoe crabs from May - July during the high tides when horseshoe crabs move into the intertidal areas and shallow waters to spawn. Typically, harvesters either drag a small skiff behind them while walking in the shallow water, or move slowly in a boat through the shallow water. Horseshoe crabs are usually collected with a rake, or by hand. Both bait and biomedical harvesters prefer large horseshoe crabs (generally females) because they yield more blood for biomedical testing, or more bait for fishing (Novitsky 1984 [AR, 5A, 165-171], Shuster Jr. 1996 [AR, 5A, 326-335], Manion et al. 2000 [AR, 1D, 504-575]). However, males are also reportedly used, especially for bait for whelk potting (Atlantic States Marine Fisheries Commission [ASMFC] 1998a [AR, 4A, 107-163]). Horseshoe crabs used by the biomedical industry in Massachusetts are purchased from harvesters for about $2.00 each, and those used by the bait industry are purchased for $.65 to $1.00 each, depending on size (Unsworth et al. 2000 [AR, 1D, 577-624]). Most horseshoe crabs are collected from the northwest tip of South Monomoy Island, from the west side of North Monomoy Island and from Morris Island, where the majority of horseshoe crabs spawn (unpubl. data from Monomoy NWR).

While harvesting horseshoe crabs for bait for commercial fisheries has been ongoing on Monomoy NWR for many years, this use was never officially allowed on Refuge lands or waters. A compatibility determination was never completed for this activity, but due to staff limitations the existing closure was not effectively enforced until 2000. A lack of Refuge enforcement and monitoring, and lack of mandatory reporting requirements of harvest by Massachusetts until 1999, render it impossible to know how many individuals historically participated in this activity, and how many horseshoe crabs were harvested annually. However, during the spawning season of

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[1] References to information compiled as a part of the Administrative Record filed in *Associates of Cape Cod, Inc. and Jay Harrington v. Bruce Babbitt, et al.* Civ. Act. No. 00-10549-RWZ, will be cited as (AR [Administrative Record], [Volume] 3 [Section] C, [pages] 161-163). If a published document that is being referenced also appears in the Administrative Record, the location in the Administrative Record will appear in brackets immediately following the citation.

1999, there was a notable increase in horseshoe crab harvesting on Monomoy NWR. There were confirmed reports of harvesters illegally taking crabs from the Refuge at night (Monomoy NWR is closed from dusk to dawn to all users except surf casting fishermen [50 C.F.R. § 32.40]), and there were rumors that some of these horseshoe crabs were being transported to other states for sale as bait (AR, 3C, 159-163). Increased activity was evident in the form of: increased number of harvesting boats in surrounding waters; increased presence of skiffs filled with horseshoe crabs in local marinas and bays; and, increased presence of rental trucks at offloading locations. Permit holders have been required (since 1999) to report to the State of Massachusetts the number of horseshoe crabs harvested daily, location of harvest, gear used, and intended use (ASMFC 2001). In 1999 over 200,000 horseshoe crabs (roughly half of the total harvest reported in Massachusetts) were harvested from lower Cape Cod, and 125, 907 of these (25% of the total harvest reported in Massashusetts) were harvested from Monomoy NWR for use as bait in commercial fisheries (Diodati 2002). In 2000 and 2001, there were no reports of horseshoe crabs being harvested from Monomoy NWR by bait harvesters (F. Germano, Commonwealth of Massachusetts, Division of Marine Fisheries, Pocasset, MA. pers. comm.). Although the Refuge closure to harvesting for this purpose was enforced in 2000 and 2001, it is likely that some horseshoe crabs were still harvested. Because the increased harvesting activity is likely due to closures of areas in mid-Atlantic states (Manion et al. 2000 [AR, 1D, 504-575]) and closures of other traditionally used fisheries, it is reasonable to expect future harvesting pressure to increase in this area (AR, 3C, 159-163).

Harvesting horseshoe crabs from Monomoy NWR for use by the biomedical industry has been occurring for over a decade. Blood is extracted from horseshoe crabs for the production of *Limulus* amoebocyte lysate (LAL) (Novitsky 1984 [AR, 5A, 165-171]) which is used for the detection of endotoxins pathogenic to humans in all injectable drugs and implantable medical devices (Berkson and Shuster Jr. 1999 [AR, 5A, 580-586]). In the early 1990's, Associates of Cape Cod (ACC), a private biomedical company in Massachusetts, approached Monomoy NWR about harvesting horseshoe crabs (AR, 2A, 18-19). In 1991, Monomoy NWR issued a Special Use Permit to Mr. Jay Harrington[2] (supplier to ACC) to harvest horseshoe crabs in "closed areas" on the west side of North Monomoy Island, which is a subset of the Wilderness Area. The areas are traditionally closed every year from April - October for the protection of critical nesting and staging habitat for a variety of shorebirds and seabirds[3].

A second person requesting a permit in 1991 was denied a permit for the closed areas but was still allowed to harvest horseshoe crabs for bait elsewhere on Monomoy NWR which include areas

[2] References to Mr. Jay Harrington (J. Harrington) of Civ. Act. No. 00-10549-RWZ should not be confused with references to Mr. Brian Harrington (B. Harrington) of Manomet Center for Conservation Sciences. J. Harrington and B. Harrington are not related.

[3] The closed area is not conterminous with the Wilderness Area as it only includes an upper portion of the Wilderness Area which can be posted and signed by the Refuge staff, and which is not so close to mean low water that the sign posts would be washed out.

now mapped as lying within the Wilderness Area (AR, 2B, 139-142). Since 1991, J. Harrington was the only person granted a permit to harvest horseshoe crabs in the closed area (AR, 2A, 20-64; AR, 3C, 159-160). The permits issued to J. Harrington from 1991-1999 allowed him to collect horseshoe crabs for the sole purpose of selling them to ACC. The Special Use Permits stipulated that horseshoe crabs could only be collected during the day and surviving horseshoe crabs were to be returned to the water from where they were collected within 72 hours (AR, 2A, 20-64; AR, 3C, 159-163). In 2000, the U.S. Fish and Wildlife Service (USFWS or Service) denied J. Harrington a permit (AR, 2A, 89-90 and 115-116; AR, Add.D, 128-148). A court ordered temporary injunction allowed the continued harvesting of horseshoe crabs by J. Harrington in 2000 and in a 2001 judgement, USFWS was ordered to issue a permit to J. Harrington for 2001[4]. Harrington reported that 7,792 and 8,369 horseshoe crabs were harvested from Monomoy NWR in 2000 and 2001, respectively (J. Harrington 2000a and 2001).

Refuge Establishment: Monomoy NWR was established on June 1, 1944 through a Declaration of Taking by Secretary of the Interior (District Court of the United States for the District of Massachusetts, Misc. Civil No. 6340). This Taking extends from the mean low water line on the eastern shores of the Refuge to an area within Nantucket Sound identified by certain latitude/longitude coordinates (Attachment 1). At the time of establishment, Monomoy NWR consisted of 2,834 acres of upland and 5,934 acres of water and intertidal zone. Monomoy NWR's strategic location on the Atlantic Flyway makes it a major staging area for fall populations of many migratory waterfowl, passerine, and shorebird species.

Monomoy NWR is renowned for its shorebirds, especially the concentrations that stop-over during southward (fall) migration. The fall migration draws approximately 24 shorebird species to the Refuge. Growing evidence shows that there are relatively few stop-over areas such as Monomoy NWR where migratory birds can find suitable habitat for resting and feeding before continuing their migration (USFWS 1988 [AR, 1C, 307-490]). Although Monomoy NWR is utilized more by shorebirds during the fall migration, many species of shorebirds also stop-over during the spring migration. Shorebirds commonly seen on Monomoy NWR from April to October include: Black-bellied Plover (*Pluvialis squatarola*), Semipalmated Plover (*Charadrius semipalmatus*), Piping Plover (*Charadrius melodus*) (Federal-threatened species, listed by the

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[4] An extensive history of litigation on this issue regarding harvest of horseshoe crabs for the biomedical industry can be found in *Associates of Cape Cod, Inc. and Jay Harrington v. Bruce Babbitt, et al.* Civ. Act. No. 00-10549-RWZ. The Court directed that the Service allow the plaintiffs to harvest horseshoe crabs within Monomoy NWR in the manner described in the 1994 compatibility determination unless the USFWS either (1) makes a valid non-arbitrary determination that the plaintiff's activities lack compatibility with the purpose of the Refuge, or (2) has another valid non-arbitrary reason for denying the plaintiff's permit. The Court found that the USFWS's jurisdiction over the intertidal area is superior to the Colonial Ordinance of 1641-1647 (a provision of Massachusetts state law regarding intertidal access) and that the USFWS could prohibit the plaintiffs from harvesting horseshoe crabs within the boundary of the Wilderness Area.

Endangered Species Act), American Oystercatcher (*Haematopus palliatus*), Greater Yellowleg (*Tringa melanoleuca*), Lesser Yellowleg (*Tringa flavipes*), Willet (*Catoptrophorus semipalmatus*), Whimbrel (*Numenius phaeopus*), Hudsonian Godwit (*Limosa haemastica*), Ruddy Turnstone (*Arenaria interpres*), Red Knot (*Calidris canutus*), Sanderling (*Calidris alba*), Semipalmated Sandpiper (*Calidris pusilla*), Least Sandpiper (*Calidris minutilla*), Pectoral Sandpiper (*Calidris melanotos*), Dunlin (*Calidris alpina*), and Short-billed Dowitcher (*Limnodromus griseus*) (USFWS 2001a).

A 1984 report of the International Shorebird Survey cites Monomoy NWR among the five most important of 454 autumn shorebird stopover areas studied east of the Rocky Mountains (B. Harrington 1984 as cited in USFWS 1988 [AR, 1C, 307-490]). In addition to hosting thousands of shorebirds during migration, Monomoy NWR's specialized habitat supports high numbers of nesting species that nest in few other locations in Massachusetts, including Common Terns (*Sterna hirundo*), Roseate Terns (*Sterna dougallii*) (Federal-endangered species, listed by the Endangered Species Act), Piping Plover, American Oystercatchers and Willets (Megyesi 1996, USFWS 1996, Koch 1999 and 2000, USFWS 2001a).

On October 23, 1970, Monomoy NWR was afforded additional protection when most of the land and intertidal land within the Refuge was designated as Wilderness by Public Law 91-504. The Wilderness Area extends to mean low water. Two exceptions to the Wilderness Area designation are Inward Point (73 acres) and Powder Hole (137 acres). Although these two areas were excepted from the Wilderness designation, Congress expected the Secretary of the Interior to manage the entire area consistent with the concept of Wilderness (House of Representatives, Report No, 91-1441). Also, the seaward boundary of the Wilderness Area differs from the seaward boundary of the Refuge, because the Wilderness Area boundary runs along the mean low water line. Since this line shifts, the configuration of the Wilderness Area has undoubtedly changed over the past 30 years. In 2000, the Regional Survey Section for the USFWS conducted a Global Positioning System survey of Monomoy NWR along the mean high and mean low water lines (Attachment 1). In 2001, the survey was reviewed by the Chief Surveyor for the USFWS who found that the map was an accurate depiction of the conditions as of September 15, 2000 (Kopach 2002).

In 1999, Monomoy NWR was designated a Western Hemisphere Shorebird Reserve Network Site (WHSRN) because of its value to migratory shorebirds as a stop-over site. Established in 1986, "WHSRN recognizes critical shorebird staging areas through a voluntary, non-regulatory designation program" (B. Harrington 1999). Due to Monomoy NWR's relative importance to birds in Massachusetts, it was also designated an Important Bird Area (IBA) by Massachusetts Audubon Society. The purpose of IBA is to identify and protect sites that contain essential habitat for one or more species of breeding, wintering, or migrating birds (Goldberg and Hecker 2001).

1994 Compatibility Determination: In 1994, a compatibility determination (Attachment 2) found harvesting of horseshoe crabs for one person (J. Harrington) to supply the biomedical company (ACC) to be compatible (AR, 1C, 491-494) under the old regulations which were in

effect at that time (Refuge Recreation Act of 1962 and NWRSAA-1966). This compatibility determination relied on limited information and research that had been conducted on direct mortality associated with handling and bleeding horseshoe crabs. It concluded that the mortality was low enough that harvest would "not pose a threat to the current population". The compatibility determination specified that "releases will be conducted in the vicinity of the capture area to enable a resumption of their spawning activities", but didn't offer any research findings that showed horseshoe crabs would actually resume normal spawning activities when released. The compatibility determination also stated that the use "will be reevaluated should the demand for horseshoe crabs for this industry increase" (AR, 1C, 492).

2000 Evaluation of the 1994 Compatibility Determination: During the 1999 horseshoe crab spawning season, due in large part to concern expressed by various members of the public over the apparent increase in horseshoe crab harvesting activities on Monomoy NWR, Monomoy NWR staff began assembling information on the jurisdiction of the USFWS over the intertidal zone and waters within the entire boundary of Monomoy NWR (AR, 3C, 159-160). From discussions with Solicitors from the Department of the Interior, it was clarified that Monomoy NWR did in fact have the authority to regulate the intertidal areas east of the boundary line of taking (AR, 1C, 496-500). As a result, in November, 1999, Refuge staff issued a news release informing the public of the horseshoe crab harvesting closure to all harvesters on Monomoy NWR (AR, 1C, 501). In April, 2000, the Project Leader found the 1994 compatibility determination for harvesting horseshoe crabs for biomedical use no longer valid.

A lawsuit was filed on March 22, 2000 by J. Harrington over the closure of Monomoy NWR to the harvesting of horseshoe crabs for use by the biomedical industry. A temporary injunction, dated May 18, 2000, allowed J. Harrington to continue to harvest horseshoe crabs for use by ACC during the 2000 season. In its June 25, 2001 Judgement the Court ordered that J. Harrington be issued a permit for the 2001 season. The Court expressed concerns with the apparent inconsistency of the USFWS's prior permits to J. Harrington to harvest in the "closed area"and it found the Refuge Manager's decision to overturn the 1994 compatibility determination and to deny J. Harrington's 2000 permit to be arbitrary since it was based upon no new information other than that considered in the 1994 Compatibility determination.

The 1994 compatibility determination for harvesting horseshoe crabs for biomedical use was written under regulations which have been recently amended (50 C.F.R parts 25, 26, and 29), pursuant to the 1997 amendments to the NWRSAA. New compatibility regulations and policy were published in Federal Register / Vol. 65, No. 202 / Wednesday, October 18, 2000 and became effective on November 17, 2000. In 50 C.F.R. § 25.12 (g) it states that " . . . we will re-evaluate compatibility determinations for all existing uses other than wildlife dependent recreational uses when conditions under which the use is permitted change significantly, or if there is significant new information regarding the effects of the use . . . In addition, a refuge manager always may re-evaluate the compatibility of a use at any time." In addition, 50 C.F.R. § 25.12 (i) states that during re-evaluation, " . . . we will take a fresh look at the use and prepare a new compatibility determination following the procedure outlined in 50 C.F.R § 26.41."

Because circumstances under which the use was allowed have changed and there is new information relative to the effects of the use that were not considered during the compatibility determination in 1994, a new compatibility determination is warranted. This compatibility determination is subject to the new regulations. This document will determine the compatibility or non-compatibility of horseshoe crab harvesting for any use Refuge-wide (including both intertidal and subtidal areas), considering the following: 1) horseshoe crab life cycle; 2) horseshoe crab population trends coast-wide and in Massachusetts; 3) current uses of horseshoe crabs in Massachusetts; 4) anticipated impacts of harvesting on horseshoe crab populations; 5) shorebird population trends worldwide and in Massachusetts; 6) relationship between horseshoe crabs and shorebirds; 7) anticipated impacts of harvesting on shorebird populations; 8) anticipated impacts of harvesting on other flora and fauna in the ecosystem; 9) application of the Wilderness Act, new regulatory standards for management of the coast-wide and Massachusetts populations of horseshoe crabs, and for management of national wildlife refuges.

Horseshoe Crab Life Cycle: The American horseshoe crab is one of four extant species of horseshoe crabs; it is the only North American representative (Shuster Jr. 1982 [AR, 5A, 90-117]). The horseshoe crab is not actually a true crab, but is a member of an ancient group of arthropods, more closely related to spiders and scorpions, which predate dinosaurs by 250 million years. Horseshoe crabs have changed little since they adapted to their environment early in the history of life on earth (USFWS 1998a [AR, 3C, 295-296]). To understand potential impacts of harvesting horseshoe crabs on the population, it is important to consider its life cycle. In general, populations of species that are characterized by high reproductive potential (begin breeding at an early age, breed often, and produce a large number of offspring or have high survivorship to reproductive age) are likely to reproduce quicker (Campbell 1990) and better sustain consumptive harvest pressures than species characterized by low reproductive potential. Horseshoe crabs are slow to reach sexual maturity (Shuster Jr. 1982 [AR, 5A, 90-117]). Although female horseshoe crabs lay thousands of eggs each spawning attempt, it is unknown how many of these eggs result in mature, reproducing horseshoe crabs.

Horseshoe crabs first spawn at 9-10 years of age (Shuster Jr. 1982 [AR, 5A, 90-117], USFWS 1998a [AR, 3C, 295-296]). Spawning occurs on sandy beaches around new and full moon high tides from May through June (Shuster Jr. 1982 [AR, 5A, 90-117], Shuster Jr. and Botton 1985 [AR, 5A, 172-176], Barlow et al. 1986 [AR, 5A, 177-187]) although, in years when spawners appear to be relatively high in abundance, they seem to spawn on almost any high tide even into August (Shuster Jr. 2000). Usually many more males than females come ashore to spawn (Shuster Jr. 2000). The adult female will dig down into the sand and lay clutches of eggs that become mixed with sand grains. A typical egg cluster, about the size and shape of a flattened golf ball, contains about 4,000 eggs (USFWS 1998a [AR, 3C, 295-296]). The nests occur in a wide band of the beach from just above the foot of the beach to the high tide line at depths up to 20cm in the sand (Shuster Jr. and Botton 1985 [AR, 5A, 172-176], Penn and Brockmann 1988 as cited in Shuster Jr. 2000). Beach geochemistry, local tidal rhythms, predation and intraspecific competition for nesting space probably all affect nest site selection (Penn and Brockman 1994). Storms can affect reproductive success by preventing adults from spawning or washing out nests that have already been laid (Shuster Jr. 1958 as cited in Shuster Jr. 2000, Shuster Jr. 2000).

Shuster Jr. and Botton (1985, as cited in Shuster Jr. 2000) note that after a female lays 80,000 to 100,000 eggs during several high tides, she returns to deeper waters.

Newly laid eggs are soft and sticky. The coat of the egg hardens in contact with seawater (USFWS 1998a [AR, 3C, 295-296]). Larvae hatch within four weeks after fertilization (Botton 1995 [AR, 5A, 315-321]). Larvae remain in the sand for several weeks and then begin moving towards the beach surface (Rudloe 1979 as in Penn and Brockmann 1994). Within two weeks, they molt into juveniles (Sekiguchi et al., 1982 as in Penn and Brockmann 1994). During the first summer, juvenile horseshoe crabs generally live in shallow waters near the shore, but undergo multiple molts, and disperse over the tidal flats moving in an offshore direction (Shuster Jr. 1979 [AR, 5A, 65-78]). The larger the animal the further it is from shore. Adults return annually to spawn on beaches and may do so for at least eight years (Shuster Jr. 2000). Horseshoe crabs may live as long as 15-20 years (USFWS 1998a [AR, 3C, 295-296]).

Natural causes of mortality include age, energy use during spawning, stranding, and predation (ASMFC 1998b [AR, 4A, 176]). Loveland et al. (1996 [AR, 5A, 413]) reports that, "Natural mortality among adult horseshoe crabs probably is very low while they are dispersed on the continental shelf." Once the crabs reach the spawning beaches, however, natural mortality increases mainly due to beach stranding. However, human actions probably account "for the greatest proportion of adult horseshoe crab mortality" (ASMFC 1998b [AR, 4A, 176]). The abundance and distribution of horseshoe crabs has been influenced significantly by commercial fishing. Botton and Ropes (1987 [AR, 5A, 188-191]) report that commercial fishermen have purposely destroyed horseshoe crabs because of their ability to prey on soft-shell clams. Until recently, regulations prohibiting placement of horseshoe crabs below the high water mark, were still in place in Chatham. "No starfish, horseshoe crab, conches, wrinkles, or moonsnails shall be returned to the waters, but shall be placed on shore above the high water mark" (Town of Chatham Shellfish Regulations 1999 [AR, 4C, 392]). This section was repealed in April, 2000 (AR, 4C, 388). Studies have also investigated importance of geochemical and erosional factors in the selection of breeding beaches by horseshoe crabs. Results indicate that spawning activity is lower in areas with peat beds. Extensive bulkheading of eroding sandy beaches along several New Jersey shore communities has restricted the availability of suitable spawning habitat, making the remaining stretches of optimal sandy beach critical for reproductive success (Botton et al.1988 [AR, 5A, 221-228]). Coastal development and beach stabilization *(e.g.* revetments, groins, bulkheads) have reduced the availability of spawning habitat in Delaware Bay (Botton et al. 1988 [AR, 5A, 221-228], Botton 1995 [AR, 5A, 315-321), and it is likely that spawning habitat on Cape Cod has similarly been affected (James-Pirri et al. 2001).

In conclusion, the horseshoe crabs' reproductive strategy makes them vulnerable to over harvest. Horseshoe crabs congregating on beaches, during high tides to reproduce, are easily collected by harvesters in large quantities. Horseshoe crabs moving from deeper waters and subtidal areas to intertidal areas on Monomoy NWR are also vulnerable to this type of harvest. In the past, harvest for bait and biomedical use on Monomoy NWR has coincided with the spawning activity of horseshoe crabs and their movement into the shallow intertidal areas to reproduce. The gentle topography of the west side of North Monomoy Island and the north tip of South Monomoy

Island, allows horseshoe crabs in the subtidal areas to be easily harvested. Horseshoe crabs collected from the subtidal areas of the Refuge during this time of year, especially close to the intertidal areas, are likely adults. In addition, because horseshoe crabs do not mature for nearly a decade, a heavily exploited population will recover slowly (Loveland et al.1996 [AR, 5A, 411-418]).

Horseshoe Crab Population Trends Coast-wide: Distribution of the American horseshoe crab extends along the Atlantic coast and the Gulf of Mexico from northern Maine to the Yucatan Peninsula (Shuster Jr. 1982 [AR, 5A, 90-117]). Observations of American horseshoe crabs have been made since 1585 (Shuster Jr. 1950 [AR, 5A, 22-28]), but only a generalized account of the species' populations can be portrayed. Say reported in 1818 (as cited in Shuster Jr. 1979 [AR, 5A, 65-78]) that the species was "common and abundant" along the east coast of the U.S. Shuster Jr. (1979 [AR, 5A, 65-78]) suggested that each major estuary along the coast has a discrete horseshoe crab population, which can be distinguished from one another by adult size, carapace, color, and eye pigmentation. The size of the adults and the size of the populations show a distinct latitudinal gradient. Larger animals and populations are located in the middle of the species' distribution (Maryland to New York) and smaller animals and populations are found in the southern and northern extent of its range (north of Cape Cod, Massachusetts and south of Georgia) (Shuster Jr. 1982 [AR, 5A, 90-117]).

Determining the impact that the proposed uses will have on the horseshoe crab population requires consideration of population trends throughout their range on the Atlantic coast, in addition to careful analysis of population trends more locally. Trends in other parts of their range could be indicative of future trends in Massachusetts. However, a panel of biologists with expertise in horseshoe crab biology recently reviewed ASMFCs data sets used in a stock assessment report (ASMFC 1999a [AR, 4A, 250-319]) and noted that, " . . . there was no single data set deemed reliable enough to provide any coast-wide information for use in the horseshoe crab stock assessment. For this reason, it is necessary to review data sets provided for portions of the coast. While it is not appropriate to extrapolate these results to the entire coast, it is appropriate to investigate what can be inferred by the examination of these more limited data sets" (ASMFC 1998c [AR, 4A, 242]).

Probably the most intensively studied and monitored population occurs in Delaware Bay, which is estimated to have the largest spawning population of all the estuaries along the Atlantic coast (Shuster Jr. 1996 [AR, 5A, 326-335]). The horseshoe crab has long been economically important (despite its lack of food value to humans), and the amount of harvest and population information available from Delaware Bay may be due in part to the fact that much of the industry has centered there. "Crabs were ground into livestock feed and fertilizer between the 1870's and 1920's . . . " (Shuster Jr. and Botton 1985 as cited in Botton and Ropes 1987 [AR, 5A, 189]). Shuster Jr. (1996 [AR, 5A, 326]) writes that " . . . even in the 1870s, at least 4 million adults were collected each year. . ." By the 1960s, economic considerations, public complaints about offensive odors, and possibly diminishing stocks, all contributed to the decline of the industry. "It has been the use of horseshoe crabs as bait in the American eel and conch fisheries, along with the resurgence of the crab population since the 1960s, that has lead to increasingly heavy annual harvests of these

crabs from Delaware Bay and the continental shelf. In addition, "commercial interest in the species was further revived in the 1970's by the discovery that its blood coagulates in the presence of minute quantities of gram-negative bacterial endotoxin. This unique property has been exploited to develop a sensitive bioassay product, LAL" (Novitsky 1984 as in Botton and Ropes 1987 [AR, 5A, 189]).

The horseshoe crab population in Delaware Bay was estimated to be about 1.5 million from the 1880s through the 1920s. Beginning in the 1930s, the population declined until the 1960s. The lowest level of spawning crabs appears to be during the 1950s and 1960s with an estimated population of 42,000 crabs in Delaware Bay in 1961 (Shuster Jr. 1996 [AR, 5A, 326-335]). The 1977 peak population of spawning crabs in Delaware Bay was 222,000 males and 51,000 females, based upon a shoreline survey of spawning intensity along Delaware and New Jersey beaches. A recent study which looked at annual censuses of peak spawning activity of horseshoe crabs within Delaware Bay suggests a steady decline in the numbers of spawning horseshoe crabs. Estimates (each year) were about 1.2 million for 1990 and 1991 and 400,000 for 1992 and 1993 (Finn, Shuster Jr., and Swan 1991 / Hall and Shuster Jr. 1993, 1994 / Swan, Hall and Shuster Jr. 1993, 1994 all as cited in Swan 1995 [AR, 5A, 289-314]). By 1994 and 1995 only 100,000 crabs were estimated (Swan 1995 [AR, 5A, 289-314]). Although these surveys may not be directly comparable due to differences in methodology (ASMFC 1998c [AR, 4A, 235-249]), the data do suggest that the current spawning population is somewhere between the probable high of a century ago and the probable low in the 1960s.

Between 1990 and 1996, reported harvests in several states (e.g., New Jersey, Delaware, and Maryland) had increased, with several reported cases of localized declines in population levels. Responding to localized concerns about increased exploitation of horseshoe crabs, the ASMFC established an Interstate Fishery Management Plan for the horseshoe crab in 1998. ASMFC is a compact of the fifteen Atlantic Coast states, created "to promote the better utilization of the fisheries, marine, shell and anadromous, of the Atlantic seaboard by the development of a joint program for the promotion and protections of such fisheries" (ASMFC 1998b [AR, 4A, 174]). ASMFC began instituting reporting and restriction guidelines coast-wide, and, in light of evidence of an increase in harvest pressure coupled with data that suggest localized declines in relative abundance, the ASMFC has established caps on horseshoe crab landings, following a conservative, risk averse approach to managing this resource (ASMFC 1998b [AR, 4A, 164-231]). To provide additional protection, the National Marine Fisheries Service established a Marine Sanctuary and in February, 2001, announced a prohibition on horseshoe crab harvesting in a portion of Delaware Bay (66 F.R. 8906). "The intent of this final rule is to provide protection for the Atlantic Coast stock of horseshoe crab and to promote the effectiveness of the Atlantic States Marine Fisheries Commission (Commission) Interstate Fishery Management Plan (ISFMP) for horseshoe crab" (66 F.R. 8906).

Horseshoe Crab Population Trends in Massachusetts: Quantitative data for Massachusetts are scarce, even for the past 50 years. During the summers of 1949 and 1950, a tagging study of horseshoe crabs in Barnstable Harbor, Massachusetts, estimated the population was 50,000-100,000 (Shuster Jr. 1950 [AR, 5A, 22-28]). In the years 1952-1954, horseshoe crabs were also

tagged and released in or near Plum Island Sound in Massachusetts. Based on tag returns, population estimates ranged from 164,000 crabs in 1951 to about 1,000,000 in 1955. The population was of considerable magnitude even with rough numbers. (Baptist et al.1957 [AR, 5A, 30-49]). A 1956 study by Turner (as reported by Shuster Jr. 1979 [AR, 5A, 65-78]) indicated the population of horseshoe crabs in Cape Cod Bay to be over 100,000 adults. In addition, a 1958 observation notes that . . . "Limulus was frequently caught, by jet dredge, in the Horseshoe Shoal - Monomoy Point area and in the area off Edgartown Harbor. It is probable that these areas form the deep water component of the population frequenting the estuaries of the south shore of Cape Cod and the offshore islands" (Shuster Jr. 1979 [AR, 5A, 75]).

More recently, a study on Cape Cod, Massachusetts, which looked at horseshoe crab spawning activity of a population in Bourne found that the population had declined by more than 80% and spawning activity decreased by 95% from 1984 to 1999. In addition, the spawning period had shortened from 56 to 11 days. Researchers also found a substantial decrease in the number of spawning individuals at Stage Harbor (Chatham, Massachusetts) over a 5 year period, suggesting that the decline of horseshoe crab populations on Cape Cod may be widespread (Widener and Barlow 1999 [AR, 5A, 578-579]). Five years of information from Chatham Massachusetts can indicate a trend, although until surveys are completed throughout the life cycle of the horseshoe crabs, it is not known whether these declines represent a depression of only a few age-classes or a trend for all age-classes.

ASMFC (1998c [AR, 4A, 235-249]) lists priorities for beginning standardized data collection coast-wide. The first priority is to conduct spawning surveys of female spawners to provide an index of spawning population size. Over the past two years, researchers and Monomoy NWR staff have been collecting this data. Data on spawning populations of horseshoe crabs were collected from four Cape Cod regions: Nauset, Cape Cod Bay, Pleasant Bay, and Monomoy NWR. Quadrat sampling was used to monitor spawning densities during the late spring and summer of 2000 and 2001. Spawning surveys were conducted at Monomoy NWR at two locations (Morris Island and South Monomoy Island) in 2000 and at three locations (Morris Island, South Monomoy Island, and North Monomoy Island) in 2001. Similar spawning densities were obtained for the two years and amongst the three locations (Mary Jane James-Pirri, University of Rhode Island, Narragansett, RI, pers. comm.). Another study is being conducted on Cape Cod to determine the demographics of the horseshoe crab population, its habitat use and movements.

Limited information exists on spawning locations, spawning densities, age structure, fecundity, and mortality rates of horseshoe crabs in New England and on Cape Cod. Gathering this information is essential for the conservation and management of this species because it may differ between populations and regions (James-Pirri et al. 2001). Additionally, the Cape Cod spawning population may be discrete, semi-isolated (Widner and Barlow 1999 as cited in James-Pirri et al. 2001), and sensitive to local harvest and extirpation (James-Pirri et al. 2001). "Slow maturity rates, harvesting during spawning, the selective use of gravid females for bait, and potential of additional mortality related to bleeding create a possible scenario of over-exploitation that could result in the loss of sub-populations" (James-Pirri et al. 2001). Information suggesting a declining population and increased exploitation over the past decade does exist. The documented declines in

population abundance in Bourne and the apparent declining trend in Chatham over 5 years, coupled with consistent anecdotal information on increased harvesting activity for bait in the late 1990s, and the growth of the lysate industry over the last decade, all suggest that the population in Massachusetts may be declining over historic levels. Since 2000, there has been a decline in the number of horseshoe crabs harvested in Massachusetts as a result of harvest restrictions from the ASMFC and Interstate Fishery Management Plan. However, because horseshoe crabs do not reproduce for many years, impacts of heavy harvest pressure to the population may not be realized for many years.

Harvesting Horseshoe Crabs for Bait for American Eel and Whelk and Anticipated Impacts on the Horseshoe Crab Population: The bait fishery has historically been concentrated in the Mid-Atlantic, however a significant fishery had been growing coast-wide (Maine to Florida) as illustrated by the dramatic increase in commercial landings of horseshoe crabs from 1990-1996 (NMFS 1998 as cited in ASMFC 1999a [AR, 4A, 250-319]). Data from 1998 - 2000 is represented in numbers of horseshoe crabs landed (Michels et. al. 2001, DRAFT), and as such, is not directly comparable.

Year	Pounds	Value (in $1000s)
1990	908,130	101.81
1991	1,089,045	121.50
1992	1,000,619	109.71
1993	1,906,059	207.22
1994	1,401,656	228.60
1995	2,547,987	378.99
1996	5,153,630	1,541.26
1997	1,885,883	334.44

Year	# Landed
1998	2,756,949
1999	2,546,610
2000	1,903,415
2001	998,992[5]

Increases in fishing effort and harvest of horseshoe crabs is partly due to stricter regulations on other traditionally harvested groundfish, declines in other groundfish, and an increase in demand for whelk and American eel (ASMFC 1998c [AR, 4A, 235-249], Berkson and Shuster Jr. 1999 [AR, 5A, 580-586], Manion et al. 2000 [AR, 1D, 504-575]). In addition, whelk and American eel fisheries are not heavily regulated (ASMFC 1998c [AR, 4A, 235-249]). The demand for whelk meat has increased especially in the past 10-15 years (Manion et al. 2000 [AR, 1D, 504-575]).

[5]The decline in landings observed from 1998 to 2000 are likely a result of the Interstate Fishery Management Plan mandates which included harvest restrictions for many States.

"Whelk meat is sold for consumption and commonly eaten with salads, sauces, or pasta. At present, the primary markets for whelk include domestic (primarily ethnic market) demand and international demand from Asia" (Manion et al. 2000 [AR, 1D, 523]). "The whelk pot fishery uses the largest portion (almost 90%) of horseshoe crabs destined for fisheries bait markets" (Manion et al. 2000 [AR, 1D, 548]). In 1998, an estimated 2.4 million horseshoe crabs were harvested for bait in the whelk pot fishery (Manion et al. 2000 [AR, 1D, 504-575]). In Massachusetts, the whelk fishery is predominantly in Barnstable, Briston, Plymouth, and Duke Counties (Manion et al. 2000 [AR, 1D, 504-575], Diodati 2002). American eel potting is widespread (every state from Maine to Florida), and in Massachusetts, occurs primarily in Barnstable County (Diodati 2002). "Domestic demand for eel as a food product is largely concentrated in ethnic and seasonal markets, although in recent years its appeal has expanded outside specialty markets. Domestic demand for eel as bait exists in both the recreational and commercial striped bass fisheries as live eels are considered among the best baits for catching striped bass. The growth of recreational striped bass fishing in recent years has greatly contributed to a significant increase in demand for live eels" (Manion et al. 2000 [AR, 1D, 542]). The use of horseshoe crab as bait in American eel potting varies. In 1998, 417,000 horseshoe crabs were used coast-wide for bait in American eel pots. In general, whelk pot fisherman rely on horseshoe crabs for bait more than American eel pot fisherman. Baiting with horseshoe crabs results in substantially more whelk, and accounts for 97 percent of the whelk pot landings. One female provides bait for 1-4 pots, and one male provides bait for 1-2 pots (Manion et al. 2000 [AR, 1D, 504-575]).

Historically, fishing regulations have varied dramatically among the Atlantic coast states. Generally, fishing regulations for horseshoe crabs have been minimal or nonexistent in comparison with other fisheries (ASMFC 1998b [AR, 4A, 164-231]). Reported coast-wide landings of horseshoe crabs were 2,756,949 in 1998. Several states initiated more restrictive harvest regulations in the late 1990's (New Hampshire, New Jersey, Delaware, Maryland, and Virginia). Conservation efforts in New Jersey, Delaware and Maryland substantially reduced landings in those states, but those efforts were negated by increased landings in Virginia where a large portion of the crabs were harvested and new landings in Pennsylvania which had no history of landings (ASMFC 1999b [AR, 4A, 339-345]). The State of South Carolina has prohibited harvest except for the biomedical industry since 1991. A 1998 ASMFC Management Plan called for developing a cap on landings for all Atlantic States by 2000. In 2000, an Addendum to the Plan required all states, except those that are deminimus (do not have a high enough harvest to restrict, but are still required to monitor and report: ME, NH, RI, NC, GA, FL) on the Atlantic Coast to cap their harvests at 25% below the 1995-1997 levels, however, this limit only applied to bait harvests. Each state is required to implement management measures and protect horseshoe crab habitat within its jurisdiction to ensure the sustainability of the population that either is produced or resides within state boundaries (ASMFC 2000b [AR, 4A, 362-363]).

Due to the lack of reporting requirements in Massachusetts until recently, and inconsistent tally methods during the past three years, harvest totals in Massachusetts prior to 1999 may be inaccurate and totals in following years must be cautiously compared [6]. In 1997 and 1998, an estimated 400,000 horseshoe crabs were landed in Massachusetts each year (ASMFC 1998b [AR, 4A, 164-231], Manion et al. 2000 [AR, 1D, 504-575]). In 1999, 440,503 horseshoe crabs were

reportedly landed in Massachusetts for bait (ASMFC 2000a). A 25% reduction applied to this number resulted in the Massachusetts quota of 330,377 crabs for bait fisheries in 2000 (ASMFC 2001). A total of 272,930 horseshoe crabs were landed in 2000 for bait, biomedical use and scientific research (ASMFC 2001). In 2001, a new permitting system allowed harvesters to collect horseshoe crabs for 1) biomedical use and subsequent return to the water or 2) biomedical use and subsequent use as bait or resold as bait (F. Germano, pers. comm.). The total number of horseshoe crabs harvested in 2001 for bait is 130,870 (Germano 2002). Horseshoe crab landings and totals from 1999-2001 are below (ASMFC 2001, Germano 2000 and 2002).

Location	1999	2000	2001
Martha's Vineyard	53,479	37,800	14,697
Nantucket	671	985	565
Upper Cape Cod	7,309	957	175
Mid Cape Cod	68,263	15,864	16,187
Lower Cape Cod	240,388	115,885	50,232
Buzzards Bay	55,659	28,012	13,568
Mount Hope Bay	13,495	6,670	117
Unknown Locations	22,335	29,716	0
Draggers	11,994	37,041	34,846
TOTAL	**473,593**[7]	**272,930**	**130,870**

The decline in harvest numbers from 1999 - 2001 " . . . is mainly due to the weekend closures, daily harvest limits, the 'use of biomedical crabs as bait' as well as the closures of Monomoy and Pleasant Bay, not a decline in crab populations" (Diodati 2002). However, declines in harvest landings due to regulatory restrictions does not eliminate the possibility of a downward horseshoe crab population trend.

[6] The total number of horseshoe crabs harvested in 2000 includes those harvested for bait, biomedical use and scientific research. Changes in regulations in 2000 allowed some horseshoe crabs to be first used by the biomedical industry and then reused as, or sold as bait. However, tracking the ultimate disposition of many of these horseshoe crabs after use by the biomedical industry under the two scenarios (returned to the harvest location, or used or resold as bait) proved difficult. As a result, almost all harvested horseshoe crabs, for any purpose, were included in the total harvest number for Massachusetts in 2000. The only harvested horseshoe crabs omitted from the total are those harvested by J. Harrington for use by the biomedical industry because the disposition of these horseshoe crabs is known (they were returned to the water) (F. Germano, pers. comm.). The total number of horseshoe crabs harvested in Massachusetts in 2001 includes only those horseshoe crabs that were ultimately used for bait (Germano 2002). All horseshoe crabs ultimately used as bait are included in the totals from 1999-2001. Therefore, these numbers are comparable relative to the number of horseshoe crabs permanently removed from the water. However, in 2000 and 2001, these total numbers also include some horseshoe crabs which were ultimately returned to the water (2000) and some horseshoe crabs that were first used by the biomedical industry (2000 and 2001).

[7] This number reported by Germano (2000) is different than that reported by ASMFC (2000a). The number reported by Germano (2000) was preliminary and later modified by removing horseshoe crabs that were used for education and research from the total, and by slightly adjusting bait harvesters' reports (F. Germano, pers. comm.).

According to the Massachusetts Division of Marine Fisheries, 125,907 (25%) of the horseshoe crabs harvested in Massachusetts in 1999 came from Monomoy NWR (Diodati 2002), suggesting that about half of the reported landings for the Lower Cape Cod were obtained from the Refuge. The State of Massachusetts has not provided any indication of what percentage of horseshoe crabs harvested in 2000 or 2001 came from Monomoy NWR. In addition, reported harvests may be lower than the actual harvest as officials sometime note the lack of reporting by some harvesters. In 1999, 7 of 150 permittees did not report. In 2000, 25 of 175 permittees did not report. Harvesters not reporting in 1999 and 2000 reportedly did not fish. In 2001, 38 of 251 permittees did not submit reports and were denied harvesting permits for 2002 (ASMFC 2001, Germano 2000 and 2002, Diodati 2002).

The State of Massachusetts indicates in 1999 that 66% of the horseshoe crabs harvested state-wide were used by 52 whelk potters who harvested for bait to be used in their own pots for commercial whelk harvesting. An additional 25% of the harvest was either sold to Massachusetts bait dealers, or directly to Massachusetts whelk pot fishermen (Germano 2000). In 1999 there were 171 whelk fishermen in the state, and at least 36 harvesters (of 95 total harvesters which reported fishing) reported using Monomoy NWR to obtain their bait (AR, Add.D, 128-148). Harvesters indicate needing 10,000-15,000 horseshoe crabs for this use in one season (AR, 3C, 159-163).

Determining how many individual horseshoe crabs are removed from the population on Cape Cod, and have been removed from Monomoy NWR is difficult, since the industry has not kept records and the State of Massachusetts' summary statistics are too vague (referring to Lower, Mid, and Upper Cape Cod without geographic specificity) to draw conclusions about specific landing sites. Although Massachusetts has recently begun mandatory reporting, changes in permitting and reporting systems, and the fact that some harvesters are not forthcoming with harvest information, (AR, 3C, 159-160) prevent making direct comparisons between years. Harvest information compiled by the state depends upon the accuracy of self-reporting by harvesters (ASMFC 2001). In addition, most harvesters collect horseshoe crabs at night (when the largest number of spawning horseshoe crabs can be collected with minimal effort), making field monitoring and enforcement logistically difficult (AR, 3C, 159-160). Despite the recent enforcement of the closure on Monomoy NWR to harvesting of horseshoe crabs for commercial bait, it is likely that some horseshoe crabs were still harvested from this productive, traditionally used area.

While we do not know how many horseshoe crabs have been historically harvested from Monomoy NWR for commercial bait, Monomoy is obviously an important spawning site for horseshoe crabs, as evidenced by harvest totals. In 1999 Monomoy NWR yielded the highest harvest of horseshoe crabs anywhere in Massachusetts (AR, 3C, 192 and 425). Without population trend information for horseshoe crabs spawning on Monomoy NWR, and the lack of accurate harvest numbers, we do not know how past bait harvesting has affected recruitment, age-classes and sex ratio of the population. In addition, since harvesters generally collect horseshoe crabs during spawning activity, and gravid females are selected over males (Manion et al. 2000 [AR, 1D, 504-575]), there are likely cumulative effects to repeatedly removing gravid females from the population.

Horseshoe crab population declines in Delaware Bay may be due to increased harvest pressure (Swan 1995 [AR, 5A, 289-314], Shuster Jr. 1996 [AR, 5A, 326-335], Harrington and Shuster Jr. 1999 [AR, 5A, 587-592]). Earlier restrictions and closures in traditional harvesting areas in states south of Massachusetts may be partially responsible for the increase in harvest pressure in Massachusetts, and specifically at Monomoy NWR (AR, 3C, 159-163). However, more recently, State officials indicate that any increase in harvest was not the result of restrictions and closures in states south of Massachusetts. State records do not show crabs being exported from Massachusetts to Delaware Bay states, but do show that the Massachusetts bait market receives horseshoe crabs from these states, and are a net importer, with nearly 26,000 horseshoe crabs imported into Massachusetts in 2001 (Diodati 2002). However, anecdotal information in 1999 suggested that harvesters were harvesting horseshoe crabs in Massachusetts and then selling them in other states (AR, 3C, 159-163). These landings would not be reflected in the State of Massachusetts records unless these harvesters had obtained permits from Massachusetts. In addition, horseshoe crab population declines on Cape Cod have coincided with intensified harvesting of horseshoe crabs for the commercial bait fishery (Widener and Barlow 1999 [AR, 5A, 578-579]). There is no current information pointing to increasing horseshoe crab populations in other states or Massachusetts.

Biomedical Industry and Anticipated Impact on Horseshoe Crab Populations: Research on horseshoe crabs for use in the biomedical industry began in the early 1900s including eye research, surgical suture wound dressing development, and detection of bacterial endotoxins in pharmaceuticals (Hall 1992 as cited in ASMFC 1998a [AR, 4A, 107-163]). Blood is extracted from horseshoe crabs for the production of LAL. LAL is a clotting agent (Novitsky 1984 [AR, 5A, 165-171]) used for the detection of endotoxins pathogenic to humans in all injectable drugs and implantable medical devices (Berkson and Shuster Jr. 1999 [AR, 5A, 580-586]). "Horseshoe crabs have been used for biomedical research and product development since the early 1900s" (ASMFC 1999a [AR, 4A, 255]). Bleeding of "large numbers" of horseshoe crabs for LAL production began in the 1970s (Shuster Jr. 1962 as cited in Berkson and Shuster Jr. 1999 [AR, 5A, 580-586]). Manion et al. (2000 [AR, 1D, 522] writes, "In 1979, the U. S. Food and Drug Administration (FDA) established requirements for the pharmaceutical industry's use of LAL to test injectable drugs and intravenous devices (e.g., catheters) for endotoxin contamination. Today, all such products released to the U.S. market are screened for endotoxins with LAL, now considered the established standard for this type of testing. . . the global market for LAL grows by about eight to ten percent annually. (Demand from Europe, where requirements for end-product testing of pharmaceuticals are similar to those in the US, historically has accounted for most of overseas demand. As pharmaceutical sectors in developing countries are established industry experts expect that demand from these areas will account for a greater portion of total overseas demand). "

Currently, three U. S. companies provide 80-90 percent of LAL utilized throughout the world: Charles River Endosafe in South Carolina, BioWhittaker in Maryland, and ACC in Massachusetts (Manion et al. 2000 [AR, 1D, 504-575]). On average, biomedical companies pay about $2.00 for each horseshoe crab (Unsworth et al. 2000 [AR, 1D, 577-624]), and $200-$250 in revenue per horseshoe crab is generated. The revenue for all three companies combined is about $50-$60

million/year (Manion et al. 2000 [AR, 1D, 504-575]). The FDA estimates medical usage increased from 130,000 horseshoe crabs in 1989 to 260,000 in 1997. Thompson (1998) reported that the yearly harvest of crabs for biomedical use in South Carolina increased over 300% since 1991, when reporting requirements were instituted (ASMFC 1999a [AR, 4A, 250-319]).

Recently, however, new advances in the medical field have resulted in " . . . successfully cloning the enzyme that clots the blood of the horseshoe crab . . ." "In developing the technology to produce the enzyme in a controlled environment, the two researchers have found an alternative source of the sensor that is more stable and chemically consistent than nature's endowment. . . A patent for the discovery of the compound, called Factor C, has been filed in the United States. The technology for its production was licensed early this year to American biotech company BioWhittaker, which is keen to use it to develop sterility test and antibiotics." (National University of Singapore 2001). While it may be years before this product is approved by the FDA and produced in large quantities, this represents a future alternative to use of horseshoe crab blood.

Little information is available on the number of horseshoe crabs harvested in Massachusetts or Monomoy NWR that are used by the biomedical industry, although ACC is required by the State of Massachusetts to report names of harvesters, locations of harvest, and disposition of horseshoe crabs each month (ASMFC 2001). J. Harrington reports that in 2000 and 2001, 7,792 and 8,369 (respectively) horseshoe crabs were transported from Monomoy NWR to ACC (J. Harrington 2000a and 2001). He also reported using 16,495 horseshoe crabs from Pleasant Bay (Harrington 2000b). ACC has stated that it bleeds about 1,200 horsehoe crabs each day from the beginning of May through late August (about 144,000 crabs/season), and that most crabs are supplied from the Refuge and Pleasant Bay (AR, 3C, 161-163 and 181; AR, 5B, 79; AR, Add.D, 128-148). ACC has not provided the Service with any more specific information about its sources and current or historical numbers of horseshoe crabs utilized. It is unclear what the source is of the other 120,000-135,000 horseshoe crabs which ACC utilizes. ACC reportedly obtains horseshoe crabs from 3 licensed vendors who purchase horseshoe crabs from permitted harvesters (ASMFC 2001). A new reporting and permitting system initiated in Massachusetts in 2001 indicates that 20 permits in Massachusetts were issued solely for biomedical harvesting (Germano 2002). However, because permitted bait harvesters can also first sell horseshoe crabs for biomedical use, available data do not indicate the total number of harvesters supplying the biomedical industry nor the total number of horseshoe crabs used.

In 2001, the U. S. FDA revised its conditions to allow horseshoe crabs to be bought by the biomedical companies from a commercial bait harvester for bleeding, and then returned to the bait harvester. These horseshoe crabs are counted against the state's quota. Otherwise, the biomedical companies collecting under a biomedical permit have no limitations as long as they are releasing them. ASMFC (2001) writes that "One of ACC's vendors does obtain crabs from a bait dealer for bleeding. These crabs are then returned to the dealer to be sold as bait. ACC was granted an exemption by the FDA to use bait crabs for biomedical use." However, the Special Use Permits issued by USFWS to J. Harrington still stipulated that all horseshoe crabs collected from Monomoy NWR for the purpose of bleeding by ACC "will be released within 72 hours after capture" (AR, Add.D, 153; USFWS 2001b). Reports provided by J. Harrington indicated delays

which resulted in horseshoe crabs not being returned within 72 hours (J. Harrington 2000a). These delays may increase stress, mortality of horseshoe crabs, or failure of egg laying, but no studies have investigated these potential impacts.

Because horseshoe crabs used by J. Harrington have not been included in harvest totals, and because there were no reporting requirements for this industry until recently, the total number of horseshoe crabs used by ACC is unknown. It is also unknown what percentage of the horseshoe crabs used by the biomedical industry come from Massachusetts waters. However, given that the FDA estimated that the number of horseshoe crabs used by the biomedical industry doubled from 1989 to 1997, and harvest reported from South Carolina (location of one of the 3 major companies) increased by 300% in the last 10 years for this industry, it is likely that use by ACC, and its reliance upon horseshoe crabs harvested in Massachusetts, has also increased.

The full impacts of the biomedical industry's use of horseshoe crabs are also unknown. Because the number of horseshoe crabs harvested for this purpose is much less than those collected for the commercial bait fishery, and surviving horseshoe crabs are returned to the waters after bleeding, the impacts of this activity are certainly less than bait harvesting. However, it is still unclear what percentage of horseshoe crabs that are harvested and bled do not survive the process, and are therefore effectively removed from the natural population. Few studies have been conducted that evaluate the mortality associated with transporting, holding, bleeding and releasing horseshoe crabs, and unfortunately, these studies can not be applied directly to the Monomoy NWR population. No studies have been done on impacts to reproductive behavior following bleeding, and limited studies have been conducted on long-term survival following bleeding.

A study conducted by Rudloe (1983 [AR, 5A, 126-151]) was the first to attempt to evaluate the impact of this industry, in the form of direct mortality. The study included a field tagging experiment and an analysis of survival in the laboratory after bleeding. About 10,000 mature horseshoe crabs were collected and tagged. Half of the crabs were bled and then all were released. The study found 1.3% mortality associated with handling. In addition, tag returns indicated a 10% percent mortality for horseshoe crabs bled during the first year after bleeding. Animals recovered during the second year following bleeding showed a cumulative 11% mortality (an additional 1% over the first year returns). No bleeding mortality studies were conducted following Rudloe's work until recently.

"Because mortality rates in the capture and bleeding processes are poorly understood, the Atlantic States Marine Fisheries Commission mandated in 1998 that all biomedical companies actively bleeding horseshoe crabs estimate mortality rates resulting from their bleeding process" (Walls and Berkson 2000). A 1999 study conducted in South Carolina (Wenner and Thompson 2000) reported that bled crabs had an estimated risk of mortality that was 1.3 to 18.7 times greater than individuals that were not bled, and based on information from their treatment group, this translates into an 8 % mortality rate. Although information on mortality due to shipping and handling are scarce, Wenner and Thompson (2000) concluded that transport mortality to and from a biomedical facility was not significant, and may be less than 2 % (AR, Add.F, 213-302). The final study was conducted in Maryland from 1999-2001. Mortality of bled and unbled horseshoe crabs was

compared, and a 7.5% differential mortality was found between the two groups over the three years. (Jim Berkson, Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA, pers. comm.). "Certainly the bait fishery is considered to have a more substantial impact on horseshoe crab populations than the biomedical industry" (Berkson and Shuster Jr. 1999, [AR, 5A, 583]), however, Wenner and Thompson (2000 [AR, Add.F, 227]) conclude "A significant risk of mortality is associated with biomedical industry processing."

The more recent studies conducted by Wenner and Thompson (2000 [AR, Add.F, 213-302]) and Walls and Berkson (2000) provide valuable information on potential mortality of bled crabs in their second year following bleeding. However, the findings of these studies may not be applicable to horseshoe crabs harvested from Monomoy NWR for use by ACC. Wenner and Thompson (2000 [AR, Add.F, 213-302]) were specifically evaluating the techniques that Charles River Endosafe was utilizing for bleeding horseshoe crabs. Walls' and Berkson's (2000) study was specifically evaluating the techniques used by BioWhittaker. "Each LAL producer has a unique operation in processing horseshoe crabs. They each have unique bleeding methods, method of capture, distance and method of travel to bleeding lab, holding time and conditions, and methods of return most appropriate to their own setting and situation. The results found in this study reflect those of BioWhittaker and may not be reflective of other companies' procedures" (Walls and Berkson 2000).

In 2000, a study was conducted by Aquacultural Research Corporation (ARC) on direct mortality of horseshoe crabs associated with the bleeding process at ACC. ARC monitored 100 total horseshoe crabs (50 bled and 50 unbled) for about 3 weeks. At the end of the monitoring period, 1 dead horseshoe crab was found from each treatment pen, but 16 total horseshoe crabs were unaccounted for (6 bled and 10 unbled). From this information, ARC concludes in a letter to ACC (included as Attachment 8 in ASMFC 2001) that " . . . it is safe to assume that the overall mortality resulting from this study was approximately 2% . . .would recommend that this study be replicated by a third party. As you are aware we, ARC, are perceived by many to be a vested interest and therefore any studies we perform are open to criticism due to that interest." ARC is one of three vendors who purchase horseshoe crabs from harvesters and supply them to ACC (ASMFC 2001). This study used small sample sizes, was conducted over a short period of time, did not release its methodology and resulted in a 16% loss of horseshoe crabs from the study pens.

Determining the effects of use given the lack of information on mortality of horseshoe crabs processed by ACC, is confounded by the fact that no studies to date have considered the long term impacts and effects of bleeding on spawning behavior, fecundity and long term survival of horseshoe crabs. Novitsky, president of ACC wrote (1984 [AR, 5A, 165-171]), "At ACC, LAL production is seasonal, beginning in the spring with the appearance of the horseshoe crabs ending their winter hibernation and returning to the Cape beaches to spawn . . . During this time, the horseshoe crabs can be easily collected in shallow waters, where mating pairs are found spawning. Fortunately for the horseshoe crab, an interruption of breeding does not have much effect on the reproductive cycle. Once returned to the water, the female crab will return to the beach, find another mate, and resume egg laying" (AR, 5A, 169). There are no scientific data that suggest

horseshoe crabs return to their regular biological and reproductive cycle after they are released (AR, Add.D, 128-148). Spawning behavior of horseshoe crabs following release could be critical to the long term health of the population. Since horseshoe crabs are collected in intertidal areas during spawning activity, or in subtidal areas on their way to spawning areas, and females are selected over males because of their size, it is reasonable to assume that some horseshoe crabs are collected before they have spawned. Following bleeding by ACC, horseshoe crabs "are either returned to the vendor who in turn notifies the harvester to pick up the crabs at their facility for return to the water or returned to the water by a dredge boat contracted by ACC." (ASMFC 2001) In addition, while aquarium studies suggest that a crab regains its blood volume in 3-7 days and amoebocytes regenerate in 3-4 months (Novitsky 1984 [AR, 5A, 165-171]), no studies have investigated how this regeneration affects the reproductive cycle of horseshoe crabs.

In conclusion, questions remain about the impact of the biomedical harvesting on the population of horseshoe crabs at Monomoy NWR. Given industry trends, it is likely that ACC's consumption of horseshoe crabs has increased over the past decade. No specific data relevant to ACC's methods of processing are available. ACC's competitors indicate that their mortality is about 10% following bleeding in the first year. There is currently no information collected by any LAL producer relevant to the effects of bleeding on reproduction, and the cumulative effects of potential decreased fecundity on the population over time. In addition, only 2 years of population data have been collected for Monomoy NWR and because horseshoe crabs do not reproduce until they are 9-10 years of age (Shuster Jr. 1982 [AR, 5A, 90-117]), declines in the population may not be realized until a decade after they have been over exploited. "Moreover, because of the advanced age of first breeding, damage to the horseshoe crab population would be expected to last years, perhaps decades" (Niles and Clark 1997-Draft [AR, 5A, 423]) making population recovery extremely difficult.

Shorebird Population Trends Worldwide: Shorebirds were historically reported to occur in "huge numbers", but hunting for sport and food during the late 1800s and early 1900s resulted in decreases in populations of many species of shorebirds. Although hunting has been illegal for all but two species of shorebirds since 1916 (Helmers 1992), many populations of shorebirds are still declining today. "Of the 49 shorebird species that migrate through North America, five have declined by 25% or more over the last five years, and 16 others have projected or actual population declines of 5% to 20% . . . Many of the negative shorebird population trends suggest habitat degradation (50% of U. S. wetlands have been lost or degraded), depletion of critical food supplies (over-harvest of Delaware horseshoe crabs may be the most recent example), or other factors at work" (B. Harrington 1999). The United States Shorebird Conservation Plan identifies a number of shorebird characteristics that pose "conservation challenges" including: 1) long distance migration; 2) low productivity and resulting slow population recovery; 3) concentration of populations and increased vulnerability to environmental occurrences; 4) dispersed and ephemeral habitat; 5) loss of habitat; 6) population changes and 7) the need to conserve across international borders (Brown et al. 2001).

Long distance migration, concentration of populations at migration sites and loss of habitat are all characteristics of shorebirds that make protection of migration sites critical to population survival.

Each year, shorebirds make two migrations to and from their breeding grounds, which generally occurs from March through May (to breeding grounds), and from July through October (from breeding grounds) (Helmers 1992). Migrations from wintering areas, which can be as far south as Tierra del Fuego, to breeding areas, which can be as far north as the Arctic Ocean (Brown et al. 2001) can be 12,000 kilometers (Helmers 1992). Helmers (1992) writes, "In most species, the adults leave breeding areas before juveniles have fledged. The staggered flights of adults and juveniles extend the migration period in the postbreeding season." During these migrations, shorebirds congregate at coastal and inland staging areas. "Shorebirds differ from many other Neotropical migrants (songbirds) in that they have narrow habitat requirements that limit them to relatively few, highly productive stopover sites. Shorebirds use the same coastal staging areas year after year, probably because the areas provide more highly productive, predictable feeding and roosting areas than other sites along the migratory route. Before departing, many shorebirds increase body mass up to 100 percent at these staging areas. Most of this increased mass is the fat required to fuel their long-distance migration. Because shorebirds have higher metabolic rates than other nonpasserines of similar size, they must spend much of their day, during staging periods, foraging for maintenance and fat storage" (Helmers 1992).

The United States Shorebird Conservation Plan notes the " . . . extraordinary degree to which some species depend upon one or a small number of strategic stopover sites; concentration makes them extraordinarily vulnerable to environmental disruption because much of the population is in the same place at the same time. Recognition of this special aspect of shorebird biology, and the need to devise novel conservation strategies, were the major factors driving the creation of the Western Hemisphere Shorebird Reserve Network" (Brown et al. 2001). Established in 1986, "WHSRN recognizes critical shorebird staging areas through a voluntary, non-regulatory designation program. Today, over 120 public and private agencies in seven countries throughout the Americas are part of the coalition. . . . WHSRN currently recognizes over 9 million acres at 34 designated sites, most hosting hundreds of thousands to millions of shorebirds annually" (B. Harrington 1999).

The loss of habitat that has been traditionally used by shorebirds has hampered recovery efforts. Shorebirds rely on migratory stop-over sites which offer an abundant, and often ephemeral, food supply. The occurrence of large numbers of shorebirds in just a few sites during migration, makes many species of shorebirds extremely vulnerable to habitat changes, or changes in food supply. In addition, shorebirds' low reproductive success means that populations will take a long time to recover (Brown et al. 2001). "Although most shorebirds nest in the Arctic or subarctic where disturbance is low, they can have low reproductive success nonetheless. Because climatic conditions here are highly variable, the breeding season is short and many raise only one brood" (Helmers 1992). While migratory stop-over sites are certainly important to breeding shorebirds heading towards nesting areas, they are also important to young of the year that are migrating south after hatching. "Increased availability of required habitats at summer and fall migratory stopover sites should increase survivorship of fledged young and therefore benefit total populations" (Helmers 1992).

Shorebird Population Trends in Massachusetts: There has been a decline of shorebird species

in Massachusetts over the years (Brian Harrington, Manomet Center for Conservation Sciences, Manomet, MA, pers. comm.). "Monomoy is one of the most spectacular migratory stopover areas in Massachusetts" (Veit and Petersen 1993). In general, the Northern Atlantic Region contains high concentrations of Black-bellied Plover, Red Knot, Sanderling, Semipalmated Sandpiper, Dunlin and Short-billed Dowitcher, all which occur in great numbers on Monomoy NWR (Veit and Petersen 1993, USFWS 2001). The North Atlantic Region is considered "extremely important to the species relative to the majority of other regions" (Brown et al. 2001). Monomoy NWR contributes to the importance of this region by offering habitat that has an abundant food supply and relatively low disturbance. It has been documented that disturbance to shorebirds during this critical time may prolong their stay at stop-over areas (Clark 1996 [AR, 5A, 344-346]). In 1999, Monomoy was designated a WHSRN site because of its value to migratory shorebirds as a stopover site. For many shorebirds, migration stopover sites are critical to success in accumulating enough fat reserves to complete their migration to breeding areas (Helmers 1992, Brown et al. 2001). "Other studies have shown that few shorebirds leaving New England staging sites at low weights are returning in later years, whereas those leaving at high weights are returning in much higher numbers" (Pfister et al. 1992). It is likely that the low-weight birds perish in their over-ocean flight to South America, but this has not been proven (B. Harrington, pers. comm.).

Shorebirds commonly seen at Monomoy include Black-bellied Plover, Semipalmated Plover, American Oystercatcher, Greater Yellowleg, Lesser Yellowleg, Willet, Whimbrel, Hudsonian Godwit, Ruddy Turnstone, Red Knot, Sanderling, Semipalmated Sandpiper, Least Sandpiper, Pectoral Sandpiper, Dunlin, and Short-billed Dowitcher. Some species occur in large numbers during both the spring and fall migrations such as Black-bellied Plover, Sanderling, Semipalmated Sandpiper, Ruddy Turnstone and Dunlin. In addition, shorebirds preparing for their journey across the Atlantic Ocean to South America on their southward migration, rely on Monomoy NWR (AR, 2B, 180-189). The largest concentrations of Red Knot, Semipalmated Plover, and Short-billed Dowitchers are observed during the southward migration on Monomoy NWR. (Veit and Petersen 1993, USFWS 2001). In fact, Monomoy NWR is one of the top ten sites for Short-billed Dowitchers, which are declining on the Atlantic Coast. Monomoy NWR is also very important to Hudsonian Godwits, which only use 2 or 3 sites on their southward migration. (AR, 2B, 183-184). "Monomoy Island is probably the most important traditional fall stopover area in North America for this transoceanic migrant . . . " (Veit and Petersen 1993).

Finally, some species of shorebirds are extremely dependent on Monomoy NWR during the breeding season, such as American Oystercatcher and Willet. The greatest concentration of nesting American Oystercatchers in Massachusetts occurs on Monomoy NWR and surrounding islands. In late summer, gatherings of adults and young of the year occur in greatest numbers on Monomoy NWR (Veit and Petersen 1993). American Oystercatchers are considered a "Species of High Concern" by the U. S. Shorebird Conservation Plan (Brown et al. 2001). Willets also occur in great numbers on Monomoy NWR during the breeding season (Koch 1999 and 2000) and are considered a "Species of Moderate Concern" by the U.S. Shorebird Conservation Plan (Brown et al. 2001).

Monomoy NWR was established because of its value to migratory birds. In addition, the

designation of Monomoy NWR as a WHSRN site and an IBA is a testament to its importance in offering valuable shorebird habitat in an landscape that is rapidly losing shoreline to development and human use. Monomoy NWR does not host the same numbers of shorebirds during the spring migration as Delaware Bay, but it is clearly a critical stopover site for thousands of shorebirds during both the spring and fall migrations. Monomoy NWR offers protected habitat for shorebirds to feed and roost in preparation for the next leg of their migration. Disturbance during these stop-overs, when shorebirds feed much of the time, can be extremely detrimental. In addition to providing vital food sources, Monomoy NWR offers habitat free of disturbance due to its seasonally closed areas. Monomoy NWR also provides critical nesting habitat to a variety of birds, including Federal-listed Roseate Terns and Piping Plovers.

Relationship Between Shorebirds and Horseshoe Crabs: The most extensive body of research examining the relationship between shorebirds and horseshoe crabs has been conducted in Delaware Bay which encompasses coastal New Jersey and Delaware. Delaware Bay became the first designated "Hemispheric Site" by WHSRN because of its importance to migratory shorebirds (Tsipoura and Burger 1999 [AR, Add.D, 207-212]. It has long been documented that shorebirds in Delaware Bay rely on horseshoe crab eggs during their migration to breeding grounds (Sperry 1940, Castro et al. 1989 [AR, 5A, 229-244], Castro and Myers 1993 [AR, 5A, 265-268], Botton et al. 1994 [AR, 5A, 276-282], Dutton 1998, Harrington and Shuster Jr. 1999 [AR, 5A, 587-592], Tsipoura and Burger 1999 [AR, Add.D, 207-212]). At least 20 species of shorebirds rely on horseshoe crab eggs to build up fat reserves during their migration to breeding grounds (Margraf and Maio 1998 [AR, 5A, 458-498]), and more than 10 species of shorebirds utilize horseshoe crab eggs in Delaware Bay (Myers 1986 as in Castro et. al. 1989 [AR, 5A, 229-244]) including: Red Knots, Short-billed Dowitchers, Sanderlings, Ruddy Turnstones, Dunlin, Least Sandpiper, Semipalmated Sandpiper, Pectoral Sandpiper and Semipalmated Plover (Sperry 1940, Recher and Recher 1969 [AR, 5A, 50-64], Shuster Jr. 1982 [AR, 5A, 90-117], Castro et. al. 1989 [AR, 5A, 229-244], Tsipoura and Burger 1999 [AR, Add.D, 207-212]). Species especially dependent on this resource are Red Knot, Sanderling, Semipalmated Sandpiper and Ruddy Turnstone. It appears that loss or impaired use of this resource would have major impacts to populations of these shorebird spp [species]" (AR, 2B, 188). "At the peak of this gathering, some 200,000 shorebirds may occupy a fifteen-mile stretch of shore, and 60,000 of them may be red knots" (Biderman 1983 [AR, 5A, 121]).

The reduction in spawning horseshoe crabs has caused up to a 70% decline in horseshoe crab eggs in Delaware Bay (Tsipoura and Burger 1999 [AR, Add.F, 207-212]). The decline in horseshoe crabs and subsequent decline in shorebirds is described by Niles and Clark (1997-Draft). "Preliminary observations of shorebirds and horseshoe crabs in 1997 suggest severe population damage to horseshoe crabs and a consequent negative impact to migratory shorebirds. The most recent count of shorebirds on the entire bay currently stands at just over 200,000 birds of all species, about 10% below average, while last year's count was the lowest total count ever recorded in 11 years of surveys. Shorebird numbers on the NJ shore have dropped to 37% of the bay-wide population, down from 51% in previous years. The shift in distribution is concentrated in red knots, where most of the population (88%) is in Delaware, along with sanderlings and ruddy turnstones. In previous years, most of the bay's sanderlings were observed in NJ, but in 1997

about half are in Delaware. Moreover, at least two of five red knots with radio transmitters attached in NJ moved to the Delaware shore. Visiting scientists Clive Minton and Alan Baker postulate that if anecdotal observations of horseshoe crabs and shorebirds movements are accurate, then a hemispheric collapse of shorebird reproduction may be likely" (Niles and Clark 1997-Draft [AR, 5A, 424]).

While discussion of the horseshoe crab-shorebird relationship has principally focused on Delaware Bay, documentation of shorebirds feeding on horseshoe crab eggs on Cape Cod dates back to 1881, when red-breasted sandpiper (Red Knot), and turnstones are referenced with respect to foraging on horseshoe crab eggs (Hadgood 1881). Forbush reported (1912) that, "Red-breasts [Red Knots] . . . are fond of the spawn of the horsefoot crab, which, often in company with the turnstone, they dig out of the sand, sometimes fighting the former birds before they can claim their share . . . ". A more recent study conducted in Plymouth, Massachusetts in 1976, confirmed that Short-billed Dowitchers were feeding on horseshoe crab eggs, and that the number of agonistic (combative) encounters among these birds were higher when foraging in areas containing horseshoe crab eggs. In addition, the number of Short-billed Dowitchers feeding at these sites declined as horseshoe crab eggs became less abundant later in the season (Mallory and Schneider 1979 [AR, 5A, 79-86]).

Many of the shorebird species that use Monomoy during migration (including Sanderling, Short-billed Dowitcher, Least Sandpiper, Semipalmated Sandpiper, Ruddy Turnstone, Red Knot, and Dunlin) have been documented feeding on horseshoe crab eggs in other areas, such as Delaware Bay. These species are present on Monomoy during horseshoe crab spawning periods, or soon enough after spawning that horseshoe crab eggs would be an available food item (Veit and Petersen 1993; USFWS 2001; S. Koch pers. comm; Sharon Fish Marino, Monomoy NWR, USFWS, Chatham, MA, pers. comm.). Further, many of these shorebird species are considered "Species of High Concern" by the United States Shorebird Conservation Plan (Brown et al. 2001) including: Ruddy Turnstone, Red Knot, Sanderling, Short-billed Dowitcher. Additional species considered "Species of Moderate Concern" which congregate at Monomoy include: Semipalmated Sandpiper, Least Sandpiper, Dunlin, and Black-bellied Plover (Brown et al. 2001).

In 2001, Refuge staff began a study specifically to determine if shorebirds are eating horseshoe crab eggs at Monomoy NWR. On June 4, 2001, one Semipalmated Sandpiper was taken on North Monomoy after it was observed (in an area where horseshoe crabs spawn) feeding with a flock of 100 sandpipers and about 10 Willets. The Semipalmated Sandpiper did contain horseshoe crab eggs in its digestive system. (unpubl. data from Monomoy NWR). In July, Refuge staff collected additional information about shorebirds feeding on horseshoe crab eggs by mistnetting shorebirds and flushing stomach contents for further analysis. In total, stomach contents from 44 Short-billed Dowitchers, 1 Willet, 3 Semipalmated Sandpipers, and 1 Semipalmated Sandpiper were collected, and the birds were then released. In total, 17 of the 49 gut samples collected contained horseshoe crab egg membranes. All samples containing membranes were collected from Short-billed Dowitchers (unpubl. data from Monomoy NWR). This new information on the actual feeding by shorebirds at Monomoy NWR confirms all reports collected elsewhere in Massachusetts and in mid-Atlantic locations.

In an attempt to gain additional information about the importance of horseshoe crab eggs to shorebirds on Monomoy NWR, blood samples were obtained from 35 Short-billed Dowitchers. Stable isotope analysis, which has been developed in Delaware Bay, was used to analyze the samples. The results of the isotope analysis indicate a major shift in foods consumed in more recent time, or likely since the birds left their Arctic breeding grounds, and a greater similarity in the birds' more recent diet at Monomoy NWR than the past diet over more widely scattered breeding areas. A more thorough interpretation, including degree of dependence on horseshoe crab eggs, cannot be made without knowledge of the isotope signatures of all potential foods available to the shorebirds while feeding on Monomoy NWR (Mike Haramis, Patuxent Wildlife Research Center, Laurel, MD, pers. comm.). More data will be collected in 2002.

Evidence of horseshoe crabs in the guts of shorebirds collected on Monomoy NWR confirms visual observations (documented by video camera) that horseshoe crab eggs are a prey item of shorebirds feeding there. This information corroborates documentation from the late 1800s of Red Knots and Ruddy Turnstones feeding on horseshoe crab eggs on Cape Cod, and documentation from the late 1970s of Short-billed Dowitchers feeding on horseshoe crab eggs in Plymouth, Massachusetts. This behavior is also consistent with shorebirds at other more southern stop-over sites on the Atlantic Flyway. While this most recent evidence of use of horseshoe crab eggs by shorebirds was collected during the fall shorebird migration, horseshoe crabs are abundant on Monomoy NWR during the spring migration as well, and it is likely that shorebirds using Monomoy NWR during the spring migration also utilize available horseshoe crab eggs.

Anticipated Impacts of the Use on Shorebirds: Harvesting for the biomedical industry and the commercial bait fishery both remove adult horseshoe crabs from the population. Since both uses target gravid females that are collected as they approach, or while on, spawning beaches, it is likely that these uses result in a decrease in the number of horseshoe crab eggs that are deposited on the beaches. In Delaware Bay, the reduction in spawning horseshoe crabs resulted in a 70% decline in horseshoe crab eggs (Tsipoura and Burger 1999 [AR, 5A, 419-437]) and this decline has been linked to subsequent declines in shorebirds on the New Jersey shores. (Niles and Clark 1997-Draft [AR, 5A, 419-437]).

A number of species of shorebirds rely on Monomoy NWR during the spring and fall migration for habitat for feeding and resting. We have confirmed that horseshoe crab eggs are one of the food items consumed by shorebirds at Monomoy NWR. While we have not identified all of the species that feed on horseshoe crab eggs on the Refuge, this information is consistent with numerous studies from Delaware Bay that document the importance of horseshoe crab eggs to shorebirds during the spring migration. Given that Monomoy NWR is a critical spawning site for horseshoe crabs (evidenced by past harvest totals and the fact that 25 percent of the total Massachusetts1999 harvest was landed from Monomoy NWR) and is a critical migratory stop-over site for shorebirds, it is likely that horseshoe crab eggs are an important food item in shorebirds' diets and a critical part of the food web on Monomoy NWR.

Available information from mid-Atlantic migratory stop-over sites indicates there have been significant declines in shorebird numbers, following the declines in spawning horseshoe crab

numbers, during a period when harvesting of horseshoe of crabs for bait and biomedical use has increased. Given the similar increase in harvesting pressure of horseshoe crabs in Massachusetts, the near extirpation of horseshoe crabs in other Massachusetts sites, and increased harvest interest on Monomoy NWR in particular, the Refuge is concerned about the incompatibility of this harvesting activity with staging and migratory shorebirds.

Over-harvesting horseshoe crabs on Monomoy NWR may result in a decline of available horseshoe crab eggs for migratory shorebirds. This degraded habitat could affect shorebird productivity, survival, and ultimately the total population. If shorebirds that rely on this site during the spring migration do not find the necessary food supplies it may result in lower body weights when they depart for their breeding area, which in turn would adversely impact survival and reproductive success. Similarly, if shorebird adults and juveniles that rely on Monomoy NWR during the fall migration do not find the necessary food supplies to finish migration to the wintering area, mortality may increase (Pfister et al. 1992).

Anticipated Impacts of the Use on Other Fauna and the Ecosystem in General: Horseshoe crabs and their eggs are utilized by a variety of other birds occurring on Monomoy NWR (USFWS 2001) including: Red-winged Blackbirds (*Agelaius phoeniceus*) (Reese 1973), Herring Gulls (*Larus argentatus*), Great Black-backed Gulls (*Larus marinus*) (Botton and Loveland 1993 [AR, 5A, 261-264]), and Laughing Gulls (*Larus atricilla*) (Shuster Jr. 1982 [AR, 5A, 90-117], Penn and Brockman 1994, Burger and Wagner 1995 as cited in Burger 1996). All of these species actually nest on Monomoy NWR. Numbers of nesting pairs of Laughing Gulls on Monomoy NWR has historically varied from a high of 1,000 pairs in 1981 to zero pairs in 1995 (USFWS 1996). Recent data however suggest an increasing trend as Laughing Gull pairs have increased from 19 pairs in 1999, to 376 pairs in 2000, and 805 pairs in 2001 (Koch 2000, unpubl. data from Monomoy NWR). In mid-Atlantic states, the diets of adult and young Laughing Gulls during the breeding season is largely comprised of horseshoe crab eggs (Burger 1996).

In addition, horseshoe crab eggs are often eaten by minnows and juveniles of larger fish. " . . . Given the chance, larger fish take entire egg masses" (B. Harrington and Shuster Jr. 1999 [AR, 5A, 590]). Eggs and larvae are documented food sources for a variety of fish occurring on or near Monomoy NWR (Mugford 1975, USFWS 1988, Nancy Finley, Cape Cod National Seashore, National Park Service, Wellfleet, MA pers. comm.) that in turn provide food for other nesting birds including: killifish (*Fundulus*) species (N. Finley pers. comm.), such as striped killifish (*Fundulus majalis*), eel species such as American eel (*Anguilla rostrata*), (Warwell 1897, deSylva et al. 1962), weakfish (*Cynoscion regalis*), northern kingfish (*Menticirrhus saxatilis*), Atlantic silverside (*Menidia menidia*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*) (deSylva et al 1962, Penn and Brockman 1994), striped bass (*Morone saxatilis*) (Martin 1974), and white perch (*Morone americanus*) (Shuster Jr. 1982 [AR, 5A, 90-117]).

Observations of other fauna feeding on horseshoe crab eggs, hatchlings and adults include: sand shrimp (*Crango septemspinosus*) (Price 1962), 8 mollusk species (*Mollusca*) (Perry 1940, as in Shuster Jr. 1982 [AR, 5A, 90-117]), fiddler crabs (*Uca* sp.)(Shuster Jr. 1958 as in Shuster Jr. 1982

[AR, 5A, 90-117]), blue crab (*Callinectes sapidus*), green crab (*Carcinides maenus*) spider crab (*Libinia sp.*) in Barnstable Harbor, Massachusetts (Shuster Jr. 1958 as in Shuster Jr. 1982 [AR, 5A, 90-117]). Devil ray (*Mobula hypstoma*), (Teale 1945 as cited in Shuster Jr. 1982 [AR, 5A, 90-117]), puffers (*Tetradontidae*) (Shuster Jr. 1958 as cited in Shuster Jr. 1982 [AR, 5A, 90-117]), sharks and loggerhead sea turtles (*Caretta caretta*) (ASMFC 1998b [AR, 4A, 164-231] and 1999a [AR, 4A, 250-319]). All of these species occur on or near Monomoy NWR.

Many species of birds nesting on Monomoy NWR feed heavily on fish during nesting and chick rearing. During this time, food availability is critical, and often influences chick survival. Monomoy NWR currently provides nesting habitat for federal-endangered Roseate Terns, and is one of only a few sites in Massachusetts where this species nests (unpubl. data from Massachusetts Division of Fisheries and Wildlife). During the past 4 years, the number of nesting pairs of Roseate Terns has varied from three to more than 40 (Koch 1999 and 2000, unpubl. data from Monomoy NWR). Roseate Terns in the North Atlantic generally nest in association with large productive Common Tern colonies (also present on Monomoy NWR) and numbers of nesting pairs often varies from year to year depending on food availability, weather, and predation (USFWS 1998b). Roseate Terns feed on a variety of fish, including Atlantic silversides (which eat horsehoe crab eggs and are present on Monomoy NWR (Gochfeld et al. 1998). During August and September, hundreds to thousands of Roseate and Common Terns congregate on Monomoy NWR and surrounding beaches before beginning their southward migration (Trull et al. 1999, Koch 2000, unpubl. data from Monomoy NWR.).

Monomoy NWR is also extremely important to nesting wading birds, including Snowy Egrets (*Egretta thula*) and Black-crowned Night-Herons (*Nycticorax nycticorax*). The number and quality of nesting sites for wading birds has slowly been declining over a long period of time in Massachusetts, largely due to human activities (Brad Blodget, Massachusetts Division of Fisheries and Wildlife, Westboro, MA, pers. comm.). Monomoy NWR currently hosts a heronry of 25-40 breeding pairs of Snowy Egrets (*Egretta thula*) and over 200 breeding pairs of Black-crowned Night-Herons (Koch 1999 and 2000; unpubl. data from Monomoy NWR.). Diet studies conducted in New Jersey and Carolina report that some of the major prey items of Snowy Egrets include Atlantic silversides and killifish (Kneib 1982 as cited in Parsons and Master 2000). Items that Black-crowned Night-Herons reportedly feed on include: eels (*Anguillidae*), killifishes (*Cyprindontidae*), flounder and puffers (Palmer1962 as cited in Davis 1993). These species of fish occur on or near Monomoy NWR and have all been documented feeding on horseshoe crabs and their eggs.

Sand shrimp, molluscs and crabs are also important food items to a variety of birds that utilize Monomoy NWR for breeding, feeding, and resting. Sand shrimp was found to be the most common invertebrate consumed by Semipalmated Sandpipers during the fall migration in coastal Massachusetts and consisted of more than half the diet by volume (Schneider and Harrington 1981 as cited in Gratto-Trevor 1992). Monomoy NWR is also an important nesting and staging site for American Oystercatchers and an important roosting site for Whimbrels. During the breeding season, more than 20 pairs of American Oystercatchers nest on the Refuge. In addition, the largest concentration of this species in Massachusetts occurs on Monomoy NWR or on the surrounding

beaches in late summer and early fall. In 2001, over 100 adults and young were counted (USFWS 1996; Koch 1999 and 2000; S. Fish Marino, pers. comm.). Numbers of Whimbrels can exceed 700 individual birds in one night during July (unpubl. data from Monomoy NWR). American Oystercatchers eat mostly shellfish and marine invertebrates including: bivalves, molluscs and worms (Heppleston 1972 as cited in Nol and Humphrey 1994) which may feed on horseshoe crab eggs. Whimbrels often eat sand shrimp on Cape Cod (Skeel and Mallory 1996). Both American Oystercatchers and Whimbrels also eat a variety of crabs (Skeel and Mallory 1996; Bent 1929, Tomkins 1947, Cadman 1979, Johnsgard 1981, Nol 1989 all as cited in Nol and Humphrey 1994) that may feed on horseshoe crab eggs. Both species are considered "Species of High Concern" by the United States Shorebird Conservation Plan (Brown et al. 2001).

Application of Wilderness Act: The Wilderness Act (P.L. 88-577) was enacted by the U.S. Congress in 1964 to establish a National Wilderness Preservation System. The Act charted a new course in history by preserving some of the country's last remaining wild places in order to protect their natural processes and values from development. Wilderness is defined by section 2(c) of the Act as land where the natural community of life is untrammeled by humans, who visit but do not remain. It is further defined as areas offering outstanding opportunities for solitude, primitive, or unconfined type of recreation. These areas may contain ecological, geological, or other features of scientific, educational, scenic, or historical values. Section 4 of the Wilderness Act authorizes uses of Wilderness Areas with the primary management goal of preserving wilderness character. Section 4(a) declares that the Wilderness Act shall be supplemental to the purposes for which refuges have been established. Except as specifically provided for in the Act, or minimum actions needed for administrative duties and emergency health and safety procedures, the Act prohibits commercial enterprises, landing of aircraft and other mechanical transport, permanent and temporary roads, motor vehicle use, motorized equipment or motor boat use, structures, and installations. Commercial services supporting recreational or wilderness purposes such as guiding services, ecological tours, outfitters, etc., are permissible.

Within the National Wildlife Refuge System, wilderness recreational uses must be compatible, wilderness dependent, non-motorized, and involve no mechanical transport. Commercial uses that are not recreational in nature are prohibited. Because harvesting of horseshoe crabs for use by the biomedical industry and/or sale as bait are both non-recreational commercial activities not supportive of wilderness purposes, these uses are already legally prohibited in Wilderness Areas on Monomoy NWR (See Attachment 1 for the Wilderness Area boundary). While the 1994 compatibility determination noted that "this low-profile harvest technique does not impact the wilderness character of the island", it never took into account the Wilderness Act's prohibition on commercial activities within a Wilderness Area. (AR, 1C, 492).

Conclusion: Compatibility determinations are based on procedural requirements and regulations and the sound professional judgement of the refuge manager. In determining whether a proposed use is compatible, the refuge manager must consider the mission of the NWRS and the purpose of the refuge. The National Wildlife Refuge System mission is to " . . administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of

present and future generations of Americans. . ." (see 16 U.S.C. § 668dd(a)(2)). Monomoy NWR was established for "...use as an inviolate sanctuary, or for other management purpose, for migratory birds." The purpose of the wilderness portions of Monomoy NWR is to "preserve the wilderness character of the Monomoy Islands" (Public Law 91-504, Designation of Wilderness Areas within National Wildlife Refuges). New regulations at 50 C.F.R. § 25.12 (a) define the following terms:

> "*Compatible use* means a proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgement, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purpose(s) of the national wildlife refuge."
>
> "*Conservation,* and *Management* mean to sustain and, where appropriate, restore and enhance, healthy populations of fish, wildlife, and plants utilizing, in accordance with applicable Federal and State laws, methods and procedures associated with modern scientific resource programs. Such methods and procedures include, consistent with the provisions of the National Wildlife Refuge System Administration Act of 1966 (16. U.S.C. § 668dd-668ee), protection, research, census, law enforcement, habitat management, propagation, live trapping and transplantation, and regulated taking."
>
> "*Fish, Wildlife,* and *Fish and Wildlife* mean any member of the animal kingdom in a wild, unconfined state, whether alive or dead, including a part, product, egg, or offspring of the member."
>
> "*Purpose(s) of the refuge* means the purpose(s) specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a national wildlife refuge, national wildlife refuge unit, or national wildlife refuge subunit. For refuges that encompass Congressionally designated wilderness, the purposes of the Wilderness Act are additional purposes of the wilderness portion of the refuge."
>
> "*Sound professional judgement* means a finding, determination, or decision that is consistent with principles of sound fish and wildlife management and administration, available science and resources, and adherence to the requirements of the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), and other applicable laws. Included in this finding, determination, or decision is a refuge manager's field experience and knowledge of the particular refuge's resources."

Since 1994, when harvesting of horseshoe crabs for biomedical use and subsequent return to the waters was found compatible on Monomoy NWR, a change in the conditions under which the use

is permitted has occurred, and new information regarding the effects of the use has been generated. The Refuge Manager decided that the changes in conditions and new information was significant enough to potentially change the outcome of the compatibility determination (50 C.F.R. § 25.21 (f) Compatibility Policy § 2.11 H (4), 65 F.R. 62490).

Since 1994, more information is available relative to horseshoe crab population trends and harvest pressure, which indicates a change in conditions from 1994 about the connections between horseshoe crabs and migratory birds and other wildlife resources, and in the regulatory programs concerning management of horseshoe crabs and the National Wildlife Refuge System. A summary of the information that was not considered in the 1994 compatibility determination but has been considered here follows:

- Horseshoe crabs' reproductive cycle makes them vulnerable to over-exploitation. The reproductive strategy of congregating in large numbers on beaches to spawn makes them easy targets for any harvester both in the intertidal and subtidal areas close to spawning beaches. Because this species does not breed until 9-10 years of age, declines in populations may not be realized for many years, and populations will be slow to recover from over harvesting.

- Both bait and biomedical harvesters generally prefer female horseshoe crabs.

- Horseshoe crabs can be harvested by trawling in deeper waters. Shallow water harvesters (both bait and biomedical) focus their efforts on high tides when the horseshoe crabs are moving into shallow waters to breed. The gentle topography of the west side of Monomoy NWR (including North Monomoy Island and the north tip of South Monomoy Island) allows horseshoe crab harvesters to easily collect animals in the intertidal areas on spawning beaches, and in the subtidal areas, on their way to the spawning beaches. The reproductive strategy of horseshoe crabs and the topography of Monomoy NWR result in a situation where horseshoe crabs can easily be over harvested. Horseshoe crabs can be harvested in numerous other places in Massachusetts, as evidenced by State totals presented earlier. The State even notes that their own surveys " . . . show that the majority of spawning beaches are not harvested." (Diodati 2002). In addition, harvesters in other parts of Massachusetts currently use other methods to harvest horseshoe crabs, including trawling in deeper waters.

- There has been a significant change in the fishing effort and harvest of horseshoe crabs rangewide from the 1990-1994 levels which were about a million pounds per year to five million pounds in 1996. Fishing effort and horseshoe crab landings have declined in recent years. This is in part due to new regulations. Bait harvest yields for the 2001 Massachusetts harvest is less than the 1997-2000 levels, as a result of new regulations, daily trip limits, closed seasons and the availability of biomedical crabs for bait (Diodati 2002). There is still no information on what effects increasing harvest pressure during the 1990s has had on the spawning population.

- There is evidence that some populations of horseshoe crabs in the mid-Atlantic states have begun declining. While coast-wide trends can not be inferred, recent data indicate that local populations in Massachusetts are also declining. Populations in Bourne declined by 80% between 1984 and 1999 and were substantially decreased at Stage Harbor by 1999 over numbers five years before.

- Harvesting of horseshoe crabs for use by the biomedical industry has increased by 100-300% over 1989-1991 levels.

- Declines in other traditionally harvested fish, and an increase in demand for whelk and American eel have resulted in larger harvests of horseshoe crabs for commercial fisheries during the 1990's.

- The Refuge observed an increase in horseshoe crab harvesting activity in and near the Refuge in 1999. The State of Massachusetts reported that 25% of the harvest was obtained from the Refuge.

- In addition to observed declines in some horseshoe crab populations, data on shorebirds indicate significant declines for many species (Brown et al. 2001).

- Monomoy NWR hosts thousands of shorebirds every year during the spring and fall migration which utilize horseshoe crab eggs as a food resource.

- Monomoy NWR was designated as a Western Hemisphere Shorebird Reserve Network Site in 1999, in recognition of its importance to migratory shorebirds.

- At least two species of shorebirds have been documented feeding on horseshoe crab eggs during migratory stop-over on the Refuge. A decline in the horseshoe crab population would result in a decline in this shorebird prey item.

- Horseshoe crabs and their eggs have been documented to be prey items of a variety of other wildlife which in turn are prey items for a variety of migratory birds, including federal-listed Roseate Terns. A decline in the horseshoe crab population could result in a decline in the food supply for a variety of species.

- Coast-wide efforts to restrict harvest of horseshoe crabs has occurred through quotas imposed by ASMFC, which Massachusetts has adopted, and more restrictive limits or closures by other states. NMFS has also established a marine sanctuary.

- No regulatory agency has information to establish harvest quotas based upon biologically sustainable levels.

- The permits issued by USFWS for biomedical harvest in 1994 and successive years allowed commercial harvest in the shallower portions of the Wilderness Area closed to other users.

Non-enforcement in the balance of the Wilderness Area resulted in commercial bait harvesting occurring there. These uses were in violation of the Wilderness Act. Commercial harvesting in areas of the Refuge outside of the Wilderness Area was never legally authorized as no compatibility determination was issued for that use.

- In 1994, harvesting of horseshoe crabs for biomedical use was found compatible because it was determined, at that time, to be a non-consumptive use. However, this was based on a single study conducted in 1983, which concluded that there was a 10% mortality rate among bled horseshoe crabs. Since 1994, two additional studies (although not directly comparable to ACCs methods) have been conducted and found similar mortality rates associated with the bleeding process. A use that results in 10% mortality is a consumptive use; the conclusion in the 1994 compatibility determination was inaccurate. Impacts of disturbance during the reproductive migration are unknown. Female horseshoe crabs are intercepted before they reach the shallow beaches and breed. No studies have been conducted to determine whether females harvested for the biomedical industry reproduce during that given year or what long term effects on survival are. That compatibility determination indicated it would be re-evaluated when use by the biomedical industry increased, which has occurred.

- New regulations were adopted by the USFWS for the issuance of compatibility determinations.

We acknowledge that there are still gaps relative to effects of the use on the resource. More research needs to be conducted on: mortality associated with bleeding by ACC; long term effects of biomedical use on horseshoe crab reproduction and populations (how does bleeding affect gravid females); population trends on Monomoy NWR and in surrounding areas; dependence of shorebirds on horseshoe crab eggs on Monomoy NWR during spring and fall migrations; and importance of horseshoe crabs and their eggs to other wildlife.

Lack of knowledge in these areas, however, does not preclude the Refuge Manager from making a compatibility determination. The Compatibility Policy, § 2.12 A (8), published at 65 F.R. 62492, states that, "Refuge Managers are not required to independently generate data on which to base compatibility determinations." To the extent that we do not have long-term harvest information, the new compatibility policy requires that where information is insufficient to document compatibility, the use must be denied, as only uses with an affirmative finding of compatibility can be permitted. If information available "is insufficient to document that a proposed use is compatible, then the Refuge Manager would be unable to make an affirmative finding of compatibility and we must not authorize or permit the use." § 2.12 A (8)(a), 65 F.R. 62492 and § 2.11 E, 65 F.R. 62490. "If an application for a use is denied, it need not be shown that the use is not compatible" (see Final Rule, Supplementary Information Issues 7: Denying Uses, 65 F.R. 62468. Several comments made by the public were to the effect that no adverse effect from a particular activity (such as harvest for use by the biomedical industry) were proven, therefore the use should be allowed. However, the regulation requires the opposite conclusion. Until a particular activity can be shown to be compatible, it cannot be permitted.

The NWRSIA establishes that compatible wildlife-dependent recreational uses are priority uses for Refuges. All horseshoe crab harvesting ultimately results in a commercial use and therefore does not qualify as a priority refuge use. Pursuant to 50 C.F.R. § 29.1, economic uses of natural resources must be found to contribute to the Refuge mission and purposes. A consumptive use, whether 100% consumptive (bait harvesting) or partially consumptive (biomedical harvesting) of wildlife prey items is not consistent with the Refuge purposes or mission and would affect the Refuge's ability to meet its mandated purposes, and therefore is inconsistent with 50 C.F.R. § 25.21, §29.1, and § 26.41 (a)(10). The Service also received comments suggesting that the Refuge close its waters to harvesting for bait, but, for the recognized public health benefits from LAL, allow harvesting and use by the biomedical industry to continue. As a matter of sustained population management, this may be a step which the State of Massachusetts chooses to take at other spawning sites in Massachusetts. However, it is not appropriate to draw such distinctions within the Refuge. The connections between migratory birds, Refuge purposes, and horseshoe crabs apply regardless of the use to which the horseshoe crabs are put. The factors pointing to their decline, their slow reproductive cycle and lack of information about long-term populations levels apply as well as lack of information on long-tern mortality and effects on productivity. Biologically, no information (other than less than 100% mortality) distinguishes the harvesting of horseshoe crabs for bait from the harvesting of horseshoe crabs for the production of LAL. Permitting private consumptive uses of a wildlife food source in light of the lack of evidence that this resource is sufficiently abundant now (and will be in the future) to both support the commercial uses and still meet shorebirds' and other wildlife's needs is inconsistent with the National Wildlife Refuge System mission, and the purpose for which the Refuge was established.

Availability of Resources: This section requires the USFWS to provide an analysis of the costs for administering and managing each use. (50 C.F.R. 26.41 (7), 65 F.R. 62483). As this use has been found to be not compatible, no significant additional costs will be incurred for the management of this activity. Law enforcement patrols, currently occurring to protect horseshoe crabs, will continue utilizing Refuge Law Enforcement staff and USFWS Special Agents when necessary. We anticipate increased patrol efforts to ensure that harvesting is not being conducted in any portion of Monomoy NWR. The USFWS will continue to conduct status research and monitor horseshoe crab populations. These studies are ongoing and, if they result in a finding which would support an affirmative compatibility determination, the matter can be re-evaluated.

Public Review and Comments: A draft compatibility determination was released for public comment from February 1 to March 25, 2002. A public hearing was held on March 21, 2002. Comments were solicited via a newspaper advertisement and by directly mailing the compatibility determination to interested parties. This final compatibility determination reflects changes made in response to public comment. In addition, a new section (Appendix A) has been added to specifically respond to the issues raised by the public.

Justification: Harvesting of horseshoe crabs from Monomoy NWR for any use has been found incompatible. Information provided in this compatibility determination indicates that the proposed uses would not contribute to the achievement of the national wildlife refuge purposes or the National Wildlife Refuge System mission, but could, based on available information, contribute to

a decline of horseshoe crabs on Monomoy NWR. Because a decline in horseshoe crabs at Monomoy NWR could impact shorebirds and other species, allowing these uses could compromise biological integrity, diversity, and environmental health. Sound professional judgement of this information calls for a conservative, risk averse strategy and supports rejection of the prior compatibility determination related to harvesting for biomedical use, and justifies a closure to all harvesting Refuge wide.

Determination (check one below):

___X___ Use is Not Compatible

_____ Use is Compatible

Signature: Refuge Manager: 5-17-02

(Signature and Date)

Concurrence: Regional Chief: Anthony D. Léger 5-23-02

(Signature and Date)

Mandatory 10- or 15-year Re-evaluation Date: **May ~~20~~, 2012** 23 5/23/02

Attachments:

1. Map of Monomoy NWR, September 15, 2000
2. Compatibility Determination-Nonconsumptive Harvest of Horseshoe Crabs, September 3, 1994

Appendix:

A. Issues Raised by the Public and Service Responses

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