

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 km² of land of which about 35,000 km² 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 km² 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

the significant amount of work that has already been accomplished by scientists throughout the western Atlantic flyway. In Delaware Bay, the departure mass of Red Knots has been linked to survival rates and would serve as a key indicator of the vitality of the stopover. Weight gain achieved is primarily influenced by the availability of food resources (horseshoe crab eggs) and weight on any particular date is a function of that as well as arrival date and arrival condition. Therefore, these interrelated effects need to be monitored carefully.

A bay-wide survey of crab eggs was implemented in 2004 after 5 yr of similar surveys conducted on the New Jersey side of the bay. Moreover a bay-wide survey of spawning crabs has also been conducted since 1999 and could serve as a useful counterpart to the egg survey. Finally, a count of shorebirds on the bay has been conducted by New Jersey Fish and Wildlife since 1986. The best monitoring tool for the long term is a model based on four main parameters: shorebird numbers, egg densities, crab numbers and departure-weight profiles.

Survival rate is a critical input into long-term modeling of the population. Banding with individually identifiable flags allows for yearly assessment of the survival of birds coming through the Delaware Bay. Ultimately, banding in each of the three major wintering areas, Tierra del Fuego, Maranhão and the southeastern U.S., coupled with stable isotope studies will help distinguish survival rates related to each. A continued focus on resighting flagged birds must be a key element of monitoring, at least until recovery is assured.

With populations of shorebirds and crabs in Delaware Bay at such low levels, departure weights may also be influenced by competition for eggs from other species, particular Laughing Gulls, as well as disturbance especially in areas of high egg density. Therefore, in the short term it will be necessary to monitor disturbance and gull populations as inputs into the model based primarily on the four parameters mentioned above. Ultimately, the model could help decide the size of the horseshoe crab harvest for bait or as a source for lystate that is consistent with maintaining the shorebird population. The goals of management in Delaware Bay should be: (1) that the majority of the Red Knots (>80%) reach a departure weight of at least 185 g by the end of May, and (2) the peak stopover population of Red Knots increase to at least 100,000 as it was in the 1980s.

More comprehensive monitoring of the effect of management on the Red Knot population will come from the continuation of yearly counts in the primary wintering areas. The Patagonia

counts have been carried out every year since 2000 allowing direct comparison with the population size at the time of the first comprehensive survey in the mid-1980s. A new count was carried out along the coast of Maranhão, northern Brazil, in February 2005 and if this can be repeated regularly, it too may serve as a useful measure of recovery. The wintering population in the southeastern U.S. must also be monitored with the same intensity as in Patagonia. The Florida Division of Fish and Wildlife intends to restart a coast-wide survey of shorebirds, first conducted in 1996. This survey, or at least that part that relates directly to Red Knots, should be conducted every year.

The population of Red Knots breeding in a study area of 9.2 km² on Southampton Island in arctic Canada was surveyed from 2000 to 2004. During this time it fell from about 1–0.3 nests/km². No survey was possible in 2005 due to lack of funds. These surveys are logistically challenging and costly and this means that it is difficult to expand them to an area of sufficient size to make year-to-year comparisons statistically robust. However, they would be a useful means of measuring recovery. Therefore, if at all possible they should be continued in order to monitor future change. The nest densities of Red Knots can be compared with those of other species to determine whether population change is likely to be the effect of arctic breeding conditions or factors affecting them elsewhere.

CONSERVATION GOALS AND THE SURVEYS, MONITORING, RESEARCH, AND MANAGEMENT NEEDED TO SUPPORT THEM

Brown et al. (2001) proposes a tentative target for restoration of the *C. c. rufa* population to 240,000. Though we agree that this would be desirable and would ensure *C. c. rufa*'s future, it does not now seem to be realistic. Moreover, no evidence exists that the population was ever that large. Overall the goal of conservation activities throughout the flyway should be to increase the *C. c. rufa* population to at least the figure of 25 yr ago of 100,000–150,000 by 2015. Given the uncertain genetic relationships between the three main wintering populations, there should also be a target for each. The following are suggested: (1) Tierra del Fuego wintering population increased to 70,000–80,000 birds, (2) Brazilian wintering population increased to 20,000–25,000, (3) Florida wintering population increased to 20,000–25,000, and (4) other sites increased to 15,000–20,000.

The means whereby such population increases might be achieved include: