Red Knot
Calidris canutus rufa

By Certified Mail

July 28, 2005

U.S. Fish and Wildlife Service
United States Department of the Interior

American Bird Conservancy **P.O. Box 249** **The Plains, VA 20198** **Tel: (540) 253-5780**	)	**Emergency Petition for a Rule to List the Red Knot (*Calidris canutus rufa*) as Endangered under the Endangered Species Act, 16 U.S.C. § 1531 et seq. (1973 as amended) within the United States**
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Introduction

The American Bird Conservancy, Audubon Maryland-DC, Audubon New York, Citizens Campaign for the Environment, Defenders of Wildlife, Delaware Audubon Society, National Audubon Society, the New Jersey Audubon Society, and the Virginia Audubon Council petition the United States Fish and Wildlife Service ("FWS" or "the Service") to list as "endangered" the *rufa* subspecies of the Red Knot (*Calidris canutus rufa*) and to designate "critical habitat" under the Endangered Species Act ("ESA") within a reasonable period of time following the listing, pursuant to 16 U.S.C. §§ 1531-1543 (2004).

The Red Knot is a medium-sized shorebird that undertakes an annual 30,000 km hemispheric migration, from breeding grounds in the high Arctic to wintering grounds in Patagonia and Tierra del Fuego. Recent studies demonstrate conclusively that the Red Knot (*rufa* subspecies) is on a path to certain extinction if substantial conservation measures are not taken immediately to halt and reverse the species' startling decline. Accordingly, petitioners seek an immediate determination under the emergency listing provisions of the ESA. 16 U.S.C. § 1533(b)(7) (2004).

This petition is filed under 5 U.S.C. § 553(e), 16 U.S.C. § 1533(b)(3)(A) and § 1533(b)(7), and 50 C.F.R. § 424.14 and § 424.20 (2004), which give interested persons the right to petition for issuance of a rule listing a species as endangered on an emergency basis. Petitioners also give notice of their immediate intent to sue if the FWS does not act expeditiously to emergency list the Red Knot under the ESA. 16 U.S.C. § 1540(g)(2)(C) (2004).

Petition Context

The FWS is currently conducting a status review of the *rufa* subspecies of Red Knot and is in receipt of a letter from a member of the Northeast Pennsylvania Audubon Society that calls upon the Service to consider adding the shorebird to the list of endangered species pursuant to the ESA. Since these processes began, substantial new information has come to light regarding the conservation status and needs of the Red Knot. This startling new information—detailed extensively in this petition—compels the FWS to use its emergency listing authority to protect the Red Knot from further decline.

The Red Knot is one of the most—if not the most—heavily studied shorebirds in the world with more than 30 biologists conducting as many as 15 projects each year (Niles et al. 2005a). Weekly aerial surveys of shorebirds in the whole of Delaware Bay have been carried out in May and early June each year since 1985 (Id.). Although the shorebird's declining numbers have been documented for several years, concern for the Red Knot has been especially high since 2004, with the publication of two important studies. Surveys of the Red Knot on its main wintering areas on the coasts of Patagonia and Tierra del Fuego in Argentina and Chile by Morrison and his colleagues showed a "dramatic decline in the wintering population" (Morrison et al. 2004). Noting that banding studies in Delaware Bay have shown that an increasing proportion of Red Knots is unable to gain sufficient mass for migration to the breeding grounds, the study concluded that the declines were likely due to reductions in their main food resource, the eggs of the horseshoe crab (*Limulus polyphemus*) (Id.) suggesting that additional restrictions on the crab harvest are necessary.

Also in 2004, Baker and his colleagues published a model predicting continued

significant decline of *C. c. rufa* resulting in extinction in or about 2010 (Baker et al. 2004). In addition to these two studies, a February 2005 expedition to South America, led by the New Jersey Endangered and Nongame Species Program ("ENSP"), found a continued significant decline in the number of wintering Red Knots (Baker et al. 2005a, Niles et al. 2005b). Disturbingly, the data matched the predictions of the Baker study, providing important corroboration of the bird's status and trend to extinction (Baker et al. 2005b; Niles et al. 2005a). We also understand that new research by Berkson shows that recent temporary closures and quotas for the horseshoe crab fishery have not yet resulted in significant increases in the availability of horseshoe crab eggs necessary to sustain the Red Knot (Berkson 2005, publication/peer review pending; Niles pers. comm. 2005).

To our knowledge, never before has the FWS considered for listing a species whose declining numbers so closely follow a well-documented extinction curve with such a short time horizon for survival. The Red Knot (*rufa* subspecies) simply does not have the luxury of time to await the Service's normal status review.

In the present petition, petitioners have compiled these and other studies that demonstrate the imperiled status of the Red Knot (*rufa* subspecies) and its immediate need for federal protection under the Endangered Species Act. We propose that conservation measures be taken immediately to protect the Red Knot and its habitat. We urge FWS to review this petition on an expedited basis as called for under the emergency listing provisions of the Endangered Species Act and its implementing regulations. Petitioners have pursued other potential avenues such as attempting to obtain a moratorium to the horseshoe crab harvest in Delaware Bay to no avail. Accordingly, if the FWS does not act expeditiously, petitioners will have no option but to pursue all

available legal remedies to secure appropriate protections for the Red Knot.

Emergency Listing is Warranted

The ESA empowers the Secretary to act immediately to list a species whenever "any emergency pos[es] a significant risk to the well-being of any species of fish or wildlife or plants." 16 U.S.C. § 1533(b)(7). This provision permits the Secretary to list a species upon notification to the affected States and publication of a regulation to that effect in the Federal Register (Id.). Such listing would remain in effect for 240 days while the FWS complies with its ordinary rulemaking procedures under the ESA (Id.).

As this petition details, an emergency situation clearly exists with respect to the Red Knot. Research shows that Red Knot numbers have declined to the point where extinction is thought to be possible by approximately 2010, an extremely short extinction trajectory. Second, the leading known cause of the Red Knot's decline—loss of their main food supply at Delaware Bay due to reductions in horseshoe crabs—continues unabated. Given the lifecycle of the horseshoe crab (discussed infra), it could take a number of years to rebuild crab stocks to the point where Delaware Bay food sources are adequate to spark a rebound in Red Knot populations. Immediate action to list the species, reduce crab harvesting, and increase the availability of crab eggs is required if the Red Knot is to have a chance of survival.

Endangered Species Act Implementing Regulations

Several sections of the regulations implementing the Endangered Species Act (50 C.F.R. § 401 et seq.) are applicable to this petition. Those concerning the listing of *C. c. rufa* as a threatened or endangered species include:

> 424.02(e) "Endangered species" means a species that is in danger of extinction throughout all or a significant portion of its range." . . .(k)

"species" includes any species or subspecies that interbreeds when mature.

"Threatened species" means a species that "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. § 1532(20)).

424.11(c) "A species shall be listed ... because of any one or a combination of the following factors:

1. The present or threatened destruction, modification, or curtailment of habitat or range;
2. Overutilization for commercial, recreational, scientific, or educational purposes;
3. Disease or predation;
4. The inadequacy of existing regulatory mechanisms; and
5. Other natural or manmade factors affecting its continued existence.

Four and possibly five of the factors set out in § 424.11(c) are applicable to the present status of the Red Knot.

Based on the documentation provided below, the petitioners contend that these provisions compel the emergency listing of *C. c. rufa* as "endangered" where it occupies habitat within the United States ("U.S."). Additionally, after emergency listing, the FWS should conduct a review and take appropriate action to designate "critical habitat" for the species and determine whether the Atlantic States Marine Fisheries Commission's ("ASMFC") failure to close the horseshoe crab fishery in Delaware Bay jeopardizes the continued existence of the Red Knot.

Petitioners

American Bird Conservancy ("ABC") is a 501(c)(3) not-for-profit membership organization dedicated to the conservation of wild birds and their habitats in the Americas. ABC has offices in The Plains, Virginia, and Washington D.C., and staff in Colorado, Oregon, Missouri, Montana, and Vermont.

Audubon Maryland-DC is the state program of the National Audubon Society.

Centered at the Jean Ellen duPont Shehan Audubon Sanctuary, Audubon Maryland-D.C. has 5 chapters and represents over 15,000 members in Maryland and the District of Columbia. Audubon Maryland's mission is to conserve and restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity.

Audubon New York is a state program of the National Audubon Society. Based out of Albany, Audubon New York represents 30 affiliated chapters and 50,000 New Yorkers. Audubon New York Audubon is dedicated to protecting birds and other wildlife and the habitat that supports them. Audubon New York's network of community-based nature centers and chapters, scientific and educational programs, and advocacy on behalf of areas sustaining important bird populations, engage people of all ages and backgrounds in positive conservation experiences.

Citizens Campaign for the Environment ("CCE") is a 501(c)(4) environmental and public health advocacy organization working in New York, Connecticut, New Jersey, and Washington D.C. CCE works to build widespread citizen understanding and advocacy for policies and actions designed to manage and protect the interdependent land and water resources, wildlife and public health. CCE carries out this mission through public education and outreach, research, lobbying and organizing.

Defenders of Wildlife ("Defenders") is a non-profit conservation organization recognized as one of the nation's leading advocates for wildlife and its habitat. Founded in 1947, Defenders is headquartered in Washington, D.C., with field offices across the country, and approximately 500,000 members and supporters. Defenders maintains a staff of wildlife biologists, attorneys, educators, research analysts, and other

conservationists. Defenders uses education, litigation, and research to protect wild animals and plants in their natural communities. Defenders advocates new approaches to wildlife conservation that will help keep species from becoming endangered, and employs education, litigation, research, legislation, and advocacy to defend wildlife and their habitat. Its programs reflect the conviction that saving the diversity of our planet's life requires protecting entire ecosystems and ensuring interconnected habitats.

Incorporated in 1977, the Delaware Audubon Society is a statewide chapter of the National Audubon Society. Delaware Audubon is dedicated to developing a better appreciation of our natural environment and working for species and habitat conservation. We advocate for environmental issues; and sponsor programs, field trips and school education. Our focus is on protection of the Delaware Bay and the Coastal Zone.

The National Audubon Society, founded in 1905, is a not-for-profit corporation organized under the law of the State of New York, with its headquarters office in New York, New York, a Public Policy Office in Washington, D.C. and over 500 chapters around the country. Audubon's mission is to conserve and restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity. Audubon works to achieve that mission through science-based public education and advocacy. Audubon has approximately 500,000 members nationwide.

New Jersey Audubon Society ("NJAS") is a non-profit corporation headquartered in Bernardsville, New Jersey. Its mission is to preserve the critical habitat and resources of New Jersey and serve endangered wildlife species. NJAS works to develop and

encourage conservation by distributing information about the natural environment, spreading awareness of New Jersey's flora and fauna and how they relate to the habitat they depend on, and by acquiring and maintaining wildlife sanctuaries and educational centers. NJAS currently maintains 34 such sanctuaries and works to advance its goals at eight staffed centers.

The Virginia Audubon Council is comprised of representatives from each of the six chapters of the National Audubon Society in Virginia, representing over 7000 members. The Virginia Audubon Council promotes the enjoyment, understanding, and preservation of birds, other wildlife and habitat through birding, education, advocacy, and fellowship.

Overview

Part I of this petition presents what is presently known about the biology and current status of the *rufa* subspecies of the Red Knot *Calidris canutus*. Part II details the reasons for considering an emergency listing under the Endangered Species Act.

Part I: Current Status

Taxonomy

The Red Knot belongs to the Order Charadriiformes, Family Scolopacidae, Genus *Calidris*, Species *canutus*, Subspecies *rufa*. Five other subspecies are recognized by Morrison et al. (2004) while four other subspecies are recognized by Harrington (2001). *Calidris canutus rufa* and *Calidris canutus roselaari* are the two subspecies found in the United States during migration and winter. *C. c. roselaari* is normally found breeding in Alaska (Tomkovich 1990) and wintering on the Pacific Coasts of North, Central, and

South America (Roselaar 1983, Tomkovich 1990). *C. c. rufa* is characteristically found along the east coast of the United States, with the greatest population staging on Delaware Bay (Tsipoura and Burger 1999). The subject of this petition is the Red Knot *Calidris canutus rufa*, which migrates from the Tierra del Fuego region of Chile and Argentina, northern Brazil and the southeastern United States along the Atlantic Coast to the Arctic and is found in the contiguous United States.

Description of Species

Appearance

The Red Knot (*rufa* subspecies) is a sandpiper that breeds in the Canadian arctic. It is distinguishable among other shorebirds by its colorful breeding plumage from which it derives its name. Other distinguishing characteristics are the bill, which is black year round, and the legs, which are dark gray to black (Harrington 1996, 2001). The average mass of the Red Knot is 135 g (which varies a lot through the year) with a body length between 23-25 cm. (Id.).

Plumage

Males in breeding plumage have a dark red or salmon breast, throat, and flanks, with a white belly. The crown is flecked with gray and salmon as is the back (Harrington 1996, 2001; Paulson 1993). Female coloration is similar to that of males but is typically less intense (Id.).

Nonbreeding plumage is a plain gray on the head and back with light fringes of gray and white along the wings, giving an appearance of a white line running the length of the wing when in flight (Id.). The breast is white mottled with gray; the belly is dull white (Id.). Molting into basic plumage normally starts the beginning of the southward

migration, late Jul-Oct/Nov depending on subspecies (Id.).

Life Span and Reproduction

Life Span

Average lifespan is estimated at 7 years (British Trust for Ornithology 2005). Banded adults of *C. c. rufa* have been sighted along Delaware Bay with estimated ages between 10 and 13 years (Harrington 1996, 2001, Harrington 1996).

Reproduction

Information on breeding behavior is primarily taken from Harrington (1996, 2001). Once flocks arrive on their Arctic breeding grounds, typically in early June, males begin to spread out over the tundra preparing the nest if conditions are favorable. The nest is prepared by the male performing 3-5 nest scrapes creating cup-shaped depressions made up of leaves, grasses, and lichens. The dimensions average 11.9 cm across, 11.1 cm wide, and 4.4 cm deep (Nettleship 1974). Shortly after males arrive on their territory females will search out a mate, forming a traditional monogamous mating system during the breeding season.

Once a male and female are paired, typical sexual displays occur and are initiated by the male. Males use an array of mating displays: a Tail-Up Display, Tail-Drop Fan Display, and a Ground-Point Display to encourage the female (Whitfield and Brade 1991). Once the female enters the scrape the male will begin the Courtship Call while his bill is pointed downward and the female in the scrape begins to place or toss vegetation at her side. As copulation approaches, behaviors are variable, but typically females are out of the scrape and males begin to follow with a Tail-Up Display and use the Copulation Call while pecking at the female's back. Once the female becomes stationary copulation

will occur (Id.). Copulation has been observed as soon as 1-2 hours after the female arrives to eight days after arrival (Id.).

The average clutch size is 4 eggs (Parmelee and MacDonald 1960), which have an incubation period of 21.5-22.4 days from the last egg laid to the last egg hatched. (Nettleship 1968). Red Knot pairs are not known to have more than one clutch per season (Harrington 1996, 2001). Both male and female incubate the eggs while the non-attending parent forages in nearby wetlands (Niles 2001). During early incubation adult knots do little to protect the nest or eggs but later in the term they are much more protective (Birula in Pleske 1928).

Chicks are precocial and soon leave the nest. Families will move quickly from higher nesting terrain to lower wetland habitats where the male normally stays with the brood while the female abandons the nesting site and brood (Whitfield and Brade 1991). There is no information on how long the young are brooded by the male. The fledging period is estimated at 18 days (Parmelee and MacDonald 1960).

Range and Migration

Range

C. c. rufa is found in the Arctic regions of Canada during the breeding season, mid June through mid August. They winter from November to mid-February in two separate areas in South America, Tierra del Fuego in Chile and Argentina, and in Maranhão, northern Brazil (Baker et al. 2005b). Additional smaller numbers of birds also winter further northwest in French Guiana and the southeastern United States. In Tierra del Fuego, the birds are found along the Bahia Lomas Bay in Chile and on the northwest side of the island in Argentina. Other peripheral sites can be found along the Patagonian

coast (Harrington 2001; Morrison et al. 2004).

Migration

C .c. rufa has one of the longest migrations of all the shorebirds. Red Knots that overwinter in southern South American embark on the northern migration in February with peak numbers leaving Argentina and southern Chile in mid-March to mid-April (Harrington 1996, 2001). The first stopover is along the coast of southern Brazil (Vooren and Chiaradia 1990). Their final stopover is the Delaware Bay. The birds stage here between late April and early June with the population peaking May 15-30 (Baker et al. 2004). Historically by June 5th, few are remaining at the Bay (Harrington 1996, 2001).

Their southward migration from the Canadian Arctic begins in mid- July. They arrive in South America along the coast of the Guianas in mid to late August (Spaans 1978). From the Guianas, Red Knots continue to move southward along the Atlantic coastline of South America, and the greater part of the population will continue on to Tierra del Fuego to overwinter (Morrison et al. 2004).

These long distance migrations can only occur when the birds have access to productive refueling stops, particularly on their northern migrations, which involve fewer stops than the southern migrations. For Red Knots (*rufa* subspecies), Delaware Bay is the most crucial spring stopover because it is the final stop at which the birds can refuel in preparation for their nonstop leg to the Arctic. When they arrive at their final destination, weather conditions can be harsh and food is scarce. Their fat reserves from the Delaware Bay must sustain them not only during their 2,400 km final flight but also upon arrival in the Arctic until food resources become more plentiful.

Habitat Requirements

Breeding Habitat

Red Knots breed in the Canadian Arctic near coastal areas, particularly on peninsulas and islands (Cramp and Simmons 1983). During the breeding season, June through mid-August, Red Knots use different nesting and foraging habitat in the tundra (Harrington 1996, 2001). Habitat selection is variable depending on snow cover and other conditions when individuals arrive in breeding areas (Id.). Nests are typically located on dry, sunny, somewhat elevated tundra (Pleske 1928, Parmelee et al. 1967, Nettleship 1974, Portenko 1981).

Nonbreeding Habitat

Harrington (1996, 2001) describes that during the winter the Red Knot frequents intertidal habitats, notably along ocean coasts and large bays. Both areas usually display high waves or strong currents while supplying a sandy habitat. These areas are selectively chosen in South America with the most abundant population on the island of Tierra del Fuego, Argentina and Chile (Morrison and Ross 1989).

Migratory Habitat

The Red Knot principally uses marine habitats in both North and South America during migration. Coastal habitats along the mouths of bays and estuaries are preferred, providing sandy beaches to forage (Harrington 1996, 2001). High wave-energy is associated with these areas (Harrington et al. 1986; Vooren et al. 1990; Blanco et al. 1992). Red Knots are also known to use tidal flats in more sheltered bays or lagoons in search of benthic invertebrates or horseshoe crab eggs (Harrington et al. 1986; Harrington 1996, 2001; Tsipoura and Burger 1999).

Feeding and Mass

Feeding

Away from their breeding grounds, Red Knots feed on small invertebrates such as mollusks, marine worms, crustaceans, bivalves (Zwarts and Blomert 1992, Dekinga and Piersma 1993, Gonzalez et al. 1996), small snails (Harrington et al. 1986), Alerstam et al. 1992), amphipods (Prater 1972) and polychaete worms (Prater 1972, Piersma et al. 1993). While on their breeding grounds, and upon first arrival when snow is often still present, feeding is mostly restricted to vegetable foods (Harrington 1996, 2001). Once the snow has melted, food consists of insects, some marine invertebrates, and occasionally vegetable matter (Harrington 1996, 2001).

In Delaware Bay, their primary food is the eggs of horseshoe crabs (Tsipoura and Burger 1999, Baker et al. 2004). Delaware Bay hosts the largest number of spawning horseshoe crabs in the United States (Western Hemisphere Shorebird Reserve Network 2005). Spawning season peaks in May and June, with peak spawning occurring on evening high tides during the full and new moons. The birds' arrival in the Bay coincides with the spawning of the horseshoe crabs. At least 11 species of migratory birds use horseshoe crab eggs as their primary food supply during their 2 to 3 week stopover. It is estimated that Red Knots can consume up to 18,000 fat-rich horseshoe crab eggs per day (Andres et al. 2003).

Mass

As with many migratory shorebirds, Red Knots vary substantially in mass through different life stages (Harrington 1996, 2001). The fluctuation in mass is due to the energetic needs of the birds during their annual migration to breeding grounds or

overwintering habitat (Baker et al. 2004).

During early winter, Red Knots have a mean mass of 125 g (Harrington 1996, 2001), though they do not maintain this mass over a long period of time. Once northern migration begins, Red Knots undergo substantial changes in mass. Red Knots will add mass at staging sites to fuel the next leg of their migration.

When the birds arrive in Delaware Bay they weigh approximately 90-120 g (Robinson et al. 2003). They have depleted their fat reserves and their muscle mass is diminished. Before they can increase in mass, their stomach, intestines, kidney and liver will increase in size (Piersma et al. 1999a, Dekinga et al. 2001). Once this occurs, the birds will increase their mass dramatically—if food is plentiful.

As noted earlier, Delaware Bay is the final and most critical staging site along the northward migration. Baker et al. (2004; p. 876) make this point clear:

> Delaware Bay is a crucial site at which to accumulate nutrients for the final flight to the breeding sites and for survival on the initially food-free tundra and through unpredictable bouts of freezing weather, which can cause high levels of mortality (Boyd 1992).

Also according to Baker et al. (2004), Red Knots arrive in Delaware Bay weighing between 90-120 g and will double their mass to 180-220 g if conditions are favorable (Baker et al. 2001). They need to reach such a critical mass during this stopover in order to successfully complete the final leg of their migration and to arrive in prime breeding condition. Baker and colleagues further state:

> At an average rate of mass increase of 4.6 g day^{-1}, the birds need to refuel over a period of ca. 19-22 days to reach maximum mass… thus achieving the nutrient-store levels necessary for migration, survival and maximizing the reproductive potential of the population (Baker et al. 2004; p. 876).

Just as their organs increase in size during the refueling phase, they reduce in size

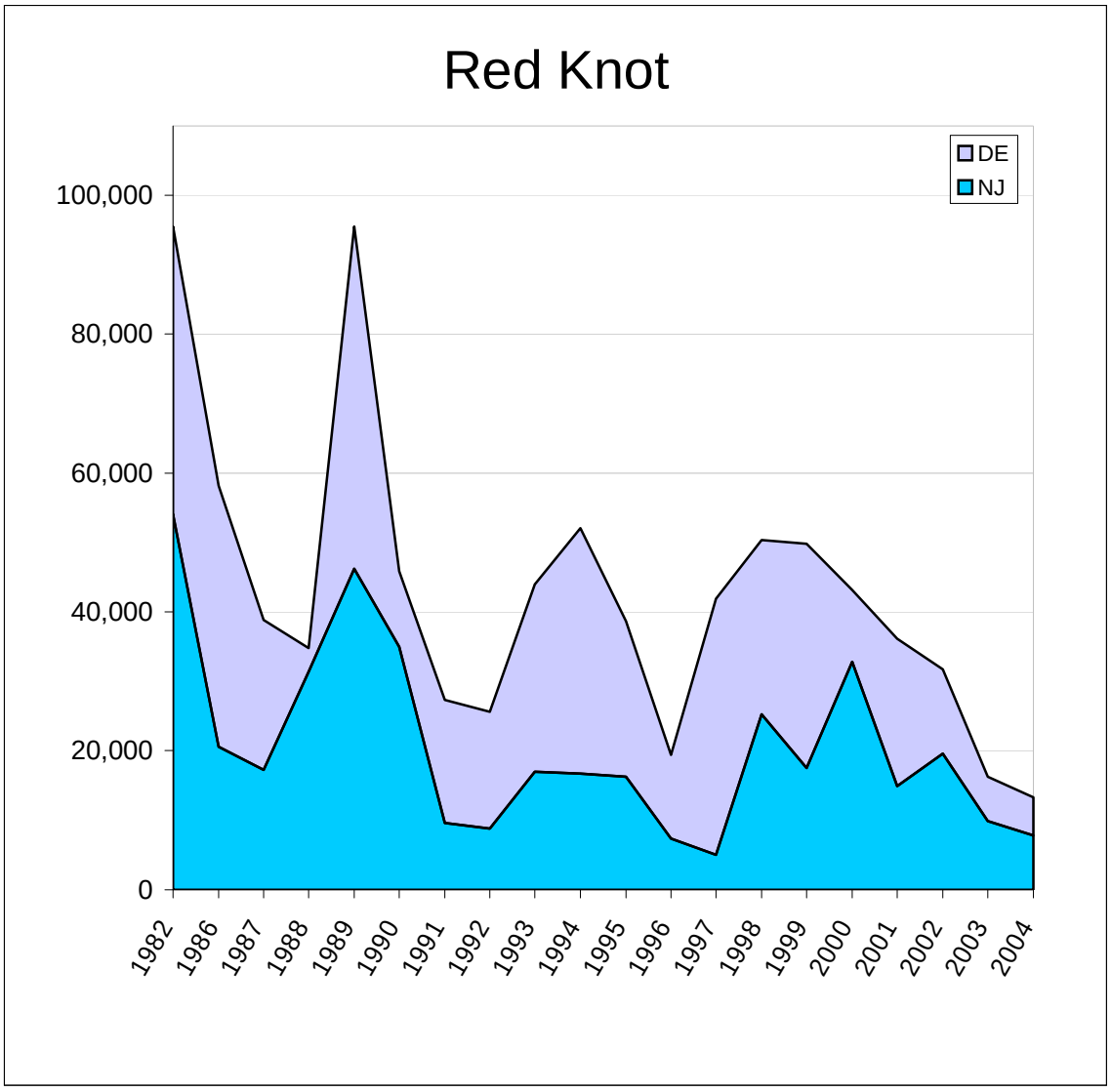
immediately prior to long distance flight (Piersma et al. 1999a), to make room for the additional fat stores. The reversible organ transformations are thought to be a response to changes in behavior and diet, such as preparation for long distance flights (Piersma 1998, Piersma and Gill 1998, Piersma et al. 1999a, Piersma et al. 1999b).

Population

Harrington (unpublished, Harrington 2001), estimated that the adult *rufa* population in spring 1989 was 152,000 ±50,3000 SD. In the same spring, Clark et al. (1993) estimated 94,460 knots on the Delaware Bay coast during a peak migration count.

Because of the large number of *C. c. rufa* using the Delaware Bay, a weekly aerial survey of the birds in the entire Bay has been carried out every year since 1989 during the month of May and early June. Consistency has been achieved by using the same methods and the same observers throughout. In the early years of the survey, Red Knot numbers reached almost 100,000 birds. By 1994, the number had dropped to about 50,000 and there has been a steady drop since 1999. The 2004 count was 13,315—the lowest point in the 20-year period of the survey. See Figure 1.

Figure 1: Peaks of weekly aerial counts of Red Knots on Delaware Bay (New Jersey and Delaware), May through early June, 1986 to 2004. No surveys were performed in 1983 through 1985. Source: Niles et al. (2005a)

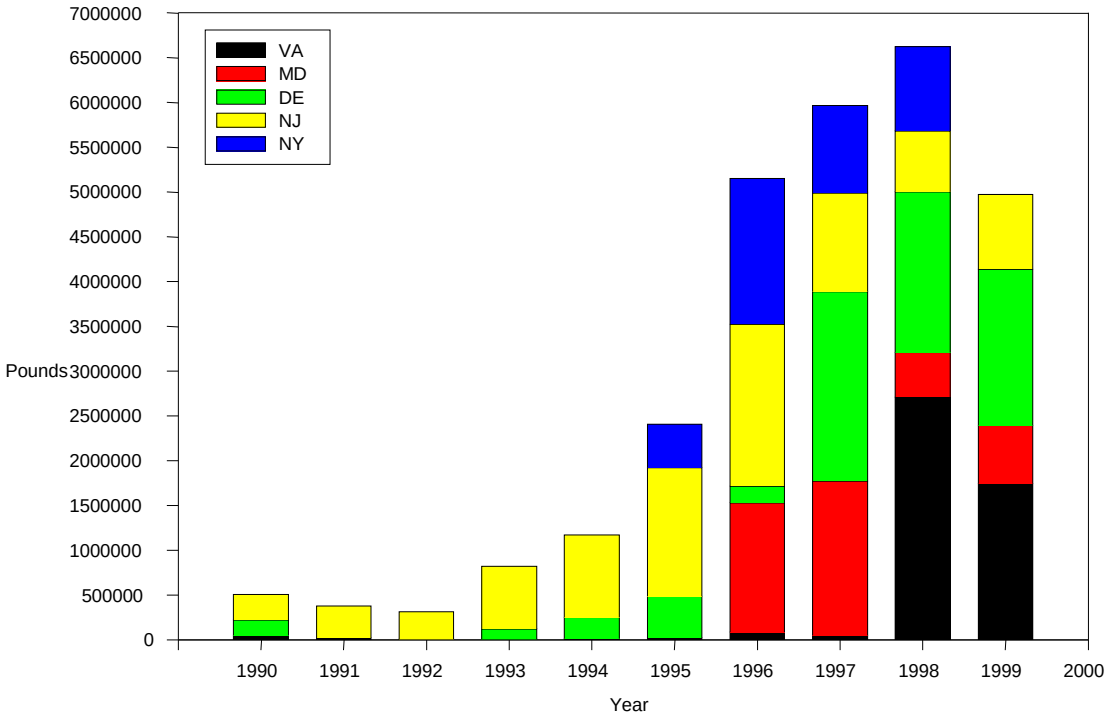


In August of 2004, the U.S. Shorebird Conservation Plan (2004) published its list of U.S. and Canadian shorebird populations that are considered highly imperiled or of high conservation concern. The Canadian Arctic-Atlantic Coast Population of Red Knot was one of eight taxa classified as "Highly Imperiled." The six factors used to determine the conservation status of shorebirds include: Population Trend (PT), Population Size (PS), Breeding Threats (TB), Non-breeding Threats (TN), Breeding Distribution (BD), and Non-breeding Distribution (ND).

Decline in Horseshoe Crabs and Effect on Red Knots

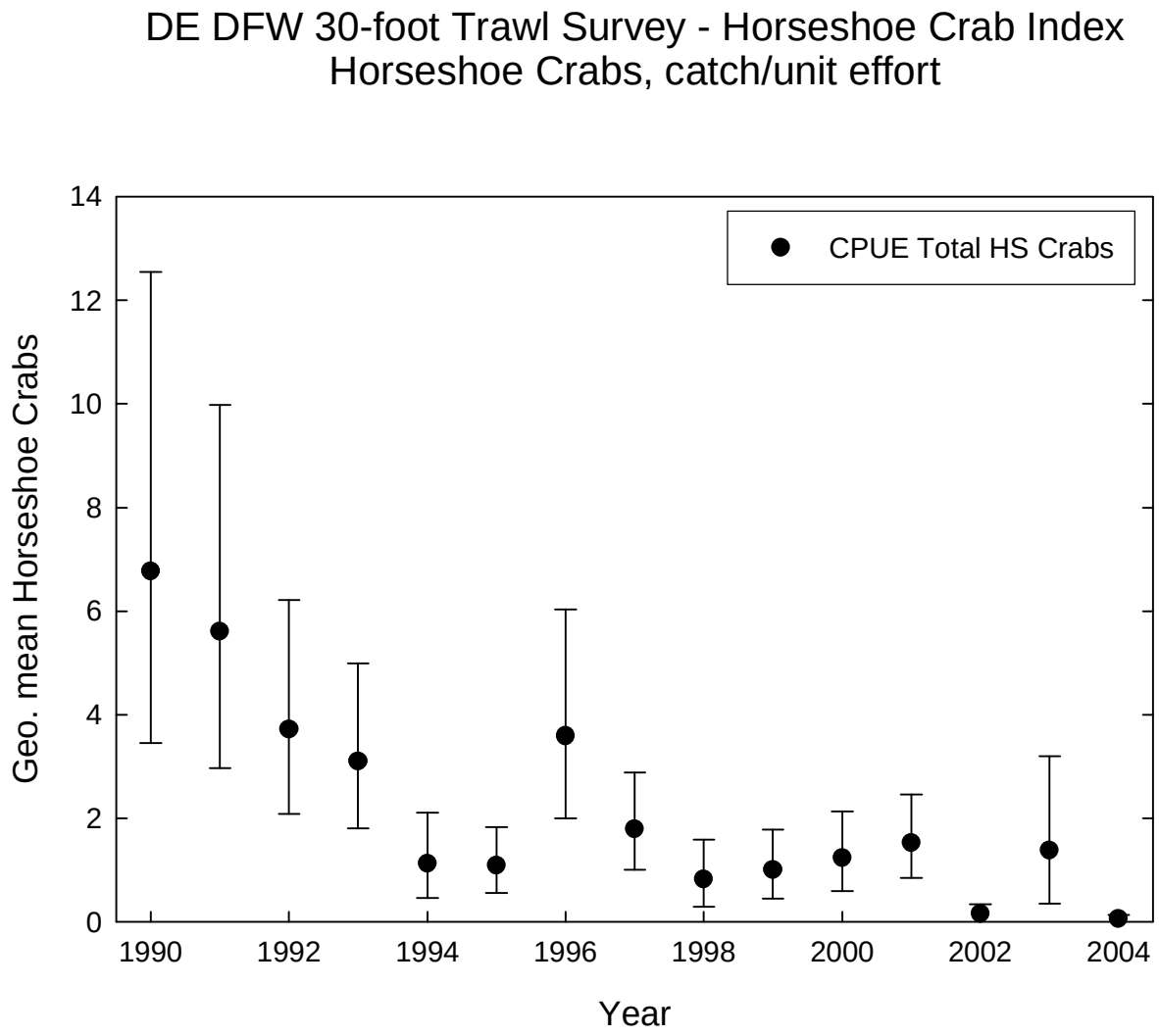
Until 1992, the harvest of horseshoe crabs was a traditional harvest to supply bait for a small eel fishery. But by 1996, millions of horseshoe crabs were harvested for use as bait for coast-wide conch and eel fisheries. See Figure 2.

Figure 2: Horseshoe Crab Landings 1990-1999
Source: Niles et al. (2005b)



In 1998, the ASMFC adopted a fishery management plan for the horseshoe crab that froze harvest at 25% of the peak harvest. However, this quota was not based on scientifically sound information regarding the horseshoe crab population. It even failed to take into account the only data available at the time—a baywide trawl survey that documented a 90% drop in the horseshoe crab stock. See Figure 3.

Figure 3



As shown in Figure 1, the Delaware Bay stopover population declined in the 1990s from the highs of the 1980s and began declining again after 1999. In response to the declines after 1999, numerous efforts to gain further insight into the declines were undertaken.

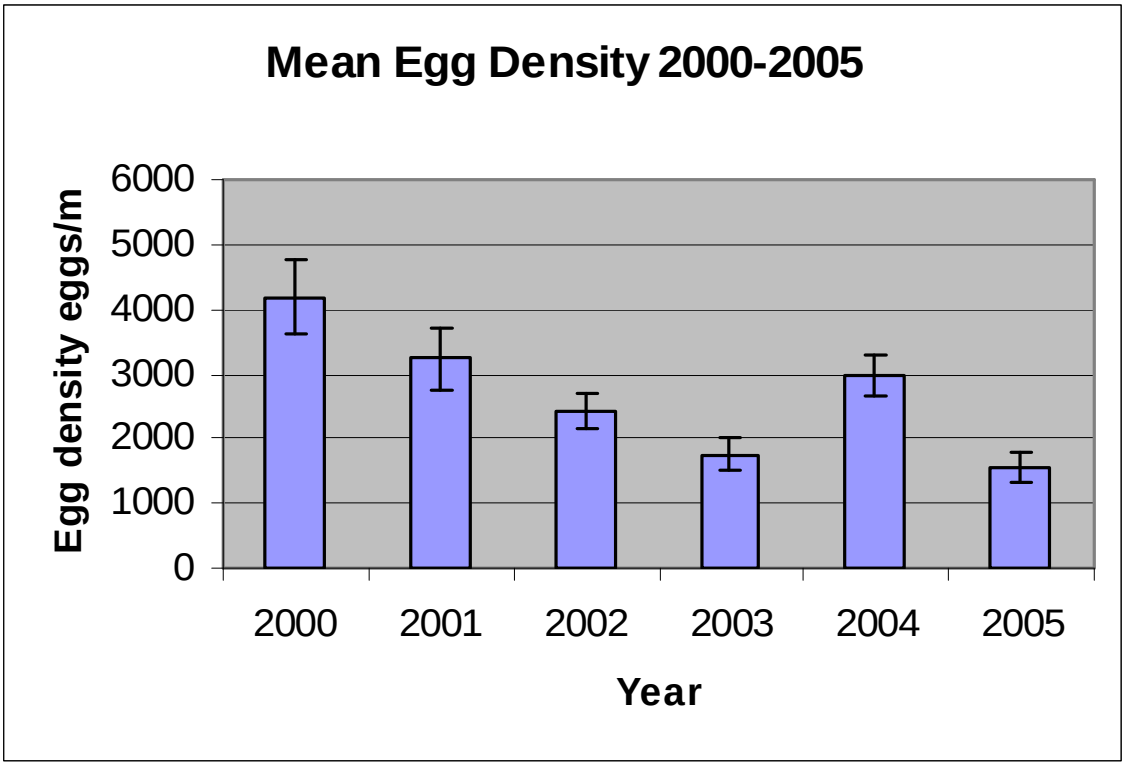
Study Results

As noted above, the Red Knot stopover on the Delaware Bay is now the most heavily studied in the world, with over 30 biologists conducting as many 15 different projects each year. In 1999 and 2000 respectively, additional studies of the bird on its breeding and non-breeding grounds were initiated. The outcome of this research is a prodigious amount of data on knot numbers, arrival and departure masses, rates of mass gain, movements, distribution, feeding ecology, behavior, and habitat use as well as complementary data on horseshoe crabs and other shorebird species.

Horseshoe Crab Egg Density and Red Knot Mass Studies

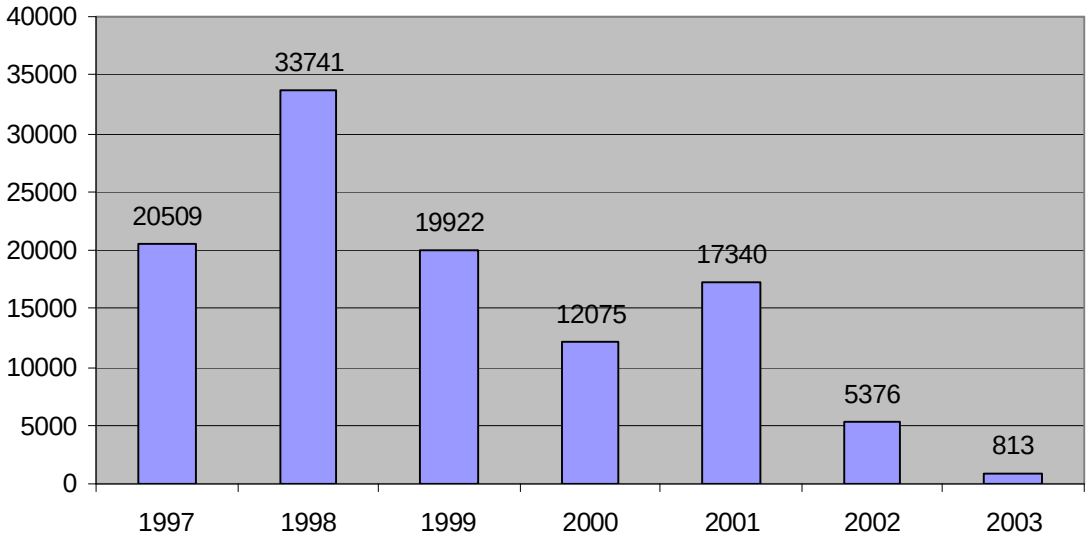
To better determine the impact of decreased horseshoe crab egg availability on shorebirds, egg density was studied. In the early 1990s, the mean egg density was 40,000 eggs/m^2 (Niles et al. 2005b). Between 2000 and 2003, densities dropped from 4,185 to 1,761 eggs/m^2. The Bay was unseasonably cold in May 2003 and most crab breeding took place in June. Egg densities increased slightly to 2,982 eggs/m^2 in 2004 when temperatures were higher and egg availability coincided better with the shorebird stopover. But by 2005, the density had declined further to less than 2,000 eggs/m^2. Current densities are insufficient for the majority of birds to gain mass for most of the month of May. See Figure 4.

Figure 4
Source: Niles et al. (2005b)



Baker et al. (2004), found that from 1997-2002 an increasing proportion of Red Knots failed to reach the threshold departure mass of 180-220 g. See Figure 5. According to this same study, from 1997 to 2002, the average increase in the mass of Red Knots caught in Delaware Bay (i.e. the average of all birds caught, not necessarily individuals) showed a significant year-on-year decline from around 8 to 2.2 g/day. The rate remained low in 2003 but increased slightly in 2004. Therefore, there has been a systematic reduction in the mass of knots leaving Delaware Bay for the Arctic, which negatively impacts their ability to survive and breed.

Figure 5: Number of Red Knots Reaching Weight 1997-2003
Source: Niles et al. (2005b)



Winter Population Counts

The most recent aerial count of Red Knots on their wintering grounds in northern Brazil took place in February 2005. The aerial count showed a population of 7,575 knots (Baker et al. 2005b). This figure is down about 600 from a previous census in the 1980s (Id.). At the same time this aerial survey was occurring, a similar aerial survey took place in Tierra del Fuego.

The Tierra del Fuego counts began in the early 1980s and were conducted for several years by the Canadian Wildlife Service. In 2000, a team led by the New Jersey ENSP re-established the Tierra del Fuego winter count. Red Knots declined in the early years of the new survey, from 51,255 in 2000 to 27,242 in 2002 and remained roughly unchanged for the next two years. In 2005, however, numbers declined to 17,653. According to Niles et al. (2005a), Red Knots in Tierra del Fuego have fallen to their lowest point in the last 20 years with significant declines noted since 2000. See Table 1.

Table 1. Aerial surveys of Red Knot, Tierra del Fuego, South America, February 1982/86 (Canadian Wildlife Service South American Atlas) and February 2000 through 2005 (Canadian Wildlife Service and ENSP). Source: Niles et al. (2005b)

Species	Region	1982/86 Atlas	2000	2002	2003	2004	2005
Red Knot	Tierra del Fuego	53232	51255	27242	29915	30778	17653

Morrison et al. (2004) suggest that the decline is due to increased mortality. They state:

> Aerial surveys of the main wintering grounds of the *rufa* subspecies of the Red Knot, in southern South America have shown dramatic declines in population size over the past three years. These declines do not appear to be the result of redistribution of wintering birds.…[S]tudies in Delaware

> Bay suggest that increased adult mortality of Red Knots resulting from inability to gain sufficient mass prior to migration to the breeding grounds could account for the magnitude of the observed declines (p. 68).

Population Projections

In response to the declines of wintering populations in 2005, Baker et al.(2005b) states:

> Unless a substantial portion of the birds were missed—and there seems no reason to suppose that this is so—this loss of 13,000 birds increases the risk of extinction of the Red Knot as modeled in the 'worst case' scenario published in Baker et al. (2004).

Baker et al. (2005b) further states:

> In conclusion, as the result of the contemporaneous Maranhão [Brazil] and Tierra del Fuego censuses and associated studies in early 2005 before the northern migration had commenced, it is now established that both locations harbour separate populations that are both endangered and the risk of extinction is greatly enhanced. If further studies using genetic markers and feather isotopes place the two populations in separate subspecies then the case is even more urgent because both will have even smaller population sizes, and consequently lower amounts of adaptive genetic variation. The resightings of Red Knots in Maranhão that were colour-banded on passage through Delaware Bay in spring each year suggests that possibly one quarter of the flocks in the Bay in 2004 were from this northern Brazilian population. If this extrapolation is approximately correct it suggests that a large number of Red Knots from Tierra del Fuego did not migrate through the Bay in 2004, either avoiding it or aborting migration in South America. In either case, the disruption to the normal migratory schedule is expected to have deleterious effects on population growth through declines in reproductive success and recruitment (Piersma and Baker 2000).

Part II: Reasons for Consideration of ESA Listing for the Red Knot (*Rufa* Subspecies)

ESA Listing Criteria Applied to the Red Knot (*Rufa* Subspecies)

Petitioners are filing this emergency listing petition because the Red Knot (r*ufa* subspecies) is severely imperiled and is in immediate need of immediate protections under the Endangered Species Act. Previous efforts to gain protections for the Red Knot and for Red Knot habitat have failed, leaving listing the only remaining option for

preventing the species' extinction.

The best evidence that the Red Knot is imperiled is its low and rapidly declining numbers, which cannot be attributed to fluctuations in breeding cycles or alterations in migration patterns. Population trend estimates have been consistently negative for several decades (Morrison et al. 2004 (citing Howe et al. 1989; Morrison et al. 1994; Morrison et al. 2001)). Population estimates of 100,000-150,000 in the early 1980s fell to approximately 50,000 in the 1990s and the numbers have fallen even further "with drastic declines of *rufa* occurring on the major wintering grounds in southern South America in recent years" (Morrison et al. 2004).

Between 2000 and 2002, population size at Tierra del Fuego declined alarmingly from 51,000 to 27,000, which Baker and colleagues conclude "seriously threaten[s] the viability of this subspecies" (Baker et al. 2004). According to the study, "demographic modeling predicts imminent endangerment and an increased risk of extinction of the subspecies without urgent risk-averse management" (Id.). In other words, if these levels of decline continue, "the population is predicted to approach extremely low numbers by 2010 when the probability of extinction will be correspondingly higher than it is today" (Id.).

The Baker curve is not merely hypothetical. Subsequent research demonstrates that Red Knot numbers are falling precipitously in proportions that match Baker's projections (Baker et al. 2005b; Niles et al. 2005a). Indeed, the latest counts show that numbers of Red Knots on both the Delaware Bay and Tierra del Fuego are at their lowest point in the 20-year period of the survey (Id.). At present rates of decline, extinction within five years is a serious possibility.

The Red Knot's five-year extinction trajectory is an imminent crisis requiring immediate action. According to Niles et al. (2005a), "That [Baker et al. 2004] predicted extinction of the New World Red Knot in five years should motivate all professionals working on the horseshoe crab and shorebirds to take a fresh look at our work and determine prudent actions that best serve this species as it moves perilously close to collapse" (Niles et al. 2005a). For these reasons, and those that follow, ESA listing is appropriate and necessary.

1. The present or threatened destruction, modification, or curtailment of habitat or range;

With many shorebird populations declining worldwide (International Wader Study Group Bulletin 2003), international attention has focused on the dependence of shorebirds upon critical stopover areas during their migration (Tsipoura and Burger 1999). The Delaware Bay is one of the four most important of stopovers for any shorebird species, and by far the most important for the Red Knot. Traditionally, shorebirds would use the Delaware Bay, and its formerly abundant supplies of horseshoe crab eggs, to "forage intensively" to gather enough fuel in the form of fat and muscle protein to complete the 2,400 km journey to the Canadian Arctic (Id.). Numerous studies detail that the shorebird diet during stopover in the Delaware Bay consists primarily of horseshoe crab eggs (Id.; Andres et al. 2003).

Baker's analysis of capture-recapture data collected in the wintering populations in Tierra del Fuego/Patagonia and from the "critically important last refueling stop in Delaware Bay reveals the dramatic drop in annual survival that occurred between the 1999/2000 … and the 2000/2001 migration years" (Baker et al. 2004). The study demonstrated that "there are striking fitness consequences for both adult survival and the

numbers of second-year birds in wintering populations of Red Knots that are correlated with the amount of nutrient stores accumulated in Delaware Bay, the last stopover site before they migrate to breeding grounds in the Canadian Arctic" (Baker et al. 2004).

As noted previously, Red Knots and other shorebirds depend on the traditional abundance of horseshoe crab eggs in Delaware Bay to refuel for the remainder of their journey to the Arctic breeding grounds. Unfortunately, reductions in spawning horseshoe crab populations have caused up to 70 percent decreases in the availability of horseshoe crab eggs on Delaware Bay beaches since the 1980s (Tsipoura and Burger 1999).

Baker's work illustrates the impact of the loss of this nutrient source on the Red Knot. The amount of food available at Delaware Bay directly affects the bird's ability to gain mass for the final leg of its journey. Baker et al. (2004) found that the Red Knot has shown increasing signs of energetic stress in refueling on Delaware Bay since 1999 and that there was a significant decrease of 70% of well conditioned knots (200 g or greater) between the years 1997/1998 – 2001/2002. Consequently Baker et al. (2004) conclude:

> There has therefore been a significant increase in the proportion of Red Knots departing Delaware Bay that are under-conditioned for the joint energetic demands of migration to and breeding success in the Artic (p. 878).

Baker's findings are consistent with data from Niles that show the number of Red Knots reaching 185 g or greater dramatically declining for the years 1997-2003 (Niles pers. comm. 2005).

As egg supplies declined in the late 1990s, Baker also found real physiological impacts in the Red Knot: critical organs reduced in size compared with prior years; reduced pectoral muscles relative to expected size; reductions in intestinal mass by up to one-third; and reduction in liver size by one-third. These changes are thought to

compromise flight, suppress immune function, and compromise long-term health (Baker et al. 2004).

The increased observance of under-conditioned knots can clearly be linked to reduced food availability along Delaware Bay (Baker et al. 2004). Morrison et al. (2004) confirm this:

> … studies in Delaware Bay suggest that increased adult mortality of Red Knots resulting from inability to gain sufficient weight prior to migration to breeding grounds could account for the magnitude of the observed declines (p. 68).

Indeed research on Red Knots and other species at staging, breeding, and wintering areas confirm that Delaware Bay is the most critical variable. Niles et al. (2005b) compared wintering populations of the Red Knot in Tierra del Fuego with that of the Hudsonian Godwit, an Arctic breeder that does not stopover on the Delaware Bay (Niles et al. 2005b). During the roughly 20 years of the study on the wintering grounds, the researchers documented a 68 percent decline in Red Knots, while the Hudsonian Godwit populations actually increased in number (Id.). Niles et al. (Id.) also compared the breeding density of the Red Knot to that of the Golden Plover, another long-distance migrant that does not stopover at the Delaware Bay. Red Knot breeding densities declined markedly from 2000-2004 while Golden Plover density generally improved (Id.). These studies appear to rule out factors in Tierra del Fuego or the Arctic as the cause of the Red Knot's decline.

Red Knots are highly vulnerable to degradation of the resources on which they depend to accomplish their migrations (Myers et al. 1987). Morrison et al. (2004) have identified four factors that cause this vulnerability:

(1) a tendency to concentrate in a limited number of locations during

> migration and on the wintering grounds, so that deleterious changes can affect a large proportion of the population at once; (2) a limited reproductive output, subject to vagaries of weather and predator cycles in the Arctic, which in conjunction with long lifespan suggests slow recovery from population declines; (3) a migration schedule closely timed to seasonally abundant food resources, such as horseshoe crab (*Limulus polyphemus*) eggs during spring migration in Delaware Bay (Tsipoura and Burger 1999), suggesting that there may be limited flexibility in migration routes or schedules; (4) occupation and use of coastal wetland habitats that are affected by a wide variety of human activities and developments (Bildstein et al. 1991; p. 61).

The factors stated above, expressly numbers one and three, have made Red Knots especially vulnerable to changes in the horseshoe crab fishery in Delaware Bay (Niles pers. comm. 2005). As Baker et al. 2004 conclude:

> The decline in the average departure masses of Red Knots follows the dramatic increase in commercial fishing that began in 1990 and peaked in 1995/96 to provide bait for eel and conch fisheries (Walls et al. 2002), and also reflected a sixfold decline in the number of horseshoe crabs caught in survey trawls in Delaware Bay by the Delaware Division of Fish and Wildlife (S. Michels, unpublished data, cited in Andres et al. (2003)). We contend that the over-harvesting of horseshoe crabs in the past and the erosion of beaches in Delaware Bay have jointly reduced the number of foraging areas for shorebirds, and has concentrated the birds into a few key locales where crab eggs are locally abundant. There is strong evidence that the increasing dependence of birds on so few vulnerable areas and the increasing proportion of poor-conditioned birds at departure time have direct and serious implications for the continuing viability of the *rufa* subspecies (Baker et al. 2004).

2. Overutilization for commercial, recreational, scientific, or educational purposes;

Historically, the Red Knot was heavily hunted for market and sport. Although the bird's populations recovered in the mid-twentieth century, it is not clear whether the population ever regained its historical numbers (Harrington 1996, 2001).

Band recoveries have shown that some knots may be killed for food in parts of South America or shot for sport in Barbados. The overall take from these activities is unknown (Id.).

3. Disease or predation;

Reduction in food sources, due to increases in the harvesting of horseshoe crabs and the resulting loss of available eggs in the Delaware Bay, has likely increased the Red Knot's susceptibility to disease. The knots' inability to obtain adequate fuel reserves has serious physical consequences for the bird. According to Schat and Myers (1991), the lining of the intestine and the mucosa it produces protect the body against pathogens ingested with the food. Reductions in intestinal mass (33% lower in 1999) have been experimentally shown to suppress immune function (Sanderson 2001). The lack of food in Delaware Bay thus not only impacts the Red Knot's ability to gain mass and undergo the physiological changes necessary to complete its migration, but it also increases the bird's vulnerability to disease.

Regarding direct predation of the Red Knot, it is thought that Long-tailed Jaeger (*Stercorarius longicaudus*), Parasitic Jaeger (*S. parasiticus*), and arctic fox (*Alopex lagopus*) commonly take young and eggs at the breeding grounds. Elsewhere, the most common predators are thought to be falcons, harriers, and a few other predatory birds (Harrington 1996, 2001).

Competition from other species for diminishing food resources is a documented negative factor. Studies have found that gulls foraging on the beaches of Delaware Bay can directly or indirectly compete with shorebirds for horseshoe crab eggs (Andres et al. 2003). Bottom et al. (1994) noted that flocks of shorebirds appeared to be deterred from landing on beaches when large flocks of gulls were present (Andres et al. 2003; Bottom et al. 1994).

Indeed, Niles et al. (2005a) suggests that the abundance of gulls may be having "a

major and detrimental effect on the availability of horseshoe crab eggs to shorebirds" Niles et al. (2005a). Stable populations of gulls, mainly Laughing Gulls, breed along the Atlantic Coast and also feed on horseshoe crab eggs on the Delaware Bay. A 2003-2004 study of competition between gulls and shorebirds and the influence of disturbance by humans and dogs found that gulls easily out compete shorebirds and are less susceptible to disturbance (Id.). The high density of gulls on the southern New Jersey shore, according to Niles, may explain why Red Knots between 2000 and 2004 favored northern Delaware Bay beaches and those on the Delaware shore even though egg densities were similar across the region (Id.).

4. The inadequacy of existing regulatory mechanisms;

Although the decline in Red Knot populations has been apparent for a decade, the Red Knot is presently without federal protection under the Endangered Species Act and receives only minimal protection under the Migratory Bird Treaty Act ("MBTA"). The MBTA protects against direct take of birds, nests, and eggs, but the act provides no authority for protection of habitat or food sources.

Because of its documented significance to numerous shorebirds, the Delaware Bay is a Western Hemisphere Shorebird Reserve Network (WHSRN) site. WHSRN status brings international attention to the species and encourages local conservation initiatives both in the United States and throughout the species' migratory range, but these efforts are voluntary. Although the Bay benefits from international interest and scientific study, such efforts provide no legal authority to protect the Red Knot.

Management efforts to protect the Red Knot on Delaware Bay currently involve local, state, and federal agencies, but there is little consistency or coordination across

state lines. The states of New Jersey, Delaware, Maryland, and Virginia are active in Red Knot conservation to varying degrees, and New Jersey has listed the bird as a state threatened species.

The states, in conjunction with the ASMFC, currently manage the Delaware Bay horseshoe crab fishery—which, as demonstrated above, has significant consequences for the knots. The ASMFC's Horseshoe Crab Management Board approved the Horseshoe Crab Fishery Management Plan ("FMP") in October 1998. The goal of the FMP was "management of horseshoe crab populations for continued use by: current and future generations of the fishing and non-fishing public (including the biomedical industry, scientific and educational research; migratory shorebirds; and, other dependent fish and wildlife (including federally listed sea turtles)" (ASMFC 1998).

The FMP outlined a comprehensive monitoring program that included mandatory monthly reporting, maintaining existing benthic sampling programs, establishing pilot programs to survey spawning horseshoe crabs and egg density, evaluating post-release mortality of horseshoe crabs used by the biomedical industry, and identifying potential horseshoe crab habitat in each state. It also maintained controls on the take of horseshoe crabs put in place by New Jersey, Delaware, and Maryland prior to the approval of the FMP. These measures were necessary to protect horseshoe crab spawning within and adjacent to the Delaware Bay, which is the epicenter of spawning activity along the Atlantic Coast. However, subsequent significant increased landings of horseshoe crabs taken in Delaware Bay in other states, particularly Virginia, largely negated these conservation efforts because crabs could still be harvested from the waters of New Jersey, Delaware, and Maryland and landed in other states.

In April 2000, the Management Board approved Addendum I to the Horseshoe Crab FMP. This Addendum established a coast-wide, state-by-state annual quota system to further reduce horseshoe crab landings. Through Addendum I the Board recommended to the federal government the creation of the Carl N. Shuster Jr. Horseshoe Crab Reserve, an area of nearly 1,500 square miles in federal waters off the mouth of Delaware Bay that is closed to horseshoe crab harvest. In May 2001, the Management Board approved Addendum II, which established criteria for voluntary quota transfers between states.

The FWS formed the Shorebird Technical Committee in 2001 with the purpose of providing technical advice to the Board on how horseshoe crab management actions might affect shorebird populations. This Committee is comprised of shorebird experts and a representative of the Horseshoe Crab Technical Committee and Stock Assessment Subcommittee. The group was charged with producing a peer-reviewed report that synthesizes current literature and data on the status of shorebirds in the Delaware Bay and to determine their energetic dependency on horseshoe crab eggs

In June 2003, the FWS Shorebird Technical Committee completed its report to the Management Board. It included conclusions and recommendations for management and research (Andres et al. 2003). These included:

- That Delaware Bay is a critical stopover point for migratory shorebirds including *C. c. rufa*, which has decreased since the 1980s.
- Stable isotope analysis indicates that Red Knots are highly dependent on horseshoe crabs.
- That a lesser proportion of Red Knots are making minimal departure masses, which suggests that food resources in Delaware Bay not be adequate.

The Peer Review Report and Panel stated "crabs should be assumed to be critically important unless a viable alternative prey base is shown to exist" and "horseshoe crabs eggs are only profitable to shorebirds if they occur in high surface density" (Andres et al. 2003).

In May 2004, the Board approved Addendum III to the FMP largely in response to the findings and recommendations of the Shorebird Technical Committee. It further reduced quotas of harvest of horseshoe crabs for bait in New Jersey, Delaware, and Maryland. It also established in the three states a closed season for bait harvest designed to coincide with the migration of shorebirds stopping in the Delaware Bay region.

Despite these efforts, however, recent reports demonstrate that horseshoe crab populations remain in decline and are not producing the abundance of eggs necessary to provide forage for migrating Red Knots (Figure 5; Niles et al. 2005b). Given that horseshoe crab management activities to date have not been adequate to improve the status of the Red Knot, a complete moratorium on harvesting is likely warranted. An ESA listing for the Red Knot would provide an opportunity for formal consultation with FWS to avoid jeopardy to the Red Knot resulting from current levels of horseshoe crab harvesting.

To avert extinction, the Red Knot needs a comprehensive, coordinated recovery effort. As existing regulatory mechanisms are clearly inadequate to provide sufficient protections for the Red Knot that are consistent across jurisdictional boundaries, listing under the ESA is appropriate and necessary.

5. Other natural or manmade factors affecting its continued existence.

The single-most important cause of the Red Knot's decline appears to be the

acceleration of harvesting of horseshoe crabs on the Delaware Bay that began in the 1990s. Recent reductions in crab harvests have not substantially increased horseshoe crab abundance (Niles pers. comm. 2005). Given the long life cycle of the horseshoe crab and the 9-12 years it takes the crab to reach sexual maturity, actions to restore the horseshoe crab may not have an immediate impact on egg abundance. Changes to the fishery are thus overdue and must be implemented immediately to halt the Red Knot's extinction trajectory.

Another factor is the tendency of Red Knot populations to occur together at a small number of nonbreeding locations. This leaves the population particularly "vulnerable to loss of key resources" (Harrington 2001). Counts of Red Knots at peak migration on Delaware Bay have shown that between 42 and 92 percent of the entire adult *rufa* population may be present in the same location at any single day. As Harrington concludes: "It thus seems clear that the adult knot population is vulnerable to events or practices that affect resources that attract them to the bay … Piersma and Baker (2000) suggest that 'the future of many species of migratory shorebirds depends on adequate conservation of …[key] wintering and staging sites'" (Harrington 2001).

Seasonal variations that either reduce horseshoe crab productivity or affect the Red Knot's breeding habitat in the Arctic also play a role. The Red Knot's historic abundance provided a buffer against such variations, but as the knot's numbers dip below the point of sustainability, such factors could combine to push the species over the edge.

Genetic studies indicate that small populations are especially vulnerable to the accumulation of harmful genetic mutation (genetic drift) (International Wader Study Group 2003). What's more, these studies also show that "effective population sizes" are

significantly smaller than "census population sizes" (Id.). In other words, not all individuals in a population contribute to the gene pool. Because of the already low genetic variability (homozygosity) of shorebirds, scientists believe there must be particular concern paid to the long-term genetic consequences of populations falling below 15,000 individuals (Id.). As noted previously, the 2004 Red Knot count in the Delaware Bay was 13,315—the lowest point in the 20-year period of the survey.

Lastly, global warming may have a strong negative impact on the species, as it is expected to impact significantly the polar and temperate regions where the knot breeds and winters. Additionally, all major known staging sites are on the temperate coastlines, where sea level rise is predicted to be the greatest (Harrington 2001; Andres et al. 2003). Models designed to predict local effects of sea level rise by 2100 indicate that sea level in Delaware Bay would rise between 0.3 and 0.6 m, which corresponds to a loss of salt marsh of between 23 percent and 57 percent (Andres et al. 2003). As Baker and Andres have noted, erosion of shoreline habitat is also a likely factor in the Red Knot's decline (Andres et al. 2003; Baker et al. 2004). In fact, according to one report, 26 percent of New Jersey's shoreline and 12 percent of Delaware's shoreline is critically eroding (Bernd-Cohen and Gordon 1999).

Summary and Conclusion

The Reasons for ESA Consideration of the Red Knot in Summation

Studies by Baker, Morrison, Niles, and others have documented the dramatic decline in the population of the *rufa* subspecies of the Red Knot. Most disturbingly, research by Baker et al. (2004) indicates that if Red Knot populations continue to decline at their present rate, the bird could go extinct by or near 2010. New research by Niles et

al. (2005a) confirms that this extinction trajectory remains on track. The evidence strongly suggests that the decline of the Red Knot closely corresponds to the massive increase in harvesting of the horseshoe crab on the Delaware Bay in the past decade. This harvesting and the failure of state and federal governments to adequately address the issue, along with other changes in the Delaware Bay ecosystem, have led to a significant reduction in food resources for the Red Knot and other shorebirds that depend on this staging area for refueling during their trans-continental migrations.

The Red Knot, because of its specialized feeding and migration ecology, could be considered an indicator of ecosystem integrity (International Wader Study Group Conference 2003). A remarkable bird worth conserving in its own right, the Red Knot also is a symbol for the shorebird community and the ecosystem processes it depends on for survival. The Delaware Bay is a critically important spring staging area for the Red Knot and other migratory birds, but overexploitation of food resources used by waders is impacting the birds' ability to make productive use of this habitat and reach their Arctic breeding grounds to breed successfully. Efforts to preserve the Red Knot will also promote the conservation and restoration of numerous shorebirds and the Delaware Bay ecosystem itself.

In the absence of an ESA listing for the Red Knot, protection efforts to date have failed to address site-specific threats to the Red Knot (i.e. habitat loss and availability of food at Delaware Bay) and have not led to the development and implementation of conservation and management strategies on the multi-state regional scale that are necessary for the preservation of the species.

Conclusion

The Red Knot is an extraordinarily well studied species of significant international interest. Scientific data on the Red Knot is abundant and numerous studies now document the species' rapid and alarming decline. The work of Morrison, Baker, Niles, and other internationally-renowned authorities provides nearly indisputable evidence of the precipice on which the Red Knot now sits. Rarely is available data as abundant and authoritative as it is with respect to the Red Knot. We are unaware of another species that—without immediate conservation action—is predicted to go extinct in such a short time horizon.

Petitioners urge the U.S. Fish and Wildlife Service to use its emergency authority to list the Red Knot as an endangered species under the ESA because "the best scientific or commercial data available" in this case clearly supports emergency listing.

Respectfully submitted,

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_____
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For Petitioners

Red Knot (*Calidris canutus rufa*)
Literature Cited

Alerstam, T., G. A. Gudmundsson, and K. Johannesson. 1992. Resources for long distance migration – intertidal exploitation of *Littorina* and *Mytilus* by knots *Calidris canutus* in Iceland. Okios 65: 179-189.

Alerstam, T., and A. Hendernström. 1998. The development of bird migration theory. J. Avian Biol. 29: 343-369.

Andres, B. A., N. Tsipoura, J. Burger, G. Breese, and K. Cole. 2003. Delaware Bay Shorebird-Horseshoe Crab Assessment Report; Biological Assessment, Shorebird Technical Committee, U.S.F.W.S.

Atlantic States Marine Fisheries Commission. 2004. Addendum III to the Interstate Fishery Management Plan For Horseshoe Crab. Fishery Management Report No. 32c: 1-9.

Atlantic States Marine Fisheries Commission. 1998. Interstate Fishery Management Plan for Horseshoe Crab. Fishery Management Report No. 32: 1-58.

Atkinson, P. W., G. F. Appleton, J. A. Clark, N. A. Clark, S. Gillings, I. G. Henderson, R. A. Robinson, and R. A. Stillman. 2003. Red Knots *Calidris canutus* in Delaware Bay 2002: Survival, foraging and marking strategy, British Trust for Ornithology. Report No. 308. (publication pending)

Baker, A. J., P. M. González, L. Benegas, S. Rice, V. L. D'Amico, M. Abril, A. Farmer, and M. Peck. 2005a. Annual international expeditions to study the Red Knot population in Rio Grande, Tierra del Fuego, 2000-2004. Wader Study Group Bull. 107: in press.

Baker, A. J., P. M. González, C. D. T. Minton, D. B. Carter, L. J. Niles, I. do Nascimiento, and T. Piersma. 2001. Hemispheric problems in the conservation of red knots (*Calidris canutus rufa*). *In* Proceedings of the VI Neotropical Ornithological Congress, International Shorebird Symposium, Monterrey, Mexico. pp. 21-28. Manomet, MA: Western Hemisphere Shorebird Reserve Network.

Baker, A. J., P. M. González, I. L. Serrano, W. R. T. Júnior, M. A. Efe, S. Rice, V. L. D'Amico, M. C. Rocha, and M. E. Echave. 2005b. Assessment of the wintering area of Red Knots in Maranhão, northern Brazil in February 2005. Wader Study Group Bull. 107: in press.

Baker, A. J., P. M. González, T. Piersma, L. J. Niles, I. L. S. do Nascimiento, P. W. Atkinson, N. A. Clark, C. D. T. Minton, M. K. Peck, and G. Aarts. 2004. Rapid population decline in red knot: fitness consequences of decreased refueling rates and late arrival in Delaware Bay. Proc. Royal Soc. London 271: 875-882.

Bernd-Cohen, T. and M. Gordon. 1999. State Coastal Program Effectiveness in Protecting Natural Beaches, Dunes, Bluffs, and Rock Shores. Coastal Management 27:187-217.

Blanco, D., H. R. Goi and G. Pugnali. 1992. [The importance of Punta Rasa, Buenos Aires Province, in the migration of the Red Knot (*Calidris canutus*).] El Hornero 13: 203-206.

Bottom, M. L., and R. E. Loveland. 1989. Reproductive risk: high mortality associated with spawning in horseshoe crabs (*Limulus polyphemus*) in Delaware Bay, USA. Mar. Biol. 101: 143-151.

Bottom, M. L., R. E. Loveland, and T. R. Jacobsen. 1994. Site selection by migratory shorebirds in Delaware Bay, and its relationship to beach characteristics and abundance of horseshoe crab (*Limulus polyphemus*) eggs. Auk 111: 605-616.

Boyd, H. 1962. Arctic summer conditions and British knot numbers: an exploratory analysis. Wader Study Group Bull. 64, suppl.: 144-152.

British Trust for Ornithology. 2005. BirdFacts (Red) Knot *Calidris canutus*. http://blx1.bto.org/birdfacts/results/bob4960.htm.

Brown, S., C. Hickey, B. Harrington, and R. Gill. 2001. The United States shorebird conservation plan, 2nd ed. Manomet, MA: Manomet Center for Conservation Sciences.

Clark, K. E., L. J. Niles, and J. Burger. 1993. Abundance and distribution of migrant shorebirds in Delaware Bay. Condor 95: 694-705.

Cramp, S., and K. E. L. Simmons, eds. 1983. The birds of the Western Palearctic. Vol. 3: waders to gulls. Oxford Univ. Press, Oxford.

Dekinga, A., M. W. Dietz, A. Koolhaas, and T. Piersma. 2001. Time Course and reversibility of changes in the gizzards of Red Knots alternately eating hard and soft food. J. Experimental Biol. 204: 2167-2173.

Dekinga, A., and T. Piersma. 1993. Reconstruction diet composition on the basis of faeces in a mollusc-eating wader, the knot *Calidris canutus*. Bird Study 40: 144-156.

Drent, R., C. Both, M. Green, J. Madsen, and T. Piersma. 2003. Pay-offs and penalties of competing migratory schedules. Oikos 103: 274-292.

González, P. M., T. Piersma, and Y. Verkuil. 1996. Food, feeding and refueling of Red Knots *Calidris canutus rufa* during northward migration at San Antonio Oeste, Rio Negro, Argentina. J. Field Ornithol. 67: 575-591.

Harrington, B. A. 2001. Red knot (*Calidris canutus*). In *The birds of North America, No. 563* (ed. A. Poole & F. Gill). 1-32. Philadelphia: The Birds of North America.

Harrington, B. A. 1996. The flight of the Red Knot. W. W. Norton and Co., New York.

Harrington, B. A., P. de T. Z. Antas, and F. Silva. 1986. Northward shorebird migration on the Atlantic coast of southern Brazil. Vida Silvestre Neotropical 1: 45-54.

Howe, M. A., P. H. Geissler, and B. A. Harrington. 1989. Population trends of North American shorebirds based on the International Shorebird Survey. Biol. Conserve. 49: 185-200.

International Wader Study Group. 2003. Are waders world-wide in decline?: Conclusions from the 2003 International Wader Study Group Conference. Cádiz. Wader Study Group Bull. 101/102: 8-12.

Jehl, J. R. 1994. Field estimates of energetics in migrating and downed Black-necked Grebes. J. Avian Biol. 25: 63-68.

Madsen, J. 2001. Spring migration strategies in pink-footed goose (*Anser brachyrhynchus*) and consequences for spring fattening and fecundity. Ardea 89: 43-55.

Manion, M. M., R. A. West, and R. E. Unsworth. 2000. Economic Assessment of the Atlantic Coast Horseshoe Crab Fishery, U.S.F.W.S.

Manomet, Western Hemisphere Shorebird Reserve Network. 2003. Delaware Bay. http://www.manomet.org/WHSRN/viewsite.php?id=6.

Mawby, F. 1984. Waders killed by hailstorm. Wader Study Group Bulletin. 42: 40.

Morrison, R. I. G., Y. Aubry, R. W. Butler, G. W. Beyersbergen, C. Downes, G. M. Donaldson, C. L. Gratto-Trevor, P. W. Hicklin, V. H. Johnston, and R. K. Ross. 2001. Declines in North American shorebird populations. Wader Study Bulletin. 94: 34-38.

Morrison, R. I. G., C. Downes, and B. Collins. 1994. Population trends of shorebirds on fall migration in eastern Canada 1974-1991. Wilson Bull. 106: 431-447.

Morrison, R. I. G. and R. K. Ross. 1989. Atlas of Nearctic shorebirds on the coast of South America. Can. Wildl. Serv. Spec. Publ. vol. 1-2.

Morrison, R. I. G., R. K. Ross, and L. J. Niles. 2004. Declines in wintering populations of red knots in southern South America. Condor 106: 60-70.

Myers, J. P. 1986. Sex and gluttony on Delaware Bay. Nat. Hist. 95: 68-77.

Myers, J. P., R. I. G. Morrison, P. Z. Antas, B. A. Harrington, T. E. Lovejoy, et al. 1987. Conservation strategy for migratory species. Am. Sci. 75: 19-26.

Nettleship, D. N. 1968. The incubation period of the knot. Auk 85: 687.

Nettleship, D. N. 1974. The breeding of the knot (*Calidris canutus*) at Hazen camp, Ellesmere Island, N.W.T. Polarforschung 44: 8-26.

Niles, L. 2000. New Jersey Division of Fish and Wildlife homepage. http://www.state.nj.us/dep/fgw/ensp/arctic2k.htm.

Niles, L., A. Dey, H. Sitters, and C. Minton. 2005a. Report on the Status of Red Knots on the Delaware Bay with Recommendations for the 2005 Field Season: New Jersey Division of Fish and Wildlife Endangered and Nongame Species Program.

Niles, L., A. Dey, H. Sitters, and C. Minton. 2005b. The Decline of the Red Knot. New Jersey Division of Fish and Wildlife Endangered and Nongame Species Program. Congressional Briefing, May 2005.

Parmelee, D.F., and S.D. MacDonald. 1960. The birds of west-central Ellesmere Island and adjacent areas. Natl. Mus. Can. Bull. 169. Ser. 63.

Parmelee, D. F., H. A. Stephens, and R. H. Schmidt. 1967. The birds of southeastern Victoria Island and adjacent small islands. Nat. Mus. Canada, Biol. Ser. 78, no. 222.

Paulson, D. 1993. Shorebirds of the Pacific Northwest. Univ. of Washington Press, Seattle.

Piersma, T. 1998. Phenotypic flexibility during migration: optimization of organ size contingent on the risks and rewards of fueling and flight. J. Avian Biol. 29: 511-520.

Piersma, T., and A. J. Baker. 2000. Life history characteristics and the conservation of migratory shorebirds. *In* Behaviour and conservation (M. J. Sutherland and L. M. Gosling, eds.). Cambridge Univ. Press, New York.

Piersma, T., M. W. Dietz, A. Dekinga, S. Nebel, J. Van Gils, P. F. Battley, and B. Spaans. 1999a. Reversible size-changes in stomachs of shorebirds: when, to what extent, and why?. Acta Orni. 34: 175-181.

Piersma, T. and R. E. Jr. Gill. 1998. Guts don't fly: small digestive organs in obese Bar-tailed Godwits. Auk 115: 196-203.

Piersma, T., G. A. Gudmundsson, and K. Lilliendahl. 1999b. Rapid changes in size of different functional organ and muscle groups during refueling in long-distance migrating shorebird. Physiol. Biochem. Zool. 72: 405-415.

Piersma, T., A. Koolhaas, and A. Dekinga. 1993. Interactions between stomach structure and diet choice in shorebirds. Auk 110: 552-564.

Pleske, T. 1928. Birds of the Eurasian tundra. Mem. Boston Soc. Nat. Hist. 6: 111-485.

Portenko, L. H. 1981. Birds of the Chuckchi Peninsula and Wrangel Island. Smithson. Inst., Washington, D.C.

Prater, A. J. 1972. The ecology of Morecambe Bay. III. The food and feeding habits of knot (*Calidris canutus* [L.]) in Morecambe Bay. J. Applied Ecol. 9: 179-194.

Robinson, R. A., P. W. Atkinson, and N. A. Clark. 2003. Arrival and weight gain of Red Knot *Calidris canutus,* Ruddy Turnstone *Arenaria interpres* and Sanderling *Calidris alba* staging in Delaware Bay in spring. British Trust of Ornithology. Report No. 307. 1-51.

Roselaar, C. S. 1983. Subspecies recognition in knot *Calidris canutus* and occurrence of races in western Europe. Beauforitioa 33: 97-109.

Sanderson, I. R. 2001. Nutritional factors and immune functions of gut epithelium. Proc. Nutr. Soc. 60: 443-447.

Schat, K. A. and Myers, T. J. 1991. Avian intestinal immunity. Crit. Rev. Poult. Biol. 3: 19-34.

Smith, D. and S. Bennett. 2003. Horseshoe Crab Spawning Activity in Delaware Bay: A Preliminary Report on 2002 and a Comparison from 1999 to 2002. Report to the ASMFC Horseshoe Crab Technical Committee.

Spaans, A. L. 1978. Status and numerical fluctuations of some North American waders along the Surinam coast. Wilson Bull. 90: 60-83.

Stiles, E. and D. Mizrahi. 2005. Meta-Analysis of Horseshoe Crab and Shorebird Research on the Delaware Bay—Are There Enough Horseshoe Crab Eggs to Sustain Spring Shorebird Migration?. Delaware Estuary Science Conference.

Strahlendorf, P. W. 1980. Migrant shorebird ecology. Ministry of Nat. Resour., Ontario.

Sutton, C. 2003. An Ecological Tragedy on the Delaware Bay. Living Bird. Cornell Lab of Ornithology 22. No. 3: 30-37.

Tomkovich, P. S. 1990. [Analysis of geographical variation in knot *Calidris canutus* (L).]. Bul. Mosco Soc. Nat., Bil. Div. 95: 59-72.

Tsipoura, N., and J. Burger. 1999. Shorebird diet during spring migration stopover on Delaware Bay. Condor. 101: 635-644.

U.S.F.W.S. 2004. Shorebirds The Delaware Bay Connection. http://www.fws.gov/northeast/primehook/Shorebirds%202004.pdf.

U.S. Shorebird Conservation Plan. 2004. High Priority Shorebirds – 2004. Unpublished Report, U. S. Fish and Wildlife Service, Arlington. 1-5.

Vooren, C. M., and A. Chiaradia. 1990. Seasonal abundance and behaviour of coastal birds on Cassino Beach, Brazil. Ornitologia Neotropical 1: 9-24.

Whitfield, D. P., and J. J. Brade. 1991. The breeding behaviour of the knot *Calidris canutus*. Ibis 133: 246-255.

Wildlife Associated Recreation on the New Jersey Delaware Bayshore: 2000. The Economic Impact of Tourism Based on the Horseshoe Crab-Shorebird Migration in New Jersey. http://www.fermatainc.com/eco_crab.html.

Zwarts, L., and A. M. Blomert. 1992. Why knot *Calidris canutus* take medium-sized *Macoma balthica* when 6 prey species are available. Mar. Ecol. Prog. Ser. 83: 113-128.