Horseshoe Crab (Limulus polyphemus) Movements in the Delaware Inland Bays

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DELAWARE CENTER FOR THE
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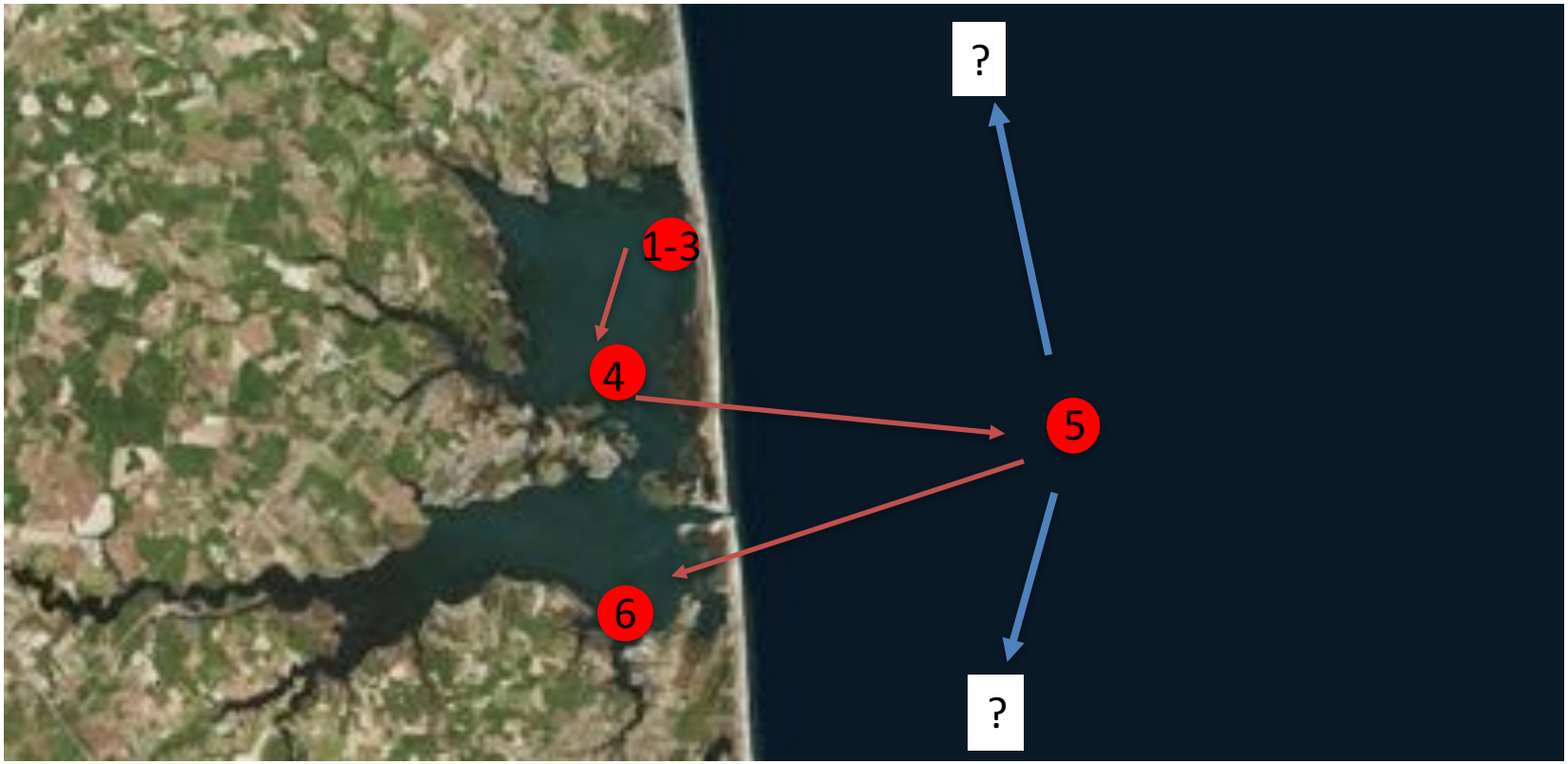
Life Cycle of Horseshoe Crabs



1. Fertilized Eggs Deposited
2. Larvae hatch after a few weeks, settle onto intertidal flats
3. Larvae develop into juveniles (first molt) after 20 days
4. Juveniles spend first 2 summers near or on intertidal flats
5. Older juveniles migrate to deeper offshore waters, remain their till they're spawning age (9-11 years old)
6. Adults migrate back to nearshore areas to spawn (May – June)

Previous Work

- **Evidence of regional populations** (ASMFC 2013; Botton and Ropes 1987; Swann 2005)
- **Resident or discrete populations in New England and upper Chesapeake** (Moore and Perrin 2007; Pierce et al. 2000; Schaller et al. 2010)
- **The presence of discrete populations, along with differences in harvest pressures, provide support for management at the regional population level** (ASMFC 2013; Rutecki et al. 2004)

Importance of Long Term Tracking

Critical to regional management is an understanding of;

a) Where the regional population begins and ends
b) How much mixing takes place between embayments within a region
c) Temporal and spatial aspects of travel within a region

Methods

Tagging Locations = Green Circles

- **Since 2002, 5,581 crabs tagged with USFWS tags. Almost 70% of those within the last 4 years**

2002-2012 = 1776
2013 = 1005
2014 = 800
2015 = 1000
2016 = 1000
TOTAL = 5581

Methods

- Tags drilled into left prosoma
- Record sex, approximate age, prosomal width
- Recaptures reported via USFWS link or phone number

Results

- 1,123 resights reported
- 20% resight rate (very good!)
- 167 resights (14.87%) in Delaware Bay or NJ Coastal Bays
- 39 resights (3.47%) in MD/VA waters
- 915 resights (81.47%) in Inland Bays
- 2 resights (0.1%) in Connecticut

*only resights with GPS locations shown

Delaware Bay/NJ Coastal Bay Resights

*only resights with GPS locations shown

N = 167, minimum diff between tag and recapture = 6 days, maximum diff = 2900 days (alive)

Inland Bays Resights

*only resights with GPS locations shown

N = 915, minimum diff btwn tag and recapture = 0 days, maximum diff = 3,014 days (alive).

Maryland/Virginia Resights

- N = 39
- minimum diff between tagging and resight = 1 day
- max diff = 2977 days (alive)

*only resights with GPS locations shown

Limits of Regional Population

- Southern limit was Chincoteague Inlet Area
- Northern limit in Barnegat Bay
- Similar to Swan (2005) limits

Mixing Between Embayments

- 92 resights in IB after 320 days
- 152 resights in Delaware Bay after 320 days.
- Evidence of strong mixing between IB and Del Bay, less so with MD Bays (27 after 320 days)
- Suggests IB Horseshoe Crabs migrate to Mid Atlantic Shelf, belong to the Delaware Bay subpopulation indicated by Swann (2005).

Spawning Behavior Analyses

- Sought to understand how long crabs stay at spawning beach
- Do females travel farther?
- Needed very accurate GPS location information for resights
- 717 resights missing this

Determining GPS Location

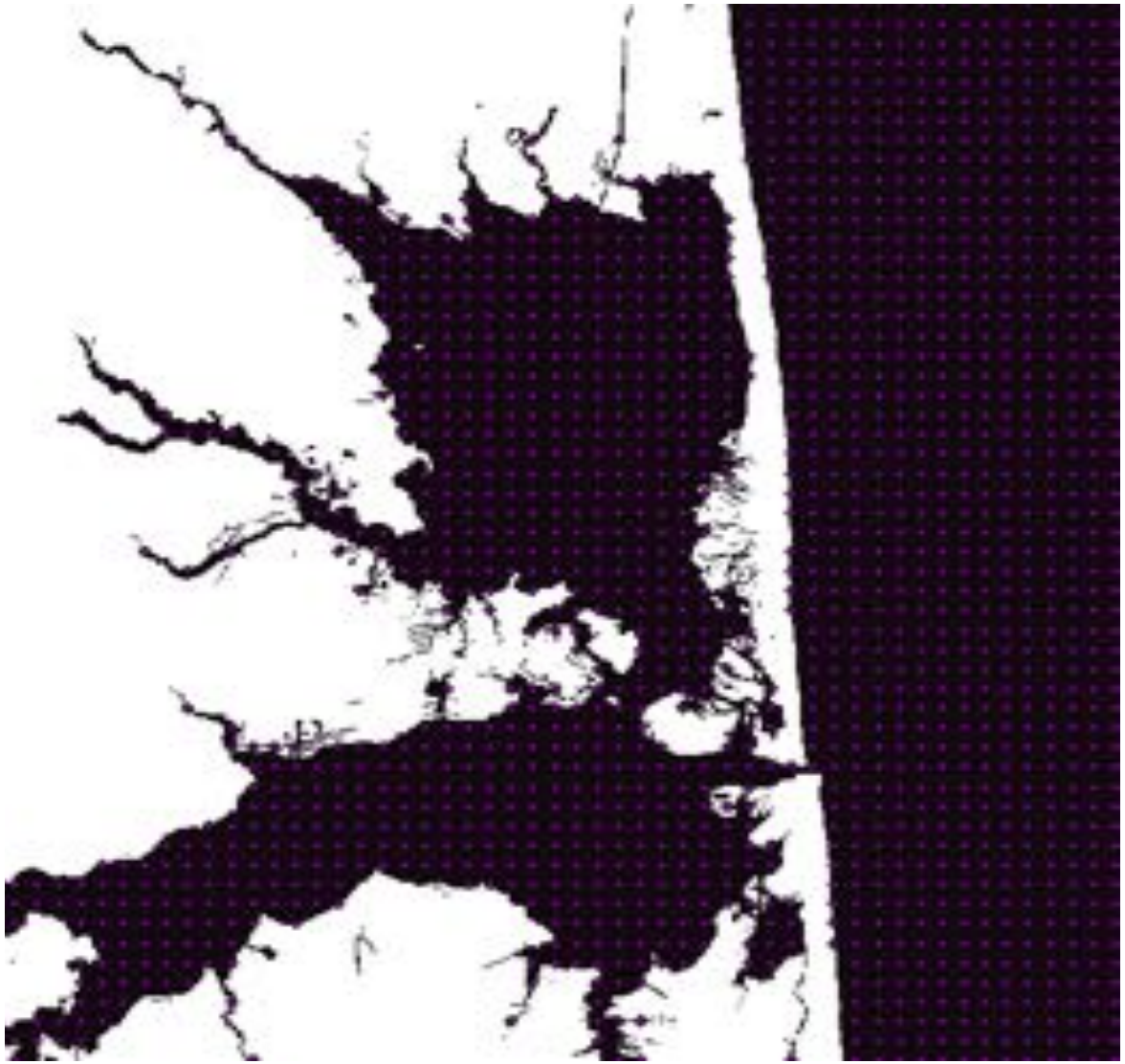
- GPS locations for Inlet recaptures were positioned at furthest position on land in the inlet, using closest city or comments section to dictate which side of the inlet to place the point.
- If just a beach was specified, the shore zone area directly across from the entrance to the beach was used. If beach has multiple entrances, entrance closest to the Center was used. (1/2 mile cutoff).
- If just a marina or street was listed, the location was determined to be the closest area of water from the entrance to the street or marina.

Determining GPS Location

- 471 resights were given a new GPS location (65.6% of missing resights)
- In total 862 resights were available for distance analysis (76.7% of all resights reported)

Getting Distance Traveled

Getting Distance Traveled



- Number of GPS points located on land
- Move them to closest water "cell" using Arc GIS. Distance between cells 0.25 miles.

Getting Distance Traveled

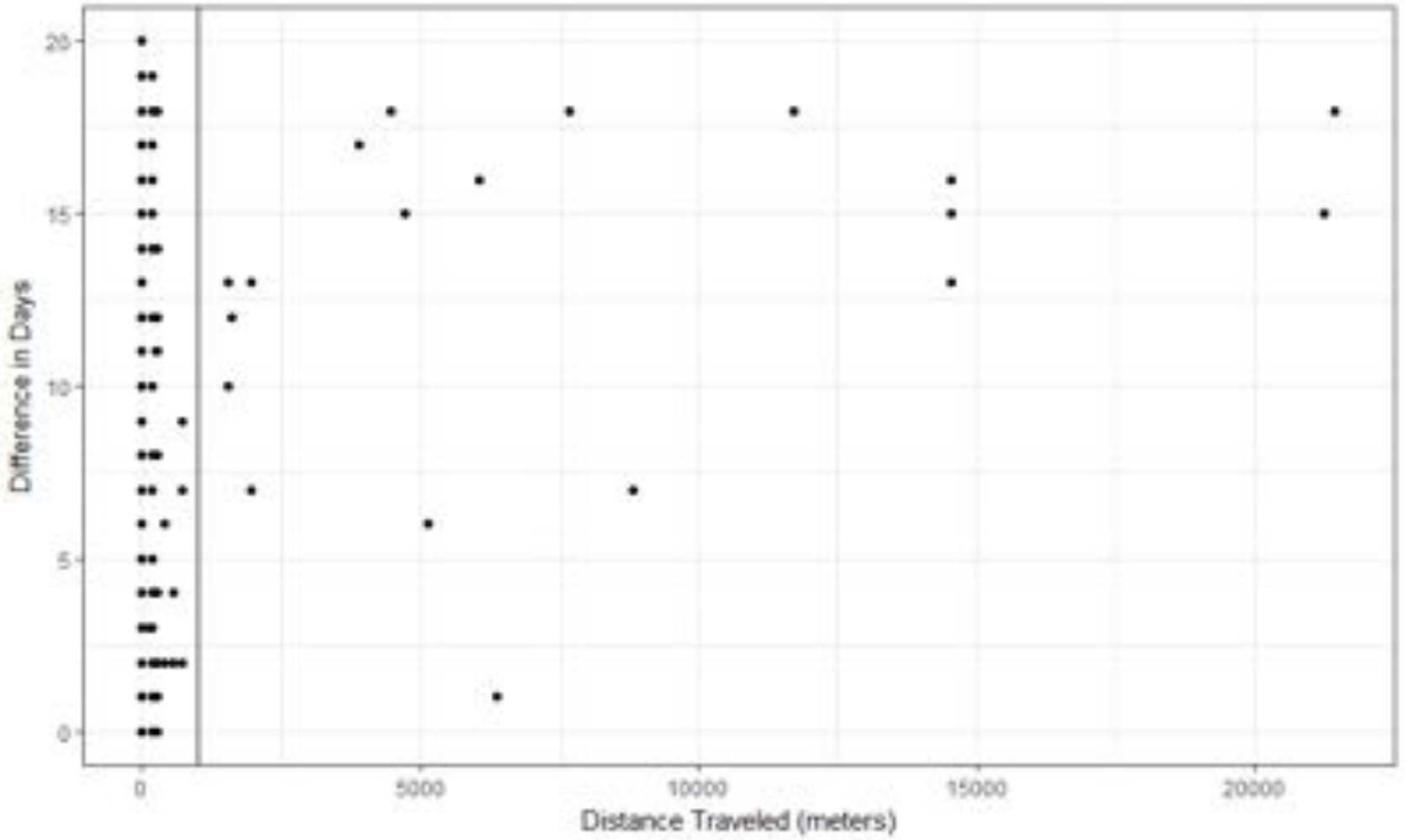
- **Using Cost Path Analysis (ArcGIS 10.4) determine the "least costly path" between original tagging location and all recapture sites.**
- **All water cells have a value of 1. All other cells have a value of Infinity.**
- **Lowest number to get from point A to point B is minimum distance traveled**

Raster (30 m cell size)

Results

- 862 useable resights
- 790 resights in Inland Bays (91.6%)
- 52 resights in Delaware Bay (6%)
- 20 resights elsewhere
- 1 was in CT, minimum distance of ~550 km (3 years between tagging and resight)

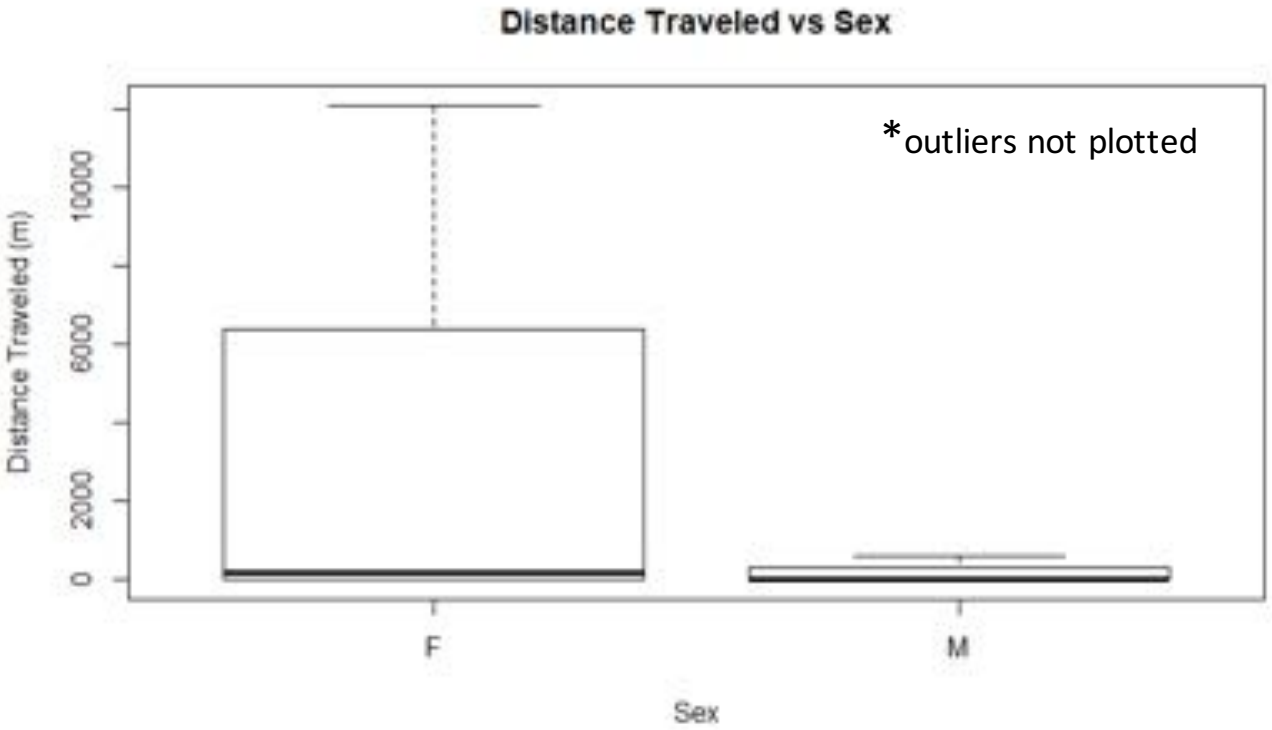
Results



- Within ~5 days most crabs remained very close to tagging location
- 99.7% of resights within 5 days occurred less than 1 km away
- By two weeks many crabs dispersed to other locations

Results

- **Females traveled farther ($p < 0.01$)**



Results

- 80% traveled less than 2 km
- Only 1% of resights greater than 100 km
- But after 320 days 86.88% of resights > 2 km away from tagging
- Evidence against site-fidelity

Literature Cited

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