

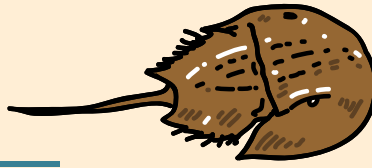


2023 Horseshoe Crab Spawning Report

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Introduction



The Maryland Coastal Bays provide habitat to hundreds of species that all play an important role in our ecosystem, however, this report will focus on one of our favorite living fossils, the Atlantic horseshoe crab (*Limulus polyphemus*). Since 2001, the Maryland Coastal Bays Program (MCCBP) and Maryland Department of Natural Resources (MDNR) have partnered together to monitor the horseshoe crab population in the Maryland Coastal Bays. You may ask, why do we monitor horseshoe crabs? Why should I care? Well, long before we walked this Earth, and still to this day, horseshoe crab eggs have provided a critical food source to migratory birds. Throughout the year roughly 500 bird species travel the Atlantic Flyway, one of the four major migratory flyways in the U.S. (Pine Island Audubon Center). Species like the red knot (*Calidris canutus*) use the beaches of Maryland, Delaware, and New Jersey as their final stopover site to fatten up on horseshoe crab eggs. Without this critical food source, the red knot would not be able to complete their migration to the Arctic Circle to breed, essentially dooming the success of this species. In addition to shorebirds, blue crabs, juvenile striped bass, and other commercially important marine species feed on the protein-rich eggs.

But wait, there is more! These ancient arthropods are used as bait in the commercial fisheries for American eel and whelk along the East Coast. In Maryland, only male horseshoe crabs are able to be harvested for bait. Last but certainly not least, for over 40 years, horseshoe crab blood has been used to ensure the safe production of vaccines and injectable drugs (Maloney et al., 2018). Their unique immune systems are able to easily detect the presence of endotoxins, making their blood extremely valuable to the biomedical industry.

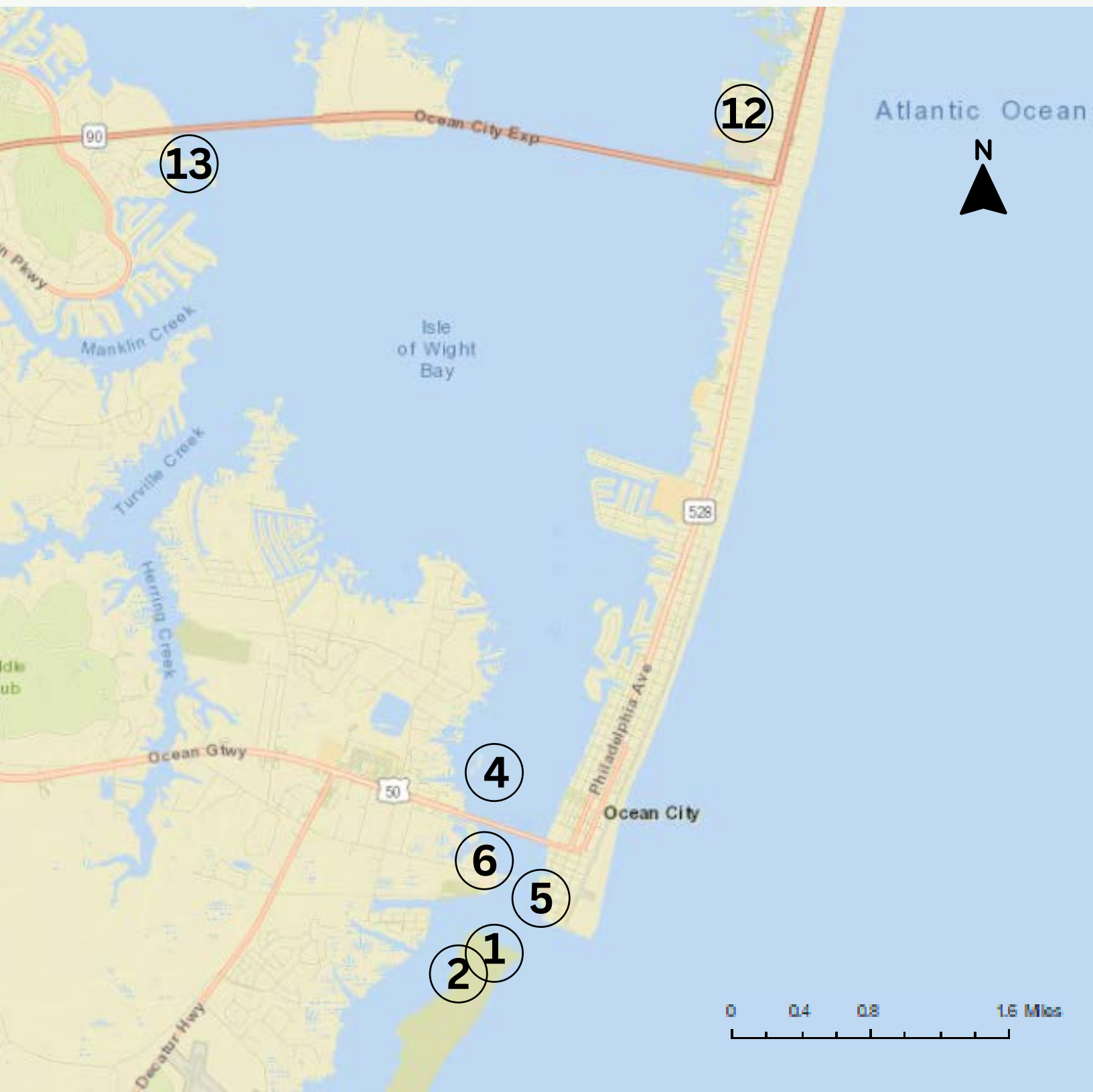
The ecosystem services provided by the horseshoe crab are the reasons this species is monitored on such a large scale. Horseshoe crab surveys take place up and down the East Coast every year. The data from these surveys are shared with the Atlantic States Marine Fisheries Commission (ASMFC), evaluated on a coastwide and regional scale, and then used to determine current population status and harvest limits. Annual surveys help us understand whether regional populations are remaining healthy and stable. The most recent ASMFC stock assessment took place in 2019 and determined that overall, horseshoe crab populations are stable.



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Where do we survey?



Site #1 - Assateague N

Site #2 - Assateague

Site #4 - Skimmer S and SE

Site #5 - Oceanic Motel

Site #6 - Homer Gudelsky Park (Stinky Beach)

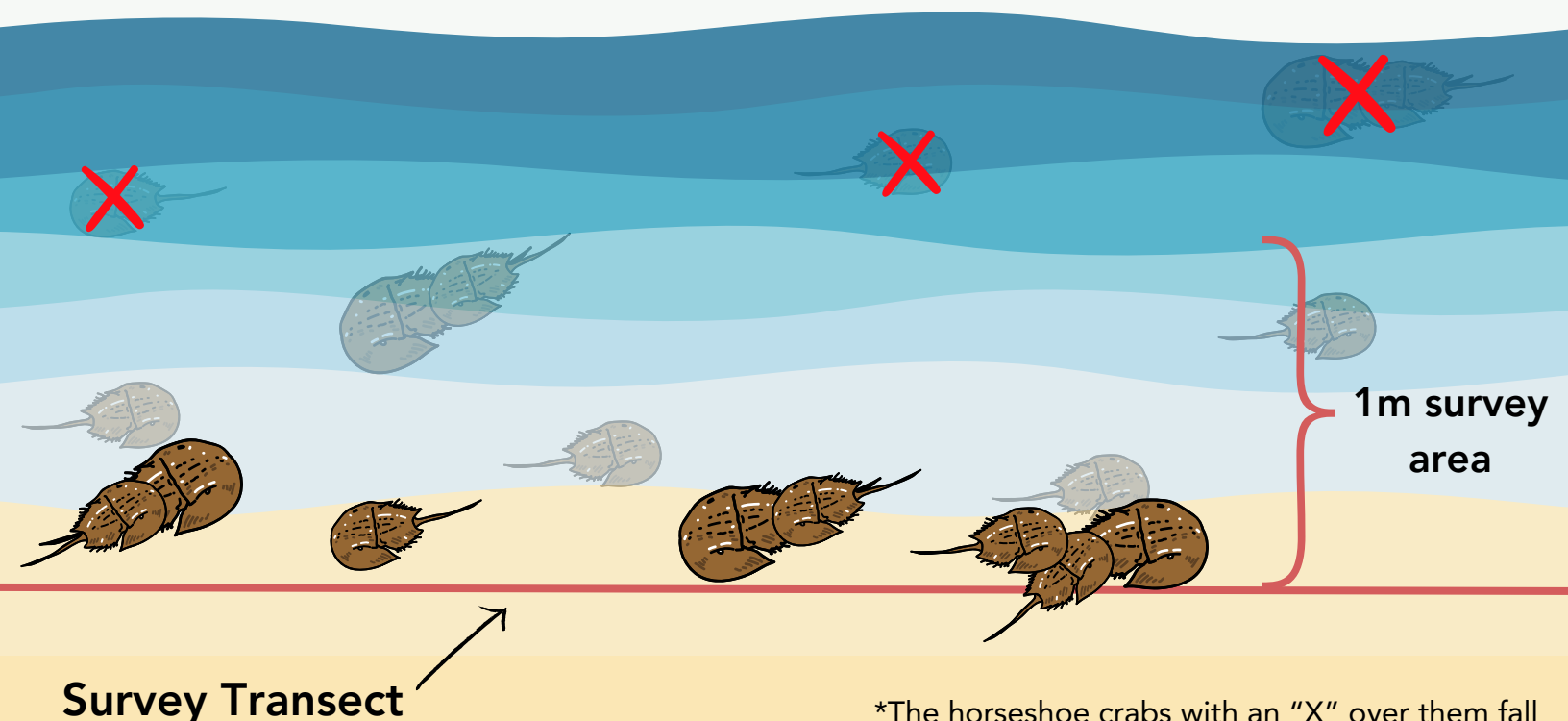
Site #12 - Sunset Island

Site # 13 - Jenkins Point*

*Data collected from this site was not included in analysis.

How do we survey?

Generally, horseshoe crabs spawn in the Maryland Coastal Bays from late-May through July. Peak spawning for horseshoe crabs tends to occur around the new and full moon lunar cycles during the evening high tides. Surveys are scheduled to occur during a 5-day window revolving around those peak spawning events to obtain data that represents the population as accurately as possible. Upon arrival, initial notes about the survey location including water temperature, weather and water conditions, and any other important notes regarding the site are recorded. The start time is then recorded and surveyors walk along the transect which marks the high tide water line. All horseshoe crabs that are found within the 1m area extending into the water from the transect line are sexed and counted. Any live horseshoe crabs that are seen outside of this 1m area are not counted (see example below). In addition to sexing and counting the horseshoe crabs, horseshoe crabs are separated based on whether they are live vs dead to get an estimate of mortality that occurs during spawning. All dead horseshoe crabs that are seen during the survey, even if they fall outside the survey area, are counted and recorded. The time is recorded to determine time elapsed at the end of the survey.



*The horseshoe crabs with an "X" over them fall outside of the survey area and are not counted.

Male vs. Female Characteristics

There are a few key characteristics that help surveyors determine the difference between male and female horseshoe crabs. The first and most obvious difference, is size. Females on average are about 25% larger than males. If size isn't a good enough indicator of sex, surveyors will carefully pick the horseshoe crab up by the sides of its shell (NOT its tail) and flip it over to look at its claws. Males have two clasping claws shaped like boxing gloves on their first set of arms (top right image) while females have the regular "scissor-shaped" claws throughout (bottom right image). A final detail that helps determine sex occurs during spawning season. You will almost always see males attached to females from behind. Males use their clasping claws to hold onto the female while she swims or scurries along the sand and lays her eggs (middle image). As the female finishes laying her eggs, she moves away with the male in tow who can then immediately fertilize those eggs. This is why males attach themselves to females.



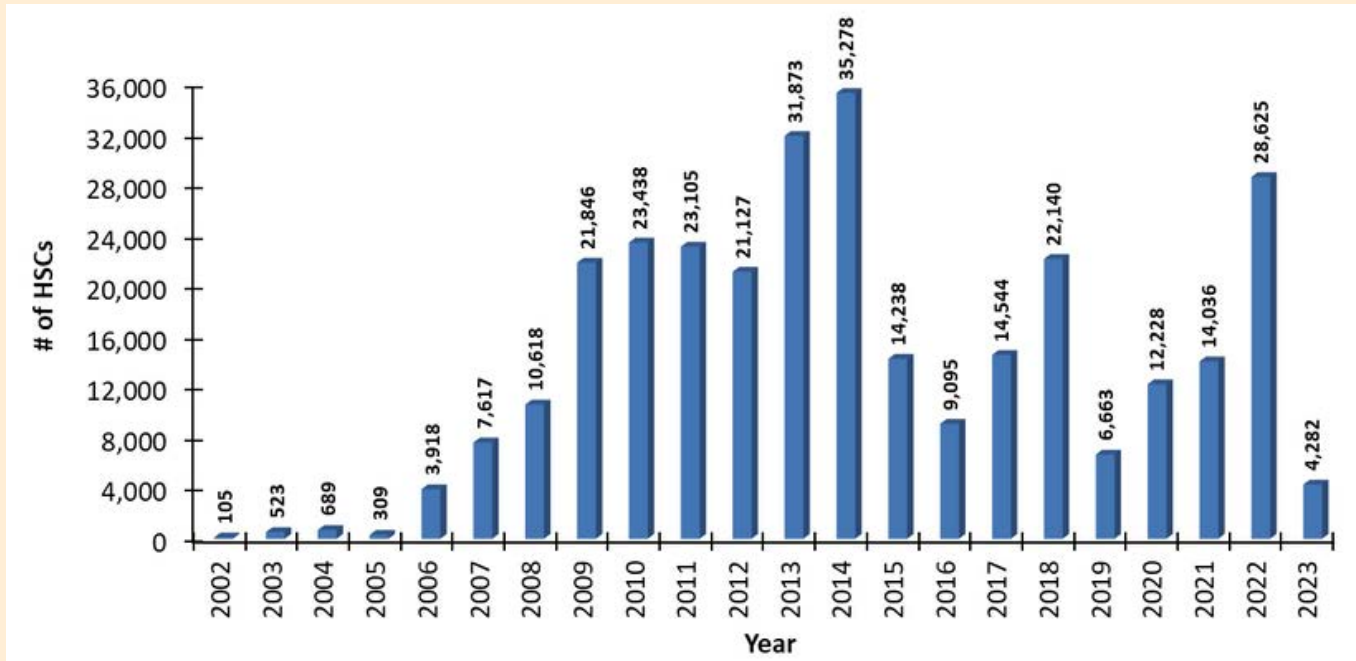


Figure 1: Total number of horseshoe crabs (live & dead) surveyed between 2002 - 2023)

The total number of horseshoe crabs surveyed includes both live and dead horseshoe crabs as seen in Figure 1. Dead horseshoe crabs typically make up a very small percent of the total number surveyed, but are important to include in the data to understand mortality rates. The percent of dead horseshoe crabs has been under 2% for 18/22 years we have conducted surveys indicating low mortality for spawning horseshoe crabs. The years when mortality was above 2% happened between 2002 - 2005 and ranged between 7 - 11%. As seen in Figure 1, the first four years had low horseshoe crab counts. The average number of dead horseshoe crabs counted between 2002 - 2025 was 34, which is significantly lower than the overall average of 91.

Results of the 2023 survey indicated considerably lower numbers. In fact, such low numbers have not been seen since 2006. Possible reasons for the low number may be due to the abnormal weather during the 2023 season that may have influenced spawning behavior. As early as April 15th we had reports of horseshoe crabs spawning in large numbers at Sunset Island. Since horseshoe crabs typically do not spawn until mid- to late-May in the Coastal Bays, we do not have any data on the early spawning event that took place. The lack of data on the early spawning events could have impacted our counts for this year. Additionally, some volunteers reported seeing large numbers of horseshoe crabs spawning later in July after the survey period. Although horseshoe crabs do tend to spawn in lower numbers throughout July and into August, the higher counts witnessed after our survey period could be another explanation for the lower horseshoe crab counts surveyed.

Although we are concerned about the lower counts observed in the 2023 survey, there is not enough data to suggest there are declines in population numbers. Figure 1 shows that the horseshoe crab populations naturally fluctuate in the Coastal Bays. As seen in 2017 and 2020, survey numbers bounced back after low counts that occurred the year prior. However, further investigation will take place if low counts continue to be reported in 2024.

Catch Per Unit of Effort Results

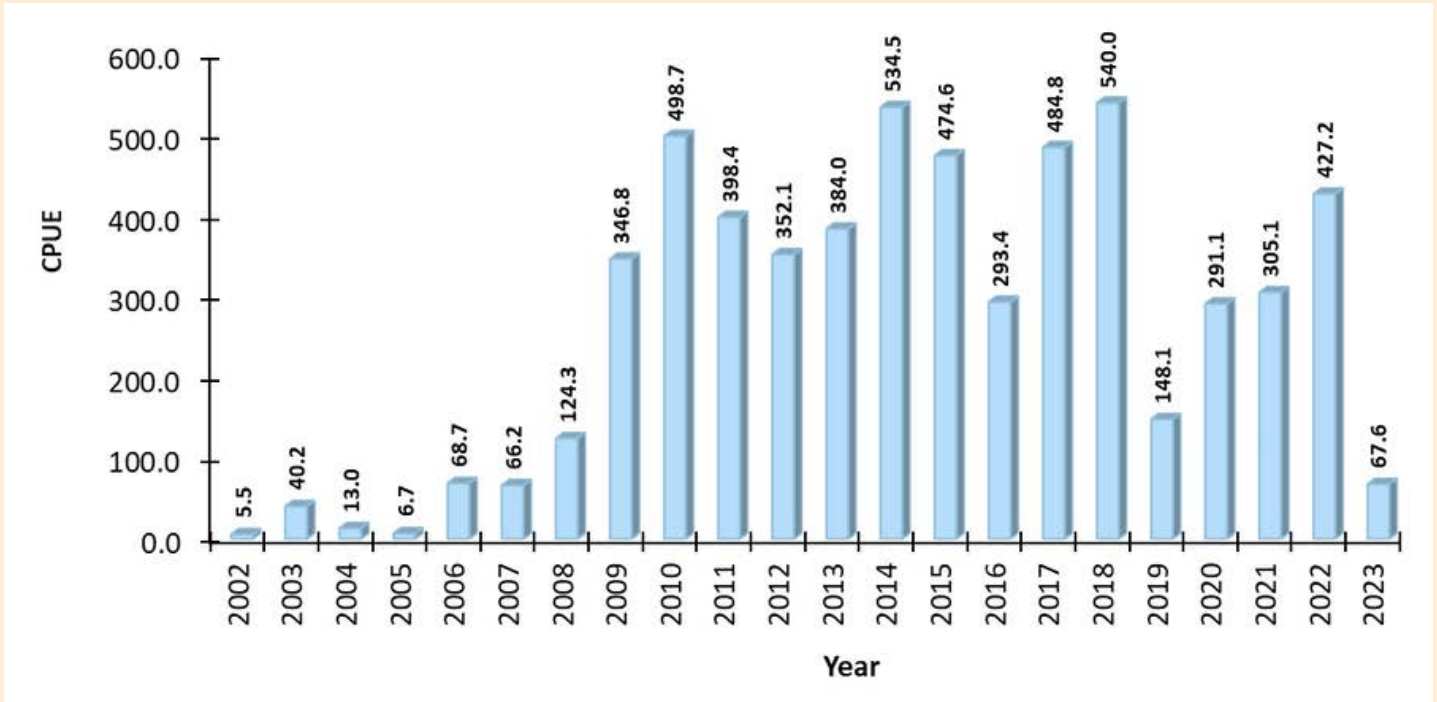


Figure 2: Catch per Unit of Effort (CPUE) based on number of surveys conducted between 2002 - 2023

Catch per unit of effort (CPUE) is a measure of abundance that is useful to assess long-term trends in animal populations. It is calculated by dividing the number of individuals by a measurable unit of effort. In the Coastal Bays, CPUE is calculated by dividing the number of horseshoe crabs counted by the total number of surveys. Since 2002, MCBP and MDNR have conducted anywhere between 13 surveys (2002) to 115 surveys (2007) with an average of 53 surveys. This year 63 surveys were conducted and 4,282 horseshoe crabs were counted resulting in a CPUE of 67.6. Consistent declines in CPUE indicate that populations may be overharvested, however Figure 2 shows that we are not seeing this in the Coastal Bays. Although this is the lowest CPUE we have had since 2007, MCBP and MDNR hope the CPUE will return to a normal value as it has in the past.

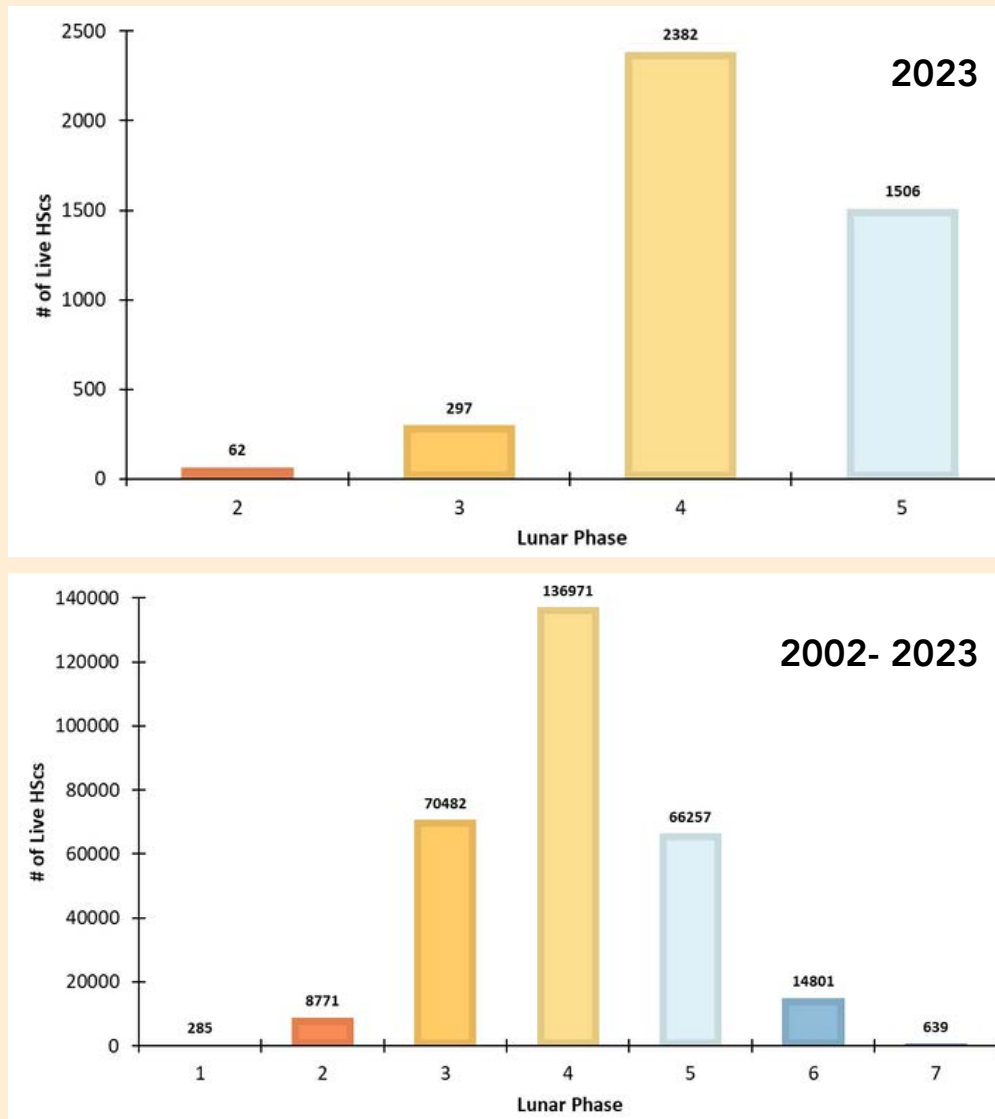


Figure 3: Comparison between live horseshoe crabs surveyed for each lunar phase in 2023 vs 2002- 2023

Although our surveys revolve around the new and full moon lunar cycles, these cycles fall on different dates every year making it difficult to compare results from year to year. Additionally, over the years we have changed when we start and end surveying based on water temperatures and the spawning behavior of the horseshoe crabs for that specific year. Standardizing the dates and establishing clear lunar phases allows us to be able to compare data collected over the last 21 years. From this standardization, we can understand peak spawning days and how those dates change from year to year. The figures above show that for 2023, no surveys occurred in phases 1, 6, or 7. MCBP and MDNR will typically survey 8 nights over the course of lunar phases 2 - 5 when peak spawning occurs. However, depending on available time and resources additional surveys may take place in late-July. For this coming year, our staff will be monitoring the spawning beaches closely to see if surveys need to begin before phase 2 or after phase 5.

The phases are broken up accordingly:

Phase 1: May 1st - 15th

Phase 2: May 16th - May 30th

Phase 3: May 31st - June 14th

Phase 4: June 15th - June 29th

Phase 5: June 30th - July 14th

Phase 6: July 15th - July 30th

Phase 7: July 31st - August 14th

Peak Spawning Temps

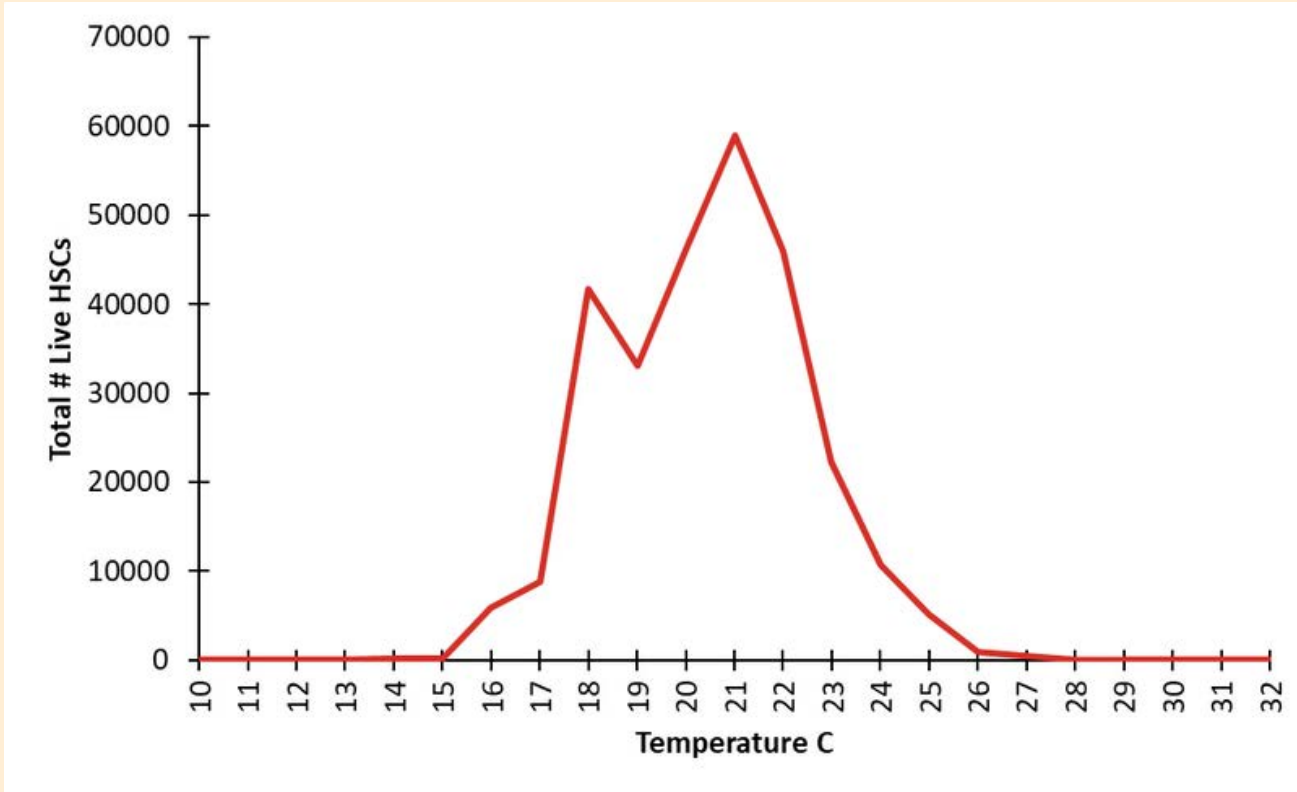


Figure 4: Total counts for (live) horseshoe crabs spawning by water temperature (2007 - 2023).

Since 2007, water temperatures have been collected at each survey location before every survey. The water temperatures at survey locations near the Ocean City inlet tend to take longer to warm up due to the influx of cool water coming in from the Atlantic Ocean. On the contrary, water temperatures at survey locations in the northern bays usually warm faster, which is why we tend to see spawning starting earlier in the season. Taking temperatures at the exact location ensures accurate reporting on how spawning behavior is influenced by water temperatures. The long-term data seen in Figure 4 shows that in the MD Coastal Bays, horseshoe crab spawning begins when water temperatures reach 15C.

Monitoring water temperatures can provide insight into how climate change is impacting spawning behavior and success. Currently, it is not fully understood how warming waters will impact horseshoe crab populations up and down the East Coast. However, some research suggests that increased water temperatures may impact survivability of horseshoe crab eggs and larvae which will cause populations to decline (NOAA).

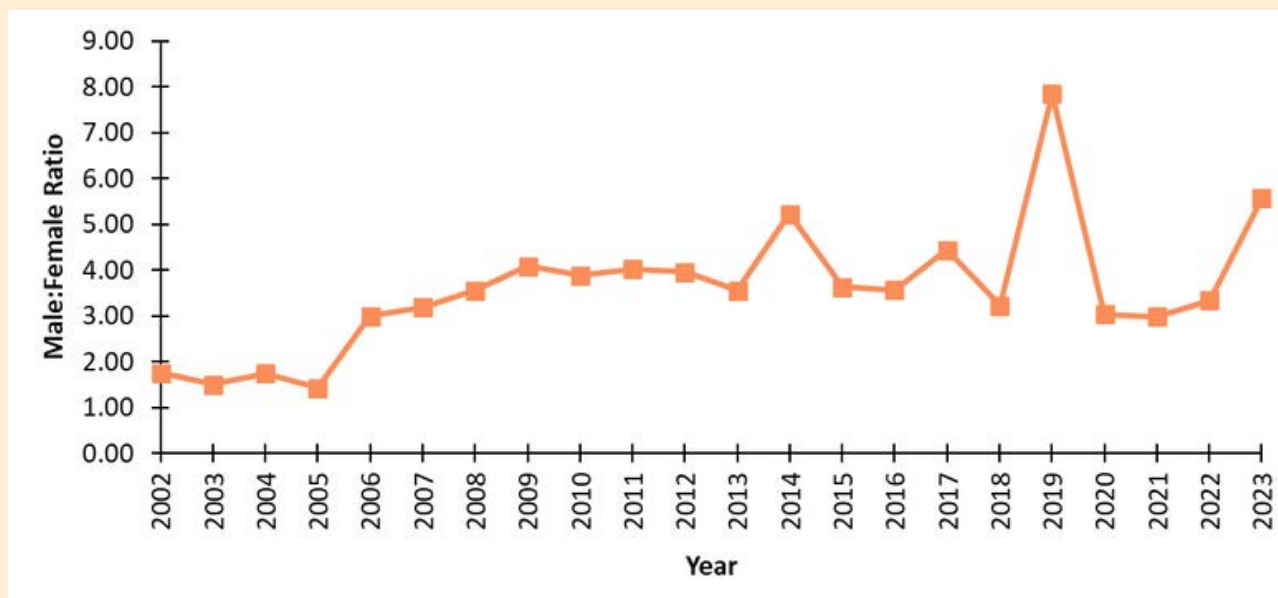


Figure 3: Operational sex ratios for horseshoe crabs counted between 2002 - 2023 surveys.

For data analysis we look at the operational sex ratio, or “the ratio of males to females among adults that are actively spawning” (ASMFC, 2021), as it is an important measure of the population structure. In 2023, there were 5.6 males to every female crab, which is a typical ratio found in the Delaware Bay region (ASMFC, 2019). The survey counts over the last two decades indicate male to female sex ratios have remained relatively stable, except for the 2019 survey that had a historic high M:F ratio due to a low number of females encountered. The overall average (2002 – 2023) sex ratio in the Coastal Bays is 3.8.

Delaware Bay regional trawl and offshore dredge surveys conducted in MD, DE, NJ indicate male to female ratios for the overall population are around 2.2:1 (ASMFC, 2019). Around our region, it is typical for a female to complete spawning activity over a couple nights during one or two lunar phases (ASMFC, 2019). However, males tend to remain at spawning beaches for longer periods of time, which is why it is normal for the operational sex ratio to be skewed towards males in the mid-Atlantic region (Walls et al., 2002). Since there is such a high density of horseshoe crabs spawning in this region, females tend to have both a clasping male (one that is attached to her), and at least one satellite male surrounding the spawning pair. A single female can lay over 80,000 eggs in one spawning season. Through genetic testing, it is estimated that clasping males fertilize 50%, while satellite males fertilize ~41% of the eggs laid by a female (Brockmann et al., 1994). It is undetermined what happens with the other 9% of eggs (Brockmann et al., 1994). Having multiple males fertilize a female’s eggs are beneficial to the overall population as this increases genetic diversity.



Spawning Horseshoe Crabs at Skimmer Island



Horseshoe crab eggs on Skimmer Island



Survey locations have been added and removed since the survey began in 2002. Locations are usually added to determine whether horseshoe crabs are using a beach for spawning, and removed once it is determined that the site is not used. Since 2002, MCBP and MDNR have surveyed 29 different transects throughout the Coastal Bays watershed. Horseshoe crabs do not have site fidelity, meaning they do not return to the same beach year after year to spawn. However, they do have short-term site fidelity during spawning season (ASMFC, 2019). Tracking the movement of horseshoe crabs within the Coastal Bays is important in learning locations that are critical to spawning. This is why we have surveyed various locations over the years. Assateague, Homer Gudelsky Park, Oceanic Motel, Skimmer, and Sunset Island have been surveyed the most due to consistent spawning occurring at these locations. One site, Assateague North, has been surveyed on and off throughout the years due to changes in spawning activity at that site.

Skimmer Island



Skimmer Island is located just north of the route 50 bridge in Isle of Wight Bay. This island is of great significance since it has contained over 60% of the total spawning population in the MD Coastal Bays for 15/18 years it has been surveyed (see Figure 4). The southeast portion of the island has been surveyed since 2006, with the southern transect being added in 2008. From 2011 to 2014, Skimmer Island received about 1,000 cubic yards of dredged sand from a nearby channel to replenish area lost due to erosion. The beneficial dredge material expanded the available area for horseshoe crab spawning. However, since the last replenishment in 2014, the island has been continually eroding. The shape of Skimmer Island is dynamic and constantly changing due to wave energy, sea level rise, and erosion. This can impact where and how many horseshoe crabs are spawning on the island from year to year.

The three years that the Skimmer Island counts were below 60% of the total population were 2006 (19%), 2022 (53%), and 2023 (19%). There was only one survey that occurred on Skimmer Island in 2006, which explains why it had such a low percent of the population recorded. However, it is believed that in the last two years horseshoe crabs have moved away from Skimmer and have begun spawning again at Assateague North. Assateague North was previously surveyed between 2006 - 2008 but has not been sampled since due to low spawning activity. That is until thousands of horseshoe crabs were spotted spawning on the beach in 2022 and again in 2023. For the past two years, Skimmer Island has seen a decline in number of spawning horseshoe crabs while Assateague North has once again become a hotspot for spawning. In fact, Assateague North contained a whopping 54% of the surveyed horseshoe crabs in 2023 (Figure 5).

As Skimmer continues to shrink, horseshoe crabs may find Assateague North to be a more suitable spawning beach, even with the increase in human disturbance and obstacles at that location. If Skimmer does not receive any replenishment, it will most likely be lost entirely to erosion like so many other islands in the Coastal Bays. MCBP and MDNR will continue to monitor the two locations to see if Assateague North continues to increase in spawning numbers over the next few years.

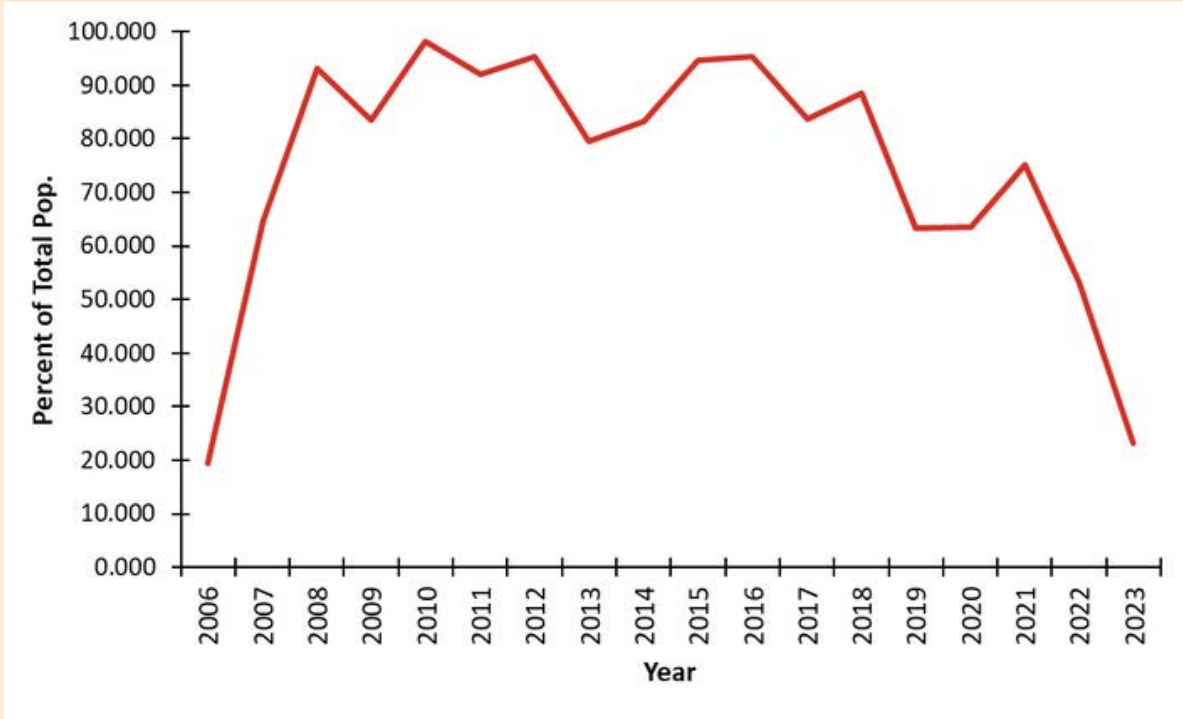


Figure 4: Percent of Skimmer Island’s population compared to the total (live & dead) population surveyed in the Coastal Bays.

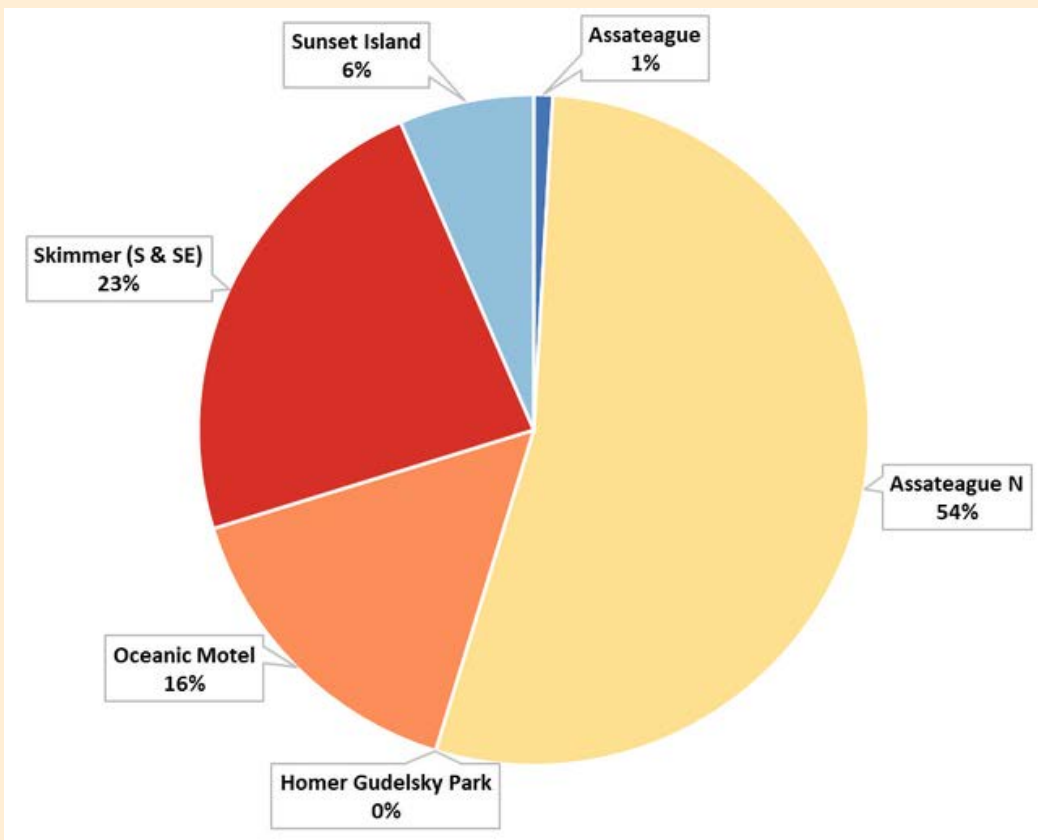


Figure 5: Percent of the total population for each site surveyed in 2023

A New Survey Site at Jenkins Point!

MCBP is currently working to gain funding for a shoreline resiliency project to restore the eroding marsh and shoreline at Jenkins Point in Isle of Wight Bay. As part of the pre-construction monitoring that must occur, MCBP trained four new volunteers who live in the nearby community to survey the beaches for horseshoe crabs. Although there were no live horseshoe crabs surveyed at this site, MCBP will continue surveying the area during spawning season to track changes in the use of the site upon completion of the restoration project. The survey data collected from this location may be incorporated into future reports once we have a better understanding of spawning activity occurring at Jenkins Point.



New Educational Signage Installed!

This year, MCBP partnered with Sunset Island Community Association and Oceanic Motel to install signage that educates tourists and residents of our watershed on the importance of horseshoe crabs spawning in the Coastal Bays, and how to help a stranded horseshoe crab. These two locations are both hotspot spawning grounds for horseshoe crabs and are survey locations. MCBP thanks both Sunset Island Community Association and OCMD Hotels for covering the cost of the signs!



Horseshoe crabs spend a significant amount of energy spawning, making this one of the greatest natural causes of mortality for adults (ASMFC, 2019). Several hotspot spawning beaches in the Coastal Bays have obstructions and obstacles (e.g. riprap) that can further increase mortality due to strandings. During high tide horseshoe crabs can easily navigate obstacles, however once the tide recedes, many become trapped and are unable to safely make it back into the water. Although horseshoe crabs can remain out of the water for a period of time, they will die if their gills dry out. As a result of these obstructions, hundreds of horseshoe crabs can become stranded after a single low tide event. The Stranded Spawning Horseshoe Crab Recovery Team was created in 2022 with the purpose of addressing the mass casualties of spawning horseshoe crabs that occur at the Oceanic Motel, Homer Gudelsky Park, Sunset Island, and Robin Drive.

In 2023...

Over 3,400
horseshoe crabs
were rescued!



Stranded horseshoe crabs at the Oceanic Motel

22 volunteers spent
over 83 hours rescuing
horseshoe crabs!



Volunteers rescuing stranded horseshoe crabs at the Oceanic Motel PC: Deb Munford

Interested in Learning More?

The Maryland Coastal Bays Program (MCBP) is a 501(c)3 non-profit and National Estuary Program dedicated to enhancing the ecological values and resiliency of the Coastal Bays, the watershed, and their communities through conservation and public engagement. Through education, scientific monitoring, outreach, and restoration, we collaborate with the stewards of our community to have a positive impact on our watershed. To learn more about who we are or sign up to become a horseshoe crab volunteer, go to our website: www.mdcoastalbays.org

Other resources to take advantage of are below!

Found a tagged horseshoe crab? Report it to the USFWS here:
<https://www.fws.gov/crabtag/>

Did you witness horseshoe crabs spawning in your area? Add your data to MDNR's map here:
<https://maryland.maps.arcgis.com/apps/webappviewer/index.html?id=391606d4a962405db2429779ff47e5d8>

THANK YOU!

MCBP and MDNR would like to personally thank the 28 volunteers who participated in our surveys and Stranded Spawning Horseshoe Crab Recovery Team! Thank you for being stewards of our environment. We appreciate your passion and care for our favorite living fossils!

Questions? Please contact:

Carly Toulan- Env. Scientist at ctoulan@mdcoastalbays.org

OR

Steve Doctor- Fisheries Biologist at steve.doctor@maryland.gov



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