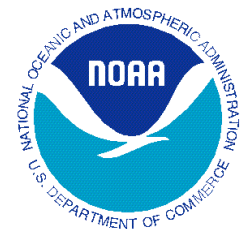


Delaware Shorebird Monitoring Team Annual Report 2002



Purpose of the Delaware Shorebird Monitoring Team

The Delaware Shorebird Monitoring Team, lead by the Delaware Coastal Programs (with guidance from the British Trust for Ornithology and the Wash Wader Ringing Group), has been undertaking research into the health and population of several species of trans-continental migratory shorebirds for the last six years. The team consists of dedicated trained volunteers, staff, and researchers.

The purpose of this research is to improve our understanding of the importance of the Delaware Bay in the life cycles of migrant shorebird populations such as the Red Knot, Ruddy Turnstone, and Sanderling particularly with regard to spawning horseshoe crabs.

About this Document

The purpose of this Annual Report is to provide an account of shorebird monitoring work that has been conducted on the Delaware side of Delaware Bay in 2002. It is intended to provide a “popular account” of activities and is not to be cited as a scientific publication or document. Separate reports will be prepared with high scientific standard for this purpose.

For More Information

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Delaware Shorebird Monitoring Team



Annual Report 2002

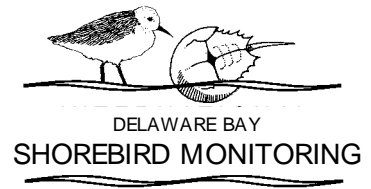
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Executive Summary

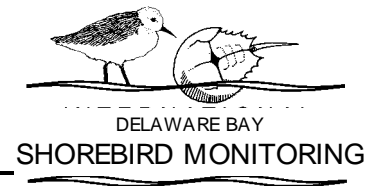
The Delaware Shorebird Monitoring Team, lead by the Delaware Coastal Programs (with guidance from the British Trust for Ornithology and the Wash Wader Ringing Group), has been undertaking research into the health and population of several species of trans-continental migratory shorebirds for the last six years. The team consists of dedicated trained volunteers, staff, and researchers.

Starting in early May and through early June 2002, a team of international and local volunteers as well as DCP researchers and staff worked almost non-stop to improve our understanding of the importance of Delaware Bay in the life cycles of migrant shorebird populations such as the Red Knot, Ruddy Turnstone, and Sanderling (*Appendix A*) with a particular emphasis on the inter-relationship between these birds and spawning horseshoe crabs.

Monitoring efforts by the team were also able to accommodate the needs of several other research groups. Samples were collected to assist with a project being conducted by staff from the USGS Patuxent Wildlife Research Center. This project, titled “A Pilot Study to Determine the Relative Abundance of Horseshoe Crab Eggs to the Diet and Body Condition of Migrant Shorebirds in Delaware Bay,” proposes using stable isotope methodology to determine the importance of horseshoe crab eggs in the diet of staging spring-migrant shorebirds. A separate team of scientists from the Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia also collected field samples as part of a project titled “Influenza Viruses in Gulls, Terns, and Shorebirds of the United States Atlantic and Gulf Coasts”. This study aims to understand the epidemiology of avian influenza virus (AIV) delineating how the virus is transmitted and maintained in gulls and shorebirds.

The purpose of this *Annual Report* is to summarize the 2002 Field Season activities for the Delaware Shorebird Monitoring Team for the Delaware Coast of the Delaware Bay. It is intended to provide a “popular account” of activities and background information on the monitoring activities of the team and related research.

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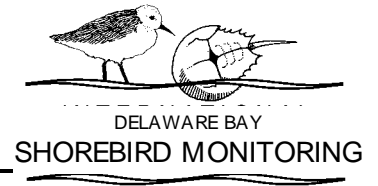
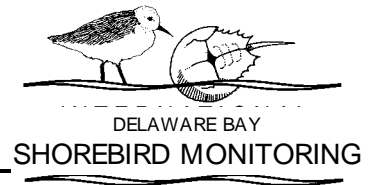


Figure 1. Map of Delaware Bay Shorebird Locations

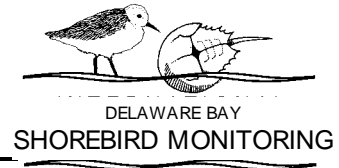
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Introduction



Delaware Bay is an estuary of extraordinary biological value. Each spring, hundreds of thousands of shorebirds time their arrival in the bay to coincide with the spawning of thousands of horseshoe crabs. A monitoring plan has been developed to answer questions regarding the population dynamics and health of key species of shorebirds on the Delaware Bay.

Some of the most amazing animal migrations known are flown each spring and fall by shorebirds between the Arctic Tundra and South American wetlands. There are over 40 northern species of migratory shorebirds and each has its own special pattern of nesting in the north, migration, and wintering in the south. Most species however, depend upon key migration sites, typically coastal and inland wetlands, to rest and feed in preparation for their long journeys lasting up to 70 hours nonstop and covering over 2,000 miles at a time! Each stopover site is a critical link in the migratory flight of shorebirds. The Delaware Bay is well recognized for its critical importance as a staging area for migratory shorebirds during spring which is attributed to the highly predictable nesting of horseshoe crabs, which largely takes place during May, providing a food resource to migrant shorebirds that feed upon the eggs. A detailed understanding of shorebird populations and habitat requirements within the Delaware Bay can, in part, be acquired through the monitoring and tracking of shorebirds staging in Delaware Bay habitats during their spring migration. Monitoring shorebirds, such as red knot, ruddy turnstone, and sanderling during their spring stopover on Delaware Bay is important and practical since it is a major concentration point in the annual migratory cycle of these species. Attempting to monitor anywhere else is far more difficult since the birds are dispersed in breeding grounds, are located in a number of remote wintering areas, and migrate over a long period in autumn.

The Delaware Shorebird Monitoring Team monitors the health of migrant shorebirds passing through Delaware Bay by using two main activities: 1) canon net and mist net catching, and 2) counting and undertaking bird color mark studies.

Canon and mist netting is conducted to collect data on individual shorebirds. Each bird caught using these methods are weighed, measured, sexed (if possible), and assessed for breeding plumage. These individual “vital statistics” allow researchers to assess the health of the shorebirds and provides critical information on weight gains over the spring migration-staging period in Delaware Bay. The monitoring of body conditions enables the quality of the habitat in Delaware Bay to be assessed. However, in assessing the habitat in Delaware Bay, one must take into consideration that long term trends have not yet been fully established (e.g. 20 plus years of data). In addition, each shorebird is banded with a numbered metal band as well as color band. The metal band identifies individual birds, allowing researchers to track its progress and life span if recaptured. The color bands allow for population and migration studies.

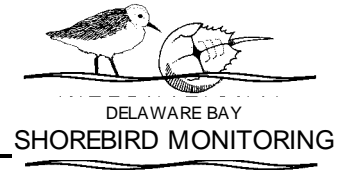
Re-sighting of color marked birds provides statistically defensible estimates of population size as well as estimates of shorebird survival. Color marking enables the monitoring of adult survival with a smaller number of marked birds than just using metal rings (which require re-capture of birds) since you can see color bands at distance through binoculars or spotting scopes. However,

it does require marking a substantial number of birds for large populations and requires large numbers of birds be observed annually for color bands. Complicating factors include the potential loss of color bands from the legs of birds as well as discoloration of the color bands.

Counts of sample areas provide detailed estimates on habitat use. This is a very accurate estimate of all species present that can also be used to validate aerial counts in many sites. However, it only represents the sites included in the census and may be time consuming if a large number of sites are included. The counts must be repeated throughout May at the same tidal stage to enable monthly trends of bird populations to be established.

Our monitoring efforts in Delaware Bay have accommodated the needs of several other research groups studying shorebirds. Samples have been collected to assist with projects being conducted by staff from the USGS Patuxent Wildlife Research Center and a team of scientists from the Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine at the University of Georgia.

2002 Field Season



Starting in early May and through early June 2002, a team of international and local volunteers as well as DCP researchers and staff worked almost non-stop to improve our understanding of the importance of Delaware Bay in the life cycles of migrant shorebird populations such as the Red Knot, Ruddy Turnstone, and Sanderling (Appendix A) with a particular emphasis on the inter-relationship between these birds and spawning horseshoe crabs.

Shorebird Population and Health Studies

In 2002, the Delaware Shorebird Monitoring Team (*Appendix C*) concentrated its efforts on catching, processing, and color-marking adequate numbers of Red Knot and Ruddy Turnstone, two species that concentrate heavily in Delaware Bay and that are believed to feed almost exclusively on horseshoe crab eggs. An essential part of assessing shorebird population size and health is capturing and color marking a representative sample of each species every year for many years.

Catch Summary

For the last six years, canon netting has been the method utilized in Delaware Bay to catch the large number of shorebirds needed for monitoring efforts. Regular canon net catches have been made each spring to maintain the percentage of color marked birds needed for population studies. Recently however, concern has arisen whether the shorebirds are able to recognize the nets on the beaches and if they actively avoid catching areas. With the overall objective of expanding the standard shorebird monitoring methods utilized by the Delaware team, mist netting efforts were also incorporated into the 2002 effort.

Table 1. 2002 Shorebird Catches

Date	Location	Method
8-May	Port Mahon	Canon Net
10-May	Mispillion	Canon Net
12-May	Mispillion	Canon Net
13-May	Port Mahon	Canon Net
13-May	Port Mahon	Canon Net
15-May	Mispillion	Canon Net
15-May	Ted Harvey	Mist Net
15-May	DNERR	-
17-May	Port Mahon	Canon Net
18-May	Ted Harvey	Mist Net
19-May	Ted Harvey	Mist Net
20-May	Slaughter	Canon Net
23-May	Mispillion	Canon Net
23-May	Mispillion	Canon Net
24-May	Port Mahon	Mist Net
25-May	Port Mahon	Canon Net
26-May	Slaughter Beach	Canon Net
26-May	Ted Harvey	Mist Net
28-May	Mispillion	Canon Net
29-May	Ted Harvey	Mist Net
30-May	Brockenbridge Gut	Canon Net
1-Jun	Ted Harvey	Mist Net

In total, 14 canon net and 7 mist net catches were made on Mispillion, Slaughter Beach, Port Mahon, Brockenbridge Gut, and Ted Harvey Wildlife Area. Mist nets proved to be good for catching small shorebirds such as semi-palmated sandpipers, semi-palmated plovers, and least sandpipers. Mist netting will be incorporated into the future years monitoring efforts in order to develop a base of knowledge about these shorebirds in an attempt to understand the importance of horseshoe crab eggs to these birds as well.

In 2002, the Delaware Shorebird Monitoring Team caught a total of 4249 shorebirds and 14 different species, easily reaching our goal of at least 500 for each of the target species (Red Knot and Ruddy Turnstone). Highlights included catching a Black-necked Stilt and Spotted Sandpipers. Also, for the first time, three Black Skimmers were caught on the Ted Harvey Wildlife Area in mist nets. This was also the first year such large number of Short-billed Dowitchers were caught on the Delaware Bay beaches.

Table 2. 2002 Catch Totals

Species Name	Total Number	Recaptures
Black Skimmer (BLSK)	3	0
Red Knot (REKN)	924	104
Ruddy Turnstone (RUTU)	910	41
Sanderling (SAND)	149	10
Dunlin (DUNL)	267	2
Semi-palmated sandpiper (SESA)	1242	3
Least sandpiper (LESA)	144	2
Black-necked Stilt (BNST)	1	0
Willet (WILL)	7	0
Short-billed Dowitcher (SBDO)	569	14
Semi-palmated plover (SEPL)	23	0
Spotted sandpiper (SPSA)	4	0
Greater Yellowlegs (GRYE)	1	0
Black bellied plover (BBPL)	2	0
Killdeer (KILL)	3	0
Grand Total	4249	176

All of the shorebirds caught were ringed with a metal USGS band identifying that individual as to where and when it was captured and processed. Data (including full biometrics) was recorded for all or a sub-sample of the shorebirds including:

- 1) wing length;
- 2) head and bill length;
- 3) age;
- 4) sex (if possible);
- 5) body moult index;
- 6) plumage score and;
- 7) weight.

In addition, captured Red Knot and Ruddy Turnstone were color banded before they were released. Please refer to *Appendix D* for the 2002 color banding combinations.

Baywide Population Counts

The Delaware Shorebird Monitoring Team conducted baywide counts along the Delaware side of Delaware Bay from Woodland Beach area to the Cedar Creek area at regular intervals during the month of May 2002.



COUNTING SHOREBIRDS ON THE BAYFRONT

- May 10th, Mispillion Harbor to Port Mahon
- May 16th, Mispillion Harbor to Woodland Beach
- May 23rd, Slaughter Beach to Woodland Beach
- May 29th, Slaughter Beach to Woodland Beach

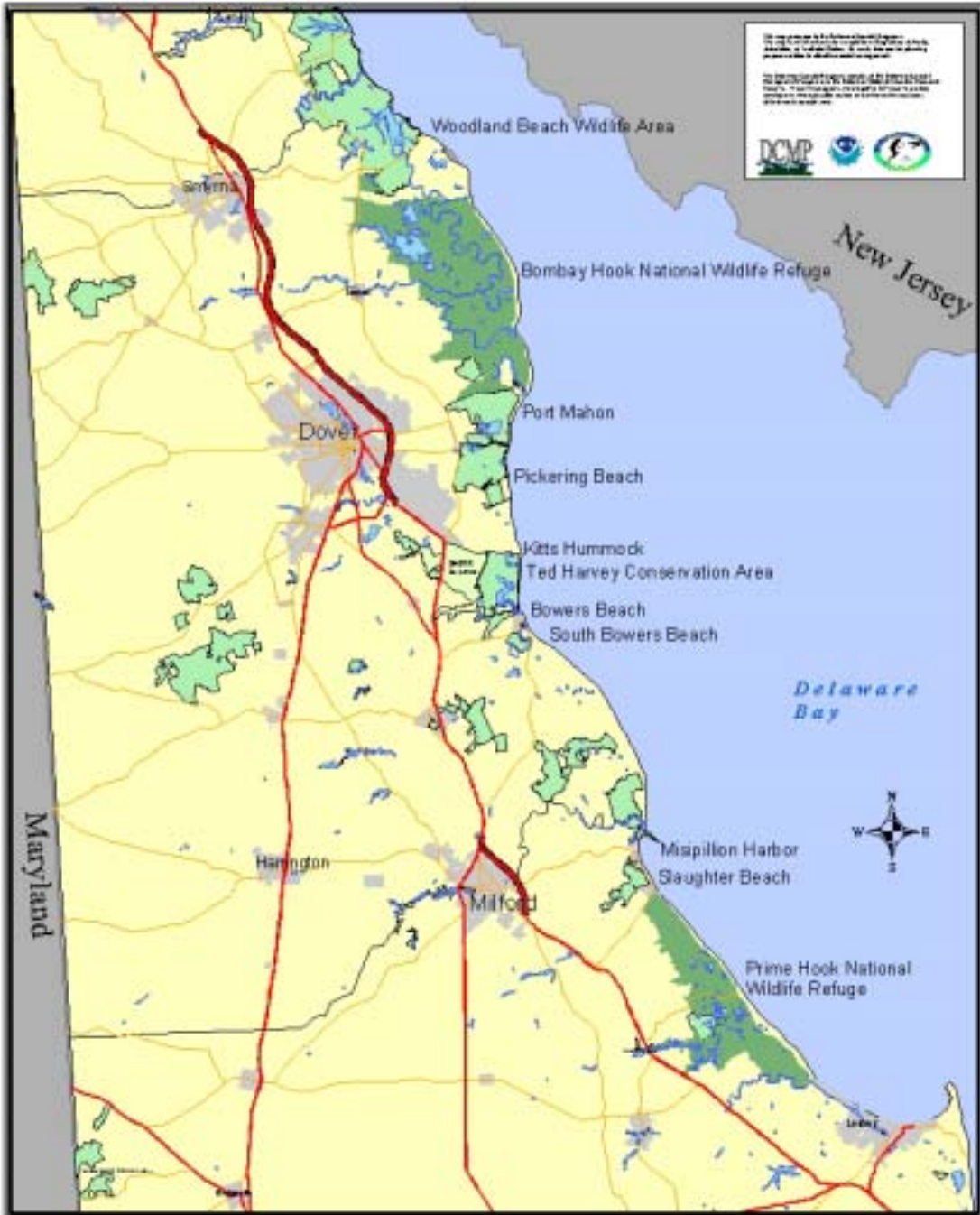
Baywide counts are derived from observations of the bayfront at the same tidal stage to provide accurate estimates of the numbers of all shorebird species present and detailed estimate of their habitat use.

Table 3. Shorebird Count Totals

Date	All Species of Shorebirds	Red Knot	Ruddy Turnstone
10-May	12,204	165	1,709
16-May	15,206	1,186	2,070
23-May	61,641	15,850	20,610
29-May	78,177	10,515	21,622

Please refer to the 2002 Field Log (*Appendix B*) for complete tables for the counts listed above.

Figure 1. Map of Delaware Bay Shorebird Site Locations



Weight Loss Experiments
British Trust for Ornithology

To understand changes in bird populations or their reaction to changing conditions it is often helpful to have a measure of the condition of individuals. Measuring weight and using this in conjunction with measures of body size, gives a measure of condition, which can be used in a variety of studies. Variations in the pattern found in different years provide an indication of the effects of differing environmental conditions.

Shorebirds are often caught for banding in large samples, and so there is usually a delay between capture and when the birds are weighed and released. During this period of temporary captivity, birds lose weight as they digest their food and void their guts. The length of time in temporary captivity varies depending on the size of the catch and therefore the mean weight loss of birds in the catch will also vary, affecting the mean weight of the catch. To enable comparisons between catches, all weights have to be corrected to a standard point. In this study samples of 10 birds in a number of catches were weighed immediately on capture, after 30 minutes, 1 hour, 2 hours and 3 hours. The numbers of droppings produced by the birds in each of the periods was recorded and correlated with the weight loss. The reweighings were used to model the expected weight of birds at capture correcting for expected weight loss through time.



COUNTING THE NUMBER OF DROPPINGS DURING A WEIGHT LOSS EXPERIMENT.

Data collected in 2001 and 2002 (from species including: Red Knot, Ruddy Turnstone, Semipalmated Sandpipers and Dunlin) are currently being analyzed.

Survival Analysis
British Trust for Ornithology

One manner to monitor the health and effects of habitat change on the shorebird populations is through survival analysis. Survival analysis is a type of model that uses long-term color banding, resighting and recapture data sets to estimate the survival rates of the population. In Delaware Bay, concern over the population numbers of the red knot has prompted the data collected by the Delaware Shorebird Monitoring Team to undergo analysis.

During the 2002 field season 1420 Red Knot were caught in Delaware Bay (both Delaware and New Jersey Teams combined), including 115 retraps. This data has been added to data from previous years and a survival analysis run. As with previous years, there are issues with some cohorts in some years having unexpectedly high or low reporting rates. This has led to imprecision in calculating survival rates.

Further exploration of the data set is needed to determine why inconsistencies between years occur. One of the assumptions in any model is that the birds are available to be sampled in the population and there are reasons as to why this might not be the case. These include the (assumed) differential timings of migration the two different populations of Knot in Delaware Bay (*rufa* and *roselari*) or due to birds arriving and departing at different times.

Further analysis of the data are needed and will be carried out during the remainder of 2002. Future developments to improve the precision of the survival and reporting rates include the use of individually marked birds which can then be seen in the field. This will increase the sample sizes of reported individuals and will not make survival rate estimation dependent on cannon-netting which, due to the amount of manpower needed, can only be carried out at irregular intervals. Re-sighting work can take place at any time and at many different sites simultaneously.

Fall Migration

In the past, the Delaware Shorebird Monitoring Team has focused their efforts on the spring migration of shorebirds through Delaware Bay. During a three week window each spring, the shorebirds concentrate in vast numbers on the bay beaches feeding upon horseshoe crab eggs and moulting into colorful breeding plumages as they prepare for the final leg of their journey to the arctic breeding grounds.

The fall migration of shorebirds through Delaware Bay looks much different. The shorebirds do not concentrate into such a specifically defined window of time. This year, a small team has conducted some preliminary counts on selected beaches during June and July in an attempt to identify the timing the shorebirds come through Delaware Bay on their fall migration. Additional bay counts are being planned for August and September.

Influenza Viruses in Gulls, Terns, and Shorebirds of the United States Atlantic and Gulf Coasts

**Southeastern Cooperative Wildlife Disease Study
College of Veterinary Medicine
University of Georgia**

Two teams from the University of Georgia were in the Delaware Bay again this field season taking cloacal samples for avian influenza research. Just over 1600 samples for the entire bay was collected. By being on both sides of the bay, the team collected samples from turnstones from 15 different days (versus less than 10 had they focused on one side at a time.) The hope is that by doing so it will help them determine if turnstones are picking up the avian influenza virus in the bay.



TAKING CLOACAL SAMPLE FROM RUDDY TURNSTONE

Table 4. 2002 Avian Influenza Field Samples

Species	Delaware	New Jersey
Ruddy Turnstone (RUTU)	428	290
Red Knot (REKN)	244	120
Sanderling (SAND)	54	197
Semipalmated Sandpiper (SESA)	72	66
Shortbilled Dowitcher (SBDO)	46	0
Fecal Samples – Port Mahon	57	0
Total Samples	975	673

As of the 17th of July 2002, the researchers are more than halfway through the samples from the Delaware Bay. They have found that 1% of the knot, 3% of the sanderling, and 14% of turnstone are tentatively positive for influenza or a paramyxovirus. This prevalence difference between species is similar to the results from 2000 and 2001. The researchers would like to investigate whether birds that have just arrived have a lower prevalence of virus versus those birds that have been in the bay for a longer time. One interesting case so far that may support that theory: a turnstone was sampled on 5/21/02 and was negative for any viruses. That bird was recaptured and sampled again on 5/28/02 and was positive for a virus. This may indicate that some turnstones are being exposed to virus in the area. The researchers will be comparing the weights of the birds to virus prevalence as in the past two years. In 2000 and 2001, it appeared that the heavier the bird the more likely it had influenza. This also suggests that many of the birds are exposed to the virus in the bay area.

Foraging Studies

The eggs that horseshoe crabs lay each spring on the Delaware Bay are an important food source for many birds, especially the migratory shorebirds such as the Red Knot, Ruddy Turnstone and Sanderling. Recently, concerns over the possibility of declining horseshoe crab populations have spurred a renewed interest in researching the role horseshoe crab eggs play in the diet of migrant shorebirds.

Building a Behavioral-Based Model (Pilot Study)

British Trust for Ornithology

It is essential to understand the relationship between the availability of eggs to shorebirds and the ability of shorebirds to reach their breeding grounds in a condition to enable them to breed successfully. In order to make predictions of the effect of future variations in the horseshoe crab egg availability the British Trust for Ornithology are developing a behavioral-based model. In any biological system there is considerable variation in the abilities between individuals such that some individuals will fail to survive even when there is enough food for the average individual. The use of behavior-based models enables this variability to be taken into account when predicting effect in a change in food supply. When the model is built it will be able to predict the effect in changes the size of the horseshoe crab population on the internationally important populations of shorebirds. It is envisaged that the fieldwork for this project would be done in both Delaware and New Jersey in the same year and all the information put into a single modeling exercise.

The model requires the following key inputs:

1. Functional response curve of intake rate against availability of eggs.
2. Interference function of intake rate against competitor density.
3. Replenishment of crab eggs during the tidal cycle.

Some of the initial baseline data was collected during the 2002 field season. This included manipulation of egg densities on predetermined sample areas (16" x 24" x 1") along Port Mahon and Mispillion Harbor during peak feeding cycles. In conjunction with horseshoe crab egg density research being conducted (*Appendix E*), video surveillance equipment was utilized to record both feeding rates dependent upon egg density as well as competitor density. Analysis of the data is being conducted by staff from the BTO and will be made available when it is complete.

USGS Shorebird/Horseshoe Crab Stable Isotope Study

G. M. Haramis

USGS - Patuxent Wildlife Research Center

This study has three aspects: 1) to profile the signature of free-ranging birds at a large sample scale, 2) to conduct a feeding trial with captive shorebirds to document their isotopic signature change when fed a diet restricted to crab eggs, 3) to verify what the alternative foods are in the environment and to confirm that the signatures of such items are indeed different, i.e. can be

discriminated from crab eggs. The pen feeding study thus compliments and interprets the signature change observed for the free-ranging birds. Crab eggs have also been widely sampled on both sides of the Bay to determine signature variances.

The 2002 field work focused on continued efforts to apply stable isotope fingerprinting to determine the relative importance of horseshoe crab eggs in the diet of spring-migrant shorebirds in Delaware Bay. Because of the short stopover period, researchers selected blood plasma as a non-invasive, rapid turnover tissue that would give researchers the best chance to track dietary change. The blood sampling approach had the added benefit of lending itself to a broad sampling scheme with potentially good sample size across species.



TAKING BLOOD SAMPLE FROM SHORT BILLED DOWITCHER

The species of focus has been the red knot but the ruddy turnstone was also maintained in captive trial during May 2002. Ten red knots and 10 ruddy turnstones were captured around the 10th of May at Slaughter Beach and Port Mahon, respectively, and transported to the Patuxent Wildlife Research Center, near Laurel, Maryland. Researchers maintained both groups of birds on crab eggs for a period of about 30 days. The pen studies would produce isotopic signatures representative of a crab egg diet, but potentially held promise of determining consumption rates during periods of hyperphagia and weight gain associated with migration.

May 2002 was an outstanding year for field blood sampling and potentially profiling a number of species with regard to stable isotope signature. These comparisons will provide the most scientific verification of species dependencies on crab eggs and lend insights to species-specific foraging niche. Blood samples were obtained from 125 red knot, 116 ruddy turnstone, 27 short-billed dowitcher, 22 dunlin, 17 sanderling and with help from David Mizrahi of NJ Audubon an additional 50 semipalmated sandpiper and 60 least sandpiper were added to the sample. This should provide some very interesting comparisons. All samples have been prepared and await freeze drying before lab analyses can be performed.

With regard to pen feeding trials, red knots showed slow but steady weight gain during the period of captivity with horseshoe crab egg ingestion rates averaging about 800 ml/day for the 10 birds during the highest period of consumption. Average weights increased from 110.4 g at capture to 150.5 g at release. The 3 heaviest birds reached 170.2, 170.4 and 173.0 g. These are good migratory weights. Average % weight gain for adults was 42.6% with a range from 22.5% to 64.4%; 2 SY birds showed the lowest % increase in weight at 6% and 16%, respectively.

Ruddy turnstones showed much aggression in captivity and had to be thinned to 5 birds/ pen (versus all 10 birds in one pen for knots). One bird continually lost weight probably due to aggression and was released early. A second bird developed a minor leg injury and was treated



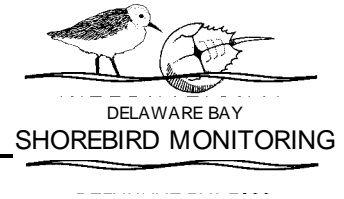
TAKING BLOOD SAMPLE FROM RUDDY TURNSTONE

successfully. A third bird was lost to accidental mortality when it was trapped in the wire overnight. Despite these difficulties the turnstones began eating well and putting on weight. Beginning and end weights averaged 103.0g and 143.3 g, respectively. Maximum percent weight gain was 60.9 % for one individual. Overall average weight gain was 39.7%. The heaviest bird was a robust 166.5g. One ruddy showed remarkable weight gain putting on 33 grams in 3 days, or 11 gms/day!!

Near the end of the trial the birds began eliciting high pitched calls that had not been heard previously. Researchers suspected this was a sign of their readiness to migrate. When the birds were released, they let go as a group by releasing them remotely from beneath a box on the beach. The ruddies were released at Mahon and immediately burst into the sky.... circled to about 300 feet and headed directly north. The knots were released at Slaughter and repeated the performance exactly. It was interesting that 2 of the knots separated from the others and flew low over the water and disappeared. Researchers suspect these were the 2 young birds that didn't gain weight and likely will spend the summer loafing around the north Atlantic coast.

2002 is the last funded year for the study, analyses and write-up will occur in 2003. After the data are analyzed, future directions and new support will be sought to continue the work. Expanding the study includes several possibilities including expanding pen feeding trials to additional species, tracing nutrients from crab eggs to eggs of shorebirds laid in the Arctic, or investigating the use of stable isotope signature to identify birds from different wintering areas. Meetings with funding partners and research collaborators will be sought to prioritize needs for horseshoe crab/shorebird research in Delaware Bay and establish their willingness to support further work.

2002 Volunteer Training



Mist Net Training

A two-day mist netting training course, based at the Delaware National Estuarine Research Reserve (DNERR), was held on the 18th and 19th of May 2002. The course was hosted by the Delaware Coastal Programs (DCP) and taught by staff from the British Trust for Ornithology (BTO) and the Wash Wader Ringing Group (WWRG).

The purpose of the course was to further train the Delaware team and introduce new volunteers in standard shorebird population monitoring techniques. With the overall objective of expanding the monitoring methods utilized in by the Delaware monitoring program and extending the knowledge of those previously trained. The course was a well-balanced combination of training talks and practical field experience similar to that of the previous years.



LEARNING HOW TO SET MIST NETS ON TED HARVEY WILDLIFE AREA

2002 Education and Outreach



Education and Outreach is an essential aspect of the research conducted by the Delaware Shorebird Monitoring Team. It provides current information to those who make decisions affecting these resources by translating the research into a format usable and easily understood.

Considerable effort has been made in 2002 to promote both the work being conducted by the Delaware Shorebird Monitoring Team and the vital role the Delaware Bay plays in the life cycle of the migrant shorebirds.

Presentations

A number of presentations have been given to a range of audiences:

- The Friends of the Delaware National Estuarine Research Reserve
- The Audubon Society
- The Green Eggs and Sand Tri-State (MD, DE, NJ) Project

The response to the efforts underway by the Delaware Shorebird Monitoring Team following such presentations has been extremely encouraging and has invariably resulted in requests for further details of various aspects of the effort.

Publications

Carter, D.B., N.A. Clark, and J.D. Hewes eds. 2002. Delaware Bay – 2000/2001 The Delaware Shorebird Monitoring Team Bi-Annual Report.

Atkinson, P.W., I.G. Henderson, and N.A. Clark. 2001. A preliminary analysis of the survival rates of red knots *Calidris canutus rufa* passing through the State of Delaware 1997-2001. British Trust for Ornithology Research Report No. 274.

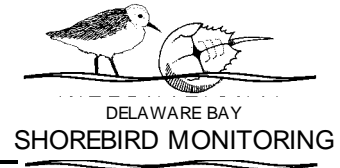
National Geographic

On the 25th of May 2002, a five-person team from National Geographic joined the Delaware Shorebird Monitoring Team at Slaughter Beach to film the research being conducted by the team. The National Geographic film crew had a minicam in the catching area as well as a camera in the hide to film the cannon nets firing from various directions. Once the catch was made, the film crew followed the birds through the processing teams filming the various measurements, color banding and samples taken. This is the second year film crews from National Geographic have joined the Delaware Shorebird Monitoring Team in the development of a half-hour National Geographic show for television on shorebirds and horseshoe crabs. The final piece for television is currently being edited.

National Public Radio

On the 11th of June 2002, National Public Radio aired a six and one-half minute broadcast on the migrant shorebirds coming through Delaware Bay. Nigel Clark and David Carter were interviewed for the piece. You can listen to the audio piece from the National Public Radio web page at: <http://www.npr.org/ramfiles/me/20020611.me.15.ram>

Future Research Directions



The Delaware Shorebird Monitoring Team lead by the Delaware Coastal Programs and the British Trust for Ornithology has been undertaking research into the relationship between shorebirds and horseshoe crabs for the last six years. This outlines the future research that is needed to ensure that the supply of horseshoe crab eggs on Delaware Bay beaches is sufficient to enable the shorebird populations to reach the arctic with the reserves needed to breed successfully. Most of the shorebird work will focus on Knot as an indicator of the health of shorebird populations.

Future Research Objectives

1. To identify the timing of arrival and duration of stay of the two populations of knot (Florida and Argentina wintering).
2. To use behavior based models to predict how the density of horseshoe crab eggs available to shorebirds effects the bird's rates of weight gain and hence whether they are able to migrate to the Arctic in good condition.
3. To assess the rates of weight gain from samples of shorebirds caught in Delaware Bay over the past 5 years taking account of weight loss after capture and body size and in relation to plumage variability.
4. To undertake fieldwork to assess the ratios of color marked birds (cohort and/or individual) and update survival models including the banding data.
5. To organize (and undertake some) counts through the tidal cycle at Mispillion, Brokenbridge and North Bowers to asses the amount of feeding effort in different areas.
6. To conduct automated radio tracking of shorebirds bay-wide to refine preferred habitat types and extent of use, as well extend of movement of birds during stopover.
7. To conduct automated radio tracking of horseshoe crabs bay wide to determine habitat selection of crabs entering Delaware Bay.
8. To undertake mist net training, organize counts and assist cannon netting operations when needed.

These objectives can be met by undertaking a series of sub projects outlined below:

Pilot Stable Isotope Analysis

Data collected to date suggests that some or all of the early arriving red knots in Delaware Bay come from the Florida/Georgia wintering population of *roselaari* rather than the *rufa* population. Analysis of feather samples that were known to be grown in the Arctic, Florida/Georgia and Argentina will be an analyzed to see if it is possible to use samples of feathers collected in Delaware Bay to work out the proportions of birds from different wintering areas that are present at different times through the migration period. This will then allow analysis of the stopover

fitness of each population on Delaware Bay. If no problems are seen in the *roselaari* population, but problems are found in the *rufa* population, it will provide strong evidence of a stopover problem in South America, and not in Delaware Bay.

Prediction of the Food Supply Needed by Shorebirds in Spring

In order to make predictions of the effect of future variations in the horseshoe crab egg availability it is essential to understand the relationship between the availability of eggs to shorebirds and the ability of shorebirds to reach their breeding grounds in a condition to enable them to breed successfully. In any biological system there is considerable variation in the abilities between individuals such that some individuals will fail to survive even when there is enough food for the average individual. The use of behavior-based models enables this variability to be taken into account when predicting effect in a change in food supply.

The following key inputs are required by the model:

1. Functional response curve of intake rate against availability of eggs.

In order to obtain the field data to set parameters, the model estimates of feeding rate are needed for known levels of prey availability. In Delaware Bay this requires experiments in the field in which the density of eggs is manipulated in sample areas. The required fieldwork is extremely time consuming as it takes a considerable amount of time for the feeding flocks to return to areas once disturbed necessitating many days of fieldwork to achieve the data set required.

2. Interference function of intake rate against competitor density.

As competitor density rises, aggressive interactions between birds may mean that some are excluded from the food supply. These birds may fail to gain weight at a high enough rate, even though a surplus of food is apparently available. Videos are needed to determine the extent to which birds of different species interact with each other. These will be used to determine the strength of interference between birds and whether or not the effect of interference needs to be incorporated into the model.

3. Replenishment of crab eggs during the tidal cycle.

Birds can deplete crab eggs on the substrate surface very quickly. The rate at which eggs move to the sediment surface or are deposited by the tide is a key parameter required by the model. A series of bird enclosures will be set up at a range of sites and shore levels to determine the densities of eggs left on the substrate surface by the receding tide, and hence the surface food supply available for birds.

When the model is built it will be able to predict the effect in changes the size of the horseshoe crab population on the internationally important populations of shorebirds.

It is envisaged that the fieldwork for this project would be done in both Delaware and New Jersey in the same year and all the information put into a single modeling exercise.

Analysis of Capture Biometrics to Assess Variability in Weight Gain between Years

Detailed shorebird biometrics and weight gain data has now been gathered over the last six years. To date, this data has only been analyzed without any correction for body size or for weight lost between capture and weighing. In addition it is possible that the amount of summer plumage may be related to the condition of the individual. The weight of each bird will be corrected for time after capture and for differences in body size. Assuming that we do not find that there is systematic variation in body size through the migration period, indicating that either different populations or sexes move through the bay at different times, weights will be corrected to standard body size. If there is differential migration groups will be split using the biometrics and then analyzed separately. Models will be developed of weight gain against date so that individual years can be tested against previous data to identify years when the species in question has either above or below average weight gains.

Survival and Movement Studies

Survival and movement studies will be undertaken in two parts; re-sightings of color marked birds and detailed observations of the feeding distribution of birds throughout the tidal cycle at selected locations. These two areas of work will be carried out in an integrated program of work to maximize efficiency. The results of the analysis of the 2002 cohort scanning work will identify the form of future work. Protocols will be developed for either searching for individually marked birds in the population or for searching for individually marked birds or a combination of the two. This will enable the survival analyses undertaken in 2001 and 2002 to be updated with 2003 data increasing the precision of the between year survival estimates.

Four sites (Mispillion, Brockenbridge, North Bowers and Port Mahon) will have a series of 5 Through the Tidal Cycle (TTC) counts using methodology developed by the BTO to monitor the distribution of shorebirds within sites. This will enable the patterns of movement to be understood as well as the feeding effort on different parts of the shore. This will help understand the area of suitable habitat that is need to support shorebirds on spring migration.

Automated Radio Tracking of Shorebirds Baywide

Management of shorebirds will depend to a large extent on the landscape-scale habitat use by these species while stopping over at Delaware Bay. Several factors influence habitat use, daily movements, and the duration of stay of shorebirds, especially tide, weather, and food availability. Past efforts to radio track these species have been difficult and resulted in spotty data due to the reliance on staff to physically be present and track these birds. New Jersey DFG, NGEPS is in the process of acquiring 5-6 fully automated radio tracking systems to track birds continuously (24 hours/day throughout May and Early June). These systems were developed and proven in the Dutch Wadden Sea and in Northwest Australia. However, recapture data and past telemetry data have documented that shorebirds, and especially the red knot, extensively utilize both sides of the Delaware Bay, often moving across several times during a stopover. This study will be

very limited in use if tracking is not conducted simultaneously on both sides of the Bay. The DCP will fully deploy and maintain the tracking systems, and conduct the analysis of the Delaware collected data annually.

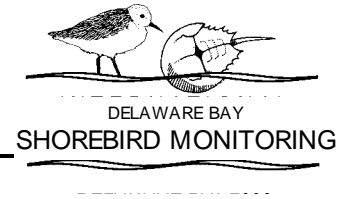
Automated Radio Tracking of Spawning Horseshoe Crabs

During 2002, a research team conducted detailed tracking of radio tagged horseshoe crabs for spawning at Bowers Beach and Ted Harvey Beach, proving the utility of this technology for helping to understand the spawning behavior and habitat selection of spawning horseshoe crab females. This technology can now be extended bay wide to better understand the habitat selection by crabs entering the Delaware Bay in early spring. This project will work with a local fisherman to capture gravid female crabs entering Delaware Bay, tag them with transmitters, and track them through the spawning period. It is proposed the 100 crabs be tagged. Transmitters are proposed to be in the same frequency range as shorebirds, and that data can be collected on both horseshoe crabs and shorebirds simultaneously. The DCP, USGS, and Cornell University Staff will carryout this study.

Mist Net Training, Counting and Cannon Net Assistance

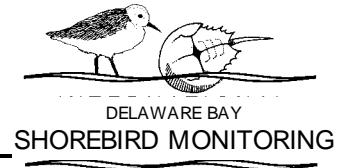
A team from the Wash Wader Ringing Group will be present for the main migration period to help with fieldwork and continue training mist netting techniques. In addition detailed work will be carried out on the migration of Least and Semi-palmated Sandpipers using the impoundments and foreshore. All data collected will be computerized so that any differences from the typical pattern of weight gain can be identified and catching operations modified to maximize value of the work. It is anticipated that the day to day team leadership will be carried out by DNREC staff. WWRG will supply mist nets suited to the conditions in Delaware.

List of Acronyms



BTO	British Trust for Ornithology
DCP	Delaware Coastal Programs
DNERR	Delaware National Estuarine Research Reserve
DNREC	Delaware Department of Natural Resources and Environment Control
GIS	Geographic Information System
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
WWRG	Wash Wader Ringing Group

Appendix A



Red Knot (*Calidris canutus*)
USFWS code: REKN



Sanderling (*Calidris alba*)
USFWS code: SAND



Ruddy Turnstone (*Arenaria interpres*)
USFWS code: RUTU



Dunlin (*Calidris alpina*)
USFWS code: DUNL



Semipalmated Sandpiper (*Calidris pusilla*)
USFWS code: SESA



Short-Billed Dowitcher (*Limnodromus griseus*)
USFWS code: SBDO



Willet (*Catoptrophorus semipalmatus*)
USFWS code: WILL



Black Necked Stilt (*Himantopus mexicanus*)
USFWS code: BNST



Black-bellied Plover (*Pluvialis squatarola*)
USFWS code: BBPL



Spotted Sandpiper (*Actitis macularia*)
USFWS code: SPSA



Black Skimmer (*Rynchops niger*)
USFWS code: BLSK



Least Sandpiper (*Calidris minutilla*)
USFWS code: LESA



Killdeer (*Charadrius vociferus*)
USFWS code: KILL



Semipalmated Plover (*Charadrius semipalmatus*)
USFWS code: SEPL



Greater Yellowlegs (*Tringa melanoleuca*)
USFWS code: GRYE



Additional Resources

If you are interested in learning more about the species listed above we suggest the following resources:

General Information/Identification

Sibley, David Allen. 2000. *National Audubon Society The Sibley Guide to Birds*. Alfred A. Knopf, Inc., New York.

Prater, A.J., J.H. Marchant & J. Vuorinen. 1997. *Guide to the Identification & Ageing of Holarctic Waders*, British Trust for Ornithology. Thetford, Norfolk.

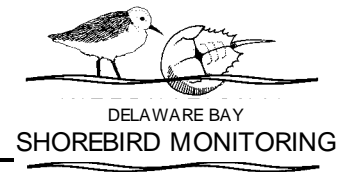
Gough, G.A., Sauer, J.R., Iliff, M. *Patuxent Bird Identification Infocenter*. 1998. Version 97.1. Patuxent Wildlife Research Center, Laurel, MD. <http://www.mbr-pwrc.usgs.gov/Infocenter/infocenter.html>

Habitat/Behavior

Elphick, C., J.B. Dunning, Jr. & D.A. Sibley eds. 2001. *National Audubon Society The Sibley Guide to Bird Life & Behavior*. Alfred A. Knopf, Inc. New York.

Hess, G.K., R.L. West, M.V. Barnhill III & L.M. Fleming. 2000. *Birds of Delaware*. University of Pittsburgh Press. Pittsburgh, PA.

Appendix B



Delaware Bay Shorebird Expedition 2002

*An account of activities by André Duiven
on behalf of the Wash Wader Ringing Group.*



**St Jones Reserve
Delaware National Estuarine Research Reserve
Dover, Delaware**

Wednesday, 8th May

A small group of the Delaware Shorebird Team made the first catch of the spring field season at Port Mahon early in the morning. The team of 9 headed out in the early morning light to set the net for the first time since last season. Within a short time the team had the net set and were back in the vehicles to await the returning Turnstone that had been seen upon arrival. After a short wait the net was fired at 0738 and a catch of 43 Turnstone and 8 Least Sandpipers were in hand. A slightly larger catch would have been made if not for one of the stakes breaking at the time of the net firing. Mike Haramis took 10 Turnstone back to Patuxent to get the cage feeding studies going for this year.

TABLE 1 TOTALS FOR THE CATCH MADE ON PORT MAHON ON 8TH MAY

Port Mahon 8th May High tide: 08:00 Firing time: 07:38	Estimated present	Caught (retraps included)	Retraps
Ruddy Turnstone		43	2
Least Sandpiper		8	0
Total		51	2
Team members: Dave C., Jim, Susan, Greg, Dave N., Mike H. and Peter, Mike S. and Karine taking cloacal samples for the avian influenza research and helping out.			

PWA and SG travel to Delaware via New York JFK and Washington-Dulles – and their luggage via Ronald Reagan airport, Washington DC. Arrival at St. Jones Reserve at 00:30 on 9th May.

Thursday, 9th May

PWA, SG and JH make a planning trip to Mispillion Harbor and Slaughter Beach to check numbers of target species and potential catching sites. Only 100 Red Knot and 200 Turnstone present in Mispillion Harbor, but several hundred Dunlin and 300 Sanderling plus several thousand Dowitchers. A potential catching site is identified at the creek end of the harbor. The tides are currently very high so limited areas available. On Slaughter Beach no Red Knot, just Dunlin and Sanderling.

The rest of the day is spent collecting extra vehicles and making shopping trips for equipment and food. Mike Haramis arrives at 21:00 ready for an early start the following morning.



PHOTO THE OLD RESTAURANT AND LIGHTHOUSE AT MISPELLION. THE LIGHTHOUSE BURNED DOWN IN 2001. THE SITE IS EXTREMELY SUITABLE TO DEVELOP A SHOREBIRD BIRD OBSERVATORY.

Friday, 10th May

The team leaves St Jones at 05:30 to set one cannon net in Mispillion Harbor. Two crabbing boats park next to the catching area but a word from Dave and they agree to work south rather than north into the catching area. Around 08:00 one/another boat comes in moving north and pushes many of the Dunlin and Dowitchers out of the catching area and we fire at 08:03. The total catch was 14 Red Knot, 100 Short-billed Dowitchers and 55 Dunlin. One of the knots was a 1998 control. Ten birds were taken by Mike Haramis for captive studies and the remaining three birds were colour-banded.

TABLE 2 TOTALS FOR THE CATCH MADE ON MISPELLION ON 10TH MAY

Mispeillion Harbor 10th May High tide: 8:36 Firing time: 08:03	Estimated present	Caught (retraps included)	Retraps
Red Knot		14	1
Dunlin		55	0
Short-billed Dowitcher		100	0
Total		169	1

Team members: Dave, Jim, Kim, Greg, Phil, Simon, Gene, Racheal, Tim, George, Erin, KMK; several people doing the processing to get re-acquainted with taking measurements and Mike, Karine taking cloacal samples for the avian influenza research (a.k.a. butt swabbing) and helping out.

After clearing up the catching equipment and getting everyone back to the slipway, DC, KBC, GH, PWA and SG took a boat back out to do a bay front count, from Mispeillion Harbor/Slaughter Beach to Port Mahon. Unfortunately, the falling tide prevented us from getting close in to Slaughter Beach where there were 5-6,000 Dunlin. By the time we reached Bowers there was insufficient water to get close to the shore so we stopped there. Later, on the evening tide (20:00), PWA and SG made a land-based count of Port Mahon where very few birds were present.

TABLE 3 COUNT TOTALS FOR A BAY FRONT COUNT CONDUCTED ON THE FALLING TIDE (12:00-15:00 HRS) ON 10TH MAY 2002. DUE TO FALLING TIDE, COUNTS WERE ABANDONED AT SOUTH BOWERS. A COUNT AT PORT MAHON WAS CONDUCTED ON THE EVENING HIGH TIDE (20:00 HRS).

COUNT SECTION	AMOY	BBPL	REKN	DUNL	SAND	LESA	SBDO	SPSA	GRYE	WILL	RUTU	TOTAL
Mispeillion Jetty	1	0	0	0	0	0	29	2	0	0	620	652
Mispeillion Jetty South & Island	0	33	14	400	22	0	0	0	0	0	0	469
Mispeillion Harbor North	3	16	28	1350	0	0	27	0	0	0	0	1424
Mispeillion Harbor South	0	3	5	172	0	6	37	5	1	2	259	490
Slaughter Beach North	0	40	65	6447	8	0	4	0	0	0	0	6564
Grecco Canal Breach	0	10	0	10	0	0	0	0	0	0	0	20
Milford Neck North	0	0	0	0	0	0	0	0	0	6	0	6
Bigstone Beach	0	19	0	25	0	0	0	0	0	0	0	44
Bennett's Pier North	0	0	2	0	0	0	0	0	0	3	0	5
Brockenbridge Gut	0	0	50	250	700	0	0	0	0	1	300	1301
South Bowers	0	20	0	203	400	0	5	2	0	0	450	1080
Port Mahon	0	0	1	20	1	40	5	2	0	0	80	149
TOTALS	4	141	165	8877	1131	46	107	11	1	12	1709	12204

Saturday, 11th May

Up at 07:00 to recce for Sunday morning catch and also to get feeding trays sorted and get some scans in. The night before a pleasant evening was had at the Lobby House where we were reacquainted with Dogfish Head, a fine Delawarean brew. Sharon was over from the UK and we hung out with Tim and his Californian surfing chum Rico who was suffering from the effects of an early morning rise.

Checked out Slaughter first, at just after high tide. Very little up by the Pilot boat station – 50 birds – 30 Dunlin, 20 Black-bellied Plovers and a smattering of Least Sand Pipers and Sanderling. At Evans approximately 75 Sanderling, 30 Dunlin, and <20 Turnstone, Leasts and 2 Semi's and <5 Spot Sands. At the Mispillion lighthouse 400 Knot were in the bay at the back of the harbour along with 500+ Dowitchers and 500+ Dunlin. No sign on the 5,000+ Dunlin seen the previous day at low tide – maybe a roost we do not know about??

Went to South Bowers and had 300-400 Sanderling, 200 Turnstone, 15-30 Knot scattered and a few Dunlin and Leasts. North Bowers was empty.

Back to St Jones then to Dover shopping for supplies and feeding experiment equipment. Then took boat to Mispillion to do colour-band scans on the rising tide. On arrival 165 Knot roosting on the sand bar in the middle of the harbour. As that was covered they moved on to the sand spit to the north where they were joined by a further c.250. Phil had at least three Argentinean banded knots, plus several Delaware cohort birds and one individually-marked bird from 1998. Also at least two metal banded dowitchers noted, plus one metal banded Dunlin. Near to high tide several large flocks, largely Dunlin, totalling 2-3,000 birds flew out from the salt marsh roost in a northerly direction.

The second contingent of the team arrived (Jacquie and Nigel Clark, André Duiven and Francis Argyle).

Sunday, 12th May

One team left for Mispillion to catch on the morning rising tide. Phil and Simon remained behind to try out the feeding experiment equipment.

On landing on the beach at the mouth of the Grecco Canal most of the Knot were at the north end so set one net very close to the hide. The flock returned but mainly Dowitchers and Dunlin in the area. Francis was sent to twinkle the Knot into the area; he was amazed at how close he got to the birds but eventually some of the knot filtered out of the main flock so we fired. The catch yielded a good number of birds with sufficient samples of Red Knot, Turnstone, Short-billed Dowitcher and Dunlin.

TABLE 4 TOTALS FOR THE CATCH MADE ON MISPELLION ON 12TH MAY

Mispillion Harbor 12th May High tide: 10:30 Firing time: 09:50	Estimated present	Caught (retraps included)	Retraps
Red Knot	450	65	9
Willet	20	5	0
Dunlin	1000	137	0
Semi-palmated Sandpiper	<10	1	0
Ruddy Turnstone	100	24	1
Black-necked Stilt	3	1	0
Short-billed Dowitcher	2000	229	2
Least Sandpiper	2-3	-	0
Total		462	12

Team members: Dave, Nigel, Jacquie, Jim, Kim, Greg, André and Francis; eight people doing the processing and Britta, Mike, young lady taking cloacal samples for the avian influenza research (a.k.a. butt swabbing) and helping out.

We processed 50 Dunlin and 50 Dowitchers and all of the other species After the catch, which was completed at 13:55, four of us (Dave, Nigel, Francis and André) went out on the salt marshes further inland to recce the place for suitable mist netting sites, the rest took the gear back to base. Compared to 2001 the shallow flooded areas had almost completely dried up, due to a dry spring. A few ponds nearby the Osprey-nest promise to be very suitable as they still had some water in them. Also lots of footprints and droppings were found at these sites. A little farther inland from the creek there was a more extensive area which still held water. There we saw about ten Black-bellied Plovers, fifteen Semi-palmated Plovers and a small number of Semi's, as well as a pair of Gadwall. Accessibility could have been a problem, especially as the ditches were very muddy as were the wet areas. The small ponds closest to the creek were selected as most promising (using a tape-lure to attract birds from the larger ponds). As the day ended with some heavy thunderstorms and torrential downpours the situation described above might well have changed overnight. Shortly before diner a shopping spree was undertaken to get necessary supplies.

Monday, 13th May

The weather forecast for today was pretty horrid, showers and regular thunderstorms throughout. Therefore, no activities were planned except for a good nights rest and a late awakening. This proved to be besides the truth. Weather was good and a quick change of plans saw everybody off to Port Mahon to make a good catch of Turnstone.

After setting up the net birds poured in swiftly. However, a burr in one of the cartridges had cut through the fuse wire and only the left hand side canon fired. Instead of a 100+ Turnstone catch only 20+ were caught along with one Dowitcher. The net was reset at a different location on the same beach and a second catch was made to crank up the totals.

TABLE 5 TOTALS FOR THE CATCH MADE AT PORT MAHON ON 13TH MAY

Port Mahon 13th May High tide: 11:15 Firing time: 10:25 & 12:18	Estimated present	Caught		Retraps	
		first catch	second catch		
Ruddy Turnstone	800	25	14	39	0
Sanderling	30	0	1	1	0
Dunlin	?	0	6	6	0
Least Sandpiper	3-400	0	19	19	0
Semi-palmated Sandpiper	250	0	3	3	0
Short-billed Dowitcher	100	1	8	9	0
Total		26	51	77	0

Team members: Nigel, Jacquie, Jim, Kim, Gene, André, Francis, Simon and Phil assisted by three American ladies; twelve people in total.

Tuesday, 14th May

All the team, except for Phil and Simon, went to do a count

TABLE 6 COUNT TOTALS FOR A LANDSIDE COUNT FROM SLAUGHTER BEACH TO PICKERING BEACH ON 14TH MAY. PICKERING, KITTS HUMMOCK AND TED HARVEY COUNTED BY AD, SLAUGHTER BEACH, BOWERS BEACH (NORTH AND SOUTH).

COUNT SECTION	T _{start}	T _{end}	SESA	REKN	DUNL	RUTU	SAND	LESA	SBDO	SPSA	WILL	SPPL	AMAV	BBPL	TOTAL
Pickering Beach North	12:45	13:20	5000	10	3000	1	0	150	5	1	7	1	1	1	8177
Pickering Beach South	13:20	13:45	225	0	350	0	0	50	1	0	2	0	0	0	628
Kitts Hummock North	09:30	09:55	750	0	500	0	0	10	50	0	0	0	0	0	1310
Kitts Hummock South	09:55	10:25	190	0	130	0	10	40	0	4	0	0	0	0	374
Ted Harvey North	11:30	11:50	300	0	0	0	0	100	3	0	5	0	0	1	409
Ted Harvey South	11:50	12:15	300	0	0	0	0	50	0	1	1	0	0	0	352
Mispillion	08:30	11:00	50	2000	3000	0	0	0	1000	0	0	0	0	0	6050
Slaughter Beach North	10:00	10:10	200	50	50	150	70	0	20	0	0	0	0	0	540
Milford Neck Roost	11:00	11:30	0	0	500	0	0	0	500	0	0	0	0	0	1000
South Bowers	11:00	11:20	300	65	1500	120	200	0	0	0	0	0	0	0	2185
North Bowers	12:00	12:15	0	0	5000	0	0	0	0	0	0	0	0	0	5000
TOTALS			7315	2125	14030	271	280	400	1579	6	15	1	1	2	26025

REMARKS: AT THE BEGINNING OF THE COUNT AT 09:30 MOST BIRDS WERE STILL FEEDING ON THE EXPOSED MUDFLATS. FROM 11:30 THE MUD WAS COVERED AND MOST BIRDS WERE SEEN ROOSTING ON THE BEACH, WHERE LEAST SANDPIPERS WERE CONCENTRATED ALONG THE HIGHEST TIDEMARK AND SEMI-PALMATED SANDPIPER ALONG THE LOWER SHORE. AT PICKERING THERE WAS HEAVY SPAWNING ACTIVITY AT THE ACCESS POINT ON THE BEACH ALONG A STRETCH OF APPROX. 2-300 METRES. MISPELLION WAS COUNTED DURING THE PRESENCE OF THE FEEDING EXPERIMENTORS. GRECCO CANAL BREACH, SOUTH BOWERS AND THE BEACHES SOUTH OF THAT WERE NOT COUNTED. SAME FOR PORT MAHON

Francis & Phil went off to Mispillion with the boat to do some scans at 08.30 – HT at 11:00. Around 5,000 birds in the bay at the back – 2,000 Knot, 2,500-3,000 Dunlin and getting on for 1,000 Dowitchers. Only <50 Semi's and stuff. Scanning was difficult at high tide as birds were pushed in tight and it was extremely windy. At high tide went to a look at the roost and got into the wrong creek with two paddles. However, got through to the roost and it had c.1,000 birds on it – mostly Dunlin & Dowitchers. The pans which Nigel, Andre, Francis and Dave had looked at were still dry but the main roost looked moister. 150+ BB Plovers on a ploughed field on the way to Mispillion from Route 1.

Wednesday, 15th May

Only good option for a Knot catch was in Mispillion again. With a strong wind with a strong wind blowing catching was slightly more complicated than usual. Because of the expected effect of the wind we had to wait until birds were well inside of the nine-yard marker and when we fired the wind indeed got hold of the net, forced it to skew off left and the right corner was blown back. This meant a good number of Knot and Dunlin escaped whereas the slower Dowitchers were caught. At some stage it looked like the birds were holding up the net when trying to fly off.



PHOTOS STRONG WINDS HAD THE ENTIRE PROCESSING TEAMS BEHIND A WINDBREAK ON MISPELLION. LOTS OF HANDS NEEDED TO COLOR BAND A RED KNOT.

TABLE 7 TOTALS FOR THE CATCH MADE AT MISPELLION ON 15TH MAY

Mispillion Harbor High tide: 11:49 Firing time: 11:34	Estimated present	Caught (retraps included)	Retraps
Red Knot	2,000	78	8
Dunlin	5,000	11	0
Semi-palmated Sandpiper	Hundreds	3	0
Short-billed Dowitcher	Thousands	217	10
Total		309	18
Team members: Dave, Nigel, Jacquie, Jim, Kim, Greg, André, Francis, Phil and Simon.			

Francis, Jeff, André and Nigel went down to Ted Harvey to try some mist netting. While putting up the nets Jeff said that catching anything would be considered a success. By the time the nets were up at near dusk we had caught seven birds. We waited by the nets for 20 minutes, then did a net round that yielded another 14. By then it was very quiet and we put out the tape lure and went to process the birds before taking down. Took down the tape lure net last so we had the least to carry and found that it had caught another 25 birds!

TABLE 8 TOTALS FOR A MIST NET CATCH MADE AT TED HARVEY ON 15TH MAY

Ted Harvey High tide: 00:36 (16 th)	Estimated present	Caught (retraps included)	Retraps
Least Sandpiper	Hundreds	25	0
Dunlin	Tens	3	0
Semi-palmated Sandpiper	Hundreds	22	0
Semi-palmated Plover	Some	2	0
Greater Yellowlegs	Some	1	0
Total		53	0
Team members: Nigel, Jeff, André and Francis.			

Thursday, 16th May

Dave, Nigel, Jacquie, Jeff and Allison did a baywide count from Slaughter Beach to Woodlands Beach.

TABLE 9 COUNT TOTALS FOR A BAYWIDE COUNT ON THURSDAY 16TH MAY

COUNT SECTION	Time	AMOY	BBPL	SKIM	REKN	DUNL	SAND	SPSA	LESA	SBDO	SESA	GRYE	WILL	BNST	RUTU	TOTAL
Woodland South	15:00	0	2	0	0	0	0	0	0	0	5	0	0	0	0	7
Edgell Cove	14:52	0	0	0	4	0	0	0	0	0	200	0	0	0	0	204
Dupont Breach	14:46	0	0	0	0	0	0	0	0	0	245	0	0	0	0	245
Bombay Hook North	14:25	0	6	0	0	405	0	0	0	292	237	0	18	0	0	958
Simons-Leipsic River		0	4	0	0	162	30	0	0	77	6	0	3	0	0	282
Kelly North	14:12	0	2	0	45	0	0	0	0	20	8	0	2	0	0	77
Kelly Mid-north		0	27	0	0	810	70	0	0	180	0	1	21	0	0	1109
Kelly Mid-south	14:02	0	1	0	0	129	0	0	0	160	28	0	7	0	0	325
Kelly South	14:00	0	2	0	70	510	0	0	0	95	140	0	2	0	0	819
Mahon North	13:35	0	0	0	0	2	0	0	10	176	379	0	3	0	0	570
Mahon South		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mahon Impoundment	13:27	0	0	0	0	1371	30	0	0	123	56	0	5	1	0	1586
Little River mouth south	13:26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North of Pickering Beach	13:16	0	2	0	20	385	0	0	0	0	390	0	2	0	0	799
Pickering Beach	13:12	0	0	0	2	28	0	0	0	0	0	0	0	0	0	30
Lewis Ditch North	13:09	0	0	0	0	30	0	0	0	0	460	0	5	0	0	495
Lewis Ditch South	13:04	0	0	0	0	50	0	0	0	0	240	0	3	0	0	293
North of Kitts Hummock	12:56	0	0	0	0	2	2	0	0	0	28	0	1	0	0	33
Kitts Hummock	12:56	0	0	0	0	11	0	0	0	0	315	0	0	0	0	326
Ted Harvey North		0	0	0	0	65	0	0	0	0	20	0	0	0	0	85
Ted Harvey South	12:49	0	1	0	0	50	0	0	0	0	120	0	2	0	0	173
St. Jones Mouth North		0	1	192	30	0	0	0	0	0	0	0	2	0	110	335
St. Jones Mouth South		0	0	0	0	280	0	1	0	0	0	0	2	0	5	288
South Bowers	12:33	0	0	0	100	67	100	0	0	0	0	0	12	0	160	439
South of South Bowers	12:25	0	10	0	20	30	40	0	0	0	30	0	18	0	255	403
Brockenbridge Gut	12:18	0	1	18	85	73	80	4	0	0	31	0	3	0	142	437

Bennett's Pier North	12:11	1	0	14	300	40	135	1	0	0	27	0	3	0	205	726
Bennett's Pier South	12:00	0	0	7	2	3	2	5	0	0	34	0	3	0	22	78
Bigstone Beach	11:54	0	0	0	0	20	0	1	0	0	11	0	0	0	1	33
Milford Neck North	11:50	0	0	0	7	43	0	0	0	0	0	0	0	0	32	82
Grecco Canal Breach	11:41	0	0	0	11	25	20	0	0	0	40	0	1	0	70	167
Milford Neck South	11:35	0	0	0	0	0	3	0	0	0	5	0	1	0	25	34
Mispyllion Jetty	11:18	1	0	0	20	0	0	0	0	150	0	0	1	0	788	960
Mispyllion Harbor North	11:04	0	0	0	415	0	0	0	0	325	410	0	2	1	20	1173
Mispyllion Harbor South	10:55	0	0	0	0	295	0	0	0	483	105	0	10	2	0	895
Cedar Creek	11:20	0	0	0	55	0	0	0	0	450	0	0	0	0	235	740
TOTALS		2	59	231	1186	4886	512	12	10	2531	3570	1	132	4	2070	15206
COUNT SECTION	Time	AMOY	BBPL	SKIM	REKN	DUNL	SAND	SPSA	LESA	SBDO	SESA	GRYE	WILL	BNST	RUTU	TOTAL

REMARKS: ONE SEMI-PALMATED PLOVER AT MISPYLLION HARBOR NORTH AND ONE AT MILFORD NECK NORTH. THE INLAND ROOSTS ARE PRESUMED TO HAVE HELD SEVERAL THOUSANDS KNOT

Friday, 17th May

The scheduled catch of Turnstone turned out all right. After a recce by Francis and Gene the previous day and a short look around, shortly before the catch, two sites were picked to set two nets. The first net was set at the usual site (serving as a backup) and the second was set along the beach straight beyond the lighthouse to be fired first.

After the set birds returned to the beach almost immediately but seemed to shy from the catching area at first. After some twinkling, done on both sides, we had birds in the catching area on at least two occasions. Because of safety these two potentially big catches had to be missed, because regular passing of vehicles towing boat trailers scared the birds of the beach before a safe catch could be made. Eventually the net was fired on a reasonably good catch, which yielded enough Turnstone to leave the second net unused. Noteworthy were also three Skimmers that had landed just outside the catching area, slowly making their way towards it, but were unfortunately chased off.



PHOTO PROCESSING TEAMS WORKING AWAY AT PORT MAHON.

TABLE 10 TOTALS FOR THE CATCH MADE AT PORT MAHON ON MAY 17TH.

Port Mahon High tide: 14:11 Firing time: 11:45	Estimated present	Caught (retraps included)	Retraps
Ruddy Turnstone	2-3000	111	4
Dunlin	Hundreds	4	0
Least Sandpiper	Tens	2	0
Semi-palmated Sandpiper	Hundreds	17	0
Total		134	4
Team members: Nigel, Jacquie, Jim, Kim, André, Francis, Tim, Rico; eight people doing the processing and Britta, Mike and Karine taking cloacal samples for the avian influenza research (a.k.a. butt swabbing) and helping out.			

The day was concluded with a meal in The Lobby House in Dover. Most of the team went home early to get some rest. Phil, Simon, André and Tim together with Pam and Karine (from the Georgian bleeding team) stayed to have a few more and later went over to Tim's to check out his lair, surfboard and his Mustang (awesome dude!)

Saturday, 18th May

As the mist netting course was scheduled for this weekend and the trainees were arriving at 15:00 hrs the morning and early afternoon were spent doing leisurely things. At about the expected time the remainder of the team arrived from Washington Dulles Airport: Mark and Jen Smart, Frances Keats, Ian Henderson and Richard Stillman. They were welcomed with open arms. The 30 trainees were introduced (or reacquainted) with the intricacies of mist netting by Nigel. Thereafter the whole group (30 trainees plus ourselves) went off to Ted Harvey to set the nets. This was only possible after some serious woodcutting by Dave, who had to clear the road to Ted Harvey of a fallen tree that had gone down that morning after a storm had gone through.

At the sandy blow-out site 12 two-shelves and four single-shelves were put up in five sections with good hopes for a very successful catch. Some people even betted that the number of birds caught would reach three or even four hundred. The first few birds flew in during daylight and after dusk each net round produced 15 to 20 birds. The majority were Semi's and Least, but also Dunlin were caught and two Spotted Sandpipers produced a ringing tick for some of us. The icing on the cake was without a doubt the three Black Skimmers that were caught in two single-shelves directly at the foot of the dunes in the impoundment. The training on Saturday was, therefore, a big success, with all the trainees being able to experience all the facets of mist netting and hardly any help with extracting in the dark (not so because of the half moon) from the team leaders (Nigel, Francis, Jacquie, Jeff and André). Shortly before high tide the nets were taken down, the last birds processed and everybody back at base at 02:00 hrs.



TABLE 11 TOTALS FOR THE MIST NET CATCH MADE ON TED HARVEY ON 18TH MAY

Ted Harvey 18th May High tide: 03:15 (19 th)	Estimated present	Caught (retraps included)	Retraps
Spotted Sandpiper		2	0
Dunlin		22	0
Semi-palmated Sandpiper		93	0
Black Skimmer		3	0
Ruddy Turnstone		1	0
Semi-palmated Plover		6	0
Least Sandpiper		26	0
Total		153	0
Team members: Thirty plus people for mist net training.			

Sunday, 19th May

After a well deserved, but rather short, night's rest a recce of all the beaches took a number of parties to different places with some parties boldly going where they hadn't been before. The counts (or estimates) of the numbers present revealed that the number of Red Knot on the Delaware side are increasing. Nigel and Jacquie went to Slaughter beach and found 400 Turnstone 300 Sanderling and 1,200 Knot present at 15:30. Scans of the various flocks revealed four individually marked Red Knots from the New Jersey side marked this year (two at Brockenbridge Gut and two at Slaughter Beach), as well as a Chilean cohort ringed Red Knot on Brockenbridge Gut, which had red leg flag on the lower right leg. It was ringed this year.

TABLE 12 TOTALS FOR A RECCE ON 19TH MAY. NOT ALL SITES WERE COVERED.

COUNT SECTION	T _{start}	T _{end}	SESA	REKN	LESA	DUNL	RUTU	SPSA	SKIM	BBPL	SBDO	WILL	SAND	BNST	TOTAL
Port Mahon	?	?	1100	0	190	55	4000	1	0	0	500	15	1	5	5852
Pickering Beach	?	?	8000	800	0	2200	900	0	0	2	0	20	0	0	11902
South Bowers Harbor	13:15	13:20	1000	250		5	0	0	0	0	10	2	0	0	1265
South Bowers Beach entrance	14:50	13:10	2000	750		1500	100	20	0	0	0	0	0	0	4370
Brockenbridge Gut	13:30	15:50	0	500		0	350	0	130	0	0	0	20	0	1000
Mispillion	?	?	15000	20000	0	10000	6000	0	0	0	0	0	0	0	51000
Slaughter Beach	15:30	17:00	0	1200		0	400	0	0	0	0	0	300	0	1900
TOTALS			27100	23500	190	13760	11750	21	130	2	510	37	321	5	77289

As planned the evening and early night were spent doing some more mist netting at Ted Harvey, the number of trainees dropped to about 15. The previous night had made us partial to catching some more Skimmers, so a few more two-shelved nets were put up on spots where we expected them. Somebody commented this would mean we would not catch any tonight. Unfortunately, this turned out to be true. A misunderstanding caused the sets of nets to be put up to be switched. The nets that were put up on the right side ended up on the left side and vice versa. All in all six

sections and two single nets were put up (from the south resp.: two 1-s, 4 1-s, 4 2 s, 1 2-s against the foot of the dune, 1 2-s and 2 2-s on the previous nights skimmer spot, 4 2-s and 2 1-s). Also, a genius thought on Nigel's part made us put up four two-shelves on the mudflats about 10 metres out from the beach and parallel to it! Stints were seen to fly under the net to reach the beach and indeed could be flushed into it during daylight. For the rest of the night this setup caught very well and not only because a tape lure was added. Of the 190 birds caught at least 100 were caught in the beach nets. This trick we can do on any beach now (in Delaware that is). At about 01:30 on the rising tide nearly reaching the beach, the wind suddenly picked up. Therefore, we decided to pack it in. The last birds were processed and the graveyard shift returned back at base at 02:30.

TABLE 13 TOTALS FOR THE CATCH MADE ON TED HARVEY ON 19TH MAY

Ted Harvey 19th May High tide: 04:15 (20 th)	Estimated present	Caught (retraps included)	Retraps
Dunlin		4	0
Semi-palmated Sandpiper		107	0
Spotted Sandpiper		2	0
Semi-palmated Plover		14	0
Short-billed Dowitcher		1	0
Least Sandpiper		63	0
Total		191	0
Team members: Fifteen plus people for mist net training.			

Monday, 20th May

The recce on Sunday proved Slaughter Beach to be the site to do a cannon net catch today. A small party consisting of Jacquie, Nigel, Kim, Jim, Francis and Greg set two nets at Slaughter Beach. The remainder of the team had been birding at different sites and reconvened at the catch site at about 14:00 h. Birds were present at the beach and with the help of two long distance twinklers (Gene and André) and two short distance twinklers (Simon and Jeff almost) a very good catch was made, shortly after Nigel proclaimed it would be difficult to actually do a catch at all. Things suddenly all coincided and the catch taken by Nigel whilst crawling on the beach to get a good view of safety.



PHOTOS PROCESSING TEAMS ON SLAUGHTER BEACH. WE ALSO CAUGHT THIS INDIVIDUALLY MARKED RED KNOT FROM ARGENTINA.

TABLE 14 TOTALS FOR THE CATCH MADE ON SLAUGHTER BEACH ON 20TH MAY.

Slaughter Beach High tide: 16:31 Firing time: 15:16	Estimated present	Caught (retraps included)	Retraps
Red Knot	5,000	190	25
Semi-palmated Sandpiper	10,000	27	0
Ruddy Turnstone	7,500	130	5
Sanderling	2,500	83	5
Total		430	35
Team members: Dave, Nigel, Jacquie, Jim, Kim, Greg, André, Francis, Mark, Rob, Jen, Frances, Ian, Phil, Rico and Richard and three people from the mist net course; 19 people doing the processing and Mike and Pete with one assistant bleeding and Pam and Karine doing the butt-swabbing makes 23 people.			

After processing, 416 birds were ringed and a good sample of Red Knot, Ruddy Turnstone and Sanderling were processed. Because of time constraints the Sanderling had to be released without colour-rings. The usual small peeps completed the tally. Again a large body of people (24 in total) worked very well together and after completion at about 19:30 hrs most of us went to The Rainbow Inn and had crabs, mozzarella sticks and other foodstuffs. Because we were well on schedule and the catch of today provided good samples of both main target species a day off was deemed to be appropriate.

Tuesday, 21st May

A day off for everybody! Hurray! Simon, Rob, Ian, Francis and André took the morning ferry to New Jersey to visit the Cape May Bird Observatory and the New Jersey team. They ended up visiting the bird observatory and a good birding spot close to it and had to pass on visiting the NJ-team. Phil and Richard went over as well to visit the NJ-team and have some discussions, which they did, to return the next morning. Pam and Karine were also on the ferry to visit their colleagues. Birding on Cape May produced a couple of good species such as Bobolink, Dicksissel, Prairie and Magnolia Warbler, White-throated Sparrow, Indigo Bunting, Blue Grosbeak and Purple Sandpiper. A Black-throated Green Warbler was spotted around the bird-obs when we were about to leave by all but André (bummer!!). Taking the five o'clock ferry back to Delaware left time to visit Prime Hook where a male Wilson's Phalarope was discovered by Simon. Ruddy Duck, Wood Duck, Green-winged Teal and Cliff Swallow were good species (and ticks for some of us) as well. The day was concluded with a semi-nocturnal visit to the forest of Prime Hook. Upon arrival a Chuck-Will's-Widow was seen on the tarmac road behind the entrance gate and several others were heard. Common Nighthawk and a calling Great Horned Owl added to the enjoyment. Tired but satisfied the birding-team arrived back at base in the evening.

Wednesday, 22nd May

Another day of leisure and relaxation. Counts and scans were done in the morning and a BBQ-party at Dave and Marge's house in the evening, together with some half-baked attempt to mist net some passerines. The BBQ was good, drink was good, catching was bad. Dave's plans to

start passerine mist netting at his home turf gave rise to some discussion as how to go about that in a forest-patch with trees as tall as they are. Hoist-nets were the agreed-upon most likely method. The party was ended at an early hour because of the early rising the next morning.

Nigel, Jacquie and Dave took Russ Peterson and his wife (former governor of Delaware) to Mispillion where estimated 20,000 Knot, 5,000 Turnstone 2,000 Dunlin 1,000 Semi's and 1,000 Dowitchers were present.

Phil took Jim Nichols to Mispillion to discuss calculating survival rates.

TABLE 15 TOTALS FOR THE RECCES DONE ON 22ND MAY.

COUNT SECTION	T_start	T_end	SESA	REKN	DUNL	RUTU	SAND	LESA	SBDO	SPSA	WILL	SPPL	AMOY	BBPL	SKIMM	TOTAL
Pickering Beach																0
Kitts Hummock			0	0	0	0	0	0	30		2	0	0			32
Ted Harvey			0	0	0	0	0	0	0	0	0	0	0			0
North Bowers	?	?	500	170	410	1900	210	0	43	3	3	0	0	4	344	3587
South Bowers	14:50	15:00	0	0	0	0	0	0	0	0	0	0	0			0
Brockenbridge Gut	15:30	17:00	3000	250	10	4000	1000	50	0	0	5	0	2	25		8342
Big Stone Beach	15:15	15:20	1000	2000	2000	5000	0	0	1000	0	0	0	0			11000
Mispillion																0
Slaughter Beach North																0
Milford Neck Roost																0
TOTALS			4500	2420	2420	10900	1210	50	1073	3	10	0	2	29	344	22961

Thursday, 23rd May

Dave, Nigel, Mark, Francis, and Amy did a baywide count, leaving Mispillion at 06.30! Jen counted Slaughter to speed up the process.

TABLE 16 TOTALS FOR A BAYWIDE COUNT ON 23RD MAY. COUNT WAS DONE BY DAVE CARTER, NIGEL CLARK, MARK SMART, FRANCIS KEATS AND AMY HOBSON. SLAUGHTER BEACH WAS COUNTED BY JEN SMART. SHE ALSO RECORDED 6,000 RED KNOT AT MISPELLION AT 06:50 HRS. IF COMPLEMENTARY THIS WOULD RAISE THE TOTAL OF RED KNOT TO 20,550, WHICH IS CONCORDANT WITH THE NUMBER ESTIMATED THE PREVIOUS DAY.

COUNT SECTION	Time	AMOY	BBPL	SKIM	REKN	DUNL	SAND	SPSA	LESA	SBDO	SESA	WILL	RUTU	TOTAL
Woodland Beach flats	10:45	0	440	0	0	0	0	0	0	0	0	0	0	440
Edgell Cove	10:31	0	4	0	0	2	0	0	0	0	40	2	2	50
Dupont Breach	10:25	0	2	0	0	190	0	0	0	0	215	0	10	417
Bombay Hook North	10:05	0	14	0	0	1315	0	0	0	80	1160	5	312	2886
Simons-Leipsic River	10:00	0	7	0	0	115	0	0	0	0	55	3	10	190
Kelly North	09:50	0	2	0	0	90	0	0	0	0	250	0	105	447
Kelly Mid-north	09:45	0	6	0	0	290	0	0	0	0	230	6	75	607
Kelly Mid-south	09:41	0	0	0	0	200	0	0	0	1	220	10	225	656
Kelly South	09:30	0	2	0	0	250	0	0	0	0	20	3	310	585
Mahon North		0	0	0	0	330	0	0	0	75	460	1	1240	2106
Mahon South		0	0	0	0	135	0	0	0	210	410	5	1115	1875
Mahon Impoundment		0	1	0	0	415	0	0	0	0	340	6	90	852

Little River mouth south		0	0	0	0	0	0	0	0	0	0	0	0	0
North of Pickering Beach	09:00	0	1	0	13	680	0	0	0	0	2	3	205	904
Pickering Beach	08:56	0	0	0	30	540	0	0	0	0	530	0	190	1290
Lewis Ditch North		0	0	0	80	245	0	0	0	100		5	485	915
Lewis Ditch South		0	0	0	0	0	0	0	0	0		0	0	0
North of Kitts Hummock	08:38	0	0	4	0	0	0	0	0	0	30	0	0	34
Kitts Hummock	08:32	0	0	0	0	6	0	0	0	0	20	1	0	27
Ted Harvey North		0	0	0	0	0	0	0	0	0		0	0	0
Ted Harvey South	08:20	0	0	1	35	7	0	0	0	0	135	2	220	400
St. Jones Mouth North		0	0	70	3	0	0	0	0	0		4	125	125
St. Jones Mouth South		0	0	8	20	0	5	0	0	0	25	1	155	214
North Bowers	08:00	0	0	28	0	0	50	0	0	0	280	0	30	388
South Bowers		0	5	0	502	5	25	0	0	0	480	1	1305	2323
South of South Bowers		0	0	0	95	0	420	0	0	0		2	813	1330
Brockenbridge Gut	07:45	0	0	0	35	0	350	0	0	0	60	6	230	681
Bennett's Pier North	07:20	1	0	0	170	0	0	0	0	0	20	2	410	603
Bennett's Pier South		0	0	0	3130	40	0	0	0	0	985	2	1995	6150
Bigstone Beach		0	0	0	2050	0	0	0	0	0	130	1	1525	3705
Milford Neck North		0	0	0	1245	0	490	0	0	0	1000	0	510	3245
Grecco Canal Breach		0	0	0	130	32	0	0	0	0	310	0	405	877
Milford Neck South		0	0	0	356	0	0	0	0	0	130	0	361	847
Mispillion Jetty		0	0	0	5	50	2	0	0	30	20	0	55	162
Mispillion Harbor North		0	0	0	1300	260	0	0	0	675	0	10	273	2518
Mispillion Harbor South	06:40	0	0	0	1	0	0	0	0	0	0	0	124	125
Cedar Creek		0	0	0	0	0	0	0	0	0	0	0	0	0
Slaughter Beach North	07:40	0	0	0	6600	190	0	0	0	0	2900	17	7400	17107
Slaughter Beach South	07:10	0	0	0	50	100	4000	2000	0	0	0	30	300	6480
TOTALS		1	484	111	15850	5487	5342	2000	0	1171	10457	128	20610	61641
COUNT SECTION		AMOY	BBPL	SKIM	REKN	DUNL	SAND	SPSA	LESA	SBDO	SESA	WILL	RUTU	TOTAL

So few birds were found that that they got back in time for the catch. Two catches at Mispillion were made on the sandy beaches opposite the lighthouse well before high tide. The first catch went haywire because of one of the fuses getting wet, so the net only half-fired. Some twenty Turnstone and fifteen Knot were caught. The second setting of the net was about 150m more inland and gave us a good sample of both Red Knot and Turnstone. If the first catch would have been completely successful it would have consisted largely of Turnstone, so again the proverb: “Every disadvantage has its advantages (Johan Cruyff 1995)” proved to be true. At least 20,000 Knot and 4,000 Turnstone present in Mispillion

TABLE 17 TOTALS FOR THE CATCH MADE AT MISPELLION ON 23RD MAY

Mispillion 23 May High tide: 06:56 Firing time: 10:25 & 12:18	Estimated present	Caught		Total	Retraps
		first catch	second catch		
Red Knot	5,000+	13	263	276	0
Ruddy Turnstone	3,000	21	58	79	0
Sanderling	Tens	0	1	1	0
Dunlin	Hundreds	1	5	6	0
Willet	Few	-	1	1	0
Short-billed Dowitcher	Tens	-	1	1	0
Total		35	329	364	0

Friday, 24th May

Nigel and Dave did a radio interview at Mahon and called in at Pickering on the way back. At 12:00 hrs they found 4,000 Semi's, 150 Turnstone, 200 Dunlin and one Sanderling.

TABLE 18 TOTALS FOR RECCES AT ONLY TWO SITES ON 24TH OF MAY. THE TOTAL OF ALMOST 55,000 BIRDS IS CLOSE TO THAT OF THE BAY FRONT COUNT DONE ON 23RD. THE NUMBER OF SEMI-PALMATED SANDPIPER IS PROBABLY UNDERESTIMATED ON 23RD SO THIS COMPARISON IS NOT COMPLETELY UNBIASED. NOT FOR THE FIRST TIME 20,000 RED KNOT WERE PRESENT AT MISPELLION. A COMPARISON WITH THE RESULTS ON 23RD SUGGEST THAT THE 20000 RED KNOT PRESENT AT THIS TIME AT SOME STAGE IN THE TIDAL CYCLE DISPERSE ALONG THE WHOLE BAY FRONT AND GATHER AT MISPELLION AT SOME OTHER TIME.

COUNT SECTION	T _{start}	T _{end}	SESA	REKN	DUNL	RUTU	SAND	LESA	SBDO	SPSA	WILL	SPPL	AMOY	BBPL	SKIMM	TOTAL
			Pickering Beach		12:00	4000	0	200	150	1	0	0	0	0	0	0
Mispillion			17500	20000	10000	3000	0	0	0	0	0	0	0	0	0	50500
TOTALS			21500	20000	10200	3150	1	0	0	0	0	0	0	0	0	54851

The remainder of the day was spent doing some shopping at Wal Mart and other places. There were noticeably more people around doing stuff, Little Creek was virtually a ghost town a couple of days ago but was teeming with life today. The traffic was also noticeably heavier, resulting in traffic jams when leaving Dover. In the evening, however, another mist net try was made at Port Mahon by Francis and André, later assisted by Ian and Rob.

TABLE 19 TOTALS FOR A MIST NET CATCH AT PORT MAHON IMPOUNDMENT ON 24TH MAY IN THE EARLY EVENING.

Port Mahon Impoundment High tide: 21:06	Estimated present	Caught (retraps included)	Retraps
Short-billed Dowitcher	Hundreds	1	0
Semi-palmated Sandpiper	Hundreds	37	0
Dunlin	Tens	1	0
Black-necked Stilt	8	0	0
Total		39	0
Team members: André, Francis, Ian and Rob			

Saturday, 25th May

With the high tide gradually moving towards evening we were able to do today's catch at Port Mahon in the early morning. The setting team set off at 06:00 hrs followed by the rest at 06:30 hrs. Getting up early was also necessary because of the air show on Dover Airforce Base, for which the road to Port Mahon was closed to accommodate for parking on an adjacent meadow.



PHOTOS THE DELAWARE TEAM AT PORT MAHON. EXAMINING THE PLUMAGE OF A RUDDY TURNSTONE.

Setting the net was successfully done at the usual site, with the furlled net beautifully camouflaged against the background of the high tide mark and some rocks. After a short wait the net was fired and produced a satisfactory catch of Ruddy Turnstone, Semi P's and some Dowitchers and Dunlin. The Semi's were used to carry out the weight loss experiment and the weights and biometrics from this catch are very useful to be compared with those caught yesterday evening.

TABLE 20 TOTALS FOR CANNON NET CATCH AT PORT MAHON ON 25TH MAY

Port Mahon High tide: 09:31 Firing time: 07:50	Estimated present	Caught (retraps included)	Retraps
Semi-palmated Sandpiper	5000	41	
Ruddy Turnstone		172	
Dunlin		4	
Short-billed Dowitcher		8	
Total		225	
Team members: Dave, Nigel, Jacquie, Jim, Kim, André, Francis, Mark, Rob, Jen, Frances, Angie, Pam, Karine, Mike, Mike and Pete, Annie, Sally, Jean, Jonna, Uday, Deborah, Rhoda, Pamela, Evan, Rico. In all 28 people were present.			

André and Frances went for a trip to Prime Hook to find that due to the strong south-easterly wind all waders present were on the far side of the impoundment sheltered from the wind. On returning they met with the rest of the team who had gone out to do some mist netting at Ted

Harvey's and who were equally hampered by the strong wind and had decided to abandon their plan. Water in the impoundments has receded somewhat and during their presence the team could observe Semi's departing on northbound migration. The plan is to mist net again tomorrow evening at Port Mahon.

Sunday, 26th May

Slaughter Beach at the second beach access was the venue today. Leaving early in the morning the setting team set two nets on the south side of the entrance to enhance chances of a good catch. Ian went to twinkle the south side and Andre ditto on the north side. There were plenty of birds on the beach and after a short while we had several thousands in the immediate vicinity of the catching area. A five-person team from National Geographic was also present to get some more footage for a longer program than the one made last year. With a minicam in the catching area and a camera in the hide they had front row seats. At some time there was a misunderstanding about the amount of reel time left on a camera and this prompted an early firing to be sure to get at least a reasonably good catch. After the bang at 08:15 we had a good catch of Turnstone and slightly less Knot. Normally we would have waited a bit longer with a promise of a really good catch. The National Geographic team got their footage and headed off to Mispillion with Dave and Nigel to shoot some more stuff on Horseshoe Crabs. Ian and Rob went to Mispillion as well to do some more scans and show the feeding stuff to the TV-people.



PHOTO THE SHOREBIRDS FEEDING ALONG SLAUGHTER BEACH AS THE TEAM PROCESSES THE CATCH.

TABLE 21 TOTALS FOR CANNON NET CATCH AT SLAUGHTER BEACH ON 26 MAY

Slaughter Beach High tide: 09:38 Firing time: 08:15	Estimated present	Caught (retraps included)	Retraps
Red Knot	2,000	49	0
Ruddy Turnstone	3,000	89	0
Sanderling	Few	1	0
Willet	Few	1	1
Total		140	1
Team members: Dave, Nigel, Jacquie, Jim, Kim, André, Francis, Mark, Rob, Jen, Frances, Angie, Pam, Karine, Mike, Mike, Pete and a couple of American volunteers			

Nigel and Dave called in at Bowers on their way back at 13:40 and found 2,000 Semi's and 200 Turnstone at South Bowers and 800 Turnstone and 3,000 Semi's at North Bowers. Also 200

Knot, 50 Skimmers and 300 Turnstone at the north side of the St Jones River. Only 2,000 Semi's could be seen on the front of Ted Harvey.

TABLE 22 COUNTS FOR SELECTED SITE ON 26TH MAY

COUNT SECTION	T _{start}	T _{end}	SESA	REKN	DUNL	RUTU	SAND	LESA	SBDO	SPSA	WILL	SPPL	AMOY	BBPL	SKIMM	TOTAL
St. Jones River Mouth			0	200	0	300	0	0	0	0	0	0	0	0	50	550
Ted Harvey			2000	0	0	0	0	0	0	0	0	0	0	0	0	2000
North Bowers Beach			3000	0	0	800	0	0	0	0	0	0	0	0	0	3800
South Bowers Beach			2000	0	0	200	0	0	0	0	0	0	0	0	0	2200
Mispillion			9000	3000	0	1000	0	0	0	0	0	0	0	0	0	13000
TOTALS			16000	3200	0	2300	0	0	0	0	0	0	0	0	50	21550

The evening turned out to be ideal for mist netting in Ted Harvey. A recce on the day before had revealed that the water level had dropped and three sections of nets were put up, crossing the largest water filled areas. Skimmers had been seen to skim the surface here so hopes were high. A beach net was also put up and tape lures were placed both on the beach and in the impoundment. As dusk approached, flocks of dunlin and Semi's were seen migrating together with one flock of 80 Knot. There was a general movement of Turnstone north but most were very low and were not thought to be migrating. The tape lure at the beach nets brought almost every Semi and most Dunlin, Sanderling and Turnstone into the area, but the nets were very visible against the sand beach (also a lot of human activity on the beach like a film crew etc). A few birds were consequently caught – only 15 in two hours in 2 two shelves and a single. The dusk round was already successful with some 40 Semi's and the first round in the dark (though with a full moon) prompted us to close the nets and take them down, as we already had caught 100+ Semi's. Processing was done on the platform with the help of those beautiful floodlights and the tiny generator and eventually we got back at the reserve at 00:30. Easy peasy so to speak.

TABLE 23 TOTALS FOR MIST NET CATCH AT TED HARVEY ON 26 MAY

Ted Harvey Impoundments High tide: 22:28	Estimated present	Caught (retraps included)	Retraps
Semi-palmated Sandpiper	Hundreds	168	0
Ruddy Turnstone	few	1	0
Dunlin	few	3	0
Least Sandpiper	few	1	1
Total		173	1
Team members: Dave, Nigel, Jacquie, Jim, Kim, André, Francis, Mark, Rob, Jen, Frances, Angie, Pam, Karine, Mike			

Monday, 27th May, Memorial Day

An easy day, with only counts and some shopping and other stuff. The count on Brockenbridge Gut was again fruitful as it produced an orange flagged/black flagged Knot, presumably ringed in Tierra del Fuego in the past, when the bird rings were in short supply. This individual was not ringed with a metal ring! A few other individuals were also present and number of scans made. Clearly the work done so far was obvious as a good number of the cohort combinations of this year were present. Interesting observation was a Brown Pelican flying south and also a good number of Semi's were seen flying south both on the walk to and from Brockenbridge Gut. This went on while AD was present at BB Gut with several thousand Semi's flying south. Whether this is a natural movement through the tidal cycle or a shift in distribution is unclear.

On the spit at BB Gut were large flocks of Knot, Semi's and Sanderling as well as good numbers of Turnstone either feeding or roosting. Feeding was done on large and clearly visible green bands of crab eggs on the mud and sand and apparently eggs were concentrated in certain spots because feeding birds were seen concentrated in compact flocks when feeding. Scanning of these highly mobile birds proves to be very difficult. The roosting birds all seemed to be very fat, especially the Knot were visibly plump, as could be seen when comparing them to a small number of lean animals (who appeared to be in a less advanced breeding plumage with less orange on the belly).

TABLE 24 RESULTS OF LAND-BASED COUNTS ON 27TH MAY

COUNT SECTION	AMOY	BBPL	REKN	DUNL	SAND	LESA	SBDO	SPSA	GRYE	WILL	RUTU	TOTAL
Bigstone Beach	0	0	0	0	0	0	0	300	0	0	0	300
Bennett's Pier North	1	20	0	20	5	0	0	50	0	4	15	115
Brockenbridge Gut	0	10	2515	160	1650	0	0	6000	0	4	1510	11849
South Bowers	10	0	500	150	0	0	0	15000	0	2	1500	17162
Pickering south	0	1	0	0	0	0	0	300	0	0	10	311
Pickering North	0	0	20	40	0	0	0	5000	0	0	350	5410
Port Mahon	0	0	0	0	0	0	0	140	0	0	940	1080
TOTALS	11	31	3035	370	1655	0	0	26790	0	10	4325	36227

Tuesday, 28th May

Up at 4:55 am to set in Mispillion; on arrival there were 2,000 Knot and 10,000 Semi's spread out over the large area of beached crabs, giving no place where we could safely set nets without birds running all over the safety area. Eventually decided to set just seaward of the grass spit where there was a patch of sand above the high tide line set two yards back from the tide line firing over the upper beach where a reasonable concentration of Knot had been feeding. Set by 7:30 but the birds did not want to come back. Had to move the flock from both ends of the beach,

which resulted in most Knot leaving for the bay front where they roosted. Finally a record catch was made and very expediently processed by a team of only twenty people (including the bleeding and BS teams)!



PHOTO TEAMS PROCESSING THE LARGE CATCH AT MISPELLION. COVERING MATERIAL IS SHADING THE BIRDS IN THE KEEPING CAGES.

TABLE 25 TOTALS FOR CANNON NET CATCH AT MISPELLION ON 28TH MAY

Mispillion High tide: 11:17 Firing time: 10:13	Estimated present	Caught (retraps included)	Retraps
Semi-palmated Sandpiper	10,000	451	
Ruddy Turnstone	Hundreds	92	
Red Knot	2,000	224	
Dunlin	Tens	10	
Short-billed Dowitcher	A few	3	
Sanderling	Tens	7	
Black-bellied Plover	Some	1	
Total		788	
Team members: Dave, Nigel, Jacquie, Jim, Kim, André, Francis, Mark, Rob, Jen, Frances, Angie, Pam, Karine, Mike			

Most of the Semi's were ringed and flinged, except for a sample of 100. The Black-bellied Plover was of special interest to most people present, as it was a male in breeding plumage and probably the first caught in several years. After this very productive and very hot day Mark, Jen,

André and Karine took off for a visit to New Jersey to meet up with Bruce Ferry and Kees Oosterbeek. At first the catch, for which we had gotten up at 05:00 hrs, promised to be finished at an early hour. Things not went as we hoped. The New Jersey visiting bunch took off in time to get the 17:00 hrs ferry where they were met by a police dude who informed us that no reservation meant no ferry, so we had to drive around the bay and take the Memorial Bridge. The team arrived at 20:00 hrs, and meeting up with Bruce, Kees and the others was good fun. The others remaining at the DE-side went out to Sambo's to get a taste of the crabs (best crab place in the area), and maybe leave their name on the wall.



PHOTO PART OF THE TEAM DNES OUT AT SAMBOS. THE BEST CRAB PLACE IN THE AREA!

Wednesday, 29th May

Strangely we got invited to be present at a catch on Fortescue, which meant we had to get up at 05:00 hrs again! After a catch of Semi's was made at 12:00 hrs we hurried off. Bruce was going elsewhere to do a count and Kees was leaving in the afternoon. Maybe next year we will see them on the Delaware side! On the way over, back to the Delaware side we saw about 15 Wilson's Petrel and a good number of dolphins, presumed to be Bottlenosed.

The remaining team did a baywide count, resulting in huge numbers. Especially the numbers at Slaughter Beach were awesome (dude!).

TABLE 26 TOTALS FOR A BAYWIDE COUNT ON 29TH MAY. COUNT DONE BY NIGEL CLARK, ROB ROBINSON, DAVE CARTER AND JACQUIE CLARK.

COUNT SECTION	Time	AMOY	BBPL	REKN	DUNL	SAND	BNST	SBDO	SESA	WILL	RUTU	TOTAL
Woodland Beach	15:00	0	1	0	0	0	0	0	28	2	12	43
Edgell Cove	14:50	0	0	0	0	0	0	0	4086	1	262	4349
Dupont Breach	14:45	0	2	3	0	20	0	0	20	2	1440	1487
Bombay Hook	14:20	0	230	0	10	0	0	0	440	1	10	691
Bombay Hook North	14:00	0	0	0	0	0	0	1	1067	7	951	2026
Simons-Leipsic River	13:44	0	5	150	0	0	0	0	573	3	355	1086
Kelly North	13:38	0	1	3	0	2	0	0	120	4	60	190

Kelly Mid-north	13:28	0	4	0	0	0	0	0	1000	8	2755	3767
Kelly Mid-south	13:24	0	0	5	0	0	0	0	20	3	607	635
Kelly South	13:17	0	1	0	0	0	0	0	0	9	225	235
Mahon North	13:10	0	0	0	0	0	0	0	130	0	40	170
Mahon South	13:07	0	0	0	0	0	0	0	0	2	0	2
Mahon Impoundment	13:02	0	0	0	0	1	0	0	2050	4	856	2911
Little River mouth	13:00	0	0	0	0	0	0	0	0	0	0	0
North of Pickering Beach	12:55	0	1	0	0	2	0	0	625	1	47	676
Pickering Beach	12:52	0	0	0	0	0	0	0	2150	0	140	2290
Lewis Ditch North	12:25	0	0	10	0	0	0	1	200	0	135	346
Lewis Ditch South	12:24	0	0	0	0	0	0	0	0	0	0	0
North of Kitts Hummock	12:18	0	1	36	0	0	0	0	50	1	179	267
Kitts Hummock	12:15	0	1	0	0	0	0	0	0	0	2	3
Ted Harvey North	12:10	0	0	0	0	0	0	0	171	0	100	271
Ted Harvey South	12:05	0	1	435	0	10	0	0	120	0	675	1241
St. Jones Mouth North	12:03	0	0	130	0	30	0	0	0	0	180	340
St. Jones Mouth South	11:59	0	0	11	0	85	0	0	2	2	0	100
North Bowers	11:57	0	0	0	0	84	0	0	35	0	0	119
South Bowers	11:52	0	0	110	0	120	0	0	6590	0	110	6930
South of South Bowers	11:44	0	1	1530	0	450	0	0	0	1	2800	4782
Brockenbridge Gut North	11:42	0	0	250	0	0	0	0	0	0	100	350
Brockenbridge Gut South	11:40	0	0	290	0	0	0	0	0	0	180	470
Bennett's Pier North	11:35	1	1	740	0	565	0	0	20	1	1010	2338
Bennett's Pier South	11:30	0	0	1570	0	20	0	0	225	2	260	2077
North of Bigstone Beach	11:22	0	6	915	0	208	0	0	501	0	267	1897
Bigstone Beach	11:20	0	1	0	0	305	0	0	0	0	0	306
Milford Neck North	11:10	0	2	80	0	180	2	0	0	2	5	271
Grecco Canal Breach	11:06	2	4	355	0	150	0	0	110	0	325	946
Milford Neck South	11:00	1	10	470	0	0	0	0	960	3	530	1974
Cedar Creek North	10:40	0		550	0	0	0	0	200	0	200	950
Mispillion Jetty	10:40	2	1	250	0	880	0	0	500	1	272	1906
Mispillion Harbor North	10:27	1	10	212	0	30	0	0	2952	7	131	3343
Mispillion Harbor South	10:20	0	1	110	0	0	0	0	40	6	401	558
Slaughter Beach North	10:00	0	10	1300	0	4500	0	0	6000	14	4000	15824
Slaughter Beach South	10:30	0	4	1000	0	2000	0	0	5000	6	2000	10010
TOTALS		7	299	10515	10	9642	2	2	35985	93	21622	78177
	Time											
COUNT SECTION		AMOY	BBPL	REKN	DUNL	SAND	BNST	SBDO	SESA	WILL	RUTU	TOTAL

In the evening they did a limited mist net at Ted Harvey impoundments and caught a few Semi's.

TABLE 27 TOTAL CAUGHT MIST NETTING ON 29TH MAY

Ted Harvey High tide: 00:21 (30th)	Estimated present	Caught (retraps included)	Retraps
Semi-palmated Sandpiper	5,000+	161	-
Total		161	-
Team members: Dave, Nigel, Jacquie, Jim, Kim, André, Francis, Mark, Rob, Jen, Frances, Angie, Pam, Karine, Mike			

Thursday, 30th May

Finally we decide to try a catch at Brockenbridge Gut (which actually is called Sandy Point on the maps). NAC, JAC, DC, KBC, FA and AD leave North Bowers by boat to set the nets, the rest of the team will arrive later by car. Upon arrival plenty of Knot, Sanderling and Turnstone are present and a swift and successful catch seems only a matter of minutes. Two nets are set slightly below the highest tidemark to cover a small bay where birds are known to feed in high densities from previous recces by AD. Base camp is in the little evergreen forest. After setting Dave and Andre take the boat to go and meet the rest of the team and twinkle the birds back to BBgut from the south end beach where they went when we were setting. Thereafter the beach towards South Bowers are recced and the quite large numbers of birds there attempted to move towards BBGut. Whatever we do the birds do not seem to be willing to cooperate and we end up taking a nap to wait for falling tide and try again. Luckily birds seem to be willing to cooperate better and after a while the catch was made.

TABLE 28 TOTALS CAUGHT CANNON NETTING AT BROCKENBRIDGE GUT ON 20TH MAY

Brockenbridge Gut High tide: 12:55 Firing time: 14:56	Estimated present	Caught (retraps included)	Retraps
Red Knot	1,500	28	0
Ruddy Turnstone	3,000	130	0
Sanderling		56	
Dunlin	Tens	1	0
Semi-palmated Sandpiper	Tens	2	0
Total		217	0
Team members: Dave, André, Francis, Ian, Rob, Nigel, Jacquie, Kim, Jim, Tim, Karine, Pam, Mark, Jen and a few others			

Friday, 31st May

Work is done, so Friday is a day off (the beach!). People went to different places. Some visited White Clay Creek and the Natural History Museum (Ivory Billed Woodpecker and Passenger Pigeon!!!). Others go to the Patuxent Bird Observatory to see what's up there (the American ringing administration office). At Port Mahon 1,320 Semi's, two Turnstone, four Willets and one Black-necked Stilt are seen.

Saturday, 1st June

Yet another day off, but mostly filled with getting ready to leave the next morning. Several venues at nearby places are visited.

We decided to try to catch a small sample of Semi's in the evening and agreed we would take down as soon as we had caught 70. Five single shelves put up on impoundments just before dusk, but the tape lure was forgotten. On the first net round the team radioed back that we had our sample! So extracted and took down.

At 02.30 AM on Sunday morning André went to Wal Mart to get some last essential shopping, to find Wal Mart closed: "they're not open 24/7 at all!"

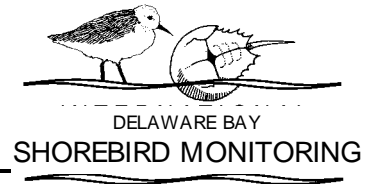
TABLE 29 TOTALS MIST NETTED AT TED HARVEY ON 1ST JUNE

Ted Harvey High tide: 03:21 (2nd)	Estimated present	Caught (retraps included)	Retraps
Semi-palmated Sandpiper		109	
Semi-palmated Plover		1	
Black-bellied Plover		1	
Total		111	

Sunday, 2nd June

Leaving at around 10:00 AM in a giant (luckily) van. Everybody and their (sometimes immense) luggage could be accommodated. A three hour ride takes us to Washington Dulles, where checking in proves to be a drag (long queues) or even impossible. Frances is getting flak from the check-in person because her tripod is not allowed as cabin luggage. Eventually everything is sorted out and we all have a successful flight back (although Frances' luggage takes a different route than she does).

Appendix C



The 2002 Delaware Shorebird Monitoring Team

Francis Argyle	Phil Atkinson
Greg Breese	Rhoda Bryan
Dave Carter	Nigel Clark
Jacquie Clark	Rachael Coffey
Kim Cole	Doug Dersch
Jonna Dersch	Andre Duiven
Robert Engler	Simon Gillings
Shireen Gonzaga	Julie Groce
Ian Henderson	Gene Hess
Jim Hewes	Amy Hobson
Francis Keddie	Jeff Kew
Allison Kew	Uday Kumar
Annie Larsen	Susan Love
Tim Lucas	Erica Broderick
Cheryl Nemazie	Dave Nemazie
Holly Niederriter	Tim O'Connor
Donald Ohlandt	Rebecca Orth
George Oshea	Debbie Pankonin
Mike Remus	Rob Robinson
Rico Santiago	Jen Smart
Mark Smart	Richard Stilman
Pam Toschik	Erin Wilson
Bonnie Willis	Carl Yetter
Karine Nunes	Mike Stevenson
Wayne Kirklin	Mike Mensinger
Katy Dulin	Pam Patterson
Jean Woods	Sally Shelton
Tricia Cosbey	Heather Hudson
Mike Haramis	Peter Osenton

Groups Represented Include:

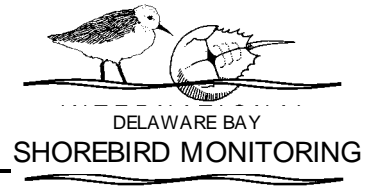
- British Trust for Ornithology
- Wash Wader Ringing Group
- Department of Natural Resources and Environmental Control
- US Fish and Wildlife Service
- Delaware Museum of Natural History
- Tri-State Bird and Rescue
- US Geological Survey
- University of Georgia
- Audubon – Delaware and New England Region
- Friends of the Delaware National Estuarine Research Reserve

Appendix D

2002 Color Band Combination		
Year	Left Leg	Right Leg
2002 DE Mispillion	Fg,R	m,B
2002 DE Bowers	Fg,O	m,B

2002 Individual Ruddy Turnstone Color Band Combinations			
Fg/BB:M/-	M/BB:Fg/-	Fg/-:M/BB	M/-:Fg/BB
Fg/BG:M/-	M/BG:Fg/-	Fg/-:M/BG	M/-:Fg/BG
Fg/BL:M/-	M/BL:Fg/-	Fg/-:M/BL	M/-:Fg/BL
Fg/BR:M/-	M/BR:Fg/-	Fg/-:M/BR	M/-:Fg/BR
Fg/BY:M/-	M/BY:Fg/-	Fg/-:M/BY	M/-:Fg/BY
Fg/GB:M/-	M/GB:Fg/-	Fg/-:M/GB	M/-:Fg/GB
Fg/GG:M/-	M/GG:Fg/-	Fg/-:M/GG	M/-:Fg/GG
Fg/GL:M/-	M/GL:Fg/-	Fg/-:M/GL	M/-:Fg/GL
Fg/GR:M/-	M/GR:Fg/-	Fg/-:M/GR	M/-:Fg/GR
Fg/GY:M/-	M/GY:Fg/-	Fg/-:M/GY	M/-:Fg/GY
Fg/LB:M/-	M/LB:Fg/-	Fg/-:M/LB	M/-:Fg/LB
Fg/LG:M/-	M/LG:Fg/-	Fg/-:M/LG	M/-:Fg/LG
Fg/LL:M/-	M/LL:Fg/-	Fg/-:M/LL	M/-:Fg/LL
Fg/LR:M/-	M/LR:Fg/-	Fg/-:M/LR	M/-:Fg/LR
Fg/LY:M/-	M/LY:Fg/-	Fg/-:M/LY	M/-:Fg/LY
Fg/RB:M/-	M/RB:Fg/-	Fg/-:M/RB	M/-:Fg/RB
Fg/RG:M/-	M/RG:Fg/-	Fg/-:M/RG	M/-:Fg/RG
Fg/RL:M/-	M/RL:Fg/-	Fg/-:M/RL	M/-:Fg/RL
Fg/RR:M/-	M/RR:Fg/-	Fg/-:M/RR	M/-:Fg/RR
Fg/RY:M/-	M/RY:Fg/-	Fg/-:M/RY	M/-:Fg/RY
Fg/YB:M/-	M/YB:Fg/-	Fg/-:M/YB	M/-:Fg/YB
Fg/YG:M/-	M/YG:Fg/-	Fg/-:M/YG	M/-:Fg/YG
Fg/YL:M/-	M/YL:Fg/-	Fg/-:M/YL	M/-:Fg/YL
Fg/YR:M/-	M/YR:Fg/-	Fg/-:M/YR	M/-:Fg/YR
Fg/YY:M/-	M/YY:Fg/-	Fg/-:M/YY	M/-:Fg/YY

Appendix E



2002 Horseshoe Crab Research

Horseshoe crabs, *Limulus polyphemus*, are an important and prominent component of Delaware Bay's ecology and economy. Horseshoe crabs are used as bait in conch and eel pots and components in their blood are used to test the purity of intravenous drugs and implantable medical devices. In addition, the eggs that horseshoe crabs lay each spring on sandy beaches are an important food source for many birds, especially migratory shorebirds. It is this interaction between shorebirds and horseshoe crab eggs, along with concerns about the populations of both, that has spurred a renewed interest in researching the biology and population status of horseshoe crabs. In order to meet some outstanding research needs, staff scientists and volunteers with the Delaware Coastal Programs has undertaken and participated a number of studies to better understand horseshoe crab populations, egg laying behavior and habitat preferences.

Horseshoe Crab Egg Density Studies

The Delaware Coastal Programs has been monitoring selected Delaware Bay beaches for horseshoe crab egg density since 1997. This egg density monitoring serves a number of purposes: (1) it gives a rough indication of the number of horseshoe crab eggs potentially available for shorebird consumption on each beach; (2) it allows scientists to further understand egg-laying behavior and egg development within the beach and; (3) it allows for in-depth study of the effect that beach characteristics (sediment size, beach width, slope, development status etc.) may have on horseshoe crab spawning site selection and egg development.

In 2002, six Delaware Bay beaches were routinely sampled for egg density: Port Mahon, Pickering Beach, Kitts Hummock Beach, North Bowers Beach, Mispillion Harbor and Slaughter Beach. Sampling occurred five times throughout May, June and July. Samples of beach sand are taken with a core sampler (a metal pipe approximately 5.7 cm wide by 20 cm deep). The top 5 cm of each sample are analyzed separately from the 5 – 15 cm portion, as it is generally thought that the eggs in the top 5 cm of sand are available as food for foraging shorebirds. The eggs in the sand are extracted by a multi-step method and counted.



CORE SAMPLING FOR HORSESHOE CRAB EGG DENSITY

On each sampling date, a number of abiotic measurements are also taken. Beach slope, a potentially important habitat consideration, is measured and recorded. Sand temperature, an

important factor in egg development, is measured at three different elevation levels in the beach. In addition, sediment samples are taken on each beach once during the season.

Data collected during the spring of 2002 is currently being analyzed. A summary report will be available in the winter of 2003.

Beach Nourishment on Delaware Bay Beaches to Restore Habitat for Horseshoe Crab Spawning and Shorebird Foraging

The State of Delaware routinely replenishes its Delaware Bay beaches with sand for protection against shoreline erosion. It is partially because of this replenishment program that expansive sandy beaches remain available for usage by shorebirds and horseshoe crabs on the Delaware side of the Bay. Because of the importance and prevalence of beach nourishment in the Delaware Bay, it is crucial to understand how nourishment projects impact horseshoe crab spawning and to understand habitat preferences and habitat utilization of horseshoe crabs so that nourishment projects can mimic these conditions.



PEA GRAVEL BEING PLACED ON NORTH BOWERS BEACH, APRIL 2002

The Delaware Coastal Programs, in cooperation with the USGS Leetown Science Center and The Nature Conservancy, conducted a special project to further investigate beach nourishment as a form of habitat restoration and to provide habitat design criteria for future replenishment projects. The project had a number of components, including restoration at Bowers Beach Delaware, egg density monitoring at the study beaches (Bowers, Ted Harvey Wildlife Area and Pickering), spawning surveys of study beaches and egg development studies.

Coarse-grained sediment was placed at Bowers Beach, Delaware in early April 2002 to optimize this beach habitat for horseshoe crab spawning. A total of 921.15 tons (614.10 cubic yards) of coarse sand was placed on two separate 300 linear foot treatment areas from the low tide shelf to the storm tide line. The coarse sand was top-dressed with 190.68 tons of pea gravel (127.12 cubic yards). In order to increase the volume of pea gravel in the spawning area, it was placed only between low tide shelf and the high tide line. The total depth of coarse sand and pea gravel in the replenished areas varied from 10-20 centimeters.

During the last weeks of May and June, cores of sediment were collected from multiple beach segments at North Bowers, Ted Harvey, and Pickering for the purpose of estimating the density horseshoe crab eggs. Samples of sediment were stratified by beach elevation to study distribution of eggs across the foreshore. The cores were separated into 0 to 5 cm and 5 to 20 cm

depths to study total spawning activity and eggs available to foraging shorebirds. In addition, egg clusters, placed in pouches, were buried in the sediment at Bowers and Ted Harvey Beaches. The clusters were dug up after 30 – 40 days and are being analyzed for development status.

Sediment was collected from multiple beach segments at Bowers, Ted Harvey, and Pickering to characterize the sediment size distribution across the foreshore. Samples of sediment were stratified by beach elevation to link sediment size with egg density. Beach profiles were also surveyed at all beach segments. At North Bowers and Ted Harvey, wells with pressure transducers were deployed across the foreshore to establish the water table and characterize water drainage at the nourished and control beaches. In addition, sediment activation rods were deployed to study depths of activation in relation to wave energy.

Horseshoe Crab Spawning Baywide Survey

Surveys of spawning horseshoe crabs on both sides of the Delaware Bay have taken place since the early 1990's. In 1999, the sampling protocol was redesigned to provide more predictability and better statistical accuracy. Spawning crabs are counted using randomly placed square meter sections along the line of spawning crabs. The spawning survey relies heavily upon volunteers to conduct the surveys.

Beaches that were surveyed in Delaware in 2002 include Cape Henlopen, Roosevelt Inlet, Broadkill, Primehook, Fowler, Slaughter, Bennetts Pier, Big Stone, South Bowers, North Bowers, Kitts Hummock, Pickering and Woodland. Ted Harvey Wildlife Area was also surveyed as part of the Beach Nourishment study (above). Beaches surveyed in New Jersey were Townbank, Norburrys Landing, South Cape Shore Lab, Highs, Pierce's Point, Kimbels, Reeds, Gandys, Sea Breeze, North Cape May.



NORTH BOWERS BEACH 1996 – RICHARD WEBER

This study was designed to be a five year study. Population trend results will be available after the 2003 survey and data analysis is complete.

Volunteer participation is crucial to the success of this monitoring effort. Persons interested in volunteering for the survey should contact the Delaware National Estuarine Research Reserve at (302) 739-3436.