

REPORT TO DELAWARE COASTAL MANAGEMENT PROGRAM ON THE INTERNATIONAL EXPEDITION TO DELAWARE BAY, 1998

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INTRODUCTION

A team of international scientists hosted by Dave Carter of the Delaware Bay Coastal Management Program travelled to Delaware Bay in late April - early June, 1998, to study the migration, conservation and ecology of shorebirds. Each year for the past three years, this team, composed of experts in shorebird research from Australia, the UK, The Netherlands, the United States and Canada have travelled to the beaches of Argentina and Brazil in March, where they visit "staging" areas, places where shorebirds rendezvous to replenish their fat reserves before continuing north. One species in particular, the Red Knot (*Calidris canutus*), is the focus of the team's research. The team then "follows" the birds to Delaware Bay, perhaps the most important staging area on the migration route, each May.

Delaware Bay is not a random choice as a staging area. Its importance is in the plentiful food source it provides in Horseshoe Crab eggs, which are a vital component in the survival and successful breeding of many species of shorebirds migrating northwards to the arctic breeding grounds. The timing of migration coincides with the spawning of hundreds of thousands of Horseshoe Crabs (*Limulus polyphemus*) on the beaches of Delaware and New Jersey each May. Their eggs are the principal food source for the Knots, and for two other species of shorebirds, Sanderling (*Calidris alba*) and Ruddy Turnstone (*Arenaria interpres*). This food supply makes Delaware Bay the most important link on the West Atlantic Flyway between the birds' wintering and breeding sites.

GENERAL ACCOUNT

A small, preliminary team arrived at Slaughter Beach, the Delaware base of operations, on April 25, 1998. It was early yet for crabs and birds to be showing up in significant numbers, and the first several days were spent making equipment and reconnoitring the local beaches to determine what species and numbers of birds were present. By arriving slightly before the birds, researchers were able to obtain important information about the general condition, breeding plumage, body weight, etc of the birds at arrival. The majority of the team were scheduled to arrive in mid-May, which coincided with the arrival of the majority of birds. This advance team was led by Clive Minton, from Australia, and two staff from the Royal Ontario Museum, Toronto, Canada. David Carter from the Delaware Coastal Management Program facilitated the work of the team by arranging accomodation, transport, communications, facilities, and general logistical support through his staff, for which the team was very grateful and appreciative.

Initial reconnaissance in Delaware took place on April 26, 1998, at various locations within

several miles of the Slaughter Beach base, including Mispillion Harbour, Big Stone Beach, North and South Bower's Beach, Bennett's Pier, Ted Harvey Wildlife Reserve, Kitt's Hummock, Port Mahon, and Bombay Hook Wildlife Reserve. No Red Knot were observed at this time, though 350 Sanderling were seen on Slaughter Beach and 20 Sanderling and five Turnstone were seen at Ted Harvey. On April 28, the first two Knot were counted at Mispillion Harbour on the man-made breakwall 50 yards from shore.

The first catch of shorebirds in Delaware was made directly across the road from base camp at Slaughter Beach on April 29th, and yielded 70 birds, mostly Sanderling and Turnstone. Joining the team were staff and volunteers from the Delaware Coastal Management Program. As we began to weigh, measure and band the birds, it became apparent that most of these birds had only just arrived from South America, as body weights were very low and many had less than 50% of their breeding plumage. This modest catch provided important data about the birds condition on arrival, and if we were fortunate enough to catch them again before they departed for the Arctic, we could gauge their success in replenishing body fat and observe any other changes in their condition. There were no Red Knots in this catch, which wasn't surprising since we had only seen two individuals thus far in the area. Another small catch of 17 Turnstones (of ca. 90 censused) at Mispillion Light on 2 May also provided important early data.

On May 1, 1998, the first reconnaissance on the New Jersey side of the Bay was conducted at Reed's Beach and Moore's Beach. The first catch in New Jersey took place on May 2. Assisting us were Larry Niles and Kathy Clark from the New Jersey Endangered & Non-game Species Program, (Division of Fish & Wildlife), who were eager to fit radio transmitters on several Knots for a research project investigating how much the birds move between the New Jersey and Delaware sides of the Bay. While our first catch in New Jersey was also largely Sanderling and Turnstone, we were successful in catching 13 Knots, and five of those birds were fitted with the transmitters. Two days later, the signals from two of those five were picked up in Delaware, proof that the birds do move between the two sides of the Bay. As few crabs had come ashore at that point in New Jersey, and a modest number had come ashore in Delaware, this seemed to confirm the theory that the crab numbers are the key factor which determine where the birds go.

Over the next several days, the numbers of birds continued to rise steadily. Two more catches in Delaware, one at Mispillion Light and one at Slaughter Beach, yielded over 500 birds, and although these were still mostly Sanderling and Turnstone, five more Knot were fitted with radio transmitters. By 6 May, the number of Knot censused had risen to around 1,500 in the Mispillion/Slaughter Beach area. This was still a long way, however, from the tens of thousands expected by mid-month. Unfortunately, the weather changed drastically on May 7th as a noreaster blew into Delaware Bay, and the spawning of crabs and arrival of birds in Delaware was delayed for over a week as the coastline was battered by the storm. A major influx of spawning crabs had been anticipated with the full moon on May 11, but that evening the beaches in Delaware were virtually empty. The weather did not ameliorate until May 19, but the storm had left the beaches covered in black detritus and the crabs did not begin to return to spawn until several days later.

Despite the poor conditions, a modest catch of ca. 170 birds, 90 of which were Knot, was made on May 9 at Mispillion Light, DE. Of significance in this catch were two Knots banded in Brazil (year unavailable), another banded in Delaware, 1997, and one banded in Tierra del Fuego in 1995. Another small catch of 25 Knot at the same location on March 14 yielded one individual which had been banded in San Antonio Oeste, Argentina, in March 1998. The majority of birds, however, had headed over to the New Jersey side of the Bay where the weather was more hospitable, and it was here that the numbers of birds began to increase dramatically. The team was joined in mid-May by Allan Baker from the Royal Ontario Museum and Patricia Gonzalez and Maria Eugenia Echave from Argentina. Also joining the team were eight volunteers from the Wash Wader Ringing Group in the UK. Their arrival coincided with a large influx of birds, and two catches in New Jersey between May 15-21 yielded 307 Knot. A catch at Slaughter Beach on 20 May showed a wide variation in bird weights (one knot weighed a scant 90 g while another one weighed 166 g), which indicated that many birds were still arriving from South America, while others had been in the Bay fattening up for several weeks.

The number of birds continued to rise over the next several days, and their weights continued to reflect the presence of new arrivals. As the days progressed, however, the gap between the highest and lowest weights in each catch narrowed. Favourable weather conditions and the large number of crabs which were now spawning resulted in fairly consistent weights of ca. 180-200 g and a top weight of 240 g. Some of the late arrivals increased their body fat at incredible rates, including one retrapped bird which gained 37 g after it was originally caught only three days earlier.

The number of shorebirds in the Bay peaked the last week in May as they began flocking prior to migration. Censusing of a roosting flock at dusk at Stone Harbour in New Jersey reported 20,000 birds, and large flock were also observed at the Ted Harvey Conservation Area in Delaware. On the same day that these roosting birds were counted, a nearly Bay-wide count of Knot returned a total of nearly 80,000. This was the highest number seen in the Bay, and suggests that the population is declining quite sharply from about 120,000-150,000 birds recorded in the previous decade. The average weight of birds caught peaked at 199.8 g on May 29th, the last occasion during the expedition that Knots were caught. The majority of the team members departed on May 30, with a few members remaining to wrap up the expedition, which ended on June 3.

Censuses in the area around Slaughter Beach turned up a scant number of Knots on June 1, and we only made small catches of 20-30 Sanderling and Turnstone at Slaughter Beach and Fowler's Beach in the next two days. With these last two catches, we were assisted by staff of the US Fish and Wildlife Service, who kindly provided staff and equipment (including a huge Marsh tractor which transported us along an extensive stretch of Fowler's Beach) to assist us in our efforts.

At the peak of migration during the month of May, it was estimated that over 75,000 Red Knots were present in Delaware Bay, along with hundreds of thousands of Sanderlings and Turnstones. In total, the team banded 4,061 birds during the month long expedition (Table 1). Of that number, 16 birds were retraps originally banded in South America, and 34 were retraps originally

banded in Delaware Bay in previous years. One retrapped bird had been banded in Delaware 12 years earlier, indicating a high level of site fidelity in the population (Tables 2 and 3).

SUMMARY OF 1998 RETRAPS

Red Knot

Fourteen of the 932 Red Knot caught on Delaware Bay in 1997 were recaptured in 1998. All had been banded on the Delaware side of the Bay, but eight of them were recaptured on the New Jersey side. Taking into account approximately equal numbers caught on both sides in 1998, this suggests half of the birds present in Delaware in 1997 were in New Jersey in 1998.

Ten birds banded in Delaware in 1998 were recaptured in the same season (out of 1,191 newly banded). Four had crossed to New Jersey. The only New Jersey 1998 bird we retrapped had remained there. One bird retrapped at Reed's Beach had been banded there 12 years previously (by Brian Harrington).

There were no recaptures in Delaware in 1998 of Red Knot banded in New Jersey. However, several birds with radio transmitters moved from New Jersey to Delaware and there were several sightings in Delaware of birds colour-banded in 1998 in New Jersey. These observations indicate that some New Jersey to Delaware cross-Bay movements did occur.

Overall, Red Knot appear to be quite mobile within the Bay, both between years and in the same season. In addition to cross-Bay movements there were also three retraps (out of six) and many colour band sightings and radio transmitter records of birds that had moved location significantly, but remained on the same side of the Bay in 1998.

In catches of Knot up to (and including) 9 May there were five Brazilian-banded birds and only one Argentinian-banded bird out of only 169 Red Knot caught. Subsequent to that date, four Argentinian and only three Brazilian Knot were recaptured out of a further 1062 birds caught. The early Brazilian-led contingent was later diluted by Argentinian and US-flagged birds. The first Argentinian bird captured on 9 May was from the 1995 catch in Tierra del Fuego. The first 1997/98 colour-marked Argentinian bird was not seen until 13 May, and the first was caught on 14 May.

Turnstone

Twelve out of 719 Turnstone caught in Delaware Bay in 1997 were recaptured in 1998. All but one had been banded on the New Jersey side of the Bay. Only one bird had relocated to the other side of the Bay, from New Jersey in 1997 to Delaware in 1998.

There were 16 recaptures in 1998 of birds banded in the same season (out of 1680 newly banded),

with eight on each side of the bay. Only two had moved across the Bay, both from Delaware to New Jersey. One of these was recaptured the next day; it was banded 1 May at Mispillion Harbour and retrapped 2 May at Reed's Beach.

Overall, Turnstone appear to be less mobile and more site-faithful than Red Knot in Delaware Bay, both between years and within the same year.

Sanderling

Only three out of 310 Sanderling banded in 1997 were recaptured in 1998. All were at the same locations where they were originally banded. There were 12 recaptures in 1998 of birds banded in the same season (out of 912 newly banded birds). Eleven of these had been banded in Delaware and 4 of these had crossed the Bay to New Jersey. Three of these had been banded early in the season and may have crossed the Bay in response to the stormy weather on the Delaware coast in the second week of May.

Only one bird banded in 1998 on the New Jersey side of the Bay was recaptured (at its same location), even though similar numbers were caught on both sides of the Bay. A bird banded near Reed's Beach, New Jersey, in 1996 (by Nellie Tsipoura) was recaptured there in 1998.

SUMMARY OF 1998 WEIGHT DATA

Red Knot

Nine samples of Knot caught between 2 - 20 May had mean weights averaging between 109g and 125g, with little difference between Delaware (six samples) and New Jersey (three samples). The standard deviations remained fairly constant in this period, also indicating that the low means were not just caused by new arrivals but also by birds not putting on weight at any significant rate overall - the mean for three retraps within this period was 2.1g/day. This was presumably because of the constant N.E. winds, rain and cold temperatures, continuous between 7 and 13 May.

There was a massive increase in average weights of Knot in New Jersey as the weather ameliorated and a sample of 88 birds on 21 May had an average weight of 177g, with a few birds already reaching 200g (Fig. 1). Weights rose rather more slowly at first in Delaware, where the storms had been most severe and the initial horseshoe crab eggs had been totally washed away, but on both sides of the Bay average weights rose to over 190g by 27 May. The peak was 199.8g in New Jersey on 29 May, when one individual had reached 240g.

Based on the New Jersey samples of 15 and 27/29 May the average weight increase of the population was 5.3 to 5.6g/day. Based on the Delaware samples of 20 and 28 May the increase averaged 8.9g/day. In 1997, the Delaware Knot population averaged weight gain rates of 7.0/day in the period 18 to 26 May, with a peak rate of 15g/day between 22 and 24 May. By any

standards these are phenomenal rates of weight increase from birds with a fat-free weight of around 115g .

The weights of eight individual Knots retrapped in the second half of May showed wide variation. The capability of extremely high rates of weight gain when horseshoe crab eggs are plentiful, as they were in Delaware in 1997 and in late May in 1998, was shown by two birds. One gained 37 grams in three days (12.3g/day) from a low (100g) starting point; and the other gained 38g in five days (7.6g/day). Long-term retraps showed somewhat lower rates (4.3g/day over 19 days and 3.8g/day over 16 days). Two birds which already weighed over 190g when first caught showed little change (one +2g, the other -2g) over a four day period, suggesting they might by then have been “cruising” to their take-off date.

An anomalous result was a bird which lost 26g in four days (-6.5g/day). Whilst it is known that some shorebirds may lose weight for a few days after capture, thus leading to some caution in the use of individual retrap weights to deduce weight gain rates, this example is so gross that other factors may have been involved. One of these factors could be feather molt, as retrapped late molting birds lost weight, or their weight remained stable (Fig. 2).

Overall it can be concluded that Red Knot on Delaware Bay seemed to successfully reach average take-off weights of 190-200g before the end of May in 1998, in spite of extremely poor weather for horseshoe crab egg production being prevalent until the middle of the month. It should be noted that the weather was, in contrast, exceptionally warm and clear during the second half of May and that this continuous period of weather favourable to horseshoe crab egg production may not occur every year. Also, catch sampling ceased before all birds had departed, and it is not known if the whole population reached take-off weight in time to reach the breeding grounds on schedule.

Turnstone

Turnstone weights followed a similar pattern to those of Red Knot in the period up to mid-May. Average weights of eight samples obtained up to 15 May (five Delaware, three New Jersey) varied between 95 and 103g, with no significant difference between the two sides of the Bay.

Many birds arrived below their fat-free weight, with quite a few birds in the 80-90g range and with the occasional bird even below this (including one at 73g). As with Knot, the unsettled weather appeared to cause a food shortage such that early arriving birds were unable to take advantage of an early start to the fat accumulation. Three individuals retrapped in this period confirmed the nearly static weights, averaging increases of only 0.3g/day.

Unfortunately, as in Red Knot and Sanderling, no samples were obtained in the 16-19 May period to indicate exactly when the upturn in weights commenced. As in Knot, the New Jersey average weights were initially ahead of those in Delaware, with the Reed’s Beach catch of 21 May averaging 135g (Fig. 3). Based on average weights this was an increase of 38g in six days from

15 May - i.e. 6.3g/day. In Delaware the increase between 14 and 23 May was 35g in nine days - i.e. 3.9g/day. Seven individuals recaptured in the 21 to 25 May period showed average weight increase rates of 3.3g/day (3.9g/day if one bird which only gained 1g in five days is excluded). These weight gain rates are rather lower than achieved by Red Knot in the same time period, even allowing for the slightly lower fat-free weight of Turnstone (around 95g).

The maximum average weight achieved was 156g in a sample of 98 birds in Delaware on 28 May. This is probably still a little below the average departure weight as it contained some birds still well below the average. Although there were big departures of migratory birds in the 26-29 May period there were significant numbers of Turnstone still present, at least in Delaware, until at least 2 June. In future years we need to obtain a sample at a later date than was possible in 1998, which may well indicate that average departure weights reach 160g or more.

Retraps of a further five individuals in late May indicate that Turnstone do not seem to reach the dramatic levels of weight gain that some Knot do. The maximum recorded for an individual Turnstone is 5.4g/day (two birds, one achieving this average over a five day period and the other over a 14 day period). This is nevertheless an extremely high rate of weight gain (5-6% per day based on fat free weight) compared with that achieved by migrant shorebirds elsewhere in the world. The overall percentage weight gain over the fat-free weight also seems to be rather less in the Turnstone than in the Knot - about 65%. This difference is surprising considering both species are thought to be aiming for the same destinations and at the same time period.

Sanderling

The average weight of the first sample of Sanderling, caught in Delaware on 29 April, was only 49.6g. Average weights remained below 60g in Delaware right up until 22 May (58g), though by this time some individuals were gaining weight and the mean was depressed by newly arriving thin birds.

Ten individuals retrapped in the period up to 15 May (nine banded in Delaware, though two Delaware birds had crossed to New Jersey) showed minimal weight increases. Though all but two showed an increase (one was static and one lost 7g in three days), none reached a rate of 1g/day and the average (excluding the one which lost weight) was only 0.3g/day.

It is clear, therefore, that Sanderling suffered more than other species from the dearth of horseshoe crab eggs in the first half of May and this also probably accounts for the number of cross-Bay movements as birds searched for food resources.

Weights on the New Jersey side of the Bay started to improve from mid-May. Between 15 and 21 May average weights increased by 2g/day. One individual recaptured on 21 May had increased its weight at the rate of 1.7g/day over a 15 day period. However, average weights continued to be held down by a small number of thin birds in the population and had only reached 77g by 27 and 29 May in New Jersey (Fig. 4).

Small samples (totalling 32 birds) were captured in Delaware on 1 and 2 June, and these probably gave a truer indication of the average take-off weight at 87g. Several birds weighed over 100g, but none quite matched a weight of 106g achieved by one bird at Reed's Beach, New Jersey, on the early date of 21 May.

Considering that many Sanderling arrived weighing less than 50g (down to 38g) and that minimal weight increases were achieved in the first half of May, it is amazing how successful the birds appear to have been in gaining the required take-off weights by late May/early June. It should be noted, however, that sampling ceased before all birds had left and it is possible that not all successfully migrated on time. Based on an estimated fat free weight of 53g, the take off weight average represents around a 65% addition to the fat free weight, similar to the Turnstone. With birds on average arriving at below fat free weight, the actual addition achieved on Delaware Bay is more like 75 to 80%.

CONCLUSION

Massive horseshoe crab egg production in the last two weeks of May appears to be absolutely critical to birds achieving the weight necessary for the last stage of their journey to the breeding grounds. The rates of weight gain achieved are unprecedented and well above those recorded at other shorebird stopover locations around the world. These abundant resources have led to the evolution of a migratory strategy which concentrates a large portion of the shorebirds in the West Atlantic flyway population at one site, Delaware Bay, for its last refuelling stop. With many birds arriving at 10-20% below their fat-free weight, and the average take-off weight being around 80% above the fat-free weight, birds are on average nearly doubling their weight during their 2-3 week stay in Delaware Bay each May. Any diminution of food supply could potentially affect their ability to successfully achieve the necessary fat deposition, and thus would jeopardize their survival and successful reproduction in the often harsh conditions on arrival in the arctic breeding grounds. Continued research on Horseshoe Crab population size and spawning rates is an urgent priority in Delaware Bay, as is the impact of harvest level on the number of eggs available to the birds.

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