gulls out competed all shorebird species including Red Knots for horseshoe crab eggs, and that the influence of gulls increases with repeated disturbance. In contrast to shorebirds, people walking dogs caused gulls to leave but they returned shortly after the disturbance ended.

Red Knot foraging efficiency is also adversely affected by the mere presence of gulls. Hernández (2005) found that the foraging efficiency of Red Knots feeding on horseshoe crab eggs decreased by as much as 40% when feeding close to a gull.

Risks Associated with Small Population Size

The threat to *C. c. rufa* may become further increased if the population drops below about 10,000 because Baker et al. (2005a) has shown that, due to their low genetic variability, the effective size of shorebird populations is much smaller than numbers censused (i.e., not all individuals contribute to the gene pool). As a result, census populations of 5,000–10,000 are likely to be especially vulnerable to the accumulation of harmful genetic mutations. Small populations are also at greater risk from the effects of stochastic events. This applies especially those which, like the Red Knot, are highly dependent on a small number of sites.

Weather-Related Threats to Red Knots

Cold and/or wet weather during the brief arctic summer can have a severely adverse effect on the breeding success of shorebirds (van de Kam et al. 2004). Global climate warming may lead to alterations in arctic weather patterns. These may be beneficial to shorebirds if they lead to warmer, longer breeding seasons but this is by no means certain (Rehfisch and Crick 2003).

In the very long term global warming may lead to large-scale habitat changes which will be greatly exacerbated by vegetation responses to increased atmospheric carbon dioxide (Rehfisch and Crick 2003). It has been predicted that this may lead to a 65% decrease in tundra habitat over a large area of the Arctic (Cramer 1997). If so, Red Knot breeding habitat would become so scarce that there is little doubt that this would restrict the size of its population.

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION FOR POPULATIONS

Appendix 4 summarizes details of the ownership of all land considered to be important for Red Knots throughout the western Atlantic flyway. This appendix also indicates the approximate percentage of land that is subject to some arrangement for habitat protection. However, it should be noted that the nature of such arrangements varies from place to place and in only a very few cases is the arrangement specifically for the benefit of Red Knots.

PAST AND CURRENT CONSERVATION AND HABITAT MANAGEMENT ACTIVITIES UNDERTAKEN TO BENEFIT THE SPECIES

As part of this assessment, biologists representing each state and country were contacted and were requested to outline management efforts for Red Knots. We found that no management efforts are directed specifically at Red Knots along the entire length of the flyway except in the area of Delaware Bay. However, many global, national, regional, and state-specific management and conservation efforts have been implemented to benefit shorebirds in general, including the Red Knot.

The Ramsar Convention on Wetlands

The Convention on Wetlands, signed at Ramsar, Iran in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Presently the convention has 146 contracting parties with 1,463 wetland sites, totaling 125,400,000 ha, designated for inclusion in the Ramsar List of Wetlands of International Importance.

The mission of the convention agreed at the eighth meeting of the Conference of the Contracting Parties in Valencia in 2002 is to promote the conservation and wise use of all wetlands through local, regional, and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world (http://www.ramsar.org).

Western Hemisphere Shorebird Reserve Network

The network is a voluntary, non-regulatory coalition of over 160 private and public organizations in seven countries working together to study and conserve shorebirds throughout their habitats. Membership in Western Hemisphere Shorebird Reserve Network (WHSRN) provides the site with international recognition as a major host for shorebirds. The network now includes 46 officially designated sites that are responsible for managing >80,940,000 ha. Member sites are located in Argentina, Brazil, Peru, Suriname, Mexico, U.S., and Canada. Further, almost 150

more sites are in Canada and the U.S. alone that are known to meet WHSRN site criteria but have not yet joined the network.

Of the 47 species of migratory shorebirds in North America, five are predicted to decline by 25% or more over the next 5 yr and 16 others have projected or actual population declines of 5–20%. Habitat degradation at critical staging, breeding, and non-breeding sites may be a major factor along with many problems that a migratory species encounter.

Important Bird Areas Program

National Audubon Society, as the partner for BirdLife International, is working to identify a network of sites that provide critical habitat for birds. This effort known as the Important Bird Areas Program (IBA) recognizes that habitat loss and fragmentation are the most serious threats facing populations of birds across America and around the world. By working through partnerships, principally the North American Bird Conservation Initiative, to identify those places that are critical to birds during some part of their life cycle (breeding, wintering, feeding, and migrating) it is hoped to minimize the effects that habitat loss, and degradation have on bird populations. Unless the rapid destruction and degradation of habitat can be slowed, populations of many birds may decline to dangerously low levels. The IBA program is a global effort to identify areas that are most important for maintaining bird populations, and focus conservation efforts at protecting these sites. In the U.S., the IBA program has become a key component of many bird conservation efforts, for example, Partners in Flight, North American Waterbird Conservation Plan, and the U.S. Shorebird Conservation Plan.

Convention on the Conservation of Migratory Species of Wild Animals 1979

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Program, concerned with the conservation of wildlife and habitats on a global scale. Since the convention came into force, its membership has grown steadily to include 101 Parties (as of 1 January 2007) from Africa, central and South America, Asia, Europe, and Oceania. At the instigation of Argentina, the Conference of the Parties to the Convention meeting in November 2005 determined that the *C. c. rufa* subspecies of the Red Knot was endangered and as such added it to Appendix 1 of the convention. Under the terms of the Convention the Parties agree to strive towards strictly protecting animals listed in Appendix 1, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them (http://www.cms.int).

National Wildlife Refuges

Refuge managers in USFWS regions 2, 4, and 5 were solicited for information on management plans that might affect Red Knots. Management efforts for shorebirds are taking place in many wildlife refuges in the flyway, but most focus on impoundment management that aim primarily at species likely to forage in moist soil, such as Semi-palmated Sandpiper, Dunlin, Short-billed Dowitcher, and Greater Yellowlegs (*Tringa melanoleuca*). The Red Knot feeds primarily on small mussels and clams normally associated with tidal sands, and would only benefit indirectly from impoundment management for shorebirds. While not the focus of specific management efforts, Red Knots benefit from the creation of safe high tide or nighttime roosts on the small islands formed by the natural topography of shallow water impoundments.

The International Shorebird Survey and Program for Regional and International Shorebird Monitoring

In 1974, the Manomet Center for Conservation Sciences organized the ISS to gather information on shorebirds and the wetlands they use. Information gathered by ISS cooperators over the last 30 yr show some disturbing trends. The data have long suggested that several shorebird species were declining rapidly, but until recently the design of the ISS did not allow for a sensitive statistical analysis. A new initiative, PRISM, is underway to coordinate and expand on existing shorebird survey efforts, including the ISS, the Western Shorebird Survey (WSS) and the Canadian Maritimes Shorebird Survey (MSS). The closer coordination and expanded survey effort will increase the power of statistical analyses and more clearly define shorebird conservation issues on a continental scale. (http://www.manomet.org/programs/shorebirds/).

Volunteer participation in the ISS has declined since 2000 (B. A. Harrington, unpubl. data) and the level of effort from year to year and state to state is highly variable. Concerted effort should be made by state and federal agencies to reinvigorate survey efforts through PRISM.

Delaware Bay—Increased Availability of Horseshoe Crab Eggs

Management in the Delaware Bay aims primarily at the protection of horseshoe crabs and spawning beaches which increases the availability of horseshoe crab eggs the Red Knot's prime food resource. Central to the protection of horseshoe crabs is the ASMFC Management Plan for the horseshoe crab. The plan adopted in 1998, along with subsequent addenda in 2000, 2001, 2004, and 2006 has provided the coast-wide framework for the protection of horseshoe crabs. The protection of horseshoe crabs has been achieved through tighter restrictions on the harvest of crabs as bait. This is covered in the section on history of regulations. However, past restrictions on the harvest have not created a substantial increase in the spawning population or crab egg numbers to date, partially because it takes nine years for crabs to reach breeding age. Thus other options have been explored to improve egg availability in the short- and mid-term periods.

Management efforts to increase the availability of horseshoe crab eggs have taken several forms. The first is protecting beaches important for crabs and birds from repeated disturbances by people and dogs. The first part of the protection is the Shorebird Steward Program conducted by NJDFW, USFWS, NJAS, TNC, and other groups, and the former Shorebird Ambassador Program conducted by the DDFW, where volunteers form a corps of stewards, educating beach users about the effects of disturbance on shorebirds and warn them of regulations that protect shorebirds. This effort is supported by agency staff providing logistical support in the form of outreach materials, signs, and post-and-string symbolic fencing. The second part of protection is conservation law enforcement, which has become necessary to obtain full compliance at the protected beaches. In New Jersey, the Red Knot is a state threatened species and conservation officers have authority to issue summonses for disturbance. In three spring seasons, only a small number of warnings and one summons have been issued. Conservation officers have become the backup for shorebird beach stewards who may encounter difficulties with the public. Finally, the ASMFC approved addendum III to the horseshoe crab management plan. In addition to reducing the Delaware Bay harvest to 300,000 crabs annually, it prohibits the collection of horseshoe crabs during the shorebird migratory period of 1 May through 7 June. By prohibiting the collection of crabs during the spawning period, females are free to spawn providing much needed eggs, and disturbance to foraging and roosting shorebirds due to beach harvesting is eliminated.

The second effort to increase the availability of horseshoe crab eggs is to develop management solutions to the high gull numbers along the New Jersey and Delaware Bay shore. The impact of gull numbers is greatest on bayshore beaches that are closest to gull colonies on the Atlantic coast, namely those along the shore of the Cape May peninsula. These beaches, including Norbury's Landing, Kimbles Beach, and Gandys Beach were among those where shorebird numbers were the greatest (B. A. Harrington, unpubl. data; K. Clark, unpubl. data; Clark et al. 1993). In 2003–2004, shorebirds shifted to beaches most distant from gull colonies on the Atlantic coast—Fortescue Beach and Gandy Beach. Birds returned to Reeds Beach in 2005 coinciding with the introduction of an experimental gull exclosure. Created by the NJDFW Shorebird Team, the exclosure consisted of metal conduit supporting strands of 200-lb test monofilament approximately 1–3 m high (C. D. T. Minton, unpubl. data). The team applied a number of variations that prevented gull predation on eggs but also restricted shorebird use. However, flocks of up to 3,000 Red Knots roosted and foraged in areas adjacent to and within the exclosure for most of the latter half of May. Further experimentation is planned for 2006.

The gull exclosure is considered to be only a short-term solution to the low density of horseshoe crab eggs in New Jersey. A longer-term solution is the control of gulls. Although the killing of gulls would provide an immediate solution, the control of gull productivity presents a more publicly acceptable management alternative.

Delaware Bay—Protection of Roosting Sites

The fourth management focus on Delaware Bay is to create secure day and nighttime high-tide roosts. Shorebirds at stopover sites require not only an adequate food supply but also safe and disturbance-free sites that are close to their feeding grounds where they can roost when not feeding and be relatively free from ground predators (Rogers 2003, Sitters et al. 2001). As is typical worldwide the main roosting sites used in New Jersey have always been the sand-spits and sand islands in Hereford Inlet on the Atlantic coast between Stone Harbor and Wildwood. In contrast, the bay shore of Delaware has no similar roosting site so birds tend to roost in areas of open marshland about

1.7 km inland near Mispillion River (H. P. Sitters, unpubl. data). Presently, this is the only place in the world where Red Knots have been recorded as roosting inland at night.

In 2004, radio tracking showed birds commuting from diurnal feeding areas on the Delaware coast to roost at Hereford Inlet, New Jersey, at night, a 94-km round trip. In 2005, perhaps because of tidal flooding just before the main arrival of Red Knots, most, if not all, Red Knots that fed in Delaware commuted to Hereford Inlet every night. On some nights, when high water occurred in the evening, the whole of the Delaware Bay stopover population of up to 20,000 birds roosted at Hereford Inlet.

In response to the increasing numbers of shorebirds roosting on the Atlantic coast at Stone Harbor Point, NJDFW created protection zones in 2005 on two areas covering approximately 125 ha. By the end of May >20,000 Red Knots and thousands of Dunlin and Sanderlings were using the protected area as a night time roost, and as many as 2,000 Red Knots were roosting in the same area during daytime high tides. In 2006, NJDFW partnered with the municipality of Stone Harbor to create year-round protection of Stone Harbor Point with emphasis on spring, fall and winter populations of all shorebirds, and spring and fall populations of Red Knots. Protection efforts include physical barriers to disturbance, outreach materials, a full time naturalist on duty at critical periods, and the development of plans for long-term protection.

On the southbound journey the same consideration for safe and secure roosts and foraging areas also apply. In a study conducted on the Two Mile Beach Unit of the Cape May NWR, which is closed to beachgoers during the period of the southbound migration, Red Knots and other shorebird species occurred ten times more often than on beaches open to the public (Mizrahi 2002).

Delaware Bay—Reduce Disturbance by Minimizing Research Activities

Research efforts on Delaware Bay, including trapping, banding, and resighting efforts have been minimized to reduce disturbance to foraging shorebirds. Trapping and banding effort was reduced to the minimum necessary to monitor weight gains of Red Knots, Ruddy Turnstones, and Sanderlings during the migratory stopover period, and individually mark enough birds to perform survival analyses via resightings of marked individuals. Catch effort is limited to six catches of 50–75 individuals of each species spread throughout the migratory stopover period (approximately 10 May–7 June), and catches are spaced 3–5 d apart. On any one day, catching activities take place at no more than one site on each side of the bay and catching effort is spread out over various locations to avoid frequent disturbance to individual beaches. Where catching takes place, disturbance is mostly limited to around 100 m of shoreline and, except for around 20 min when a catch is made, is much less than that caused by typical recreation use. Optimally, all three species are caught in one attempt to reduce disturbance and catch frequency. The effects on migratory shorebirds of disturbance by researchers were quantified and no difference was found between either the frequency or flight duration of researcher-caused disturbance as compared to control periods (B. A. Harrington, unpubl. data). Most birds are weighed, measured, and banded within 2 hr of capture, and banding activities take place away from foraging beaches to allow shorebirds to return to forage.

Researchers carrying out systematic resighting surveys for individually marked shorebirds are restricted to hidden or distant viewing areas including viewing platforms constructed for shorebird viewing, roads, and occasionally from beachfront property with the permission of the landowner.

Shorebird banding teams are led by biologists from NJDFW and DDFW and are comprised of professional local and foreign shorebird biologists as well as experienced local and foreign bird banders. The Delaware Bay Shorebird Project began in 1997 and employed cannon netting, a method widely used in Europe and Australia. Because this method is not widely used in the U.S., biologists requested the aid of certified cannon netters from the United Kingdom and Australia, all with decades of experience, to train U.S. teams in this trapping technique. This dedicated corps of experienced cannon netters, many of whom are professional shorebird biologists in their respective countries, have returned each year since 1997 to help carry out this project.

Delaware Bay—Monitor Numbers of Migratory Shorebirds on the Delaware Bay Stopover

In 1986, the NJDFW and DDFW commenced weekly aerial surveys of the Delaware Bay coastline to document shorebird abundance during the migratory stopover (May through early June). This long-term survey has tracked the decline of the migratory stopover in terms of shorebird abundance and has been used to track changes in shorebird distribution relative to horseshoe crab egg densities on bayshore

beaches. This survey has been conducted by the same observers throughout its nearly 20-yr duration and continues to be one of the most valuable long-term monitoring programs in place on the Delaware Bay stopover.

Delaware Bay—Past and Current Management Actions for Shorebird Populations

1. 1986—Delaware Governor Michael Castle and New Jersey Governor Thomas Kean designated the bayshore as a sister reserve, the first such commitment under WHSRN. The WHSRN ties together critical shorebird stopovers in North, Central and South America.
2. 1986—NJENSP with DDFW conducted bay-wide aerial surveys of shorebirds. This survey has been conducted every year since 1987.
3. 1992—NJDFW contracted a study of shorebird and shorebird habitat vulnerability to oil spills in the bay. This study projected the likely impact areas of spills from different locations under different weather conditions to provide information necessary for response planning.
4. 1993—In May 1993, the NJENSP convened a 2-d Delaware Bay shorebird workshop, which resulted in the Comprehensive Management Plan for Shorebirds on Delaware Bay. The workshop included over 100 people representing 22 organizations, and aimed to improve communication and develop a framework for conservation actions across two states and multiple government and non-governmental organizations.
5. 1994—In May 1994 the NJENSP convened a single day Delaware Bay meeting to finalize the management plan drafted after the 1993 workshop. The final plan was printed and distributed to regulatory agencies and conservation groups in the region. NJENSP completed mapping of shorebird distribution and suitable habitats, and made it available to emergency response and planning agencies.
6. 1994—New Jersey convened a shorebird outreach team as a result of the 1993 planning meeting, including representatives from NJENSP, DDFW Nongame and Endangered Species Program (NGES), NJAS, Bay Shore landowners TNC, New Jersey Natural Lands Trust (NLT), New Jersey Conservation Foundation (NJCF), USFWS, and the Wetlands Institute. This team developed educational materials including fact sheets on shorebirds and safe viewing locations.
7. 1995—New Jersey hosted a 2-d Delaware River and Bay Oil Spill Emergency Workshop, assembling all agencies responsible for spill response on the bay. The results of this workshop were incorporated into the Area Contingency Plan, the chief reference document in the case of a spill.
8. 1997—Delaware Coastal Management Program (DECMP) and WHSRN host a shorebird management workshop for Delaware Bay. The goal of the workshop was to provide information that can be used to integrate shorebird management into traditional environmental practices and programs in the Delaware Bay region such as wetlands management, public access management, and the beneficial use of dredged material.
9. 2003—NJENSP and DDFW Natural Heritage and Endangered Species Program (NHESP) conducted bay-wide aerial shorebird surveys during the fall migratory period.
10. 2005—NJENSP, Richard Stockton University in New Jersey, and DDFW-NHESP carried out the first year of bay-wide horseshoe crab egg surveys using a standardized sampling protocol developed by the U.S. Geological Survey.
11. 2004—ASMFC approved addendum III of the horseshoe crab management plan. The addendum limits Delaware Bay harvest to 300,000 crabs annually and prohibits the harvest of crabs during the shorebird migratory period (1 May–7 June). This closure decreases the number of gravid females collected and limits the disturbance to shorebirds caused by beach harvesting.
12. 2006—ASMFC approves addendum IV of the horseshoe crab management plan. In relation to New Jersey and Delaware for the 2 yr from 1 October 2006, this prohibits the directed harvest and landing of all horseshoe crabs between 1 January and 7 June and female horseshoe crabs between 8 June and 31 December and limits the harvest to 100,000 (male) crabs per state per year. In relation to Maryland and for the same 2-yr period, it prohibits the directed harvest and landing of horseshoe crabs between 1 January and 7 June. It also prohibits the landing of horseshoe crabs in Virginia from federal waters between 1 January and 7 June.

DELAWARE BAY—PAST AND CURRENT MANAGEMENT ACTIONS FOR THE HORSESHOE CRAB POPULATIONS

1. 1991—DDFW was given authority to regulate horseshoe crabs. Collecting permits were required and mandatory reporting regulations were established and horseshoe crab dredge licenses were capped at five.
2. 1992—DDFW prohibited horseshoe crab harvesting within 300 m of all state and federal lands from 1 May—7 June (except Port Mahon on Wednesday, Thursday, and Friday). A personal possession limit of six horseshoe crabs was established for non-permitees (i.e., people can have up to six to bait a minnow trap or eel pot to catch fish bait).
3. 1993—New Jersey passed regulations that prohibited harvest of horseshoe crabs on New Jersey Delaware Bay beaches during daylight hours. Reporting of harvest was voluntary.
4. 1994—New Jersey passed regulations that prohibited harvest of horseshoe crabs on New Jersey Delaware Bay beaches or within 300 m of beaches. Reporting of harvest was mandatory.
5. 1995—Regulations limited harvest of horseshoe crabs on New Jersey Delaware Bay beaches to nighttime hours on Mondays, Wednesdays, and Fridays only during the period 1 May–7 June.
6. 1996—An amendment to N.J.A.C. 7: 25-18.16 to provide added protection to spawning horseshoe crabs and reduce the disturbance to the migratory shorebirds feeding on the Delaware Bay waterfront beaches. Regulations prohibited harvest of horseshoe crabs on Delaware Bay waterfront at any time; hand harvest permitted only in back bays and tidal creeks of the state (minimum of 300 m from bay front) on Tuesdays and Thursdays commenting 1 hr after sunset until 1 hr before sunrise. Harvest and landing of crabs was prohibited during May unless by hand.
7. 1997—DDFW instituted an emergency closure of the horseshoe crab fishery in May and closed the dredge fishery and hand harvest (state and federal lands) through 30 June.
8. 1998—The ASMFC approved the Interstate Fishery Management Plan for Horseshoe Crabs. DDFW closed horseshoe crab fishery 1 May–30 June except Tuesday and Thursday hand harvest at Port Mahon and Monday, Wednesday, and Friday hand harvest on private lands. An 8.5 m^3 containment limit on hand harvest fishery was established. The dredge fishery was closed from 1 May—30 June and a 1,500 horseshoe crab limit on dredge harvest was imposed. Hand harvest permit eligibility criteria were established (had to have secured two permits prior to July 1997). Requirements for timelier reporting were established. Landings from the Exclusive Economic Zone (EEZ, 3.2–485 km) were prohibited. Nighttime harvest was prohibited.
9. 2000—The ASMFC approved addendum I to the Fishery Management Plan for Horseshoe Crab. The addendum caps bait landings to 25% below reference-period landings and recommends a closure of horseshoe crab harvest in federal waters within 56 km of the mouth of the Delaware Bay.
10. 2001—The NMFS established the Carl N. Shuster, Jr. Horseshoe Crab Reserve. The establishment of this reserve prohibits the harvest of horseshoe crabs in nearly 3,800 km^2 of federal waters off the mouth of the Delaware Bay.
11. 2004—(March). The ASMFC Horseshoe Crab Management Board agreed to adopt new conservation measures for the horseshoe crab. Specifically, the Addendum capped annual harvest in New Jersey and Delaware at 150,000 crabs per state and set Maryland's annual quota at its 2001 landings level (170,653 crabs). Further, it required the three states to prohibit the harvest and landings of horseshoe crab for bait from 1 May–7 June. Addendum III also encouraged states with both bait and biomedical fisheries to allow biomedical companies to bleed harvested crabs prior to their use as bait. This would eliminate mortality associated with the process of bleeding and returning crabs to the waters from which they were harvested.
12. 2003 for the 2004 season—New Jersey and Delaware quota reduced to 150,000 horseshoe crabs. Season established to be 1 April through 30 April and 8 June through 15 August. No harvest allowed during the period 1 May through 7 June. Permit holders must report their harvest each Friday by telephone. The dredge fishery was limited to 35% of total quota prior to 1 May. The use of bait savings devices required. DDFW bans the personal exemption of six horseshoe crabs.
13. 2006—ASMFC approves addendum IV of the horseshoe crab management plan. In relation to New Jersey and Delaware for

the 2 yr from 1 October 2006, this prohibits the directed harvest and landing of all horseshoe crabs between 1 January and 7 June and female horseshoe crabs between 8 June and 31 December and limits the harvest to 100,000 (male) crabs per state per year. In relation to Maryland and for the same 2-yr period, it prohibits the directed harvest and landing of horseshoe crabs between 1 January and 7 June. It also prohibits the landing of horseshoe crabs in Virginia from federal waters between 1 January and 7 June.

DELAWARE BAY—MANAGEMENT PLANS

1. 1998—(Dec). The ASMFC Fisheries Management Plan for Horseshoe Crab was approved requiring a suite of monitoring requirements—Delaware, New Jersey, and Maryland required to keep current regulations in place.
2. Late 1999—ASMFC Horseshoe Crab Management Board approved Addendum I to the Interstate Fishery Management Plan for Horseshoe Crab, which implemented harvest reduction measures along the Atlantic coast for the commercial horseshoe crab bait fishery. Specifically, the Addendum established a state-by-state cap at 25% below 1995–1997 levels of 2,999,491 horseshoe crabs for all states.
3. 2000 (May)—Addendum I of the Fishery Management Plan approved requiring a cap on the fishery at 361,801 horseshoe crabs.
4. 2001—Atlantic States Marine Fisheries Commission (2001) approved addendum II to the FMP for horseshoe crabs allowing interstate transfer of harvest quotas.
5. 2004—ASMFC approved addendum III to the FMP for horseshoe crabs. addendum III further limits harvest of Delaware Bay horseshoe crabs to 300,000. It also closes harvest from 1 May through 7 June to limit harvesting of spawning crabs and to limit disturbance of shorebirds from harvesters.
6. 2006—ASMFC approved addendum IV of the Horseshoe Crab management Plan. In relation to New Jersey and Delaware for the 2-yr from 1 October 2006, this prohibits the directed harvest and landing of all horseshoe crabs between 1 January and 7 June and female horseshoe crabs between 8 June and 31 December and limits the harvest to 100,000 (male) crabs per state per year. In relation to Maryland and for the same 2-yr period, it prohibits the directed harvest and landing of horseshoe crabs between 1 January and 7 June. It also prohibits the landing of horseshoe crabs in Virginia from federal waters between 1 January and 7 June.

DELAWARE BAY—HABITAT PROTECTION

1. 1999—The Ecological Research Development Group (ERDG) launched its community-based horseshoe crab sanctuary program. The program works with private landowners and communities to establish sanctuaries where crabs cannot be harvested.
2. 2000—ERDG works with the community of Broadkill Beach, Delaware, to become the first horseshoe crab sanctuary restricting the harvest of horseshoe crabs along a 4-km section of beach.
3. 2005—Currently, approximately 32 km are registered as designated horseshoe crab sanctuaries with DDFW.

DELAWARE BAY—BAIT BAGS

1. 1999—ERDG initiated phase I of its bait bag initiative dispersing 500 bait bags to Virginia conch fishermen. Bait bags were found to reduce the amount of horseshoe crab bait needed by 25–50%.
2. 2000—ERDG completes phase II of its bait-bag initiative by manufacturing and distributing 6,000 bait bags to commercial fishermen in Maryland, Delaware, and New Jersey free of charge.

NON-BREEDING AND STOPOVER AREA MANAGEMENT AND CONSERVATION

South America

Monitoring winter population of Red Knots in South America:

1. 2000–2005. NJENSP and CWS instituted a winter survey of Red Knots in South America following the protocol of Morrison and Ross (1989). Continuation of this survey is dependent on availability of funding.
2. 2000–2005. NJENSP and biologists from Chile and Argentina captured and individually marked Red Knots wintering on Bahía Lomas, Chile, to augment adult survival analyses and assess proportion of immature birds in the wintering population.

In Chile, no special protection measures exist for Bahía Lomas. In 1996, the Corporación

Nacional Forestal (Muñoz et al. 1996) recommended Bahía Lomas as one of the 21 sites in the urgent category stated in the priority sites for the conservation of the biodiversity in Chile (Muñoz et al. 1996). No activities were associated with this conservation status. Due to its world importance, Bahía Lomas was recently declared a Ramsar site in December 2004, the second southern most after the neighboring Atlantic coastal reserve of Tierra del Fuego in Argentina. Thus far, the Ramsar designation is the only unique conservation measurement that Bahía Lomas has received. The Red Knot is protected by the hunting law No. 19.473.

Argentina is a signatory party of the Convention on the Conservation of Migratory Species of Wild Animals. Migratory species that need or would benefit significantly from international co-operation are listed in appendix II of the convention. The family Scolopacidae is listed in appendix II. Migratory species threatened with extinction are listed on appendix I of the convention. The *C. c. rufa* subspecies of the Red Knot was added to appendix I at a meeting of the Parties to the Convention that took place in November 2005. Under the terms of the convention, the parties agree to strive towards strictly protecting the animals listed in appendix I, conserving or restoring the places where they live, mitigating obstacles to migration, and controlling other factors that might endanger them.

Besides the Bonn Convention, different levels of government provide legal protection status to key Red Knot critical areas as described below. International recognition from the WHSRN and IBA from Birdlife International are also included:

1. Reserva Costa Atlántica de Tierra del Fuego (1992)—provincial natural area protected.
   a. Ramsar site (1995).
   b. WHSRN hemispheric site.
   c. IBA area (Bahía San Sebastián is a priority IBA area).
2. Reserva Provincial de Río Chico para Aves Playeras Migratorias (2001) and Reserva Urbana Costera del Río Chico (2004)—provincial natural area protected and urban natural area protected.
   a. Potential WHSRN site.
   b. IBA area.
3. Bahía Bustamante—no conservation status.
4. Península Valdés—reserva natural integral provincial.
   a. Patrimony of the Humanity.
   b. Potential Ramsar and WHSRN site.
   c. IBA area.
5. Bahía Samborombón (1979)—integral natural reserve.
   a. Provincial integral natural reserve with restricted access (9,311 ha).
   b. Provincial integral natural reserve, Rincón de Ajó (2,311).
   c. Campos del Tuyú Private Reserve, Fundación Vida Silvestre Argentina.
   d. Punta Rasa Biological Station, agreement between the Naval Hydrography Service (Argentinian Navy) and the Fundación Vida Silvestre Argentina.
   e. Punta Rasa Traveled Municipal Ecological Reserve (1991).
   f. Ramsar site (1997).
   g. Priority IBA area.
   h. Potential WHSRN site.
6. Bahía San Antonio Natural Protected Area.
   a. Potential Ramsar site.
   b. Priority IBA area.
   c. WHSRN site.

Management plans are being developed for Reserva Costa de Tierra del Fuego, Provincial de Río Chico para Aves Playeras Migratorias, Reserva Urbana Costera del Río Chico, in conjunction with ongoing shorebird research and public education. Shorebird research is also ongoing at Península Valdés, which has a current management plan and is used as a camp by artesanal fishermen, and Bahía Samborombón where an Environmental Ordering Plan is implemented. No research or management is being done at Bahía Bustamante.

The Bahía San Antonio Natural Protected Area has an urban management plan which restricts land use near key shorebird areas and actively protects shorebird roosting sites. Besides the CMS national and inter-government agreement, this area has international recognition from the WHSRN, is designated as a priority IBA by Birdlife International, and is a potential Ramsar site.

The Brazilian government through CEMAVE-IBAMA has been developing conservation projects on migratory Nearctic species since the beginning of the 1980s. In addition to the Brazilian legislation that protects fauna, the conservation of these species has been given impetus by the government entering into international agreements, such as the Washington Convention in 1948, and the Ramsar Convention in 1993. Projects aimed at monitoring and developing strategies for the conservation of Pan-American migrants have been developed, particularly in coastal areas.

Over the years, Brazil has entered into various international, technical cooperation agreements in relation to nature conservation. The first was in 1981 with the US government through the USDIFWS. This led to training

in the technique of cannon-netting at Salinas, in the state of Pará. In the same year, a project with CWS resulted in an aerial survey of Nearctic shorebirds along the Brazilian coastline. This was carried out between 1982 and 1986, and the results were published in Morrison and Ross (1989).

In 1984, a workshop was held in Porto Alegre, in cooperation with Manomet Bird Observatory and Worldwide Fund for Nature, to teach and discuss techniques for monitoring migratory birds. This particularly involved the participation of teachers and researchers from the University of the Valley of the Sinos River and the Zoo-botanical Foundation of Río Grande do Sul. At the same time, field activities commenced at Lagoa do Peixe including bird banding. Subsequently CEMAVE started an annual bird monitoring program at Lagoa do Peixe during northward migration in April and May. This included catching birds with mist-nets and cannon-nets, banding, collecting biometric data, and bird surveys in the region of the Park.

Since 1992, CEMAVE has carried out surveys along several parts of the coast to study the ecological characteristics of the areas preferred by Nearctic shorebirds. It has also carried out studies along several other parts of the coasts of the states of Amapá, Pará, Maranhão, Ceará, Río Grande do Norte, Pernambuco, Alagoas, and Bahía. These have involved trained banders registered with the Brazilian National Banding Scheme.

Between 1996 and 1998, CEMAVE in partnership with CWS and with support from the Interamerican Development Bank, and WWF Canada, developed the *project Surveys of the Nearctic and Neotropical avifauna in the Marshland of the state of Mato Grosso*. These surveys were carried out in the states of Mato Grosso and Mato Grosso do Sul with the aim of identifying the main sites for passage migrant shorebirds in September and October. The results have not yet been published.

Since 1997, CEMAVE has participated in an international cooperative research project called *Migration of Red Knots in South America: ecological research to support the conservation of the longest bird flights on earth*. The aim of this project is to study the migration strategies of the species, integrating monitoring activities in the states of Maranhão and Río Grande do Sul with those carried out in others countries that share the same Red Knot population, such as Argentina and the US.

The monitoring of birds for transmittable diseases started in 2001 under an executive committee that includes representatives of the Ministers of Health, Agriculture and Environment, the National Health Foundation, IBAMA, the Office of the Secretary of Agricultural Defense in the Department of Agriculture, Livestock Farming and Supply, and the Zoological Society of Brazil. The main purpose is to achieve early detection of infected birds, and to take steps to prevent infections from spreading. Already eight serological investigations have been carried out at various sites including the coastline of the States of Amapá, Maranhão, Río Grande do Norte, Pernambuco, and Río Grande do Sul, and at other places in the states of Amazon, Mato Grosso do Sul, and Paraná. The results to date can be accessed through the epidemiology bulletins produced by the National Health Foundation, FUNASA.

In terms of shorebird conservation in Brazil, the main achievements include the designation in 1991 of the Lagoa do Peixe National Park, and the Reentrâncias Maranhenses as significant international and regional reserves, respectively, as part of the Western Hemispheric Shorebirds Reserve Network. These areas were also designated Ramsar sites at the time that Brazil joined the Ramsar Convention. Other significant achievements are the presentation of the results of shorebird studies at international and national conferences, the publication of articles in scientific journals; and participation in writing the management plan for the Lagoa do Park National Park between 1997 and 1999.

CEMAVE has promoted the training and qualification of personnel in the techniques of shorebird studies including capture, marking, and censuses. Trainees have also come from other countries including Argentina, Uruguay, Paraguay, Peru, Chile, Colombia, Venezuela, and Panama. Already, in six courses of short to medium duration, 45 professionals and biology students have been trained in shorebird study techniques.

It is noteworthy that the activities describe above received 95% financing from the Brazilian federal government, which has subsidized the monitoring of migratory birds over the years, despite of the economic instability of the country.

No current management activities in Maranhão. However, CEMAVE has organized scientific expeditions to Maranhão for banding and collection of biological data during northward migration in May, and also in November. CEMAVE have also undertaken outreach in Maranhão with the object of integrating local communities in conservation activities, as well as promoting banding and the collection of biological data. This has included talks to groups, such as schoolchildren and fishermen's associations.

United States – Florida

1. Shell Key — portions of the island are closed to entry.
2. Caladesi Island, Hurricane Pass — limited posting of signs on a roosting site.
3. Passage Key — closed to entry but poorly enforced.
4. Merritt Island NWR, Black Point Drive — restricted access.
5. Ding Darling NWR, tower stop — restricted access.
6. Kennedy Space Center — limited access.

United States – Georgia

1. Little Tybee Island — heritage preserve-natural area.
2. Ogeeche River Bar — not managed.
3. Wassaw Island — wildlife refuge.
4. Ossabaw Island — heritage preserve-natural area.
5. St. Catherines Island — undeveloped, conservation intent.
6. St. Catherines Bar — closed natural area.
7. Grass Island — not managed.
8. Blackbeard Island — wildlife refuge.
9. Sapelo Island — national estuarine research reserve-wildlife management area.
10. Wolf Island — wildlife refuge-wilderness.
11. Little Egg Island Bar — closed natural area.
12. Little St. Simons Island — undeveloped, conservation intent.
13. Sea Island — developed.
14. St. Simons Island, Gould's Inlet — developed.
15. Jekyll Island — developed.
16. Little Cumberland Island–partially developed.
17. Cumberland Island — national seashore, some private residences.

United States – South Carolina

Presently no protection efforts are specifically designed for Red Knots. Complete closures of important Red Knot roosting areas in Cape Romain NWR are planned for winter 2005–2006. Motions to completely close SCDNRs seabird nesting islands, which are also Red Knot roosting areas, will begin winter 2005–2006. SCDNR has begun tagging horseshoe crabs, identifying their critical spawning and nursery habitat, and working with harvesters to estimate and minimize fishery mortality.

United States – North Carolina

The following is a list of key sites with current management for wintering shorebirds:

1. Cape Lookout National Seashore — posting to protect breeding birds (April–August) also benefits migrants.
2. Cape Hatteras National Seashore — posting to protect breeding birds (April–August) also benefits migrants.
3. Pea Island — posting to protect breeding birds (April–August) also benefits migrants.

United States – Virginia

Previous Red Knot aerial surveys conducted in late May and/or early June indicate that the barrier islands located along the seaward margin of Virginia's Eastern Shore harbor the state's greatest densities and abundance of spring migrants and serve as important stopover locations. In addition, most of the islands are remote, free of development, and have for the most part been allowed to revert back to their natural state following periods of settlement by humans and livestock over the past several centuries.

Today, most management measures are directed toward minimizing human disturbance, reducing predator populations, and removal and/or control of invasive species. Organizations that own and manage the islands already have in place seasonal and year round public use policies designed to protect breeding waterbird populations. They include confining recreational activities to areas of the beach below the high-tide line, prohibiting dogs and other pets on the islands, temporarily closing portions of the islands that are particularly vulnerable to disturbance, and for a few of the islands, seasonal and year round closures. It should be noted a few private inholdings remain on two of the barrier islands. Owners of these private land parcels work cooperatively with conservation organizations to ensure their activities do not impact the islands' natural resources. Many of the seasonal closures and public use policies cover the peak Red Knot spring migration period.

Other sites where Red Knots have been observed during spring migration in substantially fewer numbers include Plum Tree Island NWR and Goodwin Island; both are located on the western shore of the lower Chesapeake Bay. Very little is known about the extent of use of these sites by Red Knots. Moreover, they receive very little human disturbance because they are remote and difficult to access (Plum Tree Island NWR is largely off limits to the public because of unexploded ordinances), therefore will likely not require much in the form of management.

United States – Maryland

The state of Maryland does not conduct or sponsor any organized surveys that include Red Knots. No research, monitoring, or management efforts regarding Red Knots occur in the state. Suitable habitats do exist within the state, however, these include: Hart Miller Island, Assateague Island, and Poplar Island. Hart Miller Island is owned and managed by the state of Maryland. Assateague Island is divided into three areas: Assateague Island National Seashore managed by the National Park Service, Chincoteague NWR managed by the USFWS, and Assateague State Park managed by Maryland Department of Natural Resources. Current management of Assateague Island consists of managed areas at the northern end of the island for Piping Plovers (*Charadrius melodus*) and tidal flats on the landward shore of the island managed as part of a coastal management program. Poplar Island is located off the Chesapeake Bay coastline, about 55 km south of Baltimore in Talbot County. It is currently being managed by the U.S. Army Corps of Engineers, the Maryland Port Administration, and other federal and state agencies as a site for habitat restoration and beneficial use of dredged materials.

United States – New Jersey

The principle shorebird conservation issues in the Delaware Bay stopover are human disturbance to birds and their habitats and the availability of abundant food in the form of horseshoe crab eggs. While recognition of the shorebird migration was improved with the reporting of bay wide surveys beginning in 1981 (Wander and Dunne 1981), management began in 1989 with the first shorebird wardens on three New Jersey beaches.

Outreach and protection:

1. 1989. NJENSP contracted NJAS to train and supervise shorebird wardens at three New Jersey beaches (Norbury's Landing, Reed's Beach, and Fortescue) to reduce disturbance. Educational signs were created and placed at two of those beaches (Reed's and Fortescue), and a brochure was distributed by the wardens.
2. 1990. The first year that NJENSP provided a viewing platform at Reed's Beach, to limit disturbance of that beach by encouraging use of a single viewing point. NJENSP contracted NJAS to train and supervise shorebird wardens at four New Jersey beaches (Sunray, Norbury's Landing, Reed's Beach, and Fortescue) on weekends in May. Wardens distributed an informative brochure to 1,000 people.
3. 1992. Viewing areas were put in place at Norbury's Landing, Reed's Beach (2), and Fortescue. A map was created that identified all designated viewing areas
4. NJENSP trained and supervised 12 shorebird wardens who monitored four beaches on May weekends
5. 1994. Viewing areas were set up at Norbury's Landing, Reed's Beach, and Fortescue, and other accessible beach access points were posted with information signs warning of the problems of disturbance to feeding and resting shorebirds. A new brochure that included a viewing area map was distributed at all viewing areas and through local nature centers and businesses. New Jersey fielded shorebird wardens at viewing areas on May weekends.
6. 1995. The New Jersey Shorebird Outreach Team continued to work together on educational materials for the public. This team developed educational materials including a map of viewing areas with a local business listing on the back. Viewing areas were set up at Norbury's Landing, Reed's Beach, and Fortescue, and other accessible beach access points were posted with a new sign designed to clearly indicate the safe viewing point to prevent disturbance to feeding and resting shorebirds. New Jersey fielded shorebird wardens at viewing areas on May weekends. A new brochure that included a viewing area map was distributed at all viewing areas and through local nature centers and businesses.

Human use and disturbance:

1. 1985. NJENSP began research and survey actions initiating surveys of human use (K. E. Clark and L. J. Niles, unpubl. data).
2. 1987. NJDFW conducted human use surveys on New Jersey bayshore beaches.
3. 1988. NJDFW conducted human use surveys on New Jersey bayshore beaches.

Habitat restoration:

1. 1991. Fishing Creek marsh was managed to promote shorebird habitat by controlling *Phragmites* and restore tidal flow to its western section.
2. 2006. NJDFW received funding to remove rubble from Moore's and Thompson's Beach to improve spawning conditions for horseshoe crabs

Radio telemetry of shorebirds:

1. 1989. NJENSP initiated a shorebird telemetry study to determine habitat use patterns.

2. 1990. A limited telemetry study continued (seven Red Knots) to determine habitat use patterns.
3. 2003–2005. NJENSP, in cooperation with DDFW and the USFWS, initiated a bay-wide Red Knot telemetry study using stationary receivers to monitor bay wide bird movements and identify critical foraging and roosting sites.

Aerial and ground surveys:

1. 1990. NJENSP conducted aerial transect surveys across New Jersey Atlantic and Delaware Bay habitats three times per day, once a week for 3 wk, continued in 1991.
2. 1991. This year saw increased demand for (and harvest of) horseshoe crabs as bait.
3. NJENSP conducted aerial transect surveys across New Jersey Atlantic and Delaware Bay habitats three times per day, once a week for 3 wk, similar to those done in 1990. Ground surveys of shorebirds in marsh and beach habitats were conducted in 1991 and 1992, resulting in Burger et al. (1997).
4. 2004. NJENSP and NJAS began fall shorebird surveys using a modified ISS methodology. Trained volunteers count/estimate flock size of individual species, determine the ratio of juvenile/adult Red Knots in flocks, collect data on individually marked shorebirds, record sources of disturbance.
5. 2005. NJENSP and NJAS conduct spring shorebird surveys using modified ISS methodology. Trained volunteers count/estimate flock size of individual species, collect data on individually marked shorebirds, record sources of disturbance.

Monitoring horseshoe crab egg densities:

1. 1985. NJENSP began research and survey actions initiating surveys of horseshoe crab egg density (K. E. Clark and L. J. Niles, unpubl. data). In 1985 and 1986 egg density was measured at selected bayshore beaches (Botton et al. 1988).
2. 2000–2005. NJENSP took over horseshoe crab egg sampling following a protocol established by Robert Loveland, Rutgers University, and Mark Botton, Fordham University. This survey will be replaced in 2006 with a method developed by the U.S. Geological Survey to be implemented both in New Jersey and Delaware.

Monitoring shorebird mass gains and adult survival:

1. 1997–present. NJENSP began an intensive shorebird trapping and banding program in New Jersey and Delaware to monitor weight gains of shorebirds stopping over on Delaware Bay and color mark individuals for survival analyses and population estimation. In 1998, the DECMP took over the trapping effort on the Delaware side of the Bay. These studies are ongoing and continue to the present under the direction of DDFW-NHESP.

United States — Delaware

Outreach and Protection:

1. 1995. DDFW-NGES established shorebird interpretive signs and viewing platforms at key shorebird viewing areas including Ted Harvey Wildlife Area and Little Creek Wildlife Area at Port Mahon Road.
2. 1995. DDFW-NGES launched the Shorebird Ambassador Program that placed volunteers at key shorebird stopover sites in Delaware during the weekends. The shorebird ambassadors were to provide outreach and education to Delaware Bayshore visitors.
3. 1998. DDFW-NGES developed a shorebird viewing guide to promote shorebird conservation and viewing opportunities in Delaware.
4. 1998. DDFW closed horseshoe crab fishery 1 May–30 June except for limited hand-harvest; landowners were allowed to have their beaches declared sanctuaries.

Horseshoe crab radio telemetry:

1. 2003–2005. DDFW and DECMP, in partnership with the USGS have used an array of stationary telemetry receivers located throughout Delaware Bay to track horseshoe crab movement patterns and spawning frequency. In 2004 and 2005 shorebirds were added to the system to simultaneously track horseshoe crabs and shorebirds providing insight into the spatial and temporal overlap of beach use by these species.

Aerial and ground surveys:

1. 1992. DDFW coordinates ISS in Delaware during spring migrations. The ISS surveys were largely conducted by volunteers from the Delmarva Ornithological Society and continued through 1997.
2. 2003. DDFW-NHESP began coordinating fall shorebird surveys for the Program for Regional and International Shorebird Monitoring program.

Monitoring shorebird mass gains and adult survival:

1. 1998. DECMP initiated a shorebird-monitoring program that including intensive survey and banding operations that continues to this day.

Horseshoe crab egg densities:

1. 1997–2005. DECMP began studying horseshoe crab egg densities for a variety

of objectives related to coastal management activities and permitting issues.
2. 2005. DDFW initiated the Delaware portion of a bay-wide horseshoe crab egg survey.

Land acquisition:

1. Acquisition of former Lighthouse Restaurant facility in Mispillion Harbor to create the DuPont Nature Center, an interpretive and research center for horseshoe crab and shorebird outreach, education and viewing opportunities. Facility opened spring 2007.
2. Acquisition of approximately 28 ha of marsh and dunes in Mispillion Harbor, purchased by DNREC from the Conservation Fund in July 2006 for the purpose of protecting prime horseshoe spawning and shorebird feeding areas. This acquisition, along with the DuPont Nature Center and additional surrounding state wildlife area lands, comprise the Mispillion Harbor Reserve.

United States – New York

Jamaica Bay has been designated and mapped as an otherwise protected beach unit pursuant to the federal Coastal Barrier Resources Act, prohibiting incompatible federal financial assistance or flood insurance within the unit. The New York State Natural Heritage Program, in conjunction with TNC, recognizes two priority sites for biodiversity within the Jamaica Bay and Breezy Point habitat complex—Breezy Point (B2, very high biodiversity significance) and Fountain Avenue landfill (B3, high biodiversity significance). Jamaica Bay and Breezy Point have been designated as significant coastal fish and wildlife habitats by the New York State Department of State, and the bay up to the high-tide line was designated as a critical environmental area by the New York State Department of Environmental Conservation. Jamaica Bay was also designated as one of three special natural waterfront areas by New York City's Department of City Planning. A comprehensive watershed management plan for the bay was completed in 1993 by the New York City Department of Environmental Protection in order to better protect and restore habitats and improve water quality. Wetlands are regulated in New York under the state's Freshwater Wetlands Act of 1975 and Tidal Wetlands Act of 1977; these statutes are in addition to federal regulation under section 10 of the Rivers and Harbors Act of 1899, section 404 of the Clean Water Act of 1977, and various executive orders. (http://training.fws.gov/library/pubs5/web_link/text/jb_form.htm).

United States – Connecticut

Connecticut Department of Environmental Protection, Wildlife Division completed a shorebird use assessment as part of the Wildlife Conservation and Restoration Program. This project helped in identifying priority sites for protection.

United States – Rhode Island

Rhode Island has monitored spring and fall passage of shorebirds annually and all important shorebird stopovers are known.

United States – Massachusetts

Currently management and protection plans are in place for some of the important stopover areas in Massachusett federally owned areas, Plum Island (southern three fourths only), Nasuset Coast Guard Beach, South Beach Island (portions) and Monomoy NWR, are currently managed by their respective agencies. Portions of Sandy Neck are managed by TNC. The remainder of the important areas is municipal and/or private land and may or may not be managed. Information on the management and protection status of private and/or municipal-owned important stopover areas was not available at the time of writing.

United States – New Hampshire

No known management of shorebird stopover locations at the time of this writing.

United States – Maine

During the period 1989–1995, the state of Maine began intensive shorebird surveys to locate and designate critical staging areas. These locations have been designated as shorebird areas of management concern and are candidate areas under Maine's Natural Resource Protection Act, which allows the Maine Division of Inland Fisheries and Wildlife to review permits relating to development and dock placement.

Panama

The total number of shorebirds using the upper Panama Bay at some time during the year has been estimated at well over 500,000 qualifying it as a hemispheric reserve of the Western Hemisphere Shorebird Reserve Network (Morrison et al. 1998). Despite this, the site remains unprotected and unmonitored,

and only recently the westernmost part (Watts' main study area (Watts 1998) was lost to housing (Buehler 2002).

Canada

Migration staging areas are along coastal areas in Canada and are either federally or provincially owned. The federal government has many tools and programs for nature conservation. These range from outright ownership and management of various types of formal protected areas to the negotiation of voluntary agreements with private landowners. The federal approach to conservation and protection is to combine this range of approaches and partners, using each tool when and where appropriate.

Within the federal government, Environment Canada, the Parks Canada Agency, and Fisheries and Oceans Canada have the mandate to protect critical habitats by managing complementary protected area programs:

1. Environment Canada, directly and/or through partnership arrangements, establishes and manages national wildlife areas, migratory bird sanctuaries and marine wildlife areas to protect wildlife habitat, and unique and productive ecosystems. The first two designations also allow Environment Canada to set up marine protected areas off Canada's shores and along the coasts of inland waters.
2. Fisheries and Oceans Canada has the authority to establish marine protected areas for a variety of purposes, including the conservation and protection of species at risk and their habitats, the conservation and protection of unique habitats, and the conservation and protection of marine areas of high biodiversity or high biological productivity.
3. Parks Canada establishes and manages national parks and national marine conservation areas, which are intended to protect a representative sample of the features of the country's natural regions and marine natural heritage and to provide opportunities for public education and enjoyment.

Finally, the federal government plays a lead role in managing the implementation of international protected areas programs in Canada, including UNESCO biosphere reserves, UNESCO world heritage sites.

Breeding Habitat Management

Nunavut Tunngavik Incorporated (NTI) was set up as a private corporation in 1993 to ensure that promises made in the Nunavut Land Claims Agreement are carried out. The operations of NTI are managed through offices in Iqaluit, Rankin Inlet, Cambridge Bay, and Ottawa. Features of the Nunavut Land Claims agreement include some to the more outstanding of its 41 articles include the title to approximately 350,000 km^2 of land of which about 35,000 km^2 include mineral rights.

Monitoring breeding densities on Arctic breeding area:

1. 1999–2004. NJENSP, the ROM, and Rutgers University instituted a study to relocate Red Knots (outfitted with radio transmitters on the Delaware Bay) on Arctic breeding grounds in 2000, 2001, and 2003, develop a model of potential breeding habitat, and monitor breeding densities on a 10 km^2 study site in Nunavut, Canada. Breeding densities were monitored during June–July of 2000–2004; limited funding in 2005 was dedicated to aerial survey of winter Red Knot population in South America.

Other Management Considerations and Opportunities

Recent research conducted by NJENSP has demonstrated the importance of roosts for migratory shorebirds on Delaware Bay. One series of high tides in late May flooded all available roosting sites on the bay and the entire population of shorebirds moved elsewhere to find safe roosts. NJDFW and DDFW biologists plan to investigate the creation of new roosts sites in Delaware Bay marshes and state and USFWS impoundments.

The biomedical industry could play a major role in supporting survey and monitoring of the horseshoe crab population, and identifying ways to reduce crab mortality through improved monitoring (pre- and post-bleeding) to identifying sources of mortality, subsidize improvements to transport and holding facilities, bleeding methods, and reduction of holding time to reduce mortality.

Long-term research to improve/lower cost of a synthetic test for contaminants in injectable drugs would eliminate the need for horseshoe crabs altogether.

MONITORING EFFECTS AND MANAGEMENT ACTIVITIES

Several very robust methods exist for monitoring the efficacy of conservation action because of