

Towards Sustainable Management of Horseshoe Crabs



Eric M. Hallerman, Dave Hata,
Sarah Karpanty, Jim Fraser, and Jonathan Cohen
Virginia Tech University

Mike Eackles and Tim King
USGS - Leetown Science Center

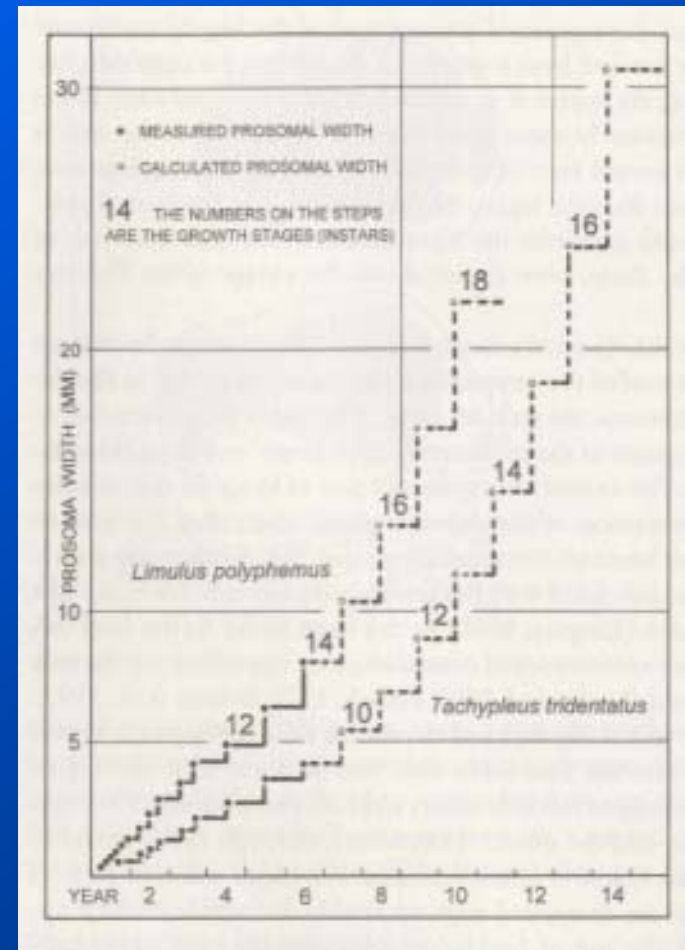
Horseshoe crab, *Limulus polyphemus*



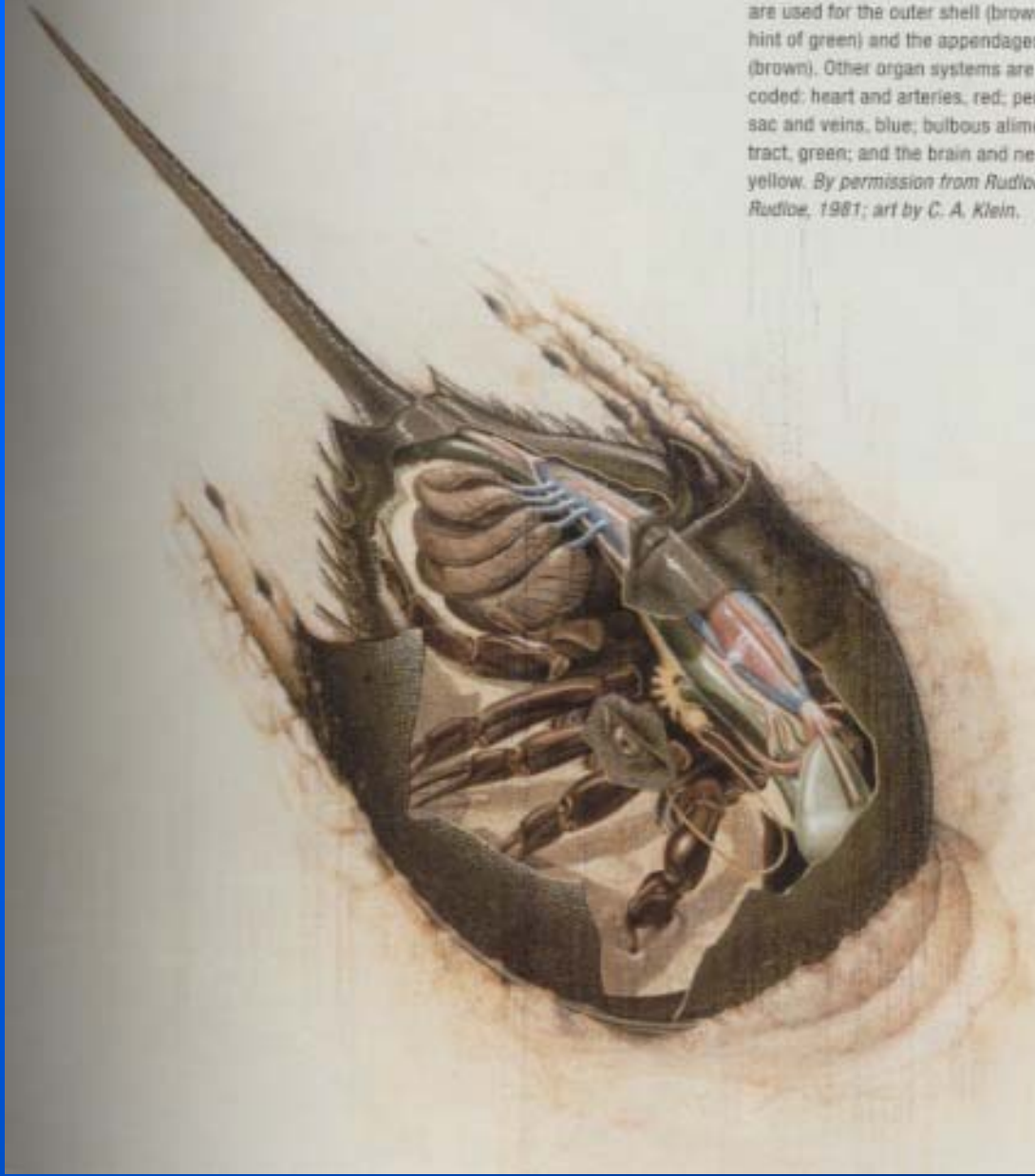
- An amazing animal
- An important animal
- A largely unknown animal

Life history

- After hatch, a number of pelagic stages
- After settlement, 18 molts
- Terminal molt at maturity (?)
- Maturity takes about ten years
- Females larger than males at maturity



COLORPLATE 11 The major interior organs of an adult male *Limulus*, shown in relation to the outer shell. Natural colors are used for the outer shell (brown with a hint of green) and the appendages (brown). Other organ systems are color-coded: heart and arteries, red; pericardial sac and veins, blue; bulbous alimentary tract, green; and the brain and nerves, yellow. By permission from Rudloe and Rudloe, 1981; art by C. A. Klein.



- Eight eyes
- Book gills
- Copper-based hemolymph
- Semi-open circulatory system

Why should we *care* about such a
bizarre creature??



Ecologically and economically important

- Benthic omnivore
- Important prey item in marine near-shore ecosystem



Ecologically and economically important

Eggs an important food item, esp. for migratory shorebirds

Great black-backed gull

Herring gull

Laughing gull

Red knot

Ruddy turnstone

Sanderling

Semipalmated sandpiper

American oystercatcher

Black-bellied plover

Boat-tailed grackle

Dunlin

Glossy ibis

Killdeer

Least sandpiper

Long-billed dowitcher

Red-winged blackbird

Semipalmated plover

Short-billed dowitcher

Spotted sandpiper

White-rumped sandpiper

Willet

Black-necked stilt

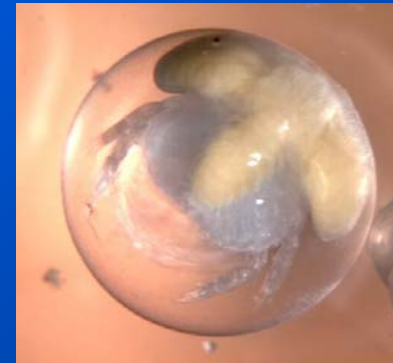
Greater yellowlegs

Hudsonian godwit

Lesser yellowlegs

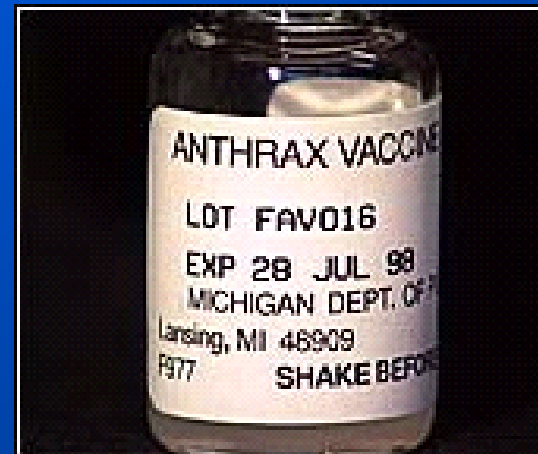
Marbled godwit

Whimbrel



Ecologically and economically important

- Crabs have strong non-specific immune system
- Blood is source of *Limulus* Amebocyte Lysate
- LAL used to test vaccines, injectable drugs, implantable medical devices



Value of industry: ~ \$100M/yr

Ecologically and economically important



Ecotourism

Value of industry: ~\$20M/yr

Ecologically and economically important

Object of a bait fishery

- A new fishery, expanded greatly in late 1990s



Value of industry:
~ 1-2M/yr

Overall economic impact (Manion et al. 2000):

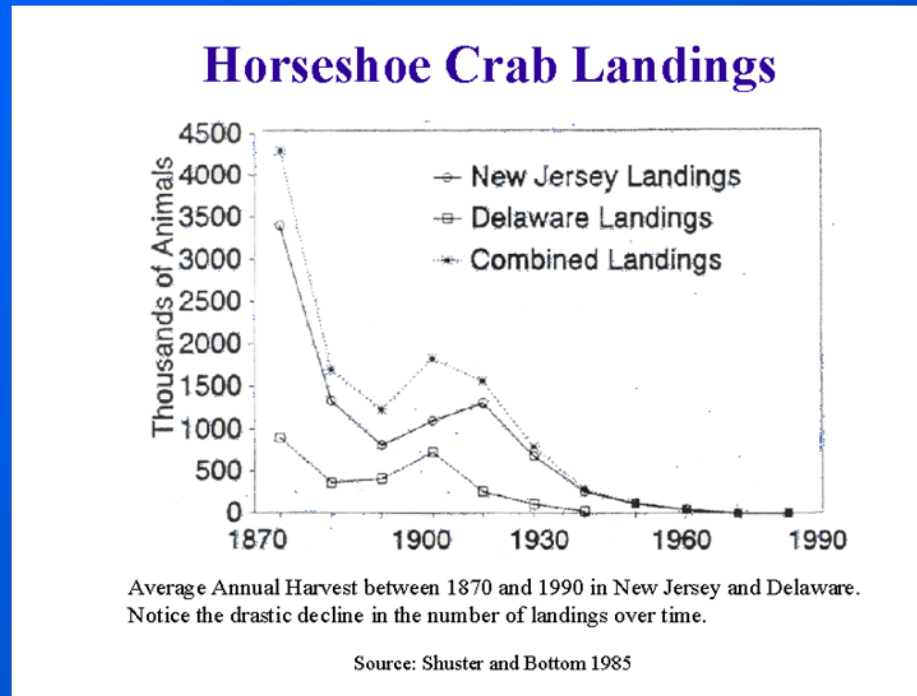
-\$93-123M/yr to regional economy

-\$175M/yr to national economy



- Once so common, it was ground up for fertilizer...

...but now, its abundance is dramatically reduced



→ Economic impact on fisheries

→ Ecological impacts, notably on shorebirds (?)



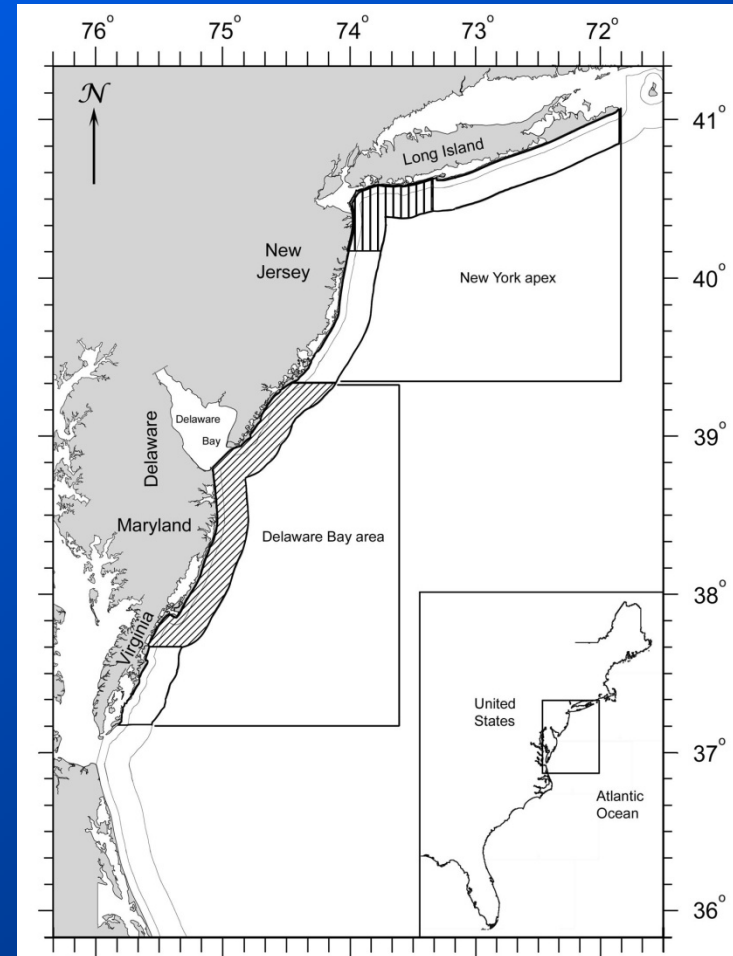
- **Goal:** To provide information needed to sustainably manage the horseshoe crab resource for the benefit of all resource users
- **Ongoing projects:**
 - Trawl survey, including bycatch
 - Population genetics
 - Shorebird interactions

Trawl Survey



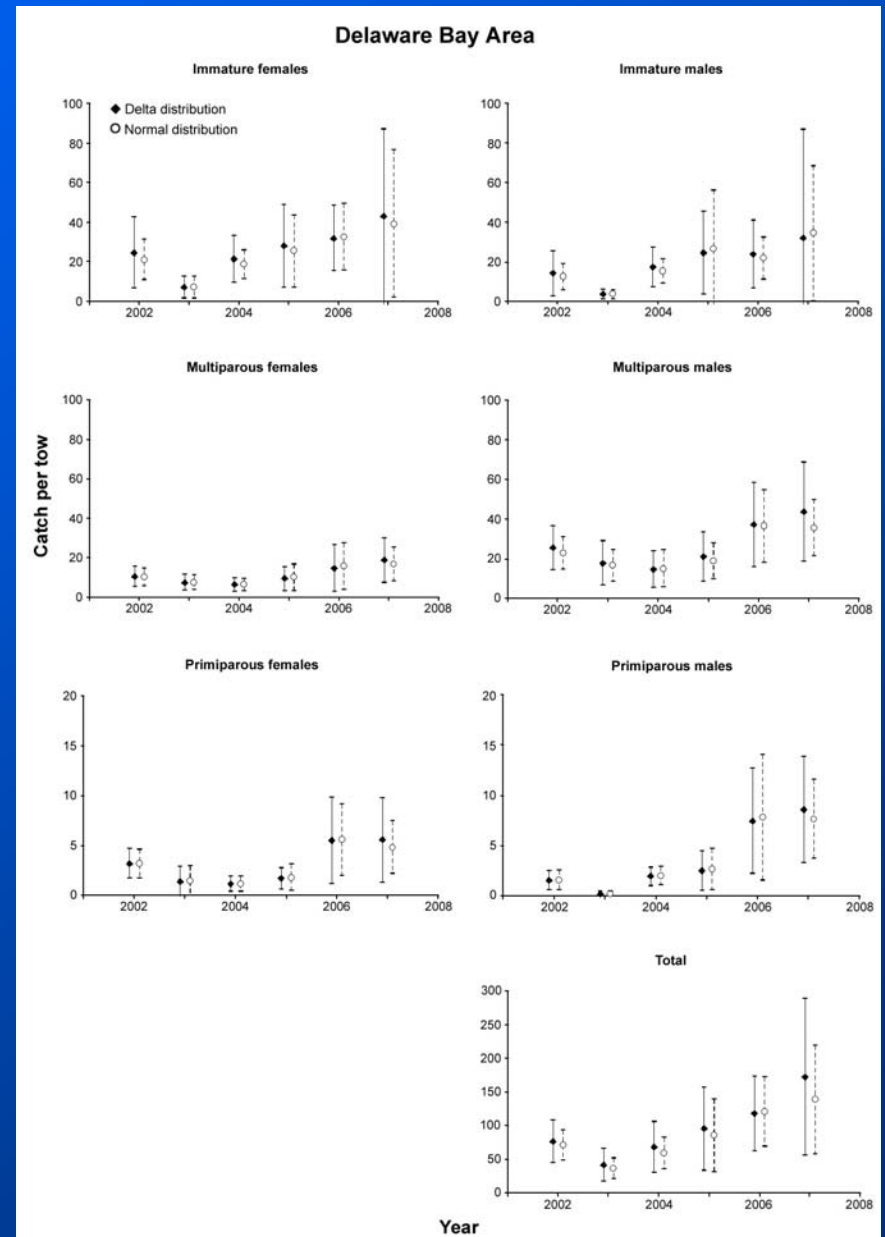
Study methods

- Abundance and population dynamics are critical unknowns, needed for management
- Need fishery-**independent** survey
- Sampling conducted aboard chartered fishing boats, using a flounder net with 6-inch mesh
- Sampling from 0 to 12 nautical miles from shore.
- Sampled 108 stations



Results - Delaware Bay

- Mean catches of immature horseshoe crabs have been increasing since 2003.
- Mean catches of primiparous crabs have been increasing since 2003 or 2004.
- Mean catches of multiparous crabs have been increasing since 2004.



Bycatch

- HSC fishery takes other species incidentally
- Potential for the bycatch issue to affect HSC fisheries
- The 2005 and 2006 trawl surveys included assessment of species composition and weight of bycatch

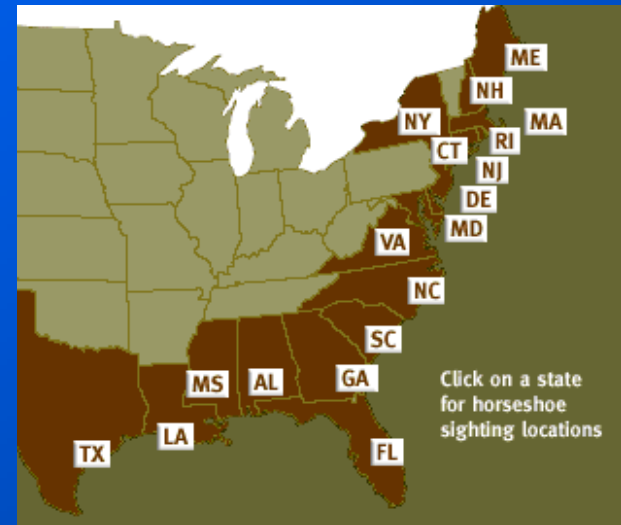


Results

- 76 species taxa were found in bycatch in commercial trawls:
- At **SOUTHERN SITES**, horseshoe crabs were caught with: knobbed and channeled whelks, clearnose skate, southern stingray, spider crab, and summer flounder.
- At **NORTHERN SITES**, horseshoe crabs were caught with: hermit crabs, little and winter skates, spider crab, windowpane flounder, striped searobin, and summer flounder.
- No threatened or endangered species



Population genetics



- Range: Nova Scotia to Atl. Florida, Gulf Florida to Alabama, Yucatan Peninsula
- Shall we manage HSC as one stock? As distinct Atlantic and Gulf stocks? As distinct regional stocks?

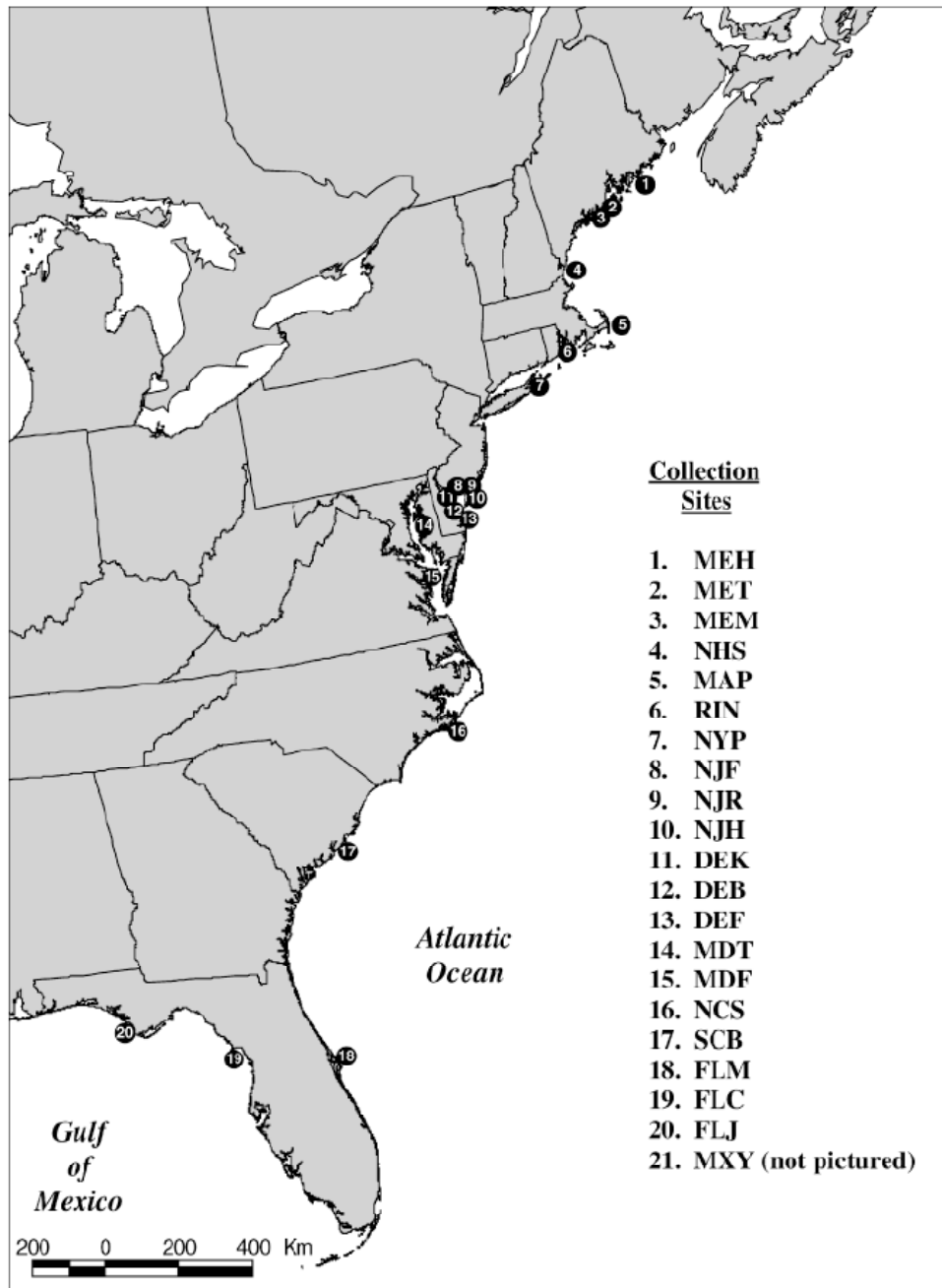


FIGURE 1.—Map indicating 20 collection sites of *Limulus polyphemus* along the Atlantic and Gulf coasts of the United States. An additional collection was made at a site on Mexico's Yucatán Peninsula (not depicted).

Collections:

1465 individuals from 33 populations, incl. spawning aggregations, commercial fisheries

Housatonic River CT

Ocean City, MD 2005

Ocean City, MD 2006

Kiptopeake State Park, VA

Tom's Cove, VA

Beaufort, SC

Savannah, GA

Ocean City, MD trawl

Chincoteague Island, VA dredge

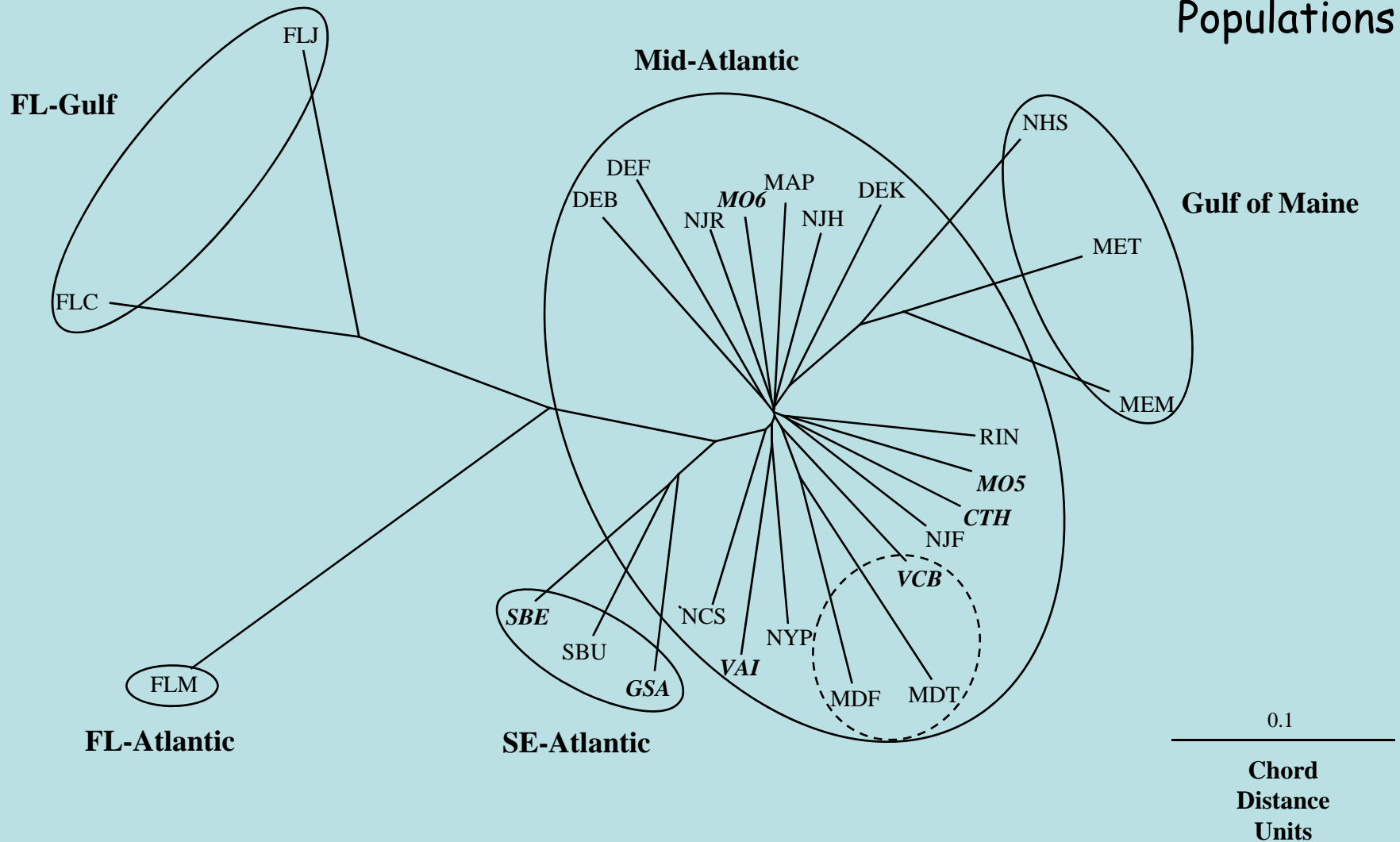
USFWS trawl

Long Island NY trawl

Cape May, NJ trawl

NJ Tree

Populations



Chord distances (Cavalli-Sforza and Edwards 1967) among HSC populations

Shorebird interaction

- Focal species, red knot
- 67-88% population decline since 1980s
- Designated a candidate species for listing under U.S. Endangered Species Act in 2006
- Amazing annual migration
- Does abundance of horseshoe crab eggs drive movement and abundance of red knots during migration stopover?



If crab egg availability *is* limiting the red knot population, then:

1. Red knot habitat selection in Delaware Bay should be driven by horseshoe crab egg abundance.

YES -- 2004

2. Red knots should deplete available horseshoe crab eggs during the migratory stopover period.
3. Red knots should not substantially use other food resources or stopover sites use other food resources or stopover sites.

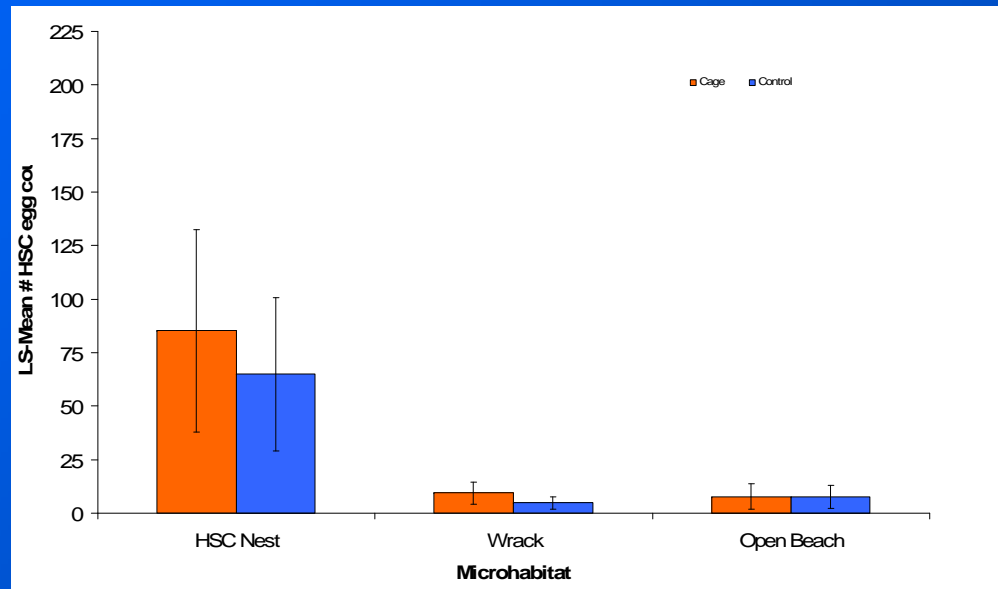
- USFWS 2003: Depletion of HSC eggs by foraging birds would be strong evidence that crab eggs *are* a limiting factor for the red knot population...
- ... but it is not known if HSC egg depletion occurs in Delaware Bay

Methods:

- Exclosures
- Core samples for quantifying egg abundance in and out of exclosures



Were horseshoe crab eggs depleted by foraging birds in Delaware Bay in 2005?



- No, foraging shorebirds did not significantly deplete horseshoe crab eggs on Delaware Bay beaches.

3. Red knots should not substantially use other food resources or stopover sites.

Are there alternative migratory staging areas to the Delaware Bay?

Red Knot Aerial Counts:

<u>Year</u>	<u>Virginia</u>	<u>Delaware Bay</u>	<u>% Virginia</u>
1995	7,985	38,600	17%
1996	8,922	19,445	31%
<hr/>			
2005	9,150	15,345	37%
2006	5,783	13,445	30%
2007	5,939	12,445*	32%

1995-96 data: Watts and Truitt 2000.

2005-07 data: Bryan Watts, Center for Conservation Biology, College of William and Mary

Red knots in coastal Virginia:

- 1) To determine if the Delaware Bay and Virginia red knot populations are separate.
- 2) To understand habitat and prey selection in Virginia.



Study Area: Virginia Barrier Islands



Methods

- Captured red knots with cannon nets
- Radio-tag/leg banded
- Located radio-tagged birds on the ground
- Collected sediment cores at foraging site
- Compared prey abundance between red knot sites and randomly placed cores



Results

Are the Delaware Bay and Virginia populations separate?

- 5-10% of birds that stop in Virginia go to Delaware Bay
- Most birds go straight from Virginia to the breeding grounds (unknown location - Canadian Arctic)

Results

- **Habitat and prey selection in Virginia:**
- Horseshoe crab eggs are virtually absent from beaches on Virginia's coastal islands
- On what do the red knots feed? *Donax*
- Size matters: Red knots are attracted to patches with larger *Donax*
- Habitat use: Distance matters; red knots stay close to night locations



Future work

- Trawl survey
- Juvenile survey
- Tag return study
- Shorebird studies

Acknowledgements



- Fishers
- Agency folks
- NGO folks
- Field volunteers

We hope that our work will help sustain this critically important living resource

