Wildlife Populations: Red Knot

Background

The red knot, *Calidris canutus rufa,* is an attractive shorebird that is listed as an endangered species in New Jersey and as a threatened species at the federal level.[1] The red knot has a remarkable life cycle with one of the longest migrations among Arctic-breeding shorebirds. After journeying from the southern tip of South America, red knots arrive on the shore of Delaware Bay in early May to feast on horseshoe crab eggs. The Delaware Bay is an important migratory stopover for six Arctic-breeding shorebirds: the ruddy turnstone, the sanderling, the semipalmated sandpiper, the dunlin, the short-billed dowitcher, and the red knot. The bay has the largest spawning population of horseshoe crabs in the Western Hemisphere, and crab eggs are a fat-rich food resource that allows birds to rapidly double body weight just prior to Arctic breeding. Packing on weight for long flights is a critical need for shorebird migrants during spring and fall migrations. Sufficient weight gain is statistically linked to higher adult survival and Arctic productivity in red knots.

Red Knot (Getty Images, 2019)

The red knot, with its straight black bill, is the largest and the stockiest of the shorebird migrants. Knots arrive on the bay in full breeding plumage – a distinctive breast of brilliant, rusty red and a patterned back of black, brown, and gray which provides camouflage when sitting on its nest. After breeding, red knots and other shorebird migrants come back through New Jersey in mid-July through September on their annual journey back to wintering grounds in South America.[2]

Red knots begin arriving on Delaware Bay during the first week of May. Between 1986 and 2002, their average peak population in May was approximately 43,000 birds (range 19,400 to 94,500). The average peak population dropped to just over 15,000 birds from 2003 to 2011 (range 12,000 to 24,000), which was the lowest peak average on record. This low population period followed unregulated horseshoe crab bait harvests in the mid-to-late-1990s. Between 2012 and 2018, the average peak count increased to 25,000 (range 18,000 to 33,000), but is still 42 percent below the historic average and well below the historic maximum count of 95,000 individuals.

Major concentrations of red knots are found along the southern bay beaches of Cape May County, which includes Reed's Beach south to Norbury's Landing spanning the US Fish and Wildlife Service Cape May National Wildlife Refuge (NWR) and also along northern bay beaches of Cumberland County (Dennis Creek Wildlife Management Area (WMA), Egg Island WMA, and Fortescue). Red knots, and 30 other Arctic-breeding shorebirds, can also be found in summer and fall using Atlantic coastal marshes and exposed tidal mudflats (Cape May to Barnegat Inlet) and high-energy beaches of the Cape May peninsula (e.g., Two-Mile Beach NWR, North Wildwood, Stone Harbor Point, Avalon and Strathmere), Atlantic County (Malibu Beach WMA, North Brigantine Natural Area, Edwin B. Forsythe NWR), Ocean County (Holgate Unit of Forsythe NWR), and Monmouth County (Sandy Hook National Seashore).

On Delaware Bay in the spring, red knots depend primarily on horseshoe crab eggs and, therefore, are frequently found in areas of dense horseshoe crab spawning, usually sandy beaches with gentle slopes and minimal wave action.[3] When they arrive on the bay, red knots have little or none of the fat they accumulated while in South America. Many birds will burn off fat and muscle to reach the bay arriving at or below fat-free weight (130 grams). By the end of May, red knots need to reach a minimum weight of 180 grams to reach Arctic nesting grounds in adequate breeding condition.

Red Knots (Getty, 2020)

Red knot success is closely tied to the productivity of spawning horseshoe crabs. Horseshoe crabs dig into the sand (5 to 30 cm deep) to lay clusters of eggs (3,000 -5,000 eggs/cluster). Red knots and other shorebird migrants rely on eggs exposed by the digging action of abundant spawning crabs laying eggs in successive spawning events. To create new nests, crabs inadvertently dig up and expose previously laid eggs. If crab numbers drop to a low density, then eggs remain largely unavailable to most shorebirds. Red knots have been observed feeding on mussel beds on the Atlantic Coast marsh in spring, but as a food resource, hard-shelled prey takes longer to metabolize into fat. Only abundant, fat-rich horseshoe crab eggs can be easily digested and quickly metabolized into fat during the brief May stopover period (12-14 days). When crab eggs were more abundant, knots could gain 8 to an astounding 15 grams of weight per day. Rapid weight gain is especially important for red knots migrating from greater distances (e.g., from Tierra del Fuego) that are more time constrained while on the Delaware Bay stopover. The loss of horseshoe crab egg resources most dramatically impacted these long-distance migrants. Figure 1 illustrates the migration path of the red knots that stopover in the Delaware Bay.

Figure 1. Red Knot Migration Path[4]

By late May to early June, with fat resources accumulated in Delaware Bay, the birds leave for the Canadian Arctic tundra. They arrive in early June often facing frozen conditions and substantial snow cover. Red knots make their nest scrapes in snow-free sections of barren rocky areas, well inland from coastal wetlands. After laying four eggs, the male and female share incubation and rely on body fat, accumulated in the Delaware Bay, for 1-2 weeks until snow melt and insect emergence. Invertebrate prey may be unavailable until the third or fourth week of June, when the eggs begin to hatch. Females begin migrating south by mid-July, followed by males and then hatching-year offspring. Significant numbers of long-distance red knots stopover in New Jersey on southbound migration starting in mid -July and remain for three to six weeks to make large weight gains (≥180 g) before departure for South America. Some portion of the hemispheric population remains in New Jersey for two months or more to molt flight feathers (short-distance migrants). Abundant intertidal prey including small clams, mussels, and marine invertebrates, along beaches, inlets, and back bays, allow long-distance migrants to make large weight gain prior to trans-Atlantic flights to South American wintering areas. Short-distance migrants remain on New Jersey's Atlantic Coast for more than two months to undergo flight feather molt before sub-freezing weather in late -November and December pushes birds to southeast US and Caribbean wintering areas.

Status and Trends

The weight of evidence strongly indicates that the loss of horseshoe crab egg resources in Delaware Bay since the late 1990s has caused the red knot stopover population to decline.[5] In general numbers, both horseshoe crabs and red knots declined by over 70 percent since the early 1990s.[6, 7] Five other shorebird species that rely on the Delaware Bay declined overall by 50 percent during the period 1998 to 2007.[8]

The red knot stopover population in Delaware Bay declined relatively rapidly from the late 1990s to 2004. From 2004 to 2011, the stopover population appeared to stabilize at a lower level (See Figure 2). From 2012 to 2019, the stopover population increased to an average peak count of 25,500 red knots, an improvement over the previous nine years, but still much lower than the 1997 to 2002 average of 42,000. The long-term aerial survey (1986-2019) was designed to assess the trend in bird relative abundance on bayshore beaches. This peak count is not a true population estimate as it does not account for the turnover of birds during May, but it is an important index of annual foraging conditions. When eggs are available on many beaches, more birds remain in the bay (e.g., 2019 red knots peaked at approximately 33,000); when eggs are scarce, fewer birds tend to remain (e.g., 2017 red knots peaked at approximately 18,000 individuals). A statistical population estimate, derived from resighting marked red knots,[9] has remained at ~45,000 individuals since the method was implemented in 2011.[10]

There is some evidence of recent improvements in the portion of red knots reaching a departure weight of 180 grams by May 26-28; in 2008 this portion was 14% but had climbed to 54% by 2012. Since 2012, nearly half of red knots coming to the bay reach 180 grams in most years, but there is substantial year-to-year variability and no clear increasing trend; (Figure 2). While conditions have improved since the 2000s, egg resources once supported 40,000 to 50,000 red knots in 1997-1998 with 60-87% reaching adequate departure weight.

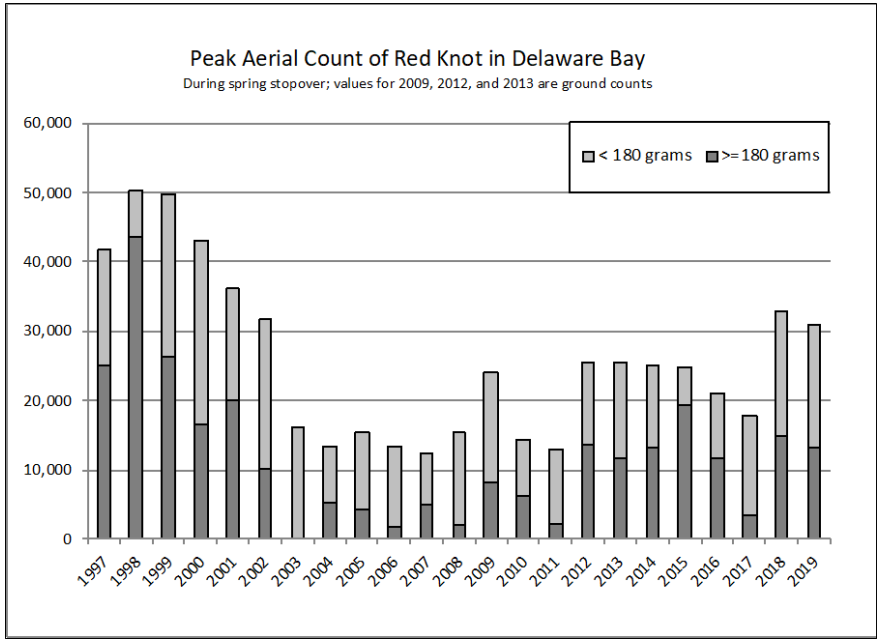

Figure 2. Peak Aerial Count of Red Knot in Delaware Bay

At least some of the improvement in the portion of birds weighing ≥180 g is due to favorable weather, allowing more widely distributed crab spawning and egg resources and less competition among shorebirds. In addition, since 2003 there have been robust efforts to reduce human disturbance on NJ Bayshore beaches allowing red knots and other shorebirds to maximize foraging time on limited egg resources.

Mean available egg densities that are located in the top 5 cm of sand are in the same range as in 2005, when NJDEP competed the first baywide egg surveys in both NJ and DE, and remain well below 50,000 eggs/m^2, the minimum considered necessary to begin red knot recovery, (Figure 3).[11, 12] Mispillion Harbor, DE, is an exception. This area has protection from severe weather, and earlier warming of water, which favors consistently high densities of spawning crabs and surface eggs– more than one to two orders of magnitude larger than mean egg densities on all other Delaware and New Jersey beaches. While Mispillion Harbor is very important, it can support only a portion of red knots and other shorebirds that come to the bay.

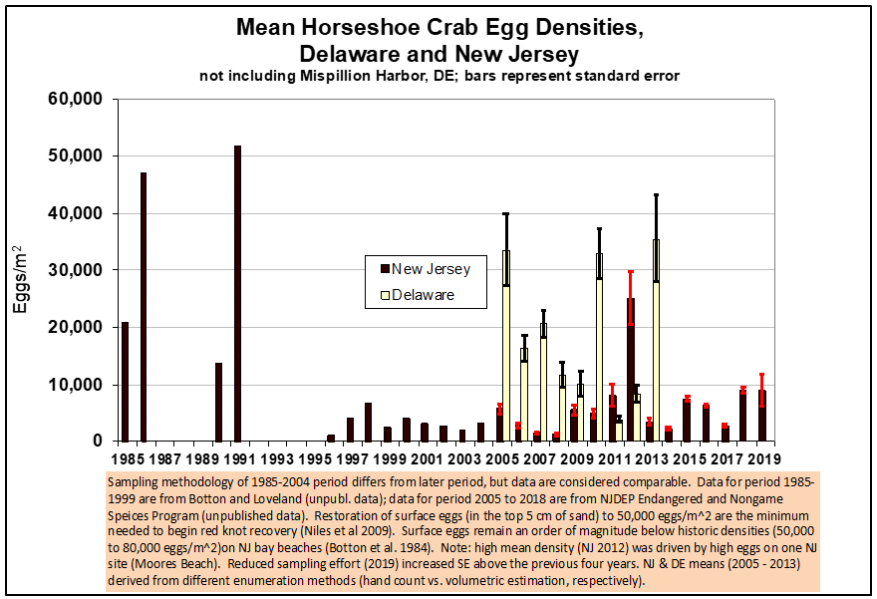

Figure 3. Mean Horseshoe Crab Egg Densities, Delaware and New Jersey

The red knot abundance in the main South American wintering areas in Tierra del Fuego, Chile, appeared to decline from 15,512 in 2010 to 13,190 in 2019.[13] Since 2010, this wintering population has fluctuated annually between ~10,000 and 15,000 individuals. As recently as 2000, however, this single wintering site held the majority of the Western Hemisphere's red knots (>51,000).[14] This wintering population, comprised of long-distance migrants, has declined most rapidly; 74% in 20 years. Overall, a hemispheric population estimated at 160,000 individuals in the mid-1980's[15] may number just under 45,000 as of August 2019.[16]

Outlook and Implications

Most biologists agree that the red knot population will take time to recover because of normally low reproductive rates associated with Arctic-breeding shorebirds. When Arctic conditions are favorable, red knots are relatively long lived and reproduction is typically episodic, but the key to adult survival and reproductive success is fat stores from Delaware Bay. A rapid recovery of horseshoe crabs and eggs (within 10 years)[17] would allow the majority of red knots to maximize productivity, stabilize and begin population recovery.

Management efforts by the States and the Atlantic States Marine Fisheries Commission (ASMFC) led to a decrease in harvest of Delaware Bay Origin horseshoe crabs from over 2 million per year in the late 1990s to approximately 500,000 per year in 2009-2012.[18] In 2013, harvest increased to 730,000[19] primarily due to the implementation of an all-male harvest in DE, MD and VA and the larger quota of male crabs allowed in these three states. The harvest dropped below 600,000 in 2014 and 2015, then increased in 2016 and again in 2017 to 780,000[20] (see Figure 4).

Adult Horseshoe Crab (Getty Images, 2019)

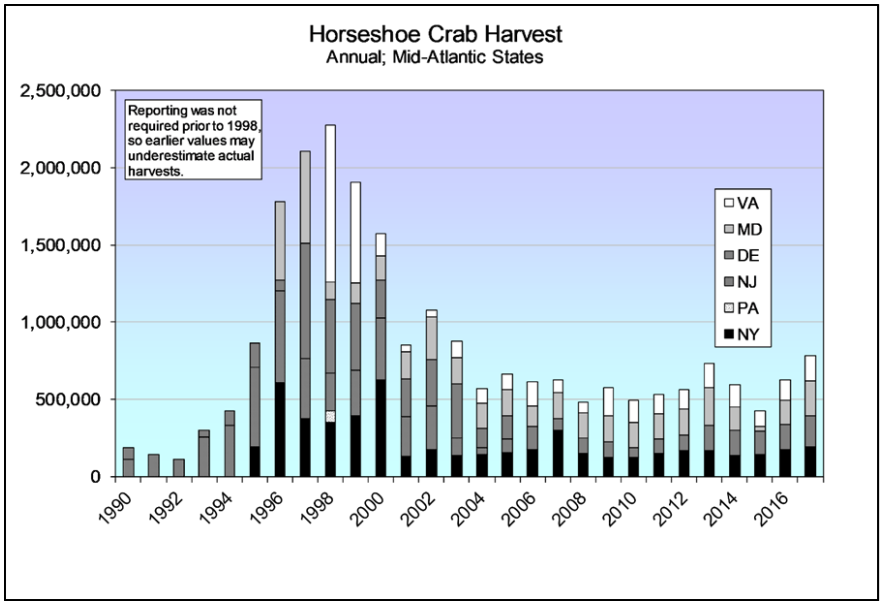

Figure 4. Horseshoe Crab Harvest, Annual; Mid-Atlantic States

The Atlantic coast benthic trawl survey has shown no substantive or sustained trend in horseshoe crab abundance, particularly mature females, since 2008.[20] This trawl survey was designed and sanctioned by ASMFC Technical Committees.

American horseshoe crabs have been classified as "Vulnerable" reflecting an elevated risk of extinction.[21] On March 25, 2008, in an effort to increase horseshoe crab populations, the New Jersey legislature passed and then New Jersey Governor Corzine signed legislation enacting a moratorium on the harvesting of horseshoe crabs that is to remain in place until the populations of both horseshoe crabs and red knots have returned to a level where they will be self-sustaining as determined by a peer-review panel of qualified shorebird and horseshoe crab ecologists and the Endangered and Nongame Species Advisory Committee. However, it is increasingly clear that without significant additional reduction of horseshoe crab mortality, particularly mature females, from various sources including bait harvest, lysate production for the biomedical industry, by-catch, and illegal harvest, horseshoe crabs and their eggs are not likely to increase in the short-term, and this continues to jeopardize red knot recovery. Of equal concern, the fisheries for which horseshoe crabs are used as bait, American eel and Whelk, are themselves overfished. American eel is classified by ASMFC as a "depleted stock".[22] While the Whelk fishery remains unregulated, the ASMFC raised concern over the dramatic increase in coastwide Whelk landings (all four species) since 2005.[23] Like horseshoe crabs, whelks have slow growth and extended age to sexual maturity making them highly sensitive to overfishing.[21] For more information on horseshoe crabs, please see the *Wildlife Populations: Horseshoe Crab* chapter in this Environmental Trends series (https://www.nj.gov/dep/dsr/trends/wildlife-horseshoe.pdf).

In an effort to offset the continued impact on the red knot, biologists have also initiated several management programs to improve conditions for red knots and horseshoe crabs, primarily enforcing restricted access to important beaches on the Delaware Bay to prevent the disturbance of feeding shorebirds. This volunteer protection program includes two Atlantic coast areas important for shorebird roosting and foraging. In addition, projects to determine annual red knot population status continue. These projects include collection of key data for long-term model development, horseshoe crab egg counts, shorebird weight surveillance, and individual marking of red knots for annual survival and population estimates.

Restoration of horseshoe crab spawning habitat has continued since 2013. With initial funding from the National Fish and Wildlife Foundation, Community Foundation of NJ and the Department of Interior, over one mile of spawning beach in Cape May and Cumberland Counties was restored after Hurricane Sandy (2013-2014). Dyers Cove in Cumberland County and Cooks Beach in Cape May County were restored in 2016 and 2019, respectively, by the American Littoral Society who is also conducting experimental work to increase elevation/revegetation of marsh damaged by salt hay farming.[21,25] Over 10,000 acres of Delaware Bay marsh were previously diked and farmed. Continued restoration efforts is expected to increase populations of horseshoe crabs and red knots (see http://www.restorenjbayshore.org/).

More Information

Migratory Shorebirds:

https://www.njfishandwildlife.com/ensp/shorebird_info.htm
http://www.conservewildlifenj.org/protecting/projects/shorebird/

Shorebird and Horseshoe Crab Spawning Beach Restoration - Projects and Reports:

https://www.littoralsociety.org/horseshoe-crabs.html
http://www.restorenjbayshore.org/
https://www.nfwf.org/media-center/videos/ready-red-knots

Inquiries regarding red knot survey data should be directed to Amanda Dey, Principal Zoologist, Endangered & Nongame Species Program, Division of Fish and Wildlife, 8747 Ferry Road, Millville, NJ 08332 (856) 785-2711 amanda.dey@dep.nj.gov or Kathy Clark, Supervising Zoologist, Endangered & Nongame Species Program, Division of Fish and Wildlife, 500 E. State Street, P.O. Box 400, Trenton, NJ 08625-0400, (609) 292-9400 or (609) 628-2103 kathy.clark@dep.nj.gov.

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