

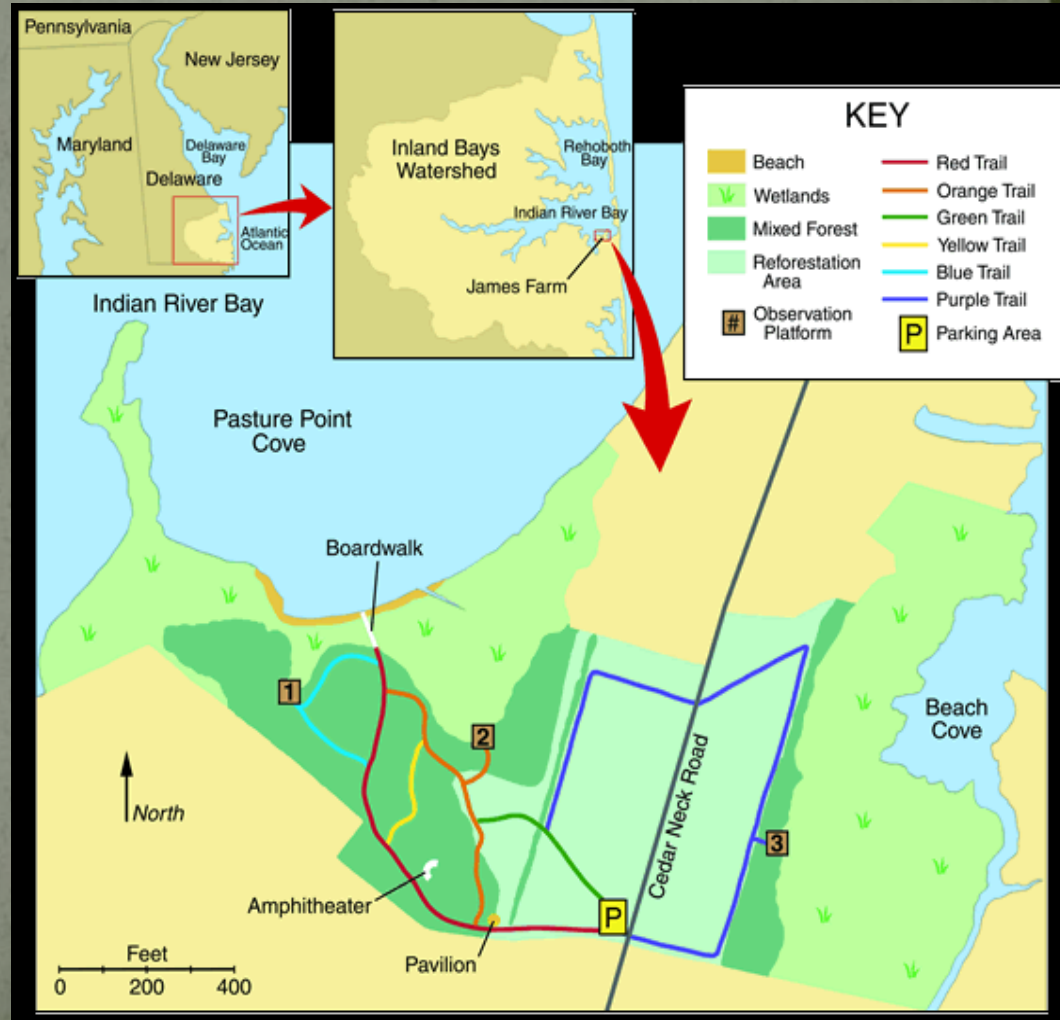
The Importance of the Inland Bays Beaches as Horseshoe Crab Nesting Sites



Purpose

- The purpose of this research is to determine if the inland bays provide important spawning beaches for horseshoe crabs.

- Results were determined by the census of both adult horseshoe crabs during peak spawning times, as well egg censuses. These censuses were then compared to previous census results from the Delaware Bay.



The American horseshoe crab (*Limulus polyphemus*)

- Evolved over 400 million years ago
- Closely related to spiders and scorpions
- Spawn in large numbers during spring tides



Research Justification

- Horseshoe crabs are very valuable to:
 - The medical industry
 - The whelk and eel fisheries
 - Migrating Shorebirds



Adult Census

■ Methodology

- 1) 15 meters are measured with a measuring tape along the beach.
- 2) Along the 15 meters, two sampling areas are chosen with a random numbers table.
- 3) At each sampling area the number of male and female horseshoe crabs are counted within a 1X1 meter quadrat.
- Repeat steps 1-3 along entire beach



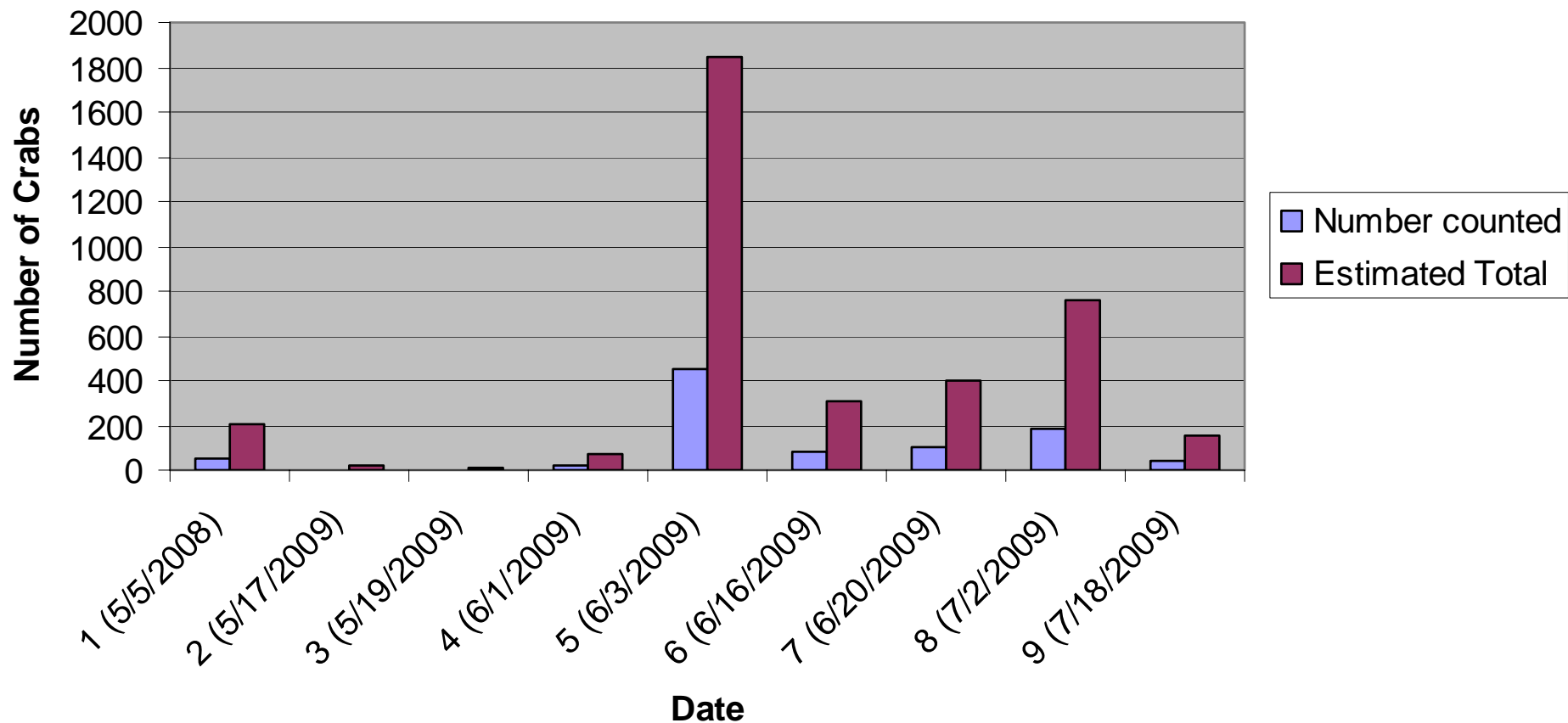
Data Collection

- Three adult counts took place on the James Farm Ecological Preserve in 2007, nine in 2008 (Indian River Bay.)
- Sandy beaches in the Inland Bays were tested for eggs in 2007. Camp Arrowhead, Bay Colony, and Holts Landing yielded eggs, and therefore, adult counts occurred in 2008.
- Egg counts occurred at James Farm and Holts Landing in both 2007 and 2008



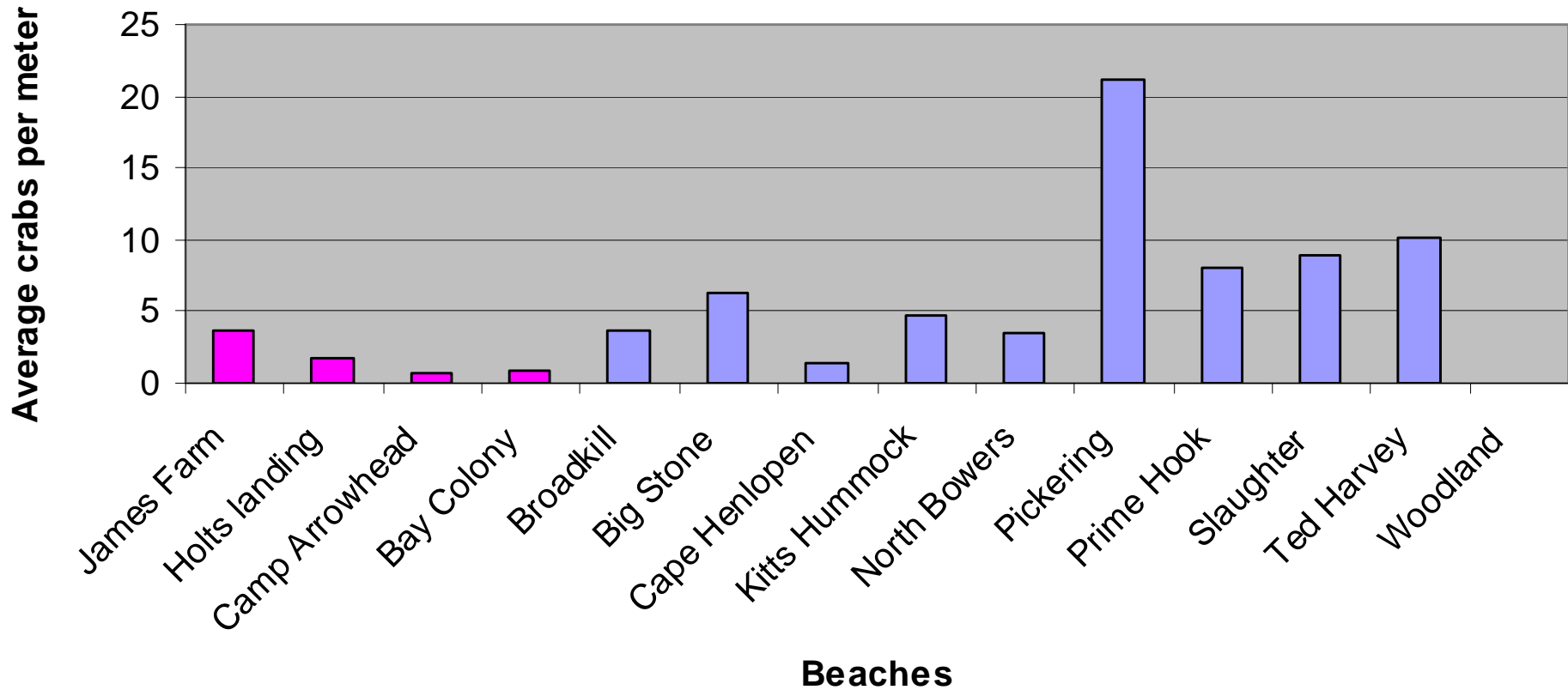
Results: James Farm 2008

Number of Spawning Adults Censused and Estimated Total Spawning Adults on James Farm, 2008



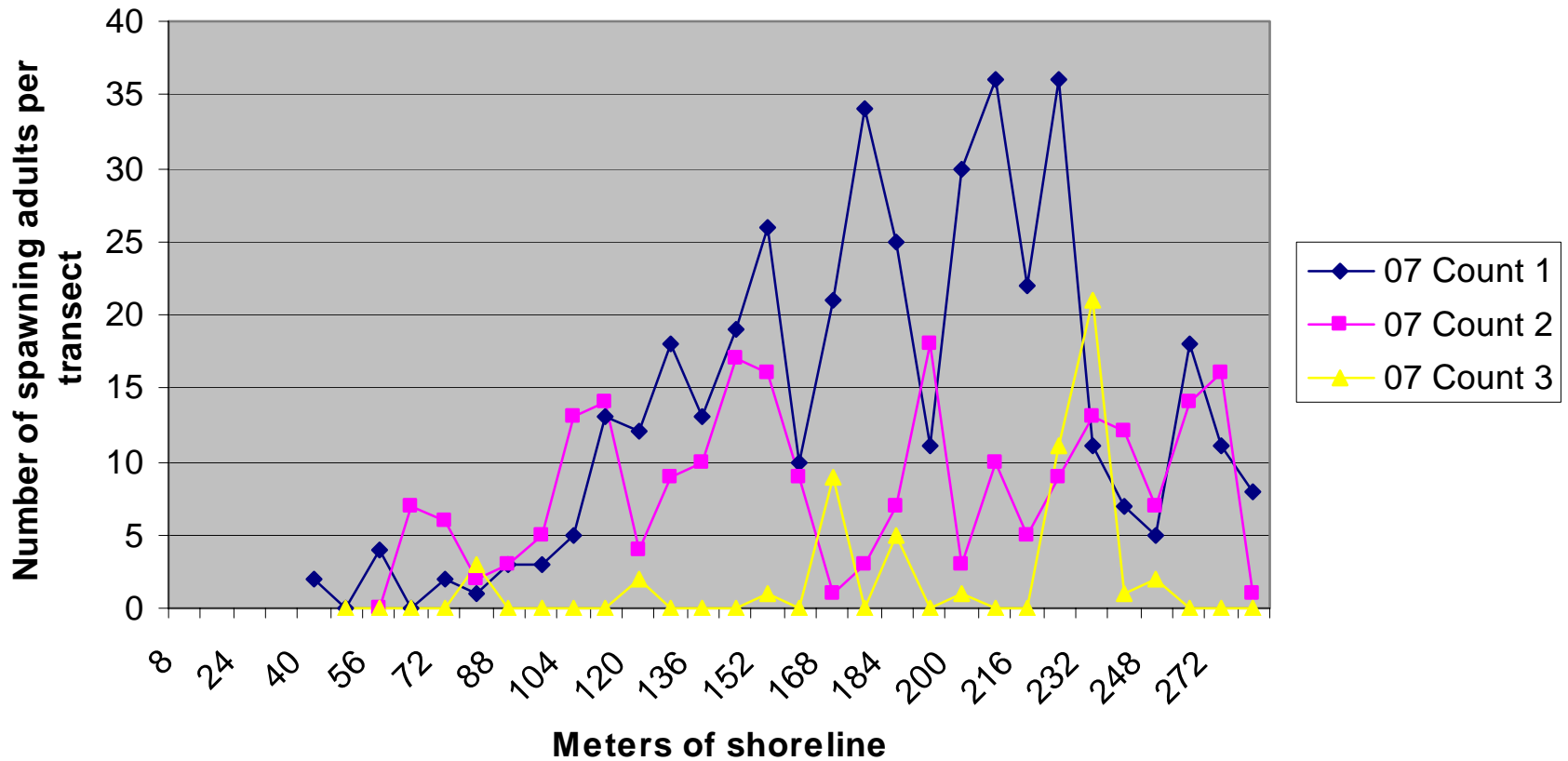
Comparison: Delaware Bay vs. Indian River Bay

Comparison of Number of Average Spawning Adults per Meter in Indian Rivery Bay Beaches V.S. Delaware Bay Beaches (From May 19 and June 3, 2008)



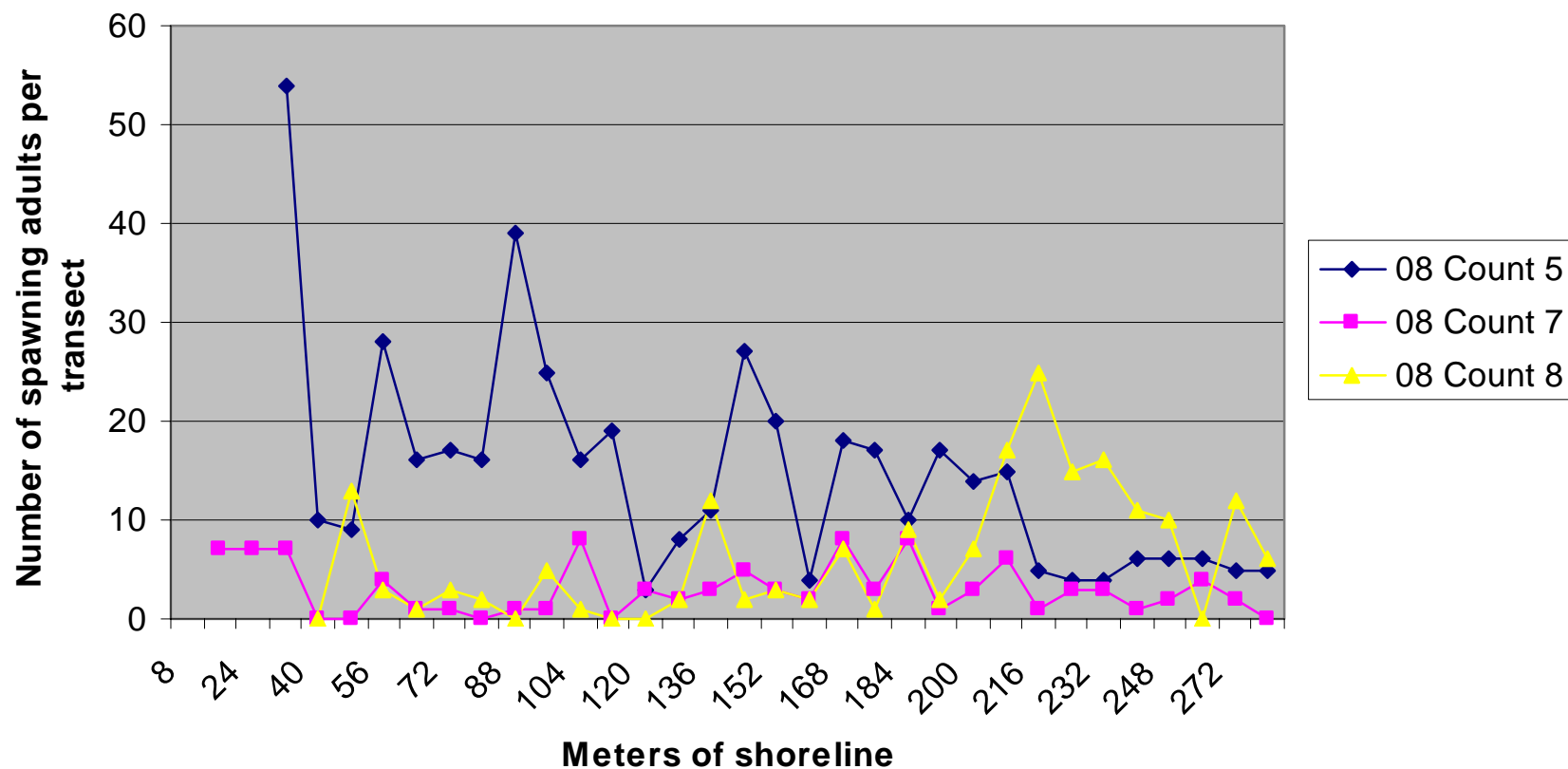
Spatial Distribution on James Farm

Spatial Distribution of Spawning Adults on James Farm Beach (2007)





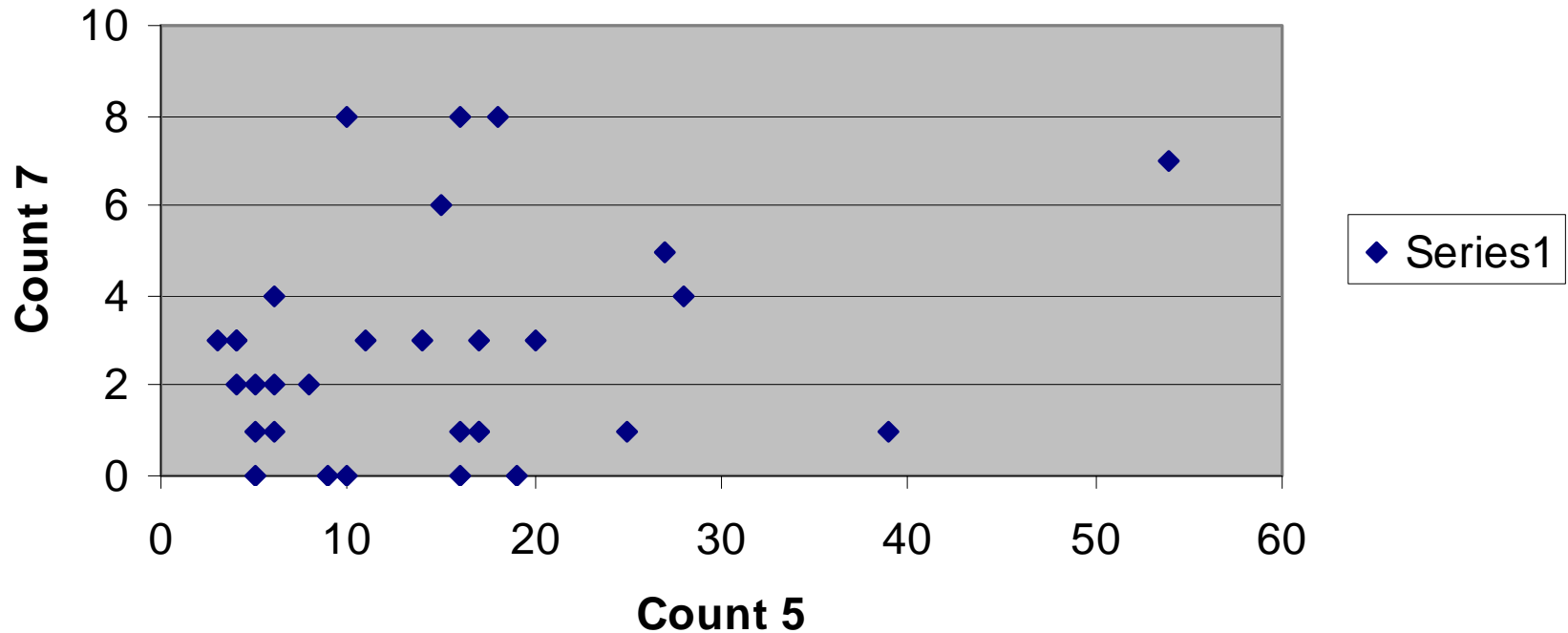
Spatial Distribution of Spawning Adults on James Farm Beach (2008)



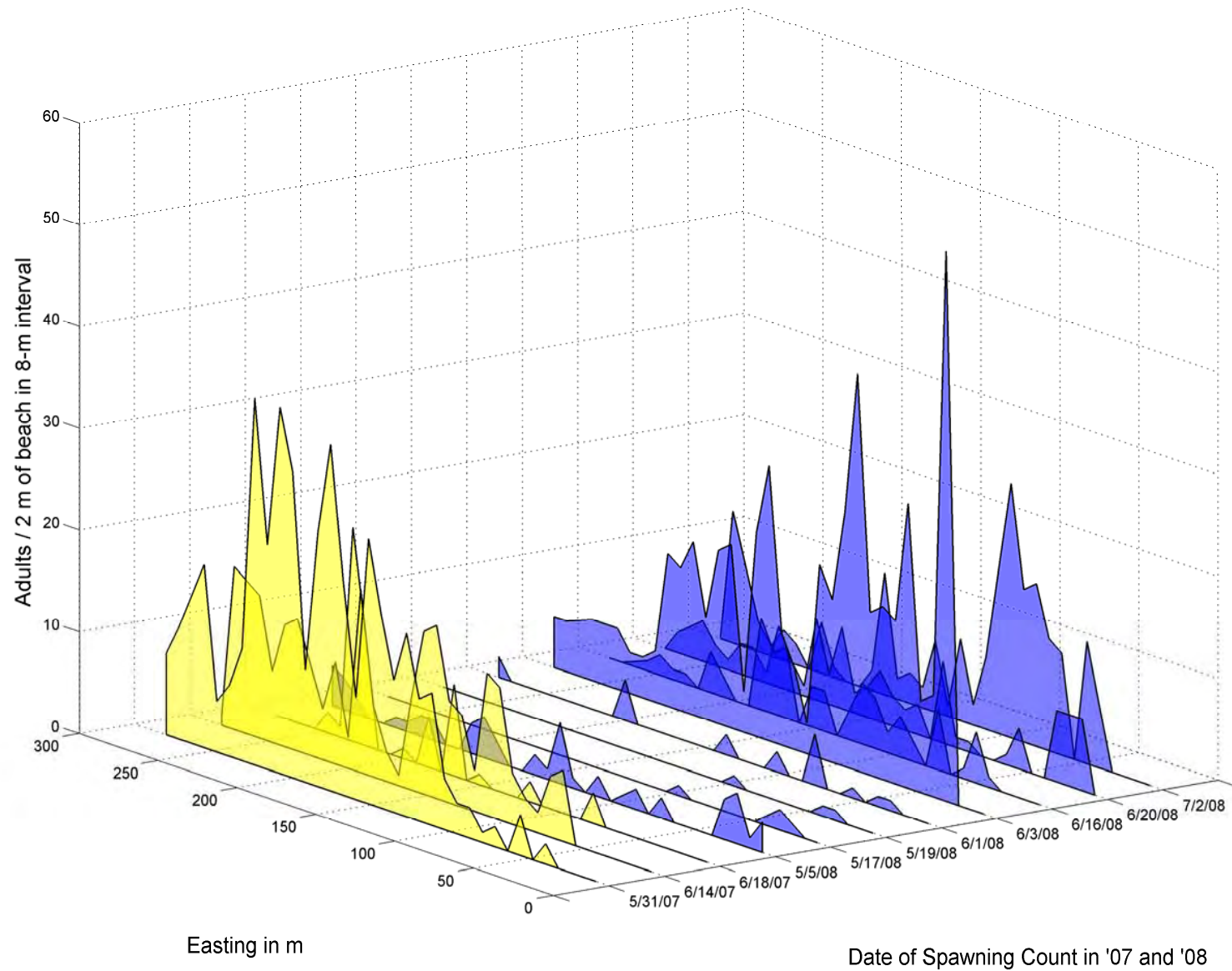
Correlation Test

Pearson's Correlation $r = .27$

**Correlation of Spatial Distribution on James Farm
Counts 5 and 7 (2008)**



Comparison of Horseshoe Crab Spatial Distribution on James Farm from 2007-2008





Male to Female Ratios

Census Number	Ratio
Census 1 May 31, 2007	6.2:1
Census 2 June 14, 2007	4.4:1
Census 3 June 30, 2007	2.7:1

As expected, There is a much greater number of males than females.
Also, the ratios decrease with time.

Egg Census

Methodology

- 1) 15 meters of measuring tape is laid out along the beach.
- 2) 10 sample sites along the 15 meters are chosen by using a random numbers table.
- 3) A 6.7X20cm core is taken at each sample site.
- 4) Each core is mixed together and a 50 ml aliquot is taken
- 5) the number of eggs and larvae the 50 ml aliquot is counted for each core.
- 6) Repeat for a total of 45 meters (a total of 30 cores).

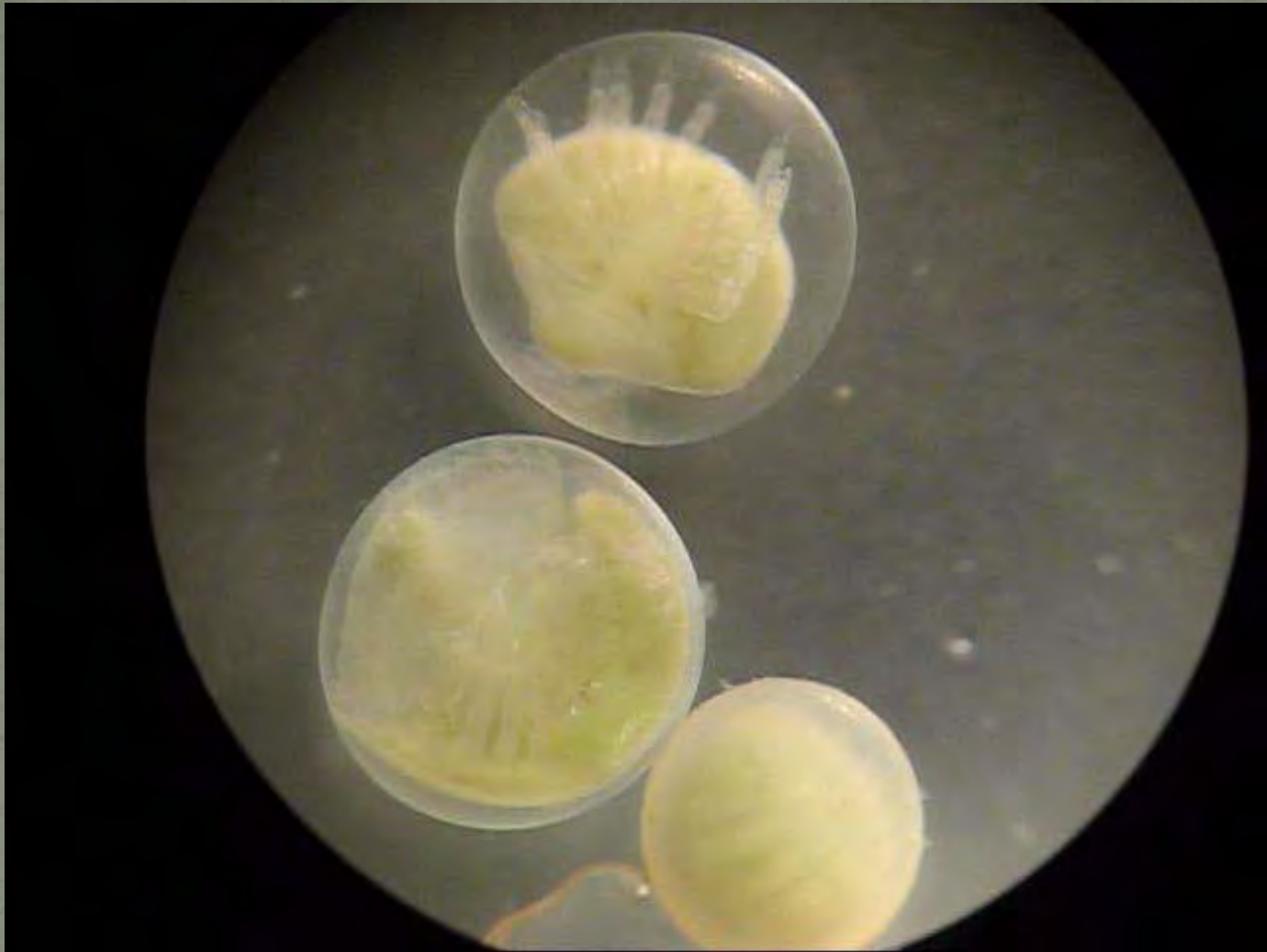


Identification of Eggs

- Horseshoe crab eggs are easily identified. They are about the size of a bebe bullet and are a pale green or light orange.



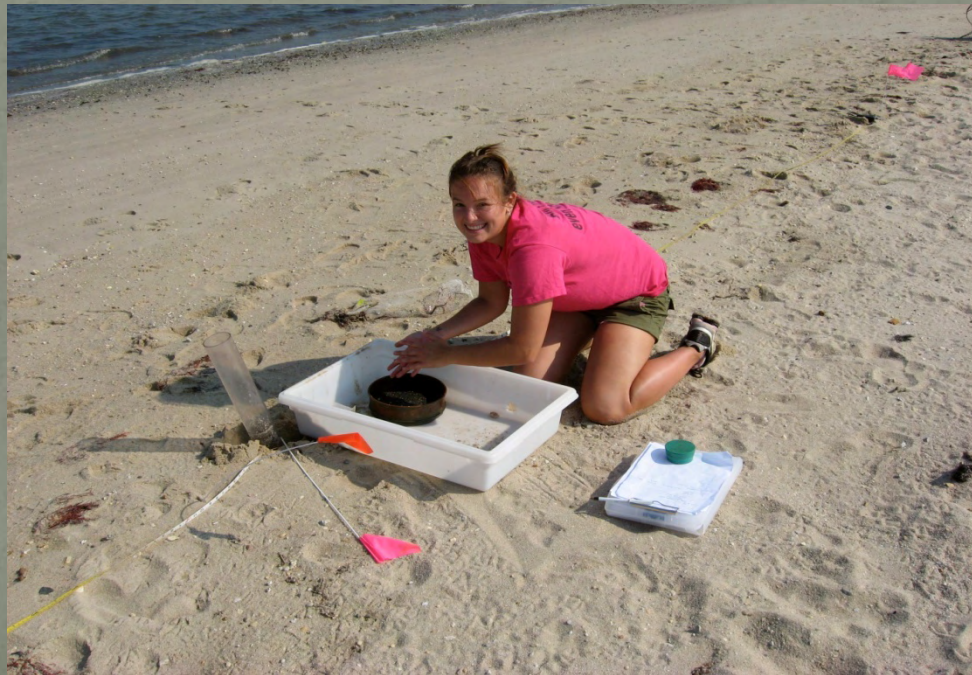
Egg Development



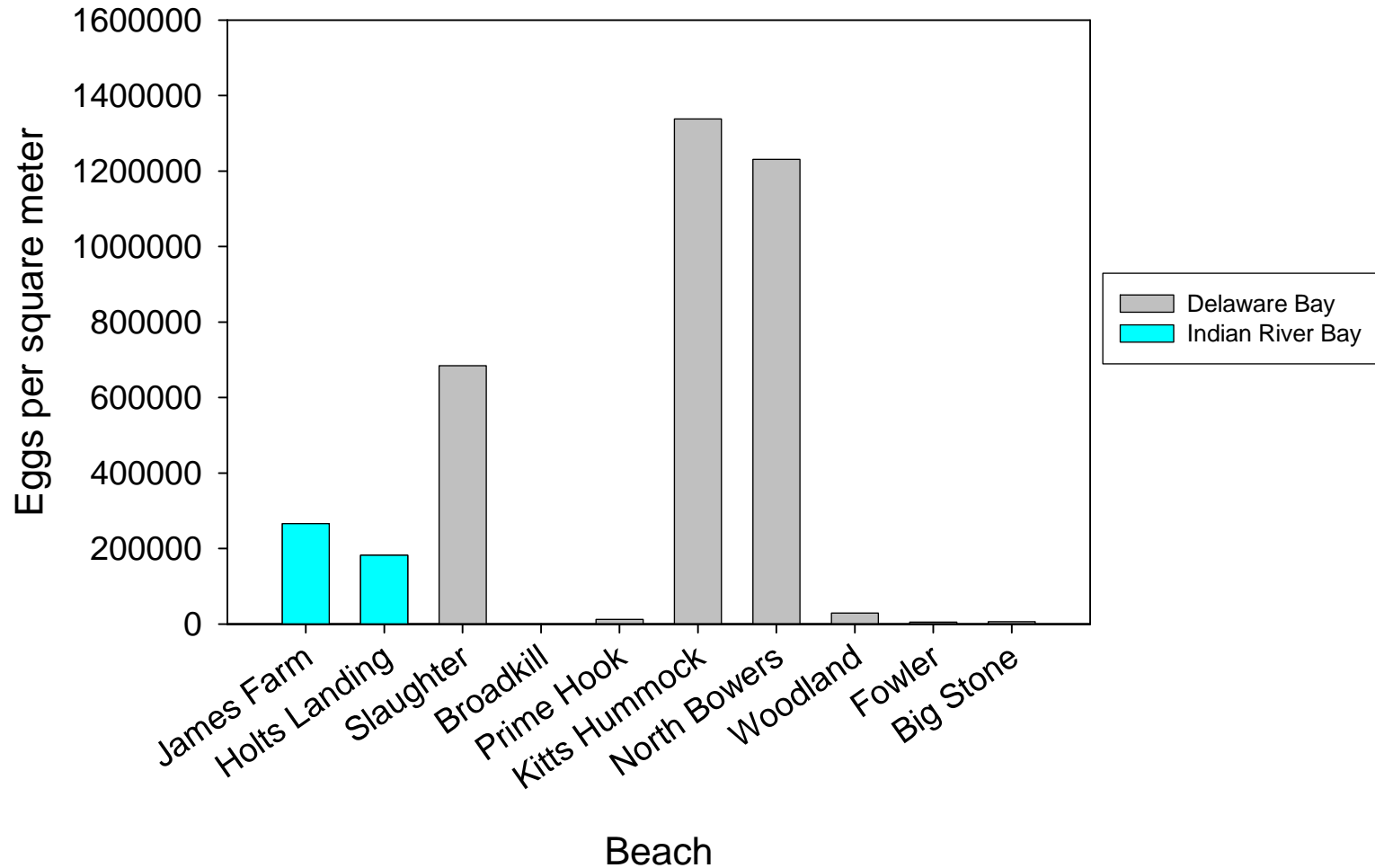
- Different stages of egg development were observed by bringing samples back to the lab.



- Egg counts occurred twice at James Farm Ecological Preserve, and twice at Holts Landing State Park.
- In both instances, many eggs were found.



Comparison of Eggs per Square Meter on Inland Bay Beaches (2007)
Versus Delaware Bay Beaches (1999)



Numbers from 2007 were compared to those in 1999 by Smith, to see if the methodology was performed accurately

Total Estimates

2007

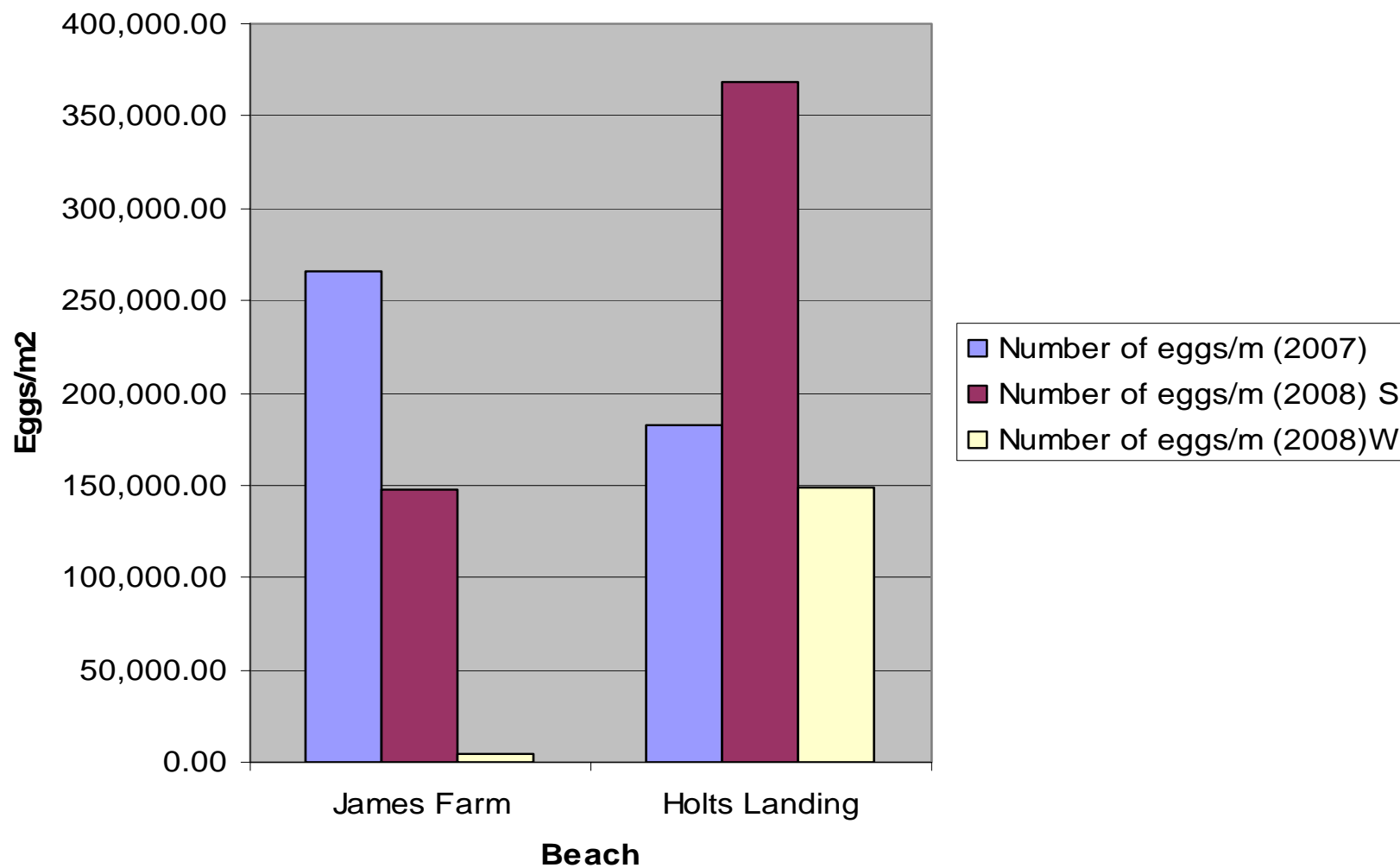
	Number of eggs & Larvae /m2	Estimated Total
James Farm (.230 km)	266,000	59,000,000
Holts Landing (2 km)	182,000	364,000,000

What's New?

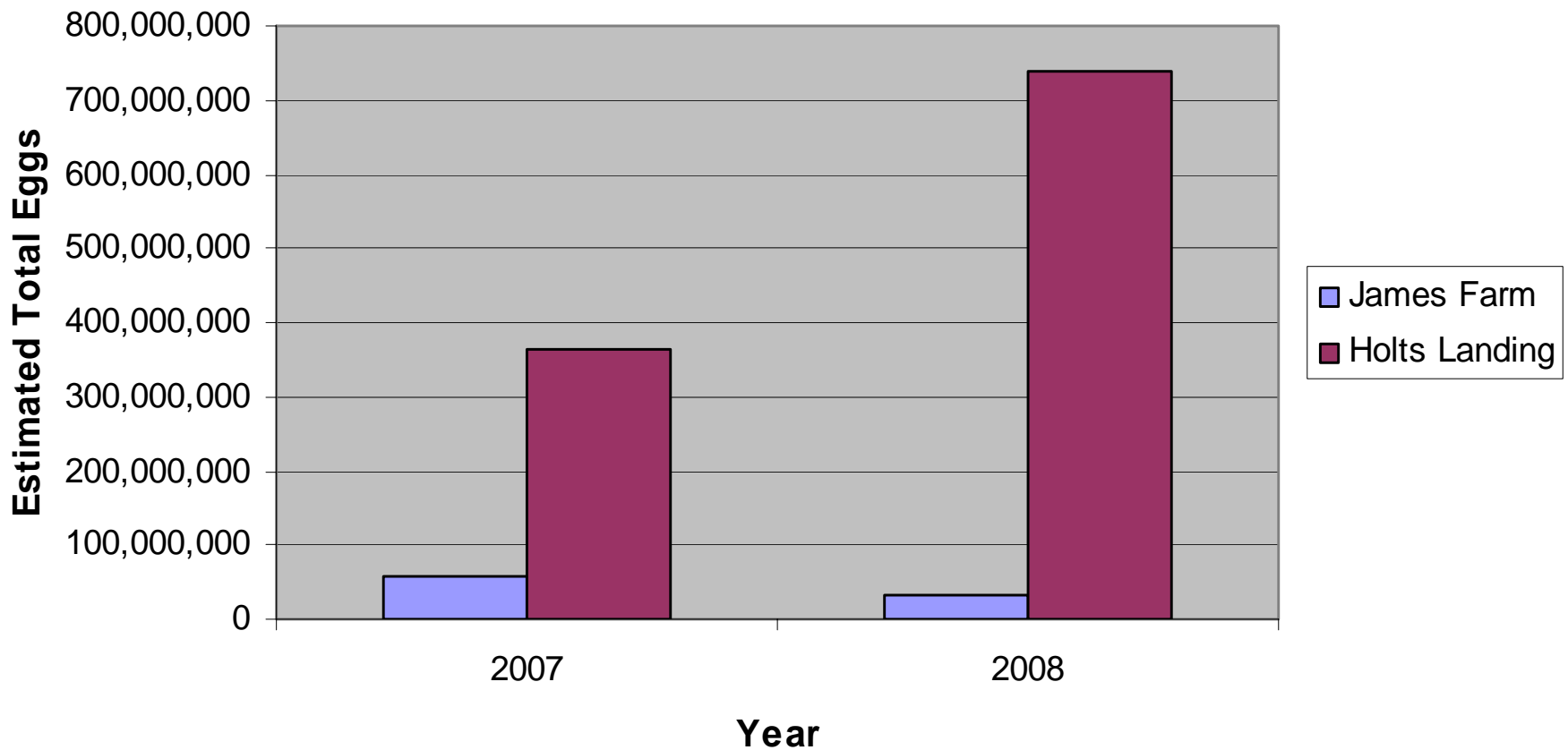
2008 Data

	Number of eggs & Larvae /m ²	Estimated Total
James Farm (.230 km)	148,000	33,000,000
Holts Landing (2 km)	369,000	738,000,000

Estimated Eggs per Meter Squared on James Farm and Holts Landing, 2007 and 2008 (Summer and Winter)



Comparison of Estimated Total Eggs on James Farm vs Holts Landing from 2007 to 2008



Over-wintering

	Estimated Total Eggs SUMMER	Estimated Total Eggs WINTER	Percent Over- wintered
James Farm (.230 km)	33,000,000	890,000	2.7%
Holts Landing (2 km)	738,000,000	298,000,000	40%

Current Conclusions

- It should be recognized that the Inland Bays do provide spawning sites for a significant number of horseshoe crabs.
- Patterns of spatial distribution of eggs and spawning crabs on certain Inland Bays beaches may occur.
- Embryos and larvae of horseshoe crabs in the Inland Bays can over-winter

Further Research

- Continue to compare spawning in DE bay to that of the Inland Bays
- Further explore the spatial distribution of spawning adults
- Explore ways to better adult and egg count methodology

Acknowledgements

- Dr. Doug Miller and the Miller lab
- National Science Foundation (NSF)
- The Center for the Inland Bays
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Inland Bays Journal

NEWS FROM THE DELAWARE CENTER FOR THE INLAND BAYS Spring 2008

Horseshoe Crabs Abundant on Indian River Bay

By Doug Miller and Kathleen McCole, College of Marine and Earth Studies, University of Delaware

Surveys for horseshoe crabs conducted at the James Farm in late May and June 2007 documented that many adults spawn and lay eggs there. Although the beach at the James Farm is only a few hundred yards wide, the densities of spawning adults recorded are well within the range found at the much better studied beaches of Delaware Bay, which have been surveyed regularly for nearly a decade.



The female pauses every few feet to dig a hole and deposit as many as 20,000 pearly green, birdshot-sized eggs. The male then fertilizes the eggs as he is pulled over the nest. After the spawning is complete, the crabs leave and the waves wash sand over the nest.

Our initial data from this summer provide quantitative support for anecdotal observations that have long indicated that large numbers of horseshoe crabs use the James Farm beach.

In a follow-up study, we also took core samples of beach sand for horseshoe crab eggs at the James Farm and near Ellis Point, adjacent to Holts Landing State Park. High densities of viable eggs and developing embryos were found at the James Farm. Near Ellis Point, eggs were also abundant,

though lower in average density than at the James Farm. This suggests that other similar beaches in Indian River Bay may be favorable for horseshoe crab recruitment as well.

Horseshoe crabs are a notable and important species in the Mid Atlantic. They are not crabs at all, but are more closely related to spiders and scorpions. Despite being known as a "living fossil" and virtually unchanged for hundreds of millions of years, only four species exist at present.

Delaware Bay is world-renowned as the center for spawning and reproduction of one of these species, *Limulus polyphemus*, and their billions of tiny pale-green eggs are a critical food source for several species of migrating shorebirds. This is especially true for the red knot, whose stop-over on our shorelines en route to their breeding grounds in the Arctic is timed to coincide with the late springtime egg-laying of the horseshoe crabs on our beaches.

Our evidence of spawning, egg-laying and larval development definitely suggests that James Farm's and other sandy shorelines in the Inland Bays are important mating and nesting sites. But more data are needed to confirm this tentative conclusion.



What's Inside



TERP Time Again!
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Volunteers on the Ground
Page 4.



Tagging Horseshoe Crabs
Page 6 & 7.

The Inland Bays Journal is a quarterly publication of the Delaware Center for the Inland Bays. The CIB is a nonprofit organization and a National Estuary Program. The purpose of the Inland Bays Journal is to educate and inform citizens and visitors to the Inland Bays watershed about this "estuary of national significance."

For more information or inquiries, contact our offices at 302-645-7325, or visit www.inlandbays.org. Email letters to the editor to outreach@inlandbays.org.

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Questions?

