



Expansion of Horseshoe Crab Tagging and Resighting in New Jersey 2014 Report & Recommendations

Introduction

Twenty-five years ago, the Delaware Bay was the first site of Hemispheric Importance for shorebirds designated by Western Hemisphere Shorebird Reserve Network. The WHRSN designation recognized the bay's value to thousands of red knots, semipalmated sandpipers, ruddy turnstones and other arctic nesting migratory shorebirds. Each May, the birds arrive from wintering sites as far away as Tierra del Fuego, Chile, to refuel on horseshoe crab eggs before continuing their 10,000 mile odyssey from wintering areas to Arctic breeding sites. The horseshoe crab underpins this migration and has done so for thousands of years.

In the mid-1990s, the horseshoe crab was overharvested and after a 15 years effort to restore the crabs, populations remain at historic lows. Because of their critical dependence on horseshoe crab eggs, migratory shorebird numbers dropped drastically as well.

Many efforts are underway to restore the horseshoe crab including harvest management. The Atlantic States Marine Fisheries Commission (ASMFC) have developed a state-of-the-art mathematical model, Adaptive Resource Management Framework, also known as the ARM Model that estimates the greatest number of crabs that can be harvested without impairing either bird or crab populations. In an effort to help these populations, large-scale restoration has also begun in areas that are currently marginal breeding habitat. Last year a consortium of conservation groups, New Jersey Department of Fish and Wildlife, United States Fish and Wildlife, and other partners restored over a mile of crab breeding habitat in the historically important beaches and more are targeted this year. A better understanding of the crab population and how they are using beaches in the Delaware Bay is essential to both projects' success.

To obtain more data on the horseshoe crabs, volunteer-based horseshoe crab tagging was expanded in New Jersey in 2014. This pilot program will begin to provide the data needed to monitor restoration projects and support the ARM model. Throughout the spawning period for crabs, volunteer teams followed standardized protocols to tag crabs and conduct a rigorously defined survey of the ratio of tagged and untagged crabs counted on the beach during spawning. This effort involved several partner groups who managed field teams for six events on each of the designated New Jersey beaches.

There is an existing and successful spawning survey on the Delaware Bay that began in 1990, which estimates the density of crabs based on the number of crabs seen within a designated area. This allows for density, but it does not estimate the population. Utilizing a similar technique as the spawning survey, but focusing on a tagged to untagged ratio, a population estimate can be established.

Coordination with the US Fish and Wildlife Service (USFWS) will be a critical part of this project in order to obtain resighting data from the public that is housed at the USFWS. This data will be made available to any scientist with the permission of the principle biologists in charge of collecting the data. Coordination with the existing spawning survey will also help spread limited resources and build on existing efforts to collect more data.

Based on the results, field experience, and feedback from participants; recommendations have been made for improvement.

Goal:

To provide valuable data that will inform regulatory decision-making and ongoing science by utilizing volunteers to increase the number of tagged horseshoe crabs and the reporting of resighted tagged crabs on Delaware Bay beaches.

Objectives:

1. Better understand movements and distributions of Delaware Bay breeding crab population, to inform management decisions including contribution to the ARM model that sets harvest allocations and quotas.
2. Utilize mark-recapture rates to estimate the population size of horseshoe crabs.
3. Increase public engagement and stewardship through improved understanding and hands-on interaction with horseshoe crabs.
4. Improve habitat restoration efforts by identifying restoration techniques that are most attractive to returning crabs.
5. Support the ongoing scientific research of horseshoe crab populations and shorebird populations by making data available, upon request and approval, to scientists and researchers.

Project Leads: American Littoral Society
Celebrate Delaware Bay; Manomet Center for Conservation Sciences
Delaware Riverkeeper Network
Conserve Wildlife Foundation of New Jersey

Partners: US Fish and Wildlife Service
New Jersey Dept. of Fish and Wildlife
Wetlands Institute
Bayshore Discovery Center at Bivalve
NJ Audubon Society
Friends of Cape May National Wildlife Refuge

Project Management

Tagging Protocol

The pilot project received 3,000 tags from the USFWS. The goal was to deploy 700 tags per beach, except Fortescue and Kimbles, which have existing tagging programs. Cape May National Wildlife Refuge (CMNWR) deploys 1,000 tags at Kimble's Beach each year. Another individual, Mike Oates, had 500 tags for Fortescue. This project did not deploy any tags at Kimbles and deployed 200 tags at Fortescue.

Initially, the goal was to deploy approximately 175 tags per event at each beach over the first four events, but due to sporadic crab spawning or poor weather the 175 tags/event was not always achieved. Despite these challenges, all tags were deployed at or near their designated beaches. In May, the teams did not perform any tagging or surveying during daylight hours when beaches were closed for migrating shorebirds.

To best conform to existing tagging efforts, USFWS protocols and reporting requirements were used for the actual tagging. During each event, the goal was to reach a 2:1 male to female ratio of deployed tags.

Resighting Survey Protocol

Each resighting survey consists of two components: (1) a quadrat-based count identical to the horseshoe crab spawning survey protocol and (2) a comprehensive search of the beach for tagged horseshoe crabs (beach sweep).

The quadrat-based survey, which only notes tagged crabs if they are within a quadrat, allows for an estimation of horseshoe crab population size to be calculated from the ratio of marked to unmarked individuals. Alternatively, the comprehensive search allows the team to record the maximum number of tags in order to calculate survival estimates and examine movement patterns. The team scanning for tags outside of quadrats started at the same place as the quad-based survey and thus they will be ahead of the taggers the whole time, not recording recently tagged crabs. Crabs that were actively spawning and buried females were not disturbed. In many cases of "dug-in" crabs, the tags were still visible.

The comprehensive beach search for tags consisted of a group of people walking slowly down the beach abreast of each other, with all tag sightings recorded. The start and end time of the survey along with the number of people searching was recorded as well. The beach search was only completed if there was enough people.

Timeline

Events took place on average once weekly from May 15 to June 21. (This timeline was a week later than intended because crabs arrived late due to cooler than ideal water temperatures.) Most of the events occurred on the designated days, but on several occasions site leaders had to shift their date if they were unable to find a beach captain, lacked sufficient volunteers, or there was bad weather. Each event conducted the tagging and resighting activities at the same time. As anticipated, events not held during the full or

new moon had lower spawning numbers than those events that were on or near the full and new moon. This meant that tagging was difficult and resighting was limited.

Events were timed to coincide with high tides and after sunset to account for peak spawning and minimal shorebird foraging. Events began at the peak of high tide, just as the spawning surveys do and go until 100 quadrats are completed. On certain beaches it seemed that peak spawning was happening, a half an hour after tide. It may be difficult to adjust timing of surveys for this, but it is an additional challenge. This year there was only one early morning event. The goal was to complete before sunrise, but shorebirds did begin foraging before dawn on at least one beach (Moore's) towards the end of the event and the team had to discontinue.

The regular spawning survey, led by Limuli Labs and University of Delaware, coincides with new and full moons. In order not to disturb this effort, these events were held on different nights than that historical spawning survey. To increase efficiency, reduce redundancy, and collect high quality data, this project needs to continue its coordination with other horseshoe crabs projects.

Dates Tagging and Resighting

Thursday, May 15th 10:00 pm- Full Moon
 Saturday, May 22th 4:00 am
 Thursday, May 29th 10:00 pm- New Moon
 Thursday, June 7th 5:00 pm-
 Saturday, June 14th 10:00 pm- Full Moon
 Saturday, June 21st 4:30 pm

Locations

Events were conducted on Fortescue, Moore's, Cook's, Pierce's, Reed's, and Kimble's Beaches. All but Fortescue have had recent restoration projects. This program was piloted in New Jersey in 2014, with the long-term goal to expand the program to include both sides of the Delaware Bay as resources allow.

Each beach was managed by one partner. That partner was responsible for coordinating with the other horseshoe crab projects in the region such as reTURN the Favor and the spawning survey.

| Beach | Partner | reTURN the Favor | Spawning Survey |
|--------------|--|--------------------------------------|------------------------|
| Moore's | DE Riverkeeper Network | Bayshore Center | None |
| Fortescue | American Littoral Society | Bayshore Center | Resident of Fortescue |
| Cooks | American Littoral Society | Audubon | |
| Pierce's | DE Riverkeeper Network | Audubon | |
| Reeds | Celebrate DEBay and The Wetlands Institute | CeleDEBay and The Wetlands Institute | None |
| Kimbles | CMNWR with Celebrate DEBay | Friends of CMNWR | CMNWR |

Volunteer Recruitment and Management

Each partner group managed their own volunteers for their own events. The goal was to have at least two volunteers for tagging, two volunteers for quadrats, and two volunteers for full beach survey, with two site leaders. This was achieved or exceeded in many cases, but several of the evening events had fewer volunteers. Events continued even without the recommended number of volunteers, but the priority focused on completing the quadrat resighting, with tagging and the beach sweep conducted as site leaders were able. If necessary, site leaders may have returned to deploy additional tags if they did not achieve the deployment goals that were needed. It was evident that on nights with more volunteers, tagging could run smoothly and easily exceed the 175 target. Volunteers were often eager to come back for additional nights of tagging and resighting and enjoyed the experience tremendously.

A shared website was created (horseshoecrabtagging.org) to recruit volunteers and provide consistent information to volunteers. RSVPs were collected through the website and evenly divided amongst sites. Approximately 140 people signed up through the website with other volunteers contacting groups individually. Several groups also requested to participate including Defenders of Wildlife, NJ Audubon, Delaware Valley Ornithological Society, New Jersey Aquarium Aquatic Academy, and a few scouting groups. While the website was useful, volunteer coordination could certainly be improved; this could be done either through an automated volunteer coordination on the website or by having a dedicated person to manage the RSVPs. It also might be useful to minimize the choices: only offer date choices and not location; to help with coordination.

Site leaders were experienced volunteer crab taggers or staff professionals and scientists who had significant experience with scientific protocols and handling of wildlife. A two-hour training for the site leaders was conducted by Heidi Hanlon, biologist at CMNWR, and a standardized written protocol was developed to add to the existing USFWS protocol.

A brand for the project was not created in order to focus on the scientific component of the sampling and to best coordinate and cooperate with existing programs already underway on the Bayshore. In most instances, the lead organizations and the partnering groups have been conducting horseshoe crab related work for over two decades.

Results

Six tagging and survey events were conducted on six beaches. 4,000 tags were deployed. Each event also conducted a 100 quadrat resighting survey, where tagged and untagged male and female crabs were counted along a designated length of beach, using existing protocol for quadrat surveys. If there was an adequate number of volunteers, a beach sweep was also conducted.

Of the 4,000 tags deployed, 8 tags were resighted in quadrats and 38 tags were resighted outside the quadrats, giving a resighting rate of 1.15 % (Figure 1). When compared to a bay-wide resighting study published in 2005, this resighting rate is similar.

Figure 1

Summary for Cooks, Kimbles, Pierces, N reeds, Fortescue and Moores

| | D. Smith et al. 2005 | 2014 |
|--|----------------------|--------|
| Total tags deployed | 17,543 | 4,000 |
| Total spawning crabs male | 22,051 | 9,577 |
| Total spawning crabs female | 6,675 | 1,678 |
| Resights in quads | 19 | 8 |
| Resights between quads | 29 | 38 |
| Percent of total tags resighted | 0.0115 | 0.0115 |

Summary based only on tags deployed in 2014

Most resights were on the beaches where the tags were deployed, with a few exceptions which are noted in Figure 2. This is useful information as recently restored beaches are evaluated for their success.

Figure 2

Resight summary by site

| | Tags deployed | Unique resights | notes |
|------------------|---------------|-----------------|--|
| Pierces | 687 | 8 | 1 ♀ resighted twice, sightings 1 week apart. 1 tag resight that was originally marked on Kimbles |
| Cooks | 650 | 5 | 1 ♂ resighted twice, sightings 1 week apart. 3 sightings crabs originally marked on Kimbles |
| Kimbles | 1,000 | 7 | 2 tag resights originally marked on Cooks |
| N Reeds | 700 | 1 | |
| Moores | 700 | 14 | 1 tag resight originally marked on Kimbles |
| Fortescue | 200 | 0 | |

All resights were originally marked on the beach they were resighted on unless otherwise noted.

The goal was to achieve a 2:1 ratio of tagged male:female. Most beaches achieved around a 30% of tags deployed female, with Moore’s beach having a 54% ratio and Kimbles Beach having a 10% ratio (Figure 3). Kimble’s tagging events were conducted by the refuge and were conducted with a large number of volunteers where it is difficult to manage how the tags are deployed. For the other beaches that did come close to or exceed the 2:1 ratio, it did take a good deal of effort, but it is achievable.

Figure 3

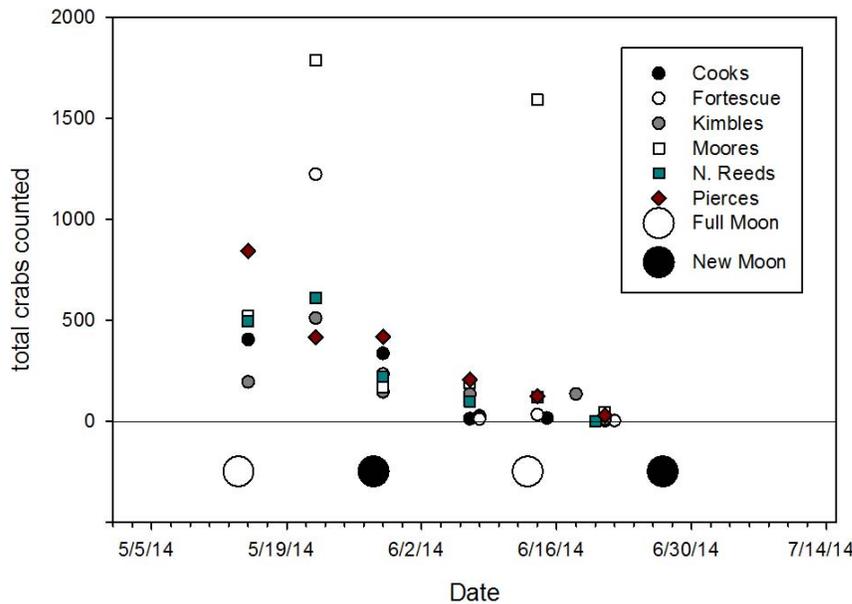
Sex ratio of deployed tags by site

| | percent female |
|------------------|----------------|
| Pierces | 31% |
| Cooks | 32.3% |
| Kimbles | 10% |
| N Reeds | 31.7% |
| Moores | 54.4% |
| Fortescue | 30% |

Summary based only on tags deployed in 2014

Crab numbers were higher in May and then started to slowly decline in June, this includes surveys that were conducted in-between full and new moon in May (Figure 4).

Figure 4: Total crab count by beach and date with full and new moon dates



Initially the goal was to deploy all tags as earlier in the spawning season as possible, but logistical challenges prevented this in the inaugural year. Appendix A has a full summary of the deployment dates by beach. The variability in tag deployment was affected by staffing, volunteers, beach conditions, and number of spawning crabs.

If tags were deployed earlier and there was an increase in the frequency of surveys conducted earlier in the season, there may also be an increase in the number of resights.

Key results:

- We had similar resighting success to a bay-wide resighting study published in 2005.
- Most resights were on the same beach where the crab was originally tagged.
- Two ways to improve resighting success are to deploy tags as early in the season as possible and to change the timing of spawning surveys to coincide with peak spawning periods.

Recommendations for Future Years

- 1. Consider merging resighting surveys and existing spawning surveys.** Resighting on beaches that have spawning surveys could be discontinued, and spawning surveys could be added to the beaches that don't currently have spawning surveys. This will provide three days of data on the full and new moons on all beaches, without being duplicative. This would also eliminate surveys on the weeks that were not during peak spawning since this proved not to be very good resighting events due to a limited number of crabs.
 - It will be important to coordinate with the spawning survey coordinators for sharing data and event schedule. Additionally, it will be important to ensure that spawning survey protocol has the rigor that we need while also balancing the longevity of their dataset.
 - One consideration for this shift would be the loss of any critical data for the crabs that are spawning in between peak lunar events. Further data analysis will be conducted to access this potential loss.
- 2. Develop better methods and timing for targeting females to tag.** While the goal male:female ratio, 2:1, was achieved, it was still difficult. One suggestion is to reserve a bag of tags for after the high tide and tag the stranded females. Another good time to target females was when females completed laying eggs and were coming out of the sand, returning to the water. This means that tagging often continued after the resighting survey to wait for the crabs and the lowering tide. It was critical that buried females were not to be disturbed.
- 3. Deploy tags early on in season, with separate tagging events** This could increase the likelihood of resighting later in the season. This would also help to minimize coordination challenges when there was only one site leader for an event. USFWS for example, deploys 500 tags in one tagging event early on in the season. This project could model a similar approach and then focus on more resightings as the season progresses.
- 4. Consider a separate tracking system for tag sightings throughout the season.** Frequently partners sighted tags on different days than the resighting events. These could be collected in a central location to increase the number of resightings in the season. These would be utilized in the same way that the beach sweep data is used. This would primarily be for internal use since the general public will report to USFWS, and project coordinators will receive this information from USFWS.
- 5. Engage more partners earlier.** Many hands make light work. This is an excellent project for volunteers and many partners were eager to participate with their volunteers. Even if a partner isn't able to participate they should still be engaged early. There are other horseshoe crab projects in the region and it is essential to coordinate with them, understanding what and when each project will be on the beach.

6. **Obtain funding.** Funding will be needed to support many aspects of this project, but in particular volunteer management, event coordination, and data management are time-consuming and will need designated funding sources in the future especially if the project wants to expand to both sides of the Bay and increase the number of tags deployed.

Appendix A

Dates of tag deployment by site

(for Kimbles, all tags were deployed on 15May2014 and 29May2014)

