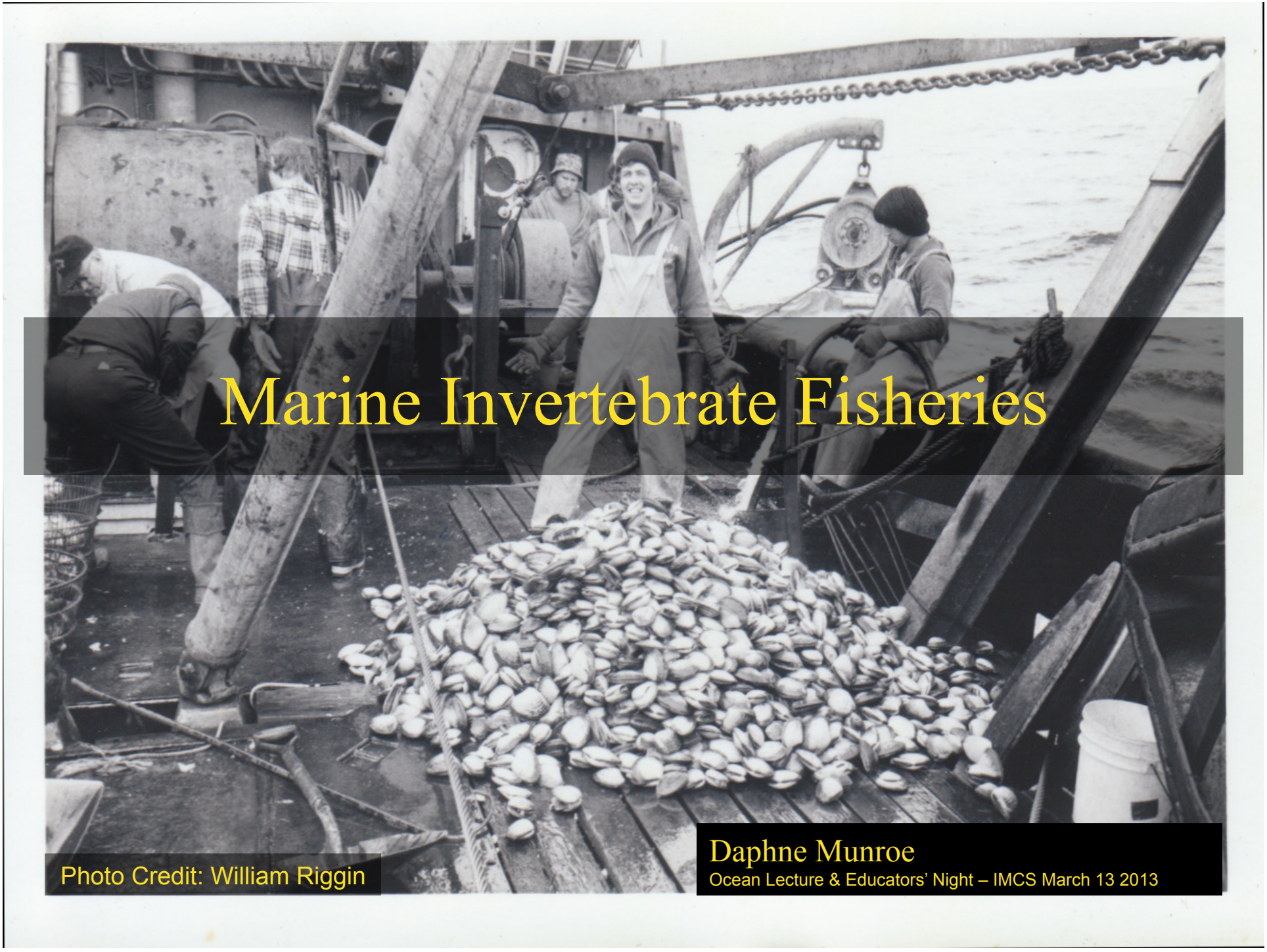
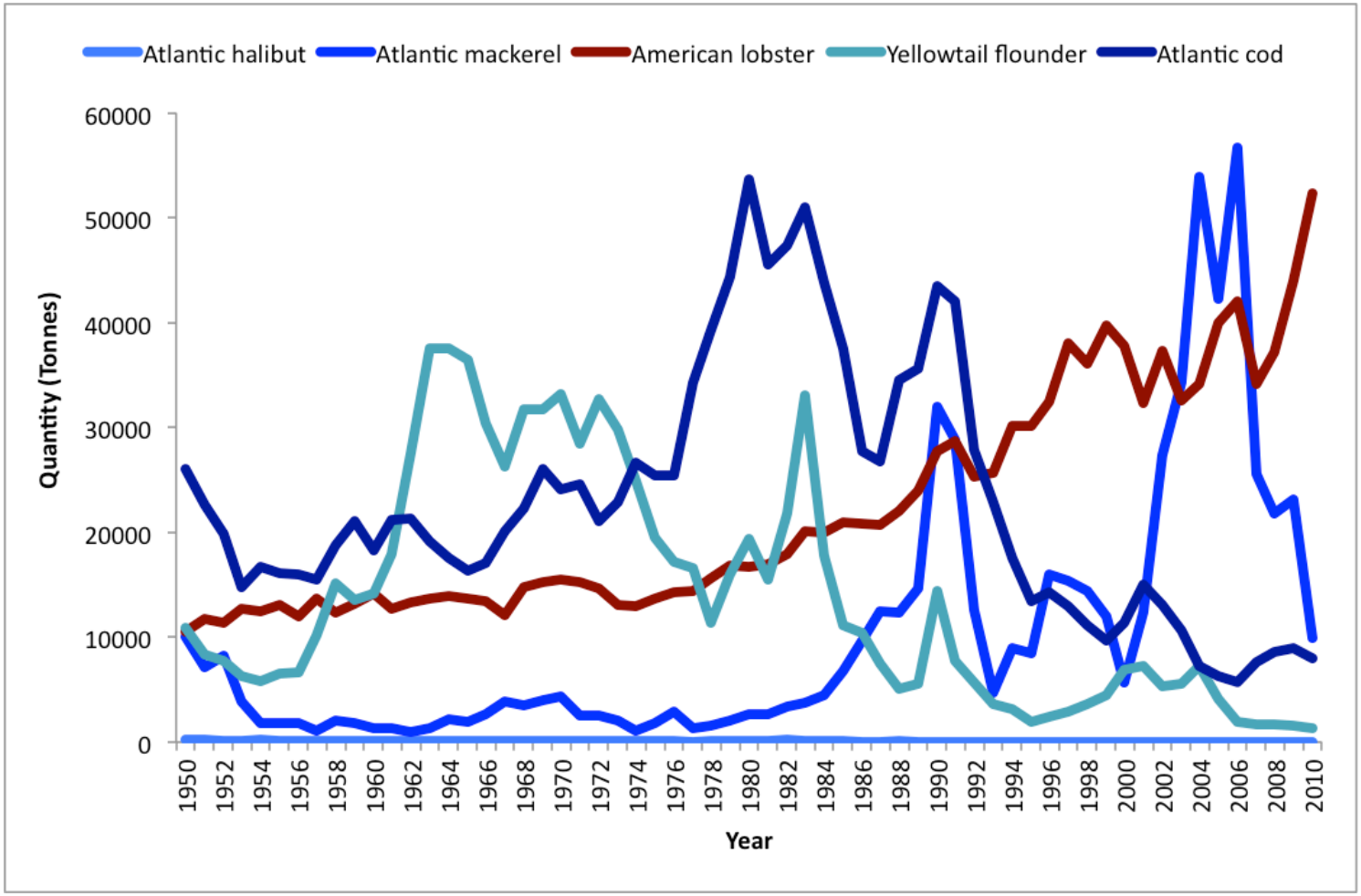


Marine Invertebrate Fisheries

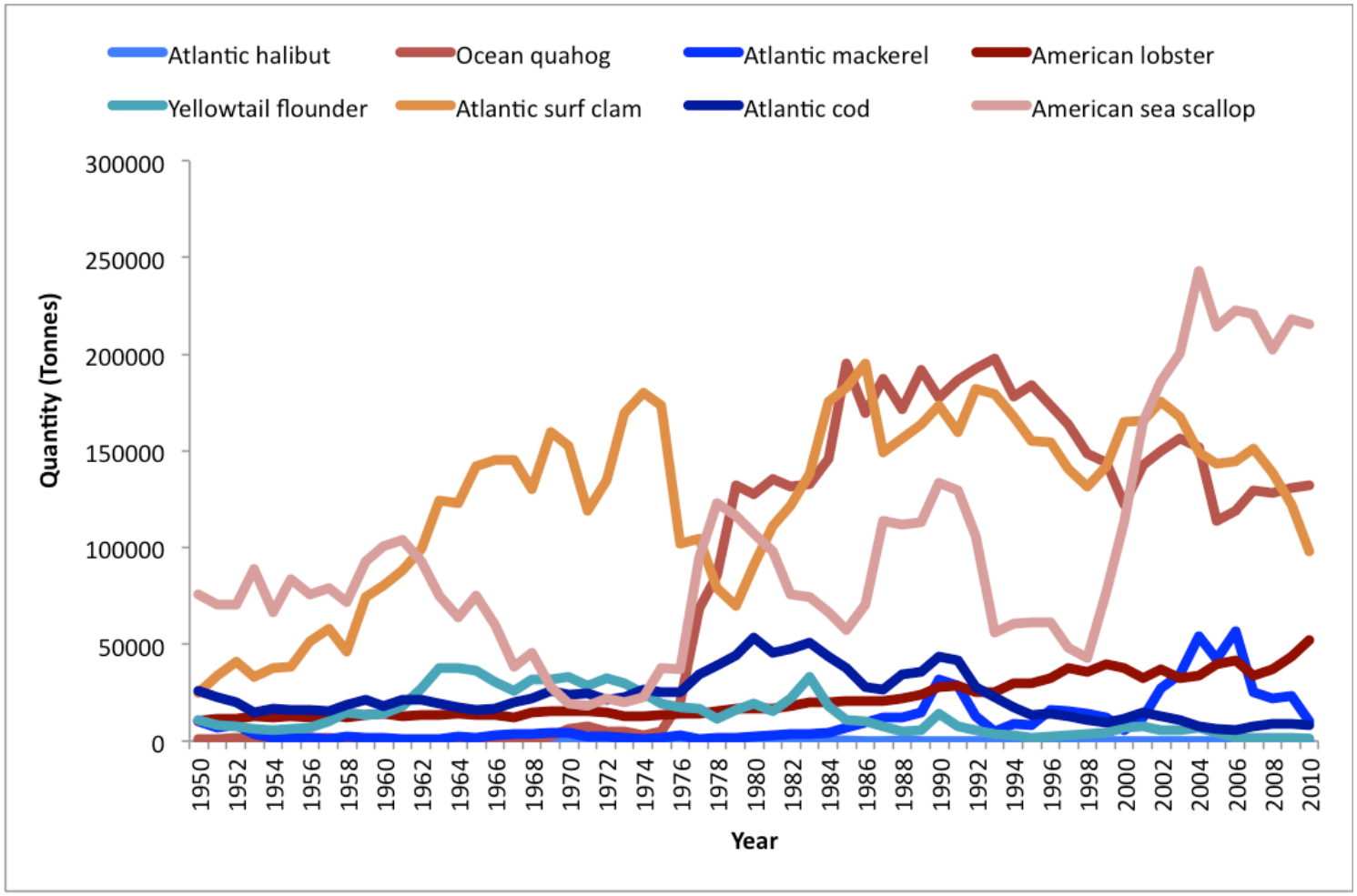
Photo Credit: William Riggin

Daphne Munroe

Ocean Lecture & Educators' Night – IMCS March 13 2013

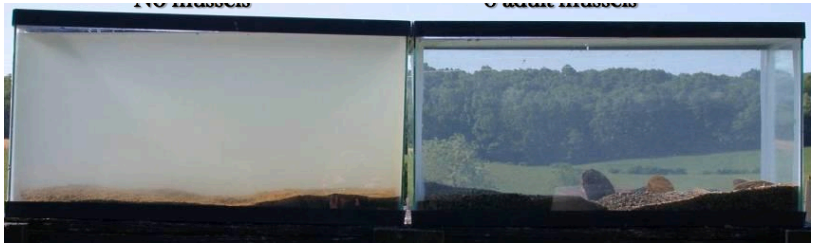


Data: FAO FishstatJ



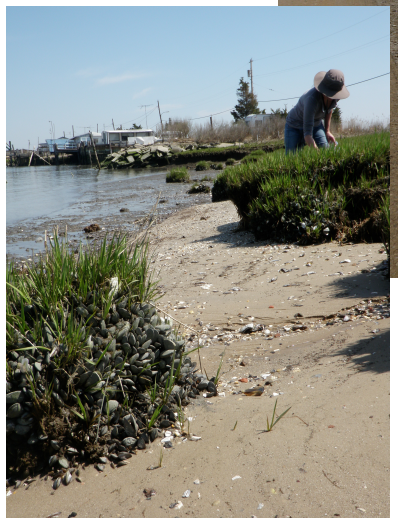
Data: FAO FishstatJ

Shellfish and Ecosystem Services

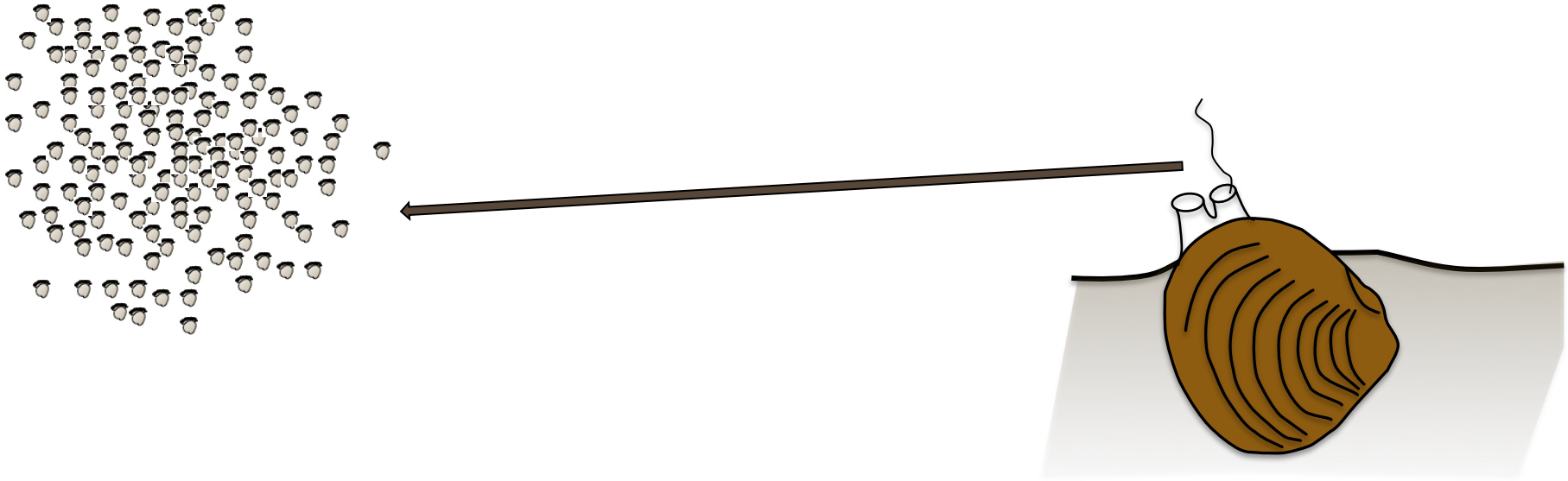


http://blog.stopextinction.org/2012_02_01_archive.html

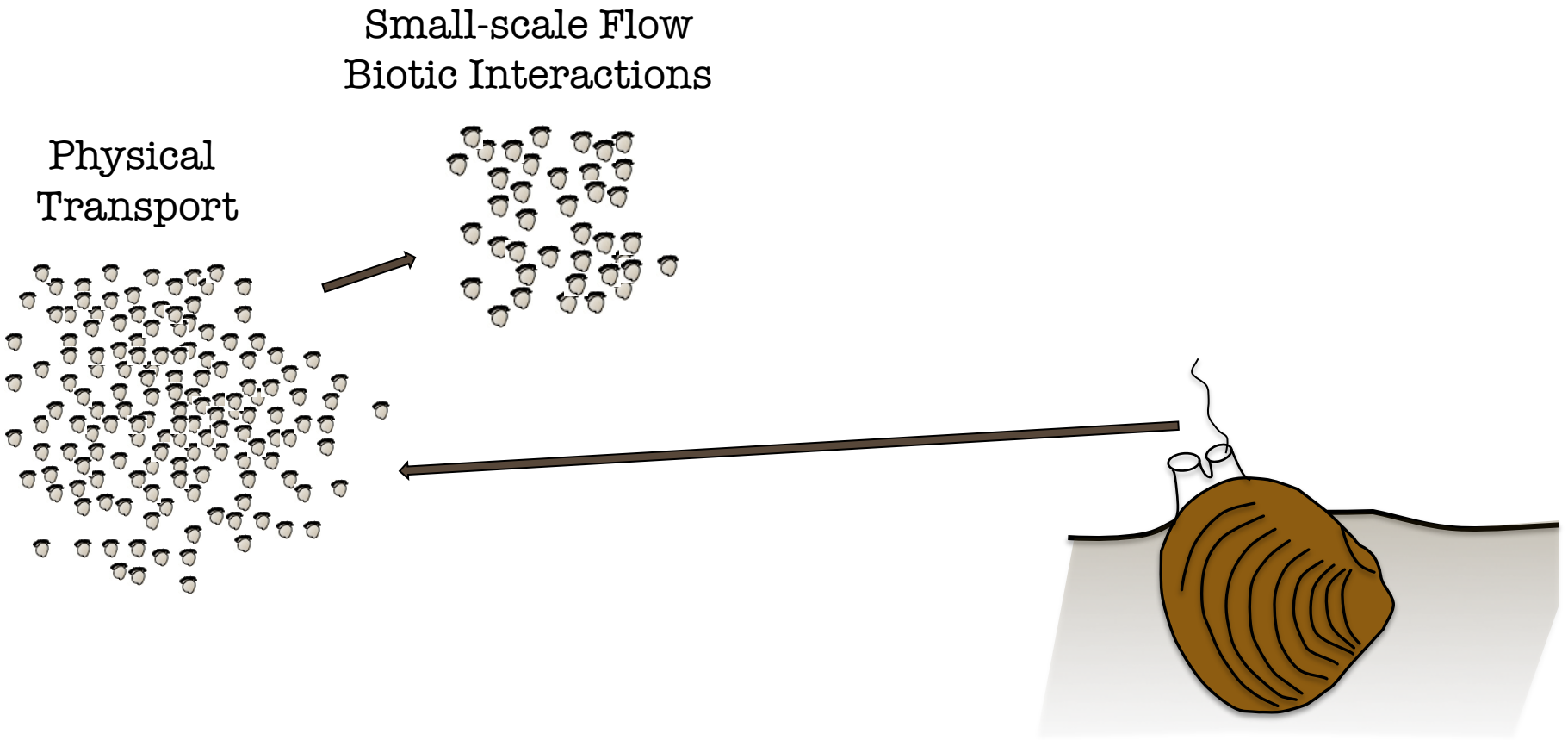
- Water quality
  - Filtration
    - Single Delaware River mussel bed = 30 Mill L/day
      - D. Kreeger; Partnership for the Delaware Estuary
  - Nutrient Cycling
- Shoreline Protection
  - Stabilization
  - Sediment trapping
- Habitat Creation
  - Reefs



Physical Transport



Modified from: Pineda, 2000, *Oceanography of the Eastern Pacific*



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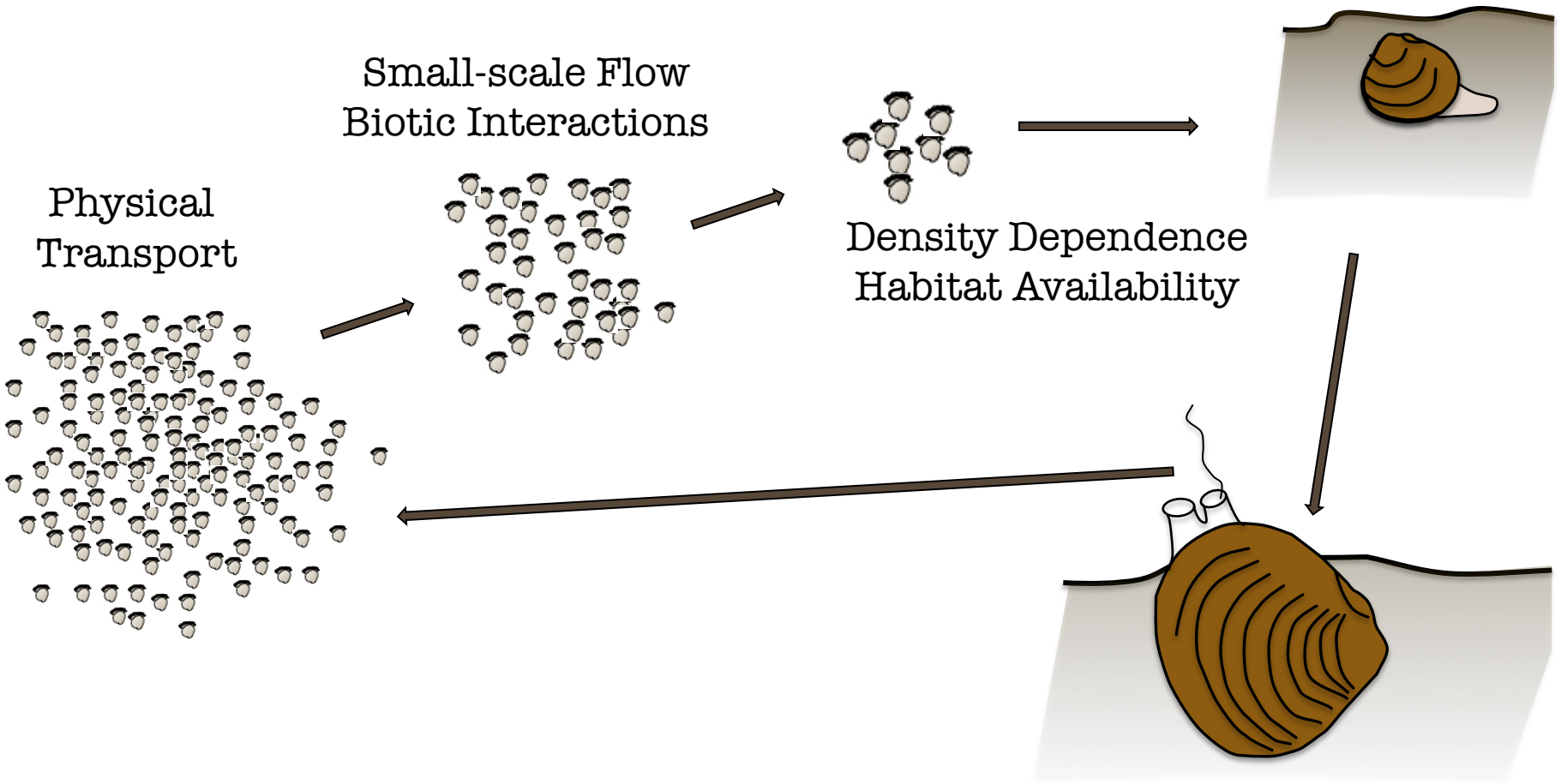

Modified from: Pineda, 2000, *Oceanography of the Eastern Pacific*

The New York Times

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Salmon Gone, Fishermen Try to Adapt on a Changing Coast

By WILLIAM YARDLEY
Published: May 9, 2008

TWITTER
LINKEDIN

CHARLESTON, Ore. — So long, salmon. Steve Wilson is refitting his 51-foot troller to fis
conflicted symbol o
fishing for a myth.

Enlarge

Leah Nash for The N
Steve Wilson is converting boat to fish for prawns, wh sold to high-end restaurant is growing along the Oregc
More Photos »

The New York Times

The Opinion Pages

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OP-ED CONTRIBUTORS

How to Catch Fish and Save Fisheries

By CARL SAFINA and BRETT JEN
Published: October 19, 2012

BBC News | Sport | Weather | Travel

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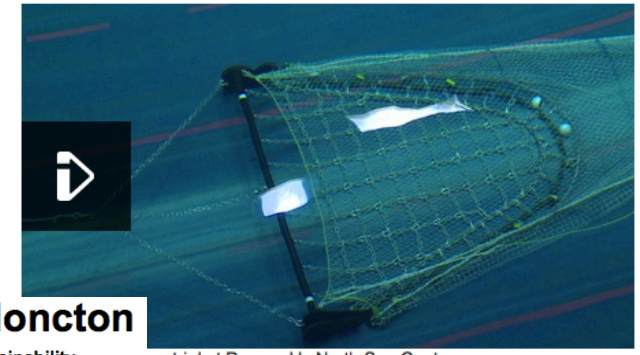
Can new technology save fish?

By Roger Harrabin
Environment analyst



on trial at Denmark's North Sea Centre

al revolution is needed for Europe to end the

Sustainable lobstering forum hits Moncton

Attendees told that healthy stocks now don't necessarily mean long-term sustainability

CBC News Posted: Jul 24, 2012 4:04 PM AT | Last Updated: Jul 24, 2012 6:40 PM AT

About 130 lobster industry stakeholders gathered Tuesday in Moncton to discuss lobster fishing and sustainability practices.

Attendees included researchers, re and fishermen, their shared go the Lobster Sci Workshop and livelihood, conti

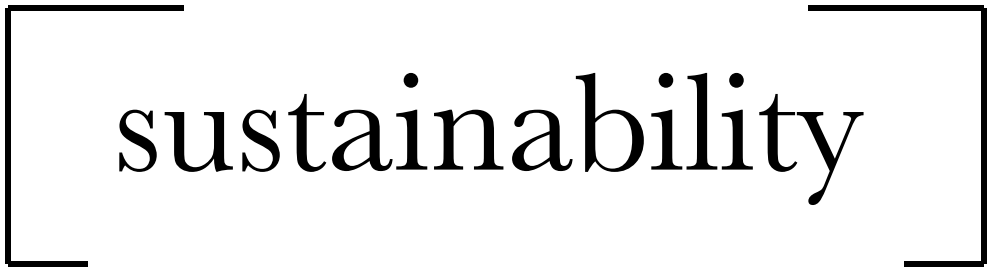
FOOD

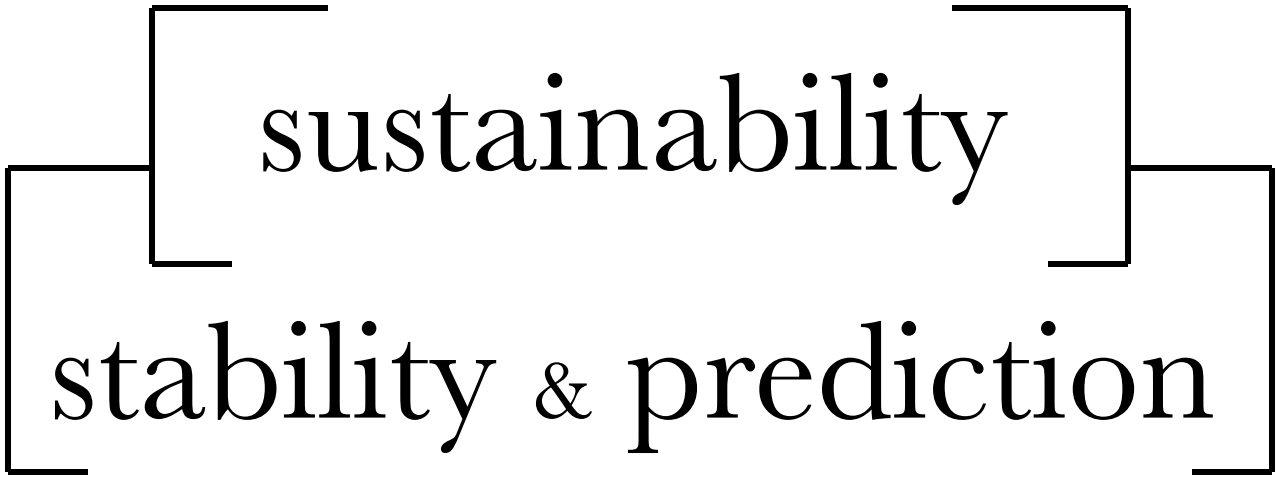
McDonald's fish to carry 'sustainable' labeling

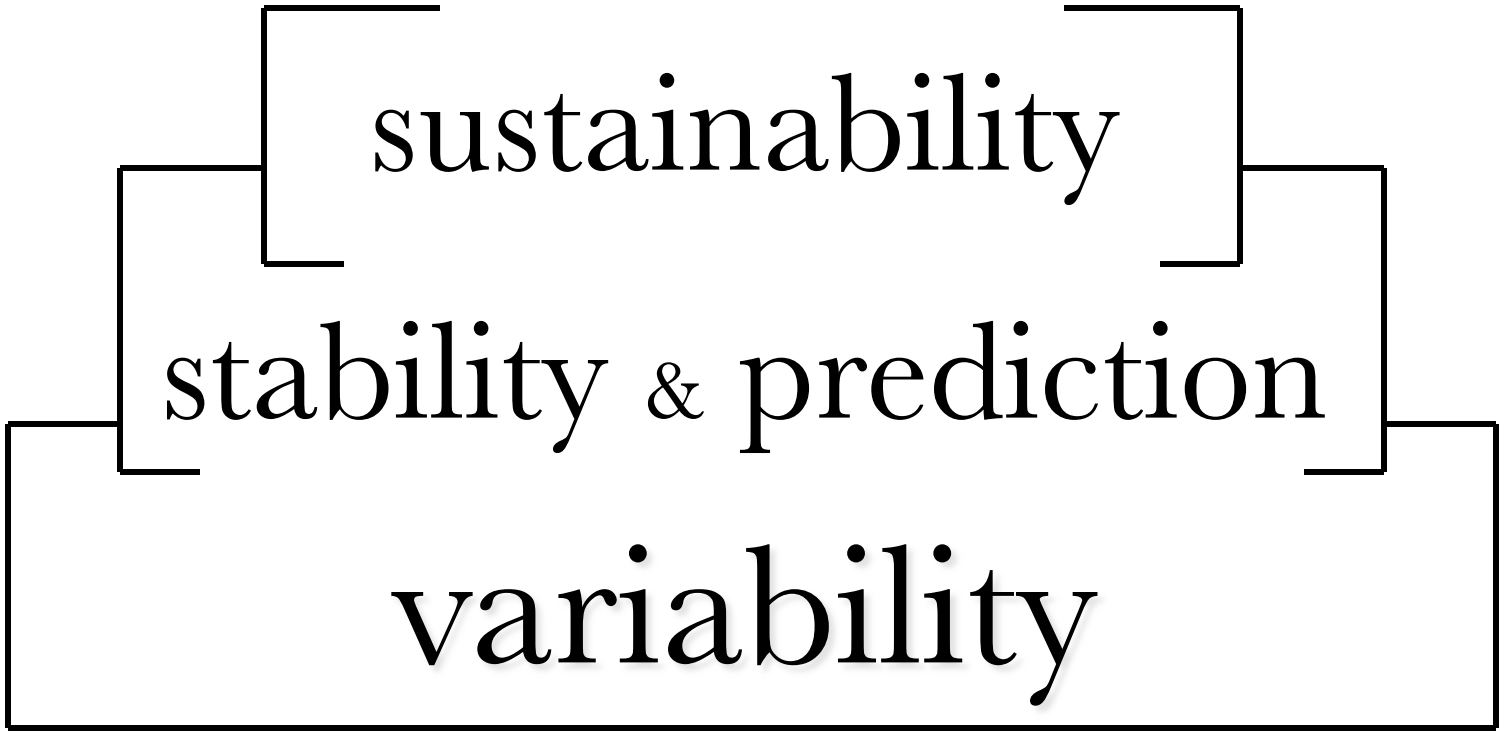
Fast-food eateries to become first national restaurant chain to use 'ecolabel' from the Marine Stewardship Council to show they buy from suppliers with sustainable practices.

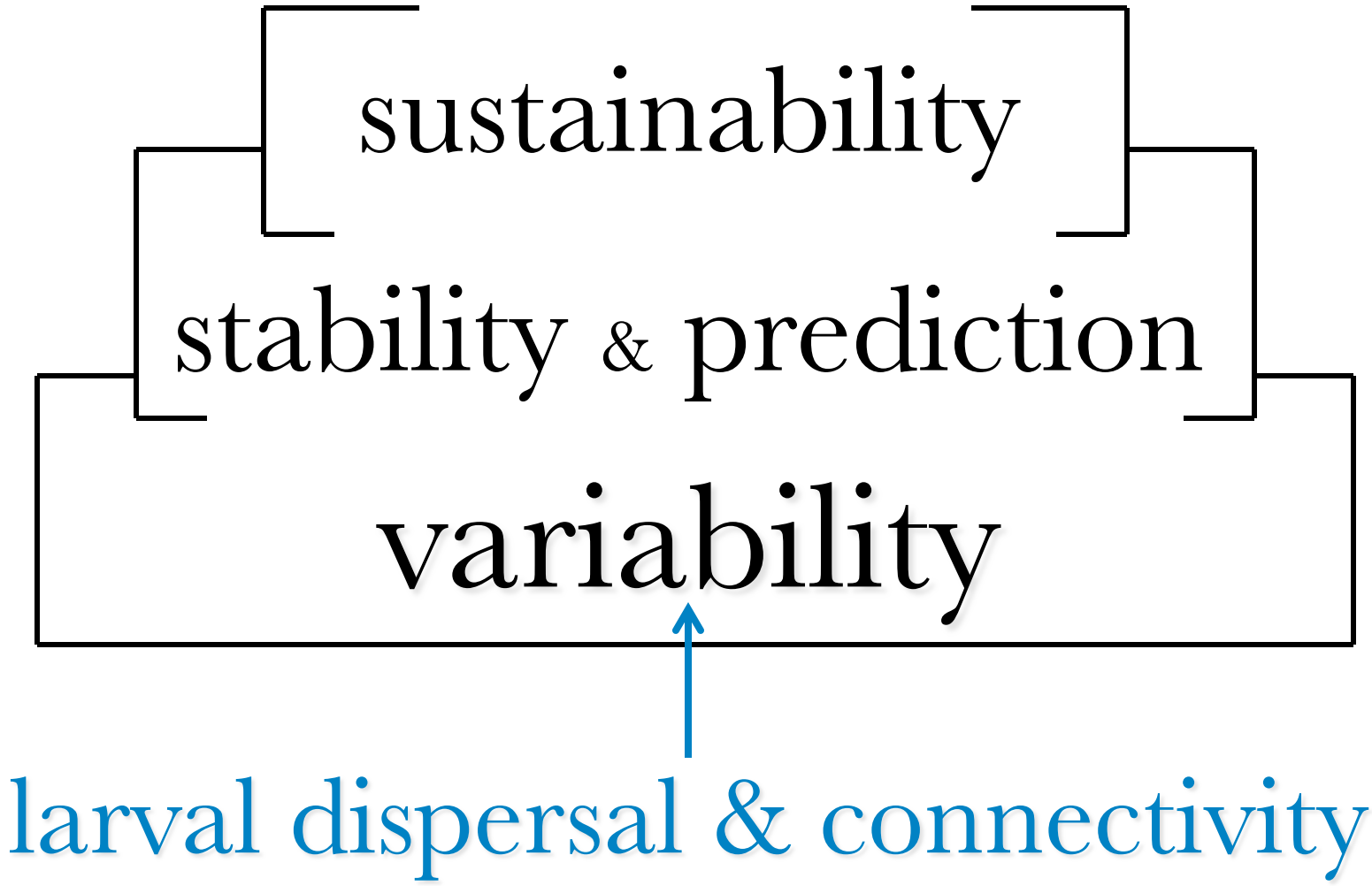
THE ASSOCIATED PRESS

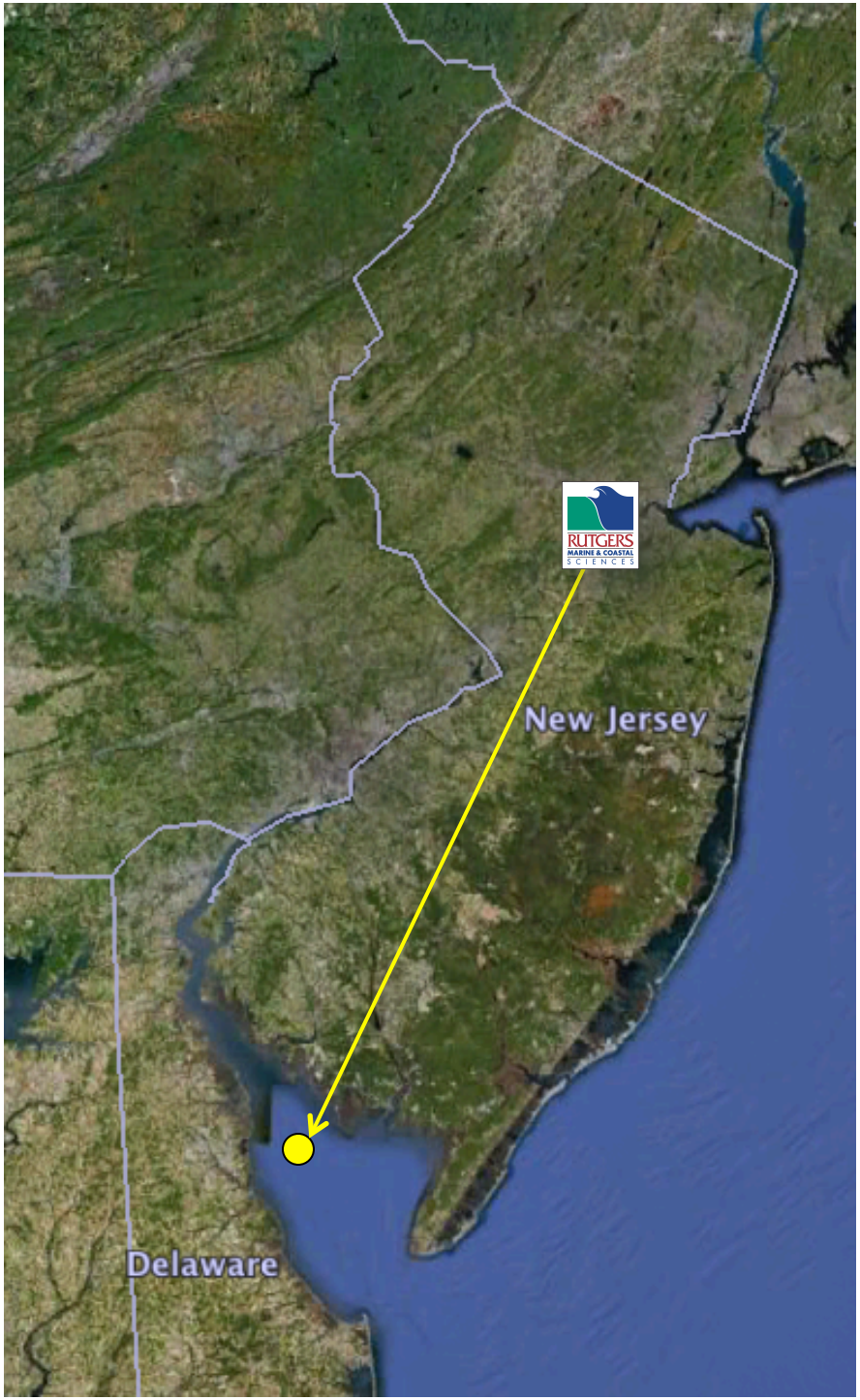
FRIDAY, JANUARY 25, 2013, 11:58 AM


sustainability


sustainability
stability & prediction


sustainability
stability & prediction
variability


sustainability
stability & prediction
variability
larval dispersal & connectivity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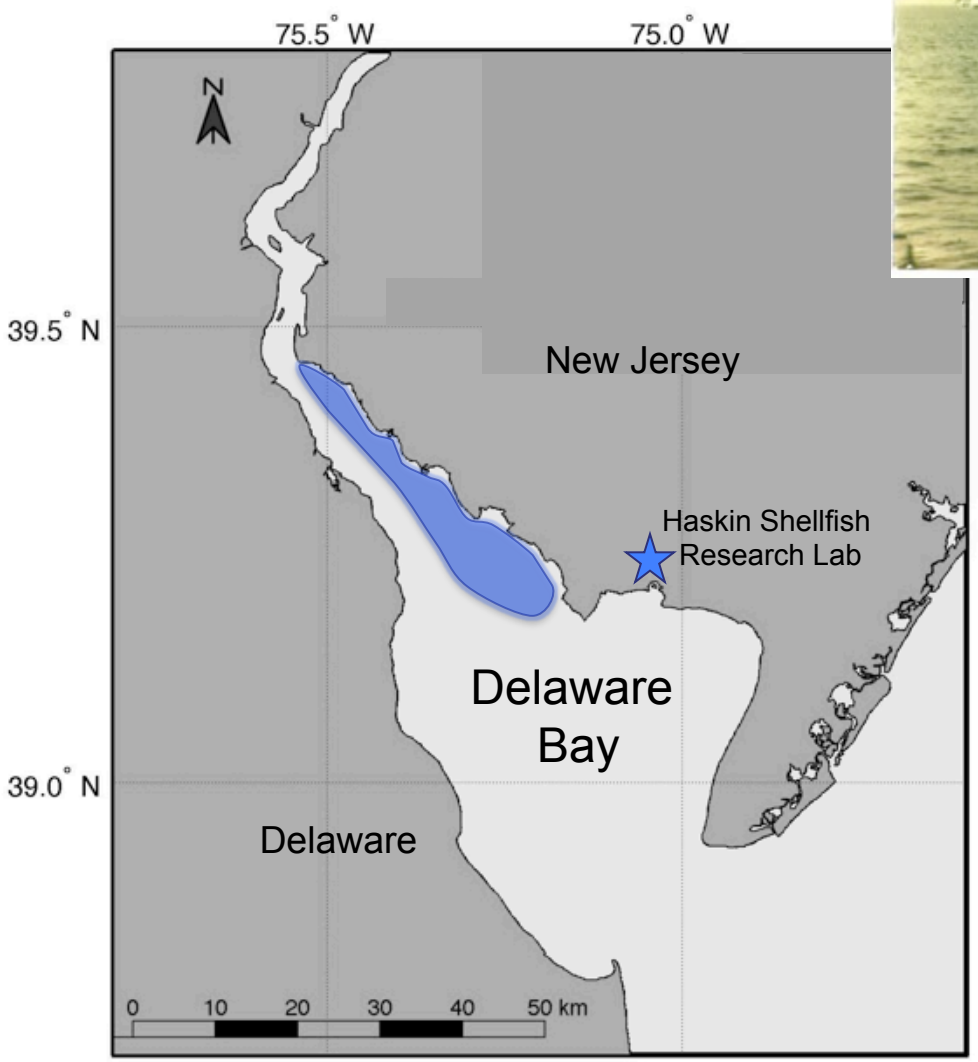
Delaware

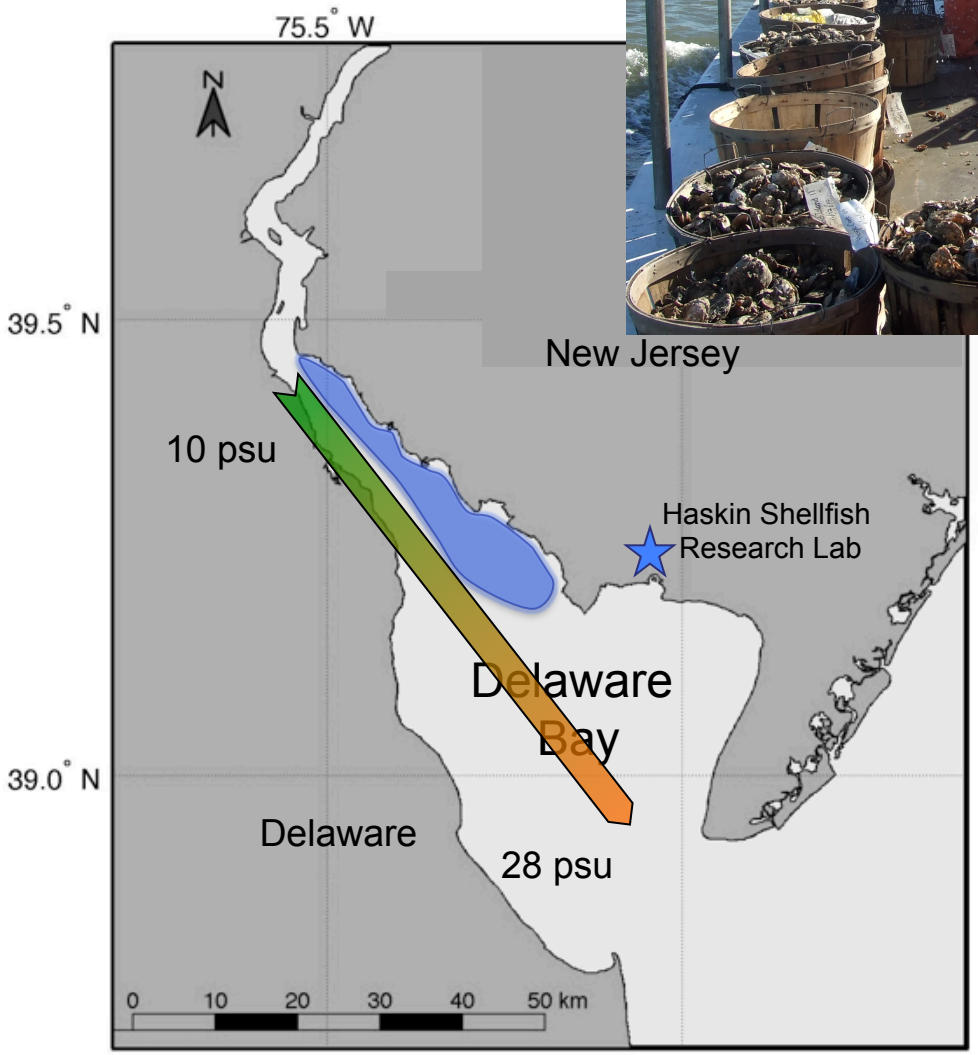
Delaware Estuary Oyster Fishery

Eastern Oyster *(Crassostrea virginica)*



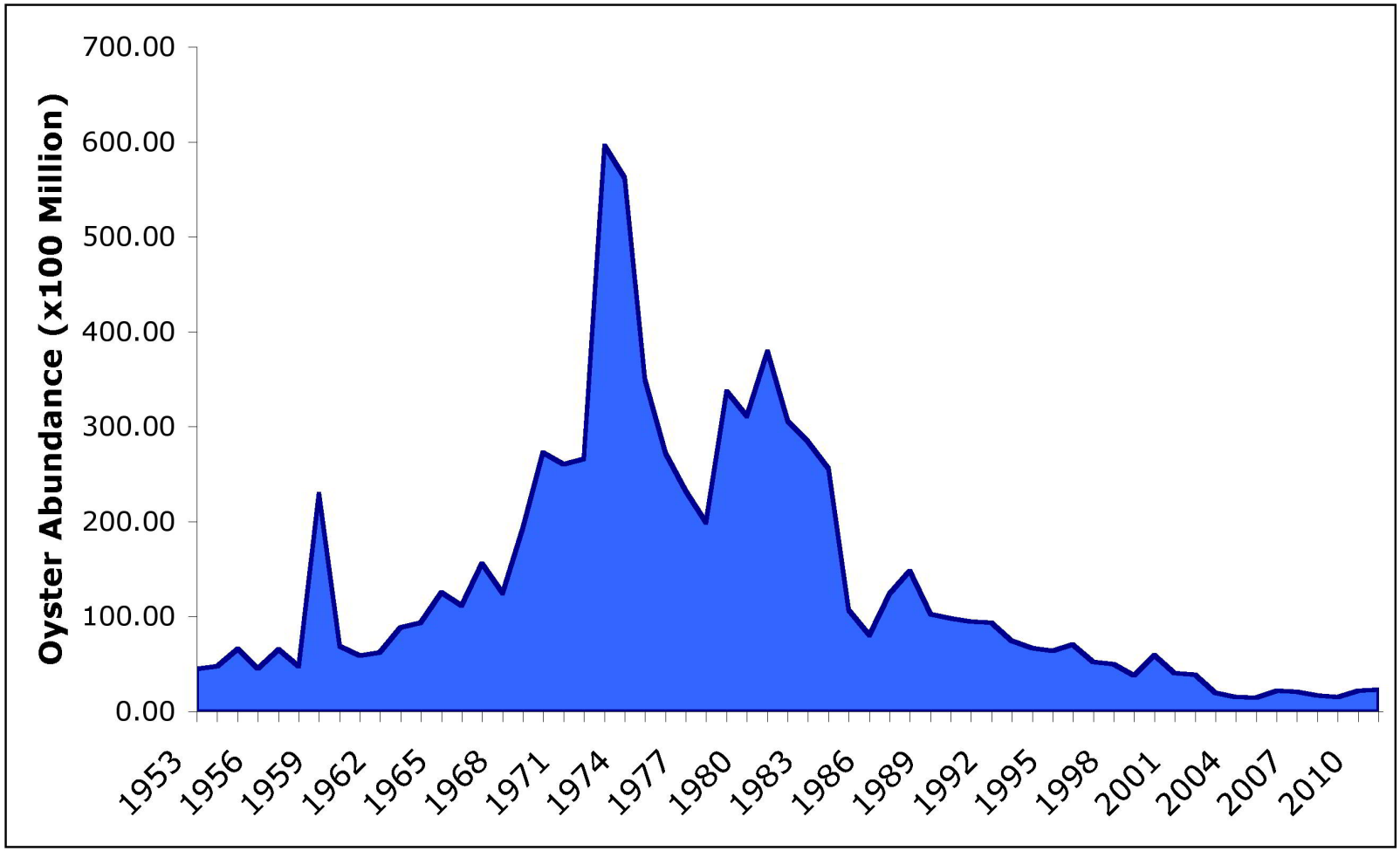
- First recorded legislation 1719
- 2.7 million bushels consumed or shipped from Philly in 1880
  - (Ingersoll, 1881)
- Julius Nelson: NJ Oyster Report 1894
- Sail dredge until 1940s
- Modern fishery quota (limit) based
- Closed seasonally

- Delaware Estuary Oyster Fishery
  - Eastern Oyster *(Crassostrea virginica)*

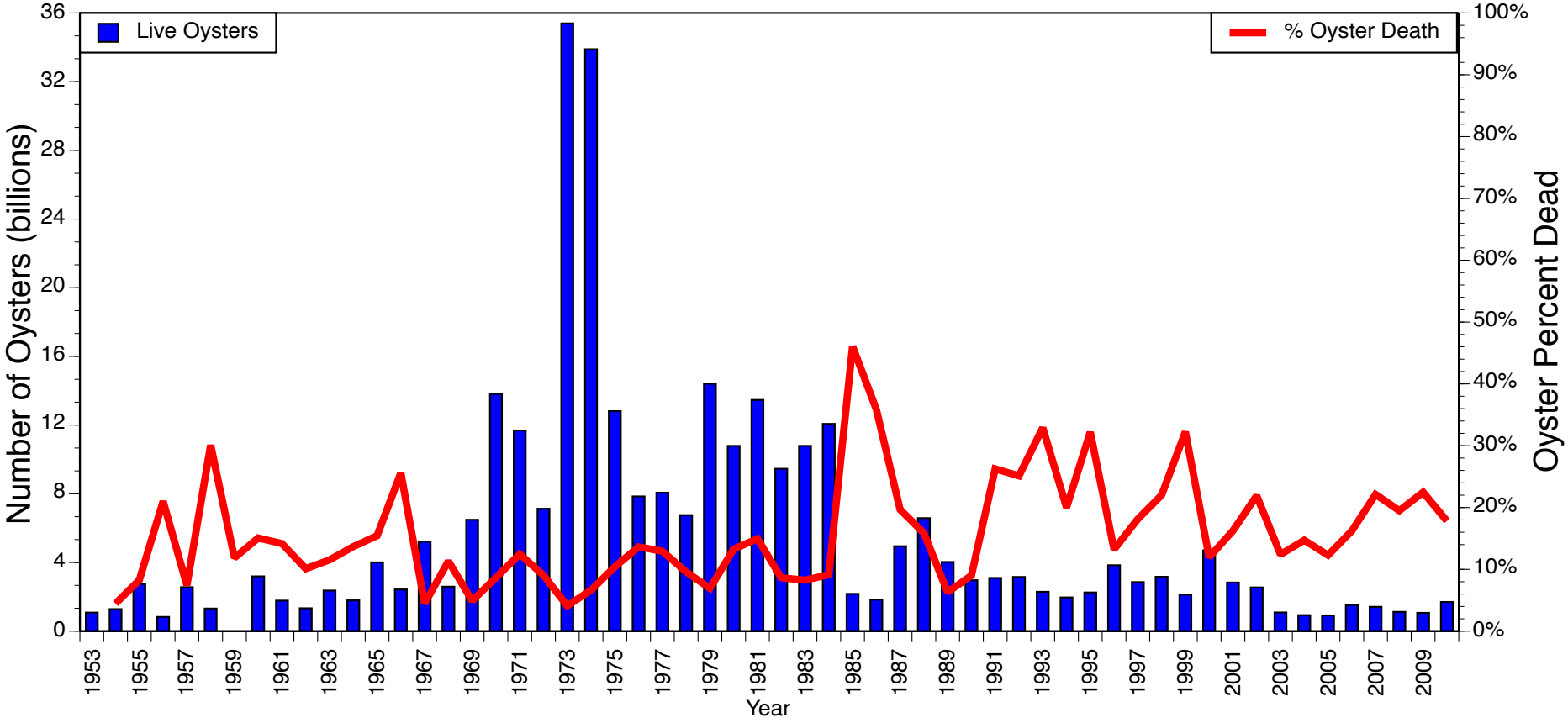


- Dredge fishery ~ 40 boats
- Landed ~ 90,000 bushels
  - Worth ~$4 million (ex-vessel in 2011)
- Stock Assessment

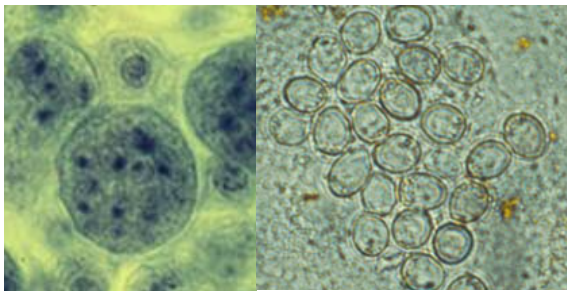
Oyster Abundance Timeseries
What causes change over time?



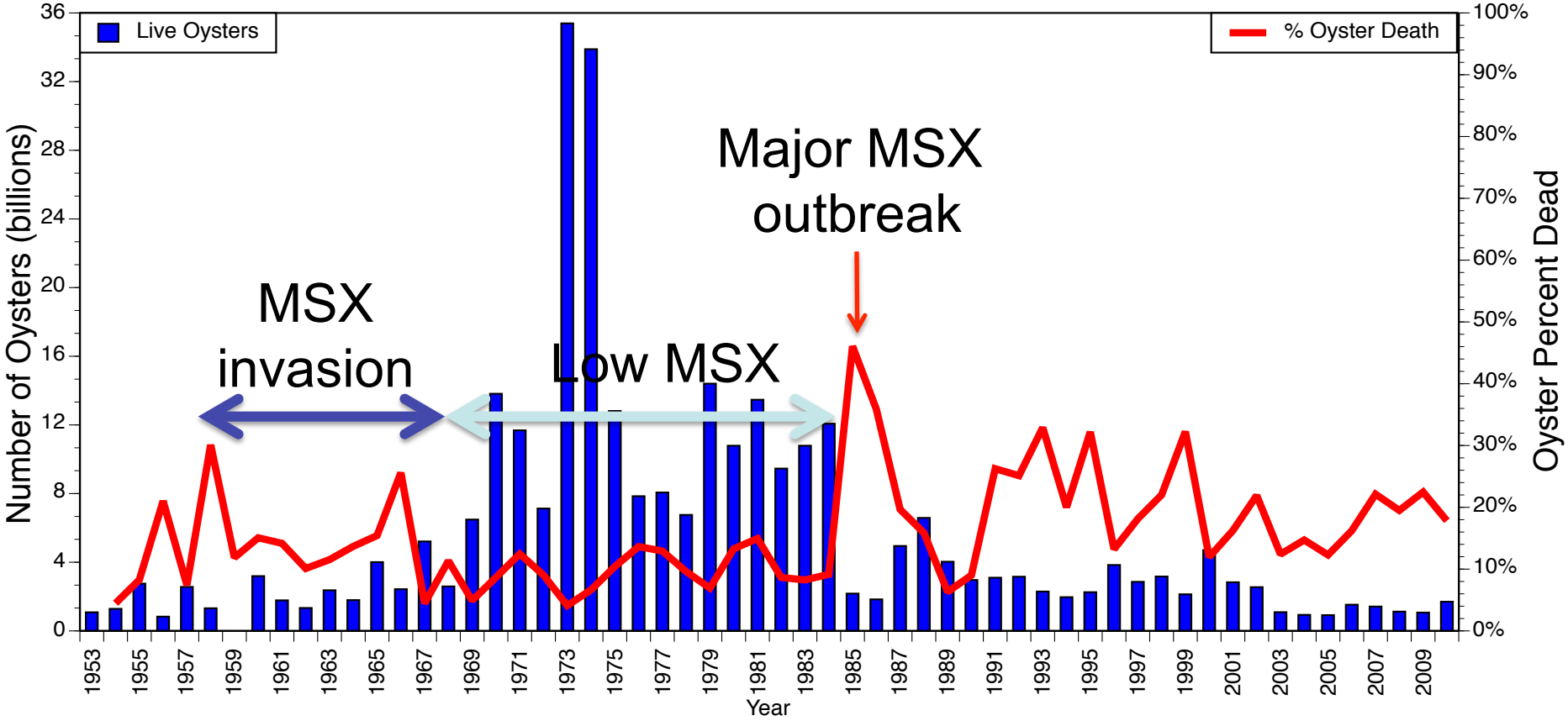
Oyster Abundance Timeseries



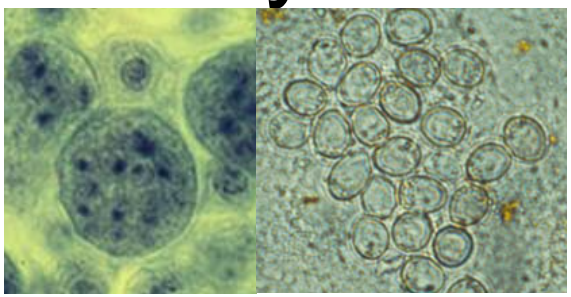
Oyster Abundance Timeseries
Oyster Diseases



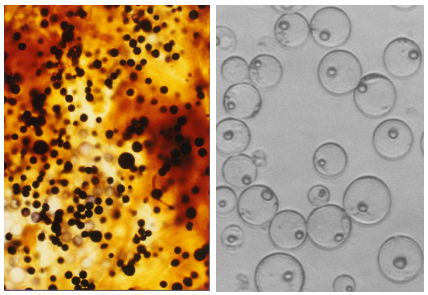
MSX = *Haplosporidium nelsoni*



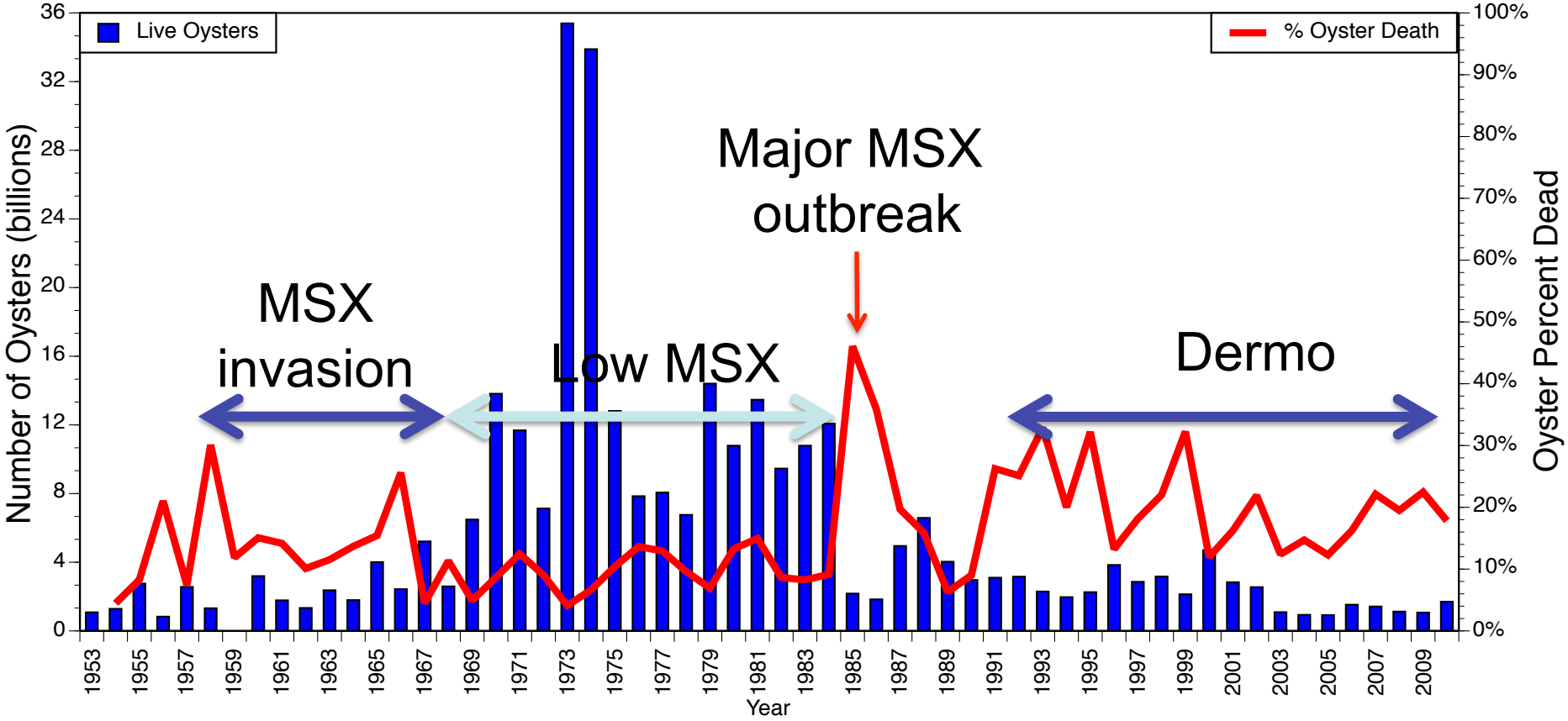
Oyster Abundance Associated with Oyster Diseases MSX and Dermo



MSX = *Haplosporidium nelsoni*



Dermo = *Perkinsus marinus*



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Disaster's Aftermath: Assessing Hurricane Irene's Damage

Scientists from some of the areas hardest hit have now had time to evaluate the storm's dramatic geologic effects on their home states

By Andrea Mustain and OurAmazing Planet | October 14, 2011

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MINNEAPOLIS — Less than two months after Hurricane Irene barreled up the eastern coastline of the United States, a group of scientists from some of the areas hardest hit presented evidence of the storm's dramatic geological effects on their home states.

Researchers from Pennsylvania, New Jersey, New York and Vermont took to the podium at a meeting of the Geological Society of America, to discuss what they've learned since the massive storm swept across the Northeast.

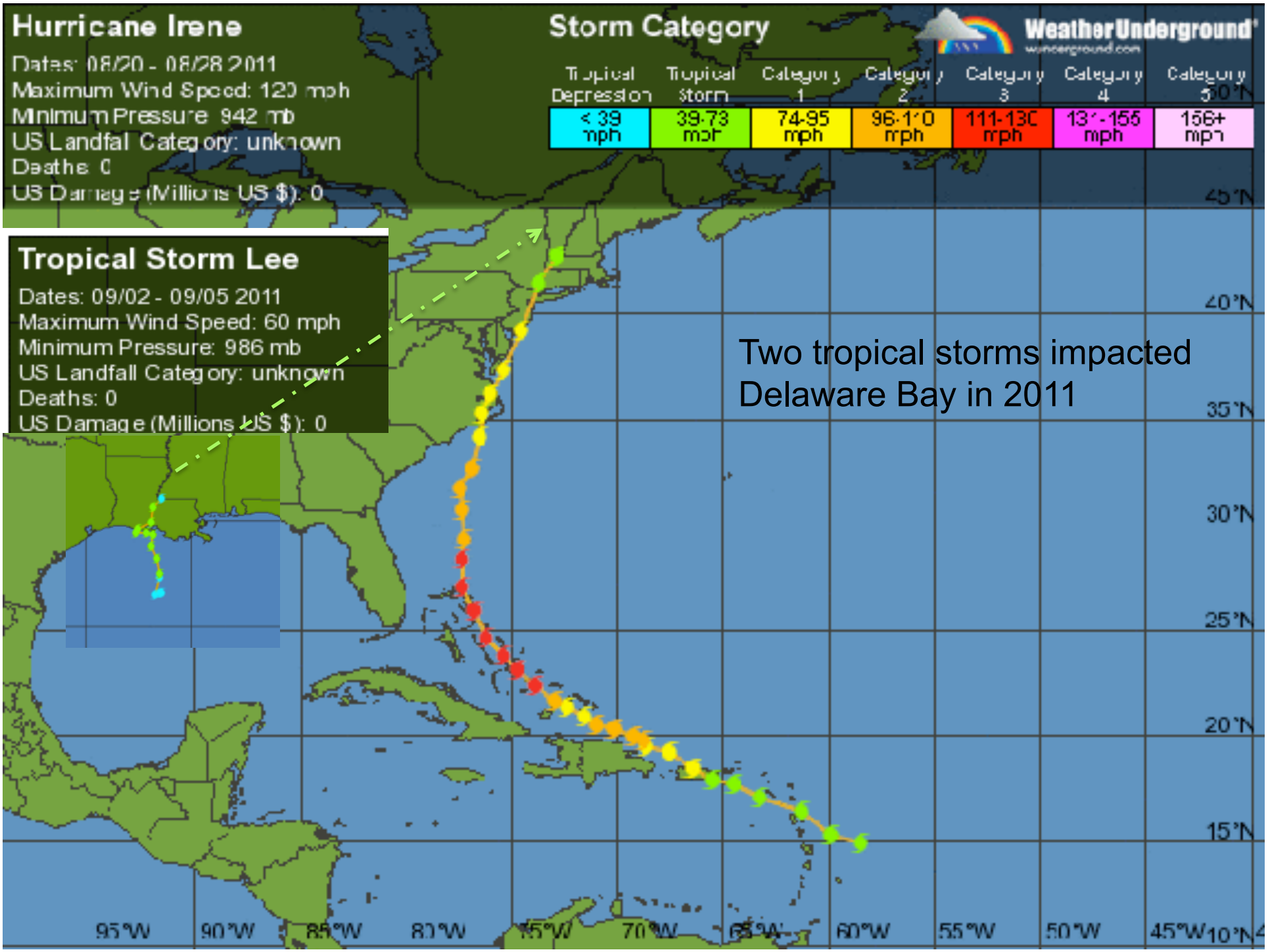
EYE FROM THE SKY: Hurricane Irene makes landfall over New York City. For much of New England, the extreme damage was still to come. *Image: NASA/NOAA GOES Project*

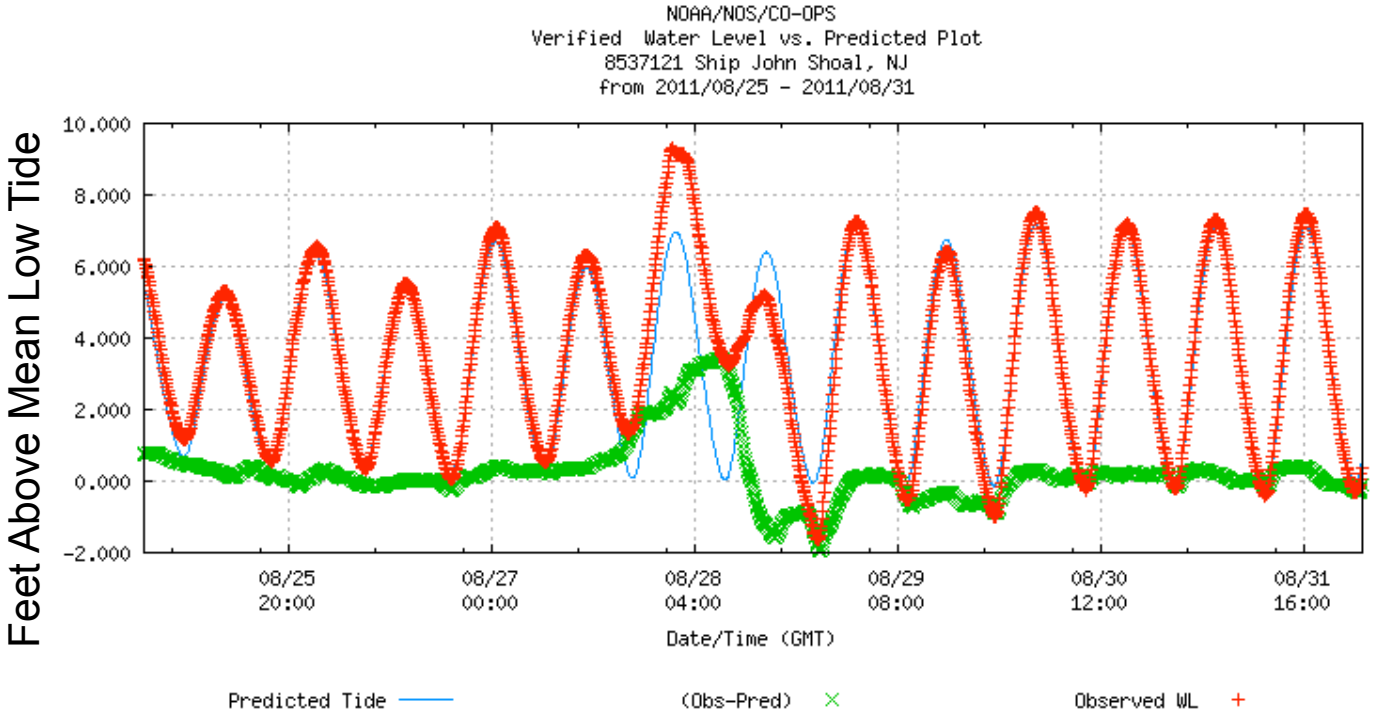
The numbers that are emerging, not

Tropical Storms Irene and Lee

- "we got a year's worth of precipitation in those two months."
- "Some streams… saw peak levels that were 300% higher than high-water records"
  - Joshua Galster, Montclair State University
- "The flood was so massive it pushed all the salt water out into the ocean"
  - Douglas A. Burns, U.S. Geological Survey

http://www.scientificamerican.com/article.cfm?id=hurricane-east-coast-damage


Hurricane Irene
Dates: 08/20 - 08/28 2011
Maximum Wind Speed: 120 mph
Minimum Pressure: 942 mb
US Landfall Category: unknown
Deaths: 0
US Damage (Millions US $): 0
Storm Category
Tropical Depression
< 39 mph
Tropical Storm
39-73 mph
Category 1
74-95 mph
Category 2
96-110 mph
Category 3
111-130 mph
Category 4
131-155 mph
Category 5
156+ mph
WeatherUnderground
Tropical Storm Lee
Dates: 09/02 - 09/05 2011
Maximum Wind Speed: 60 mph
Minimum Pressure: 986 mb
US Landfall Category: unknown
Deaths: 0
US Damage (Millions US $): 0
Two tropical storms impacted Delaware Bay in 2011
45°N
40°N
35°N
30°N
25°N
20°N
15°N
10°N
95°W
90°W
85°W
80°W
75°W
70°W
65°W
60°W
55°W
50°W
45°W

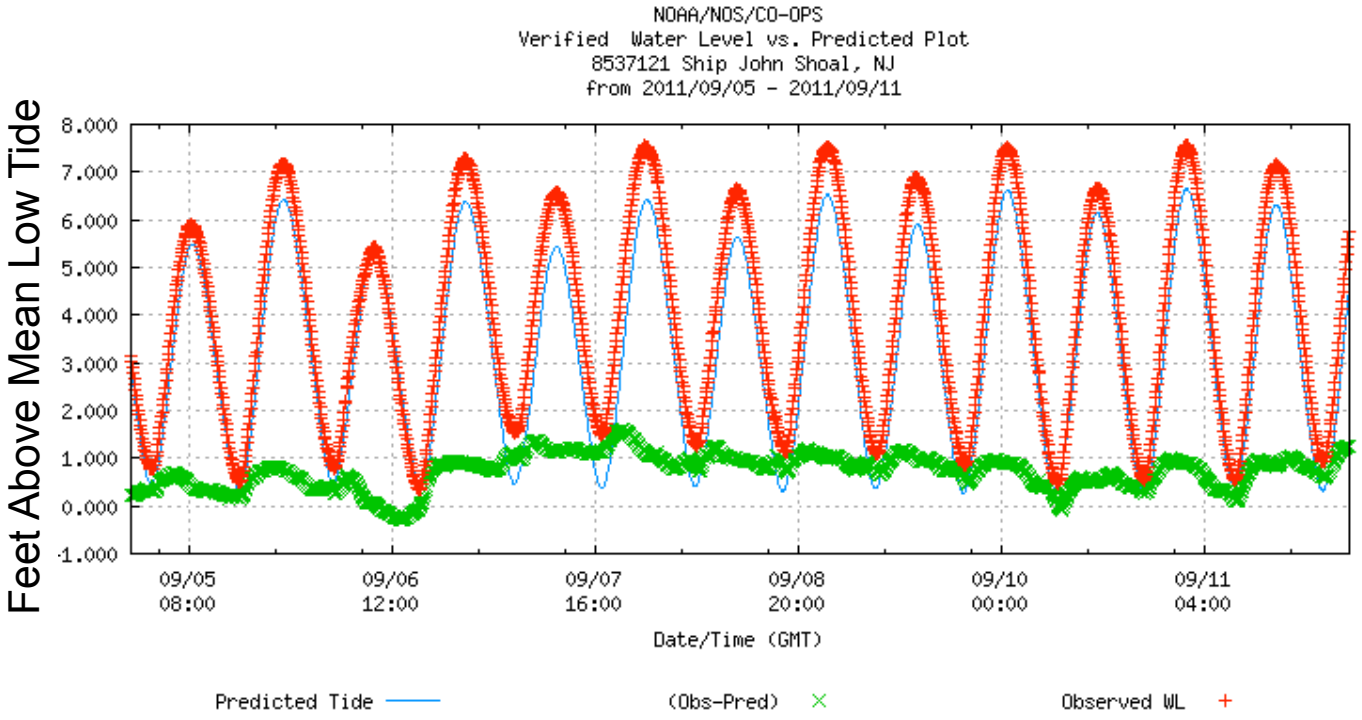


Irene storm surge August 28, 2011

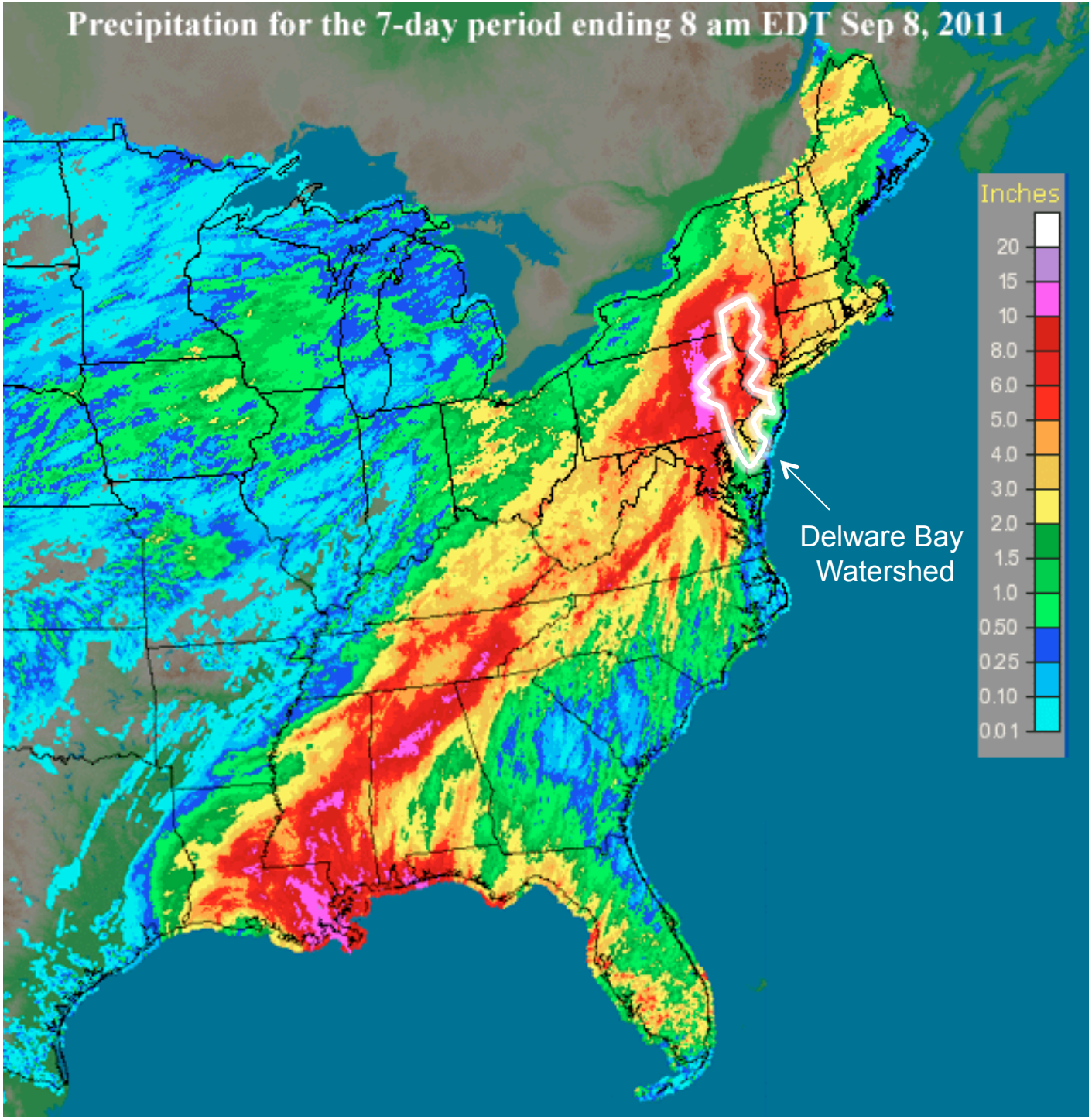
Peak at low tide

TS Lee
Sept 8, 2011

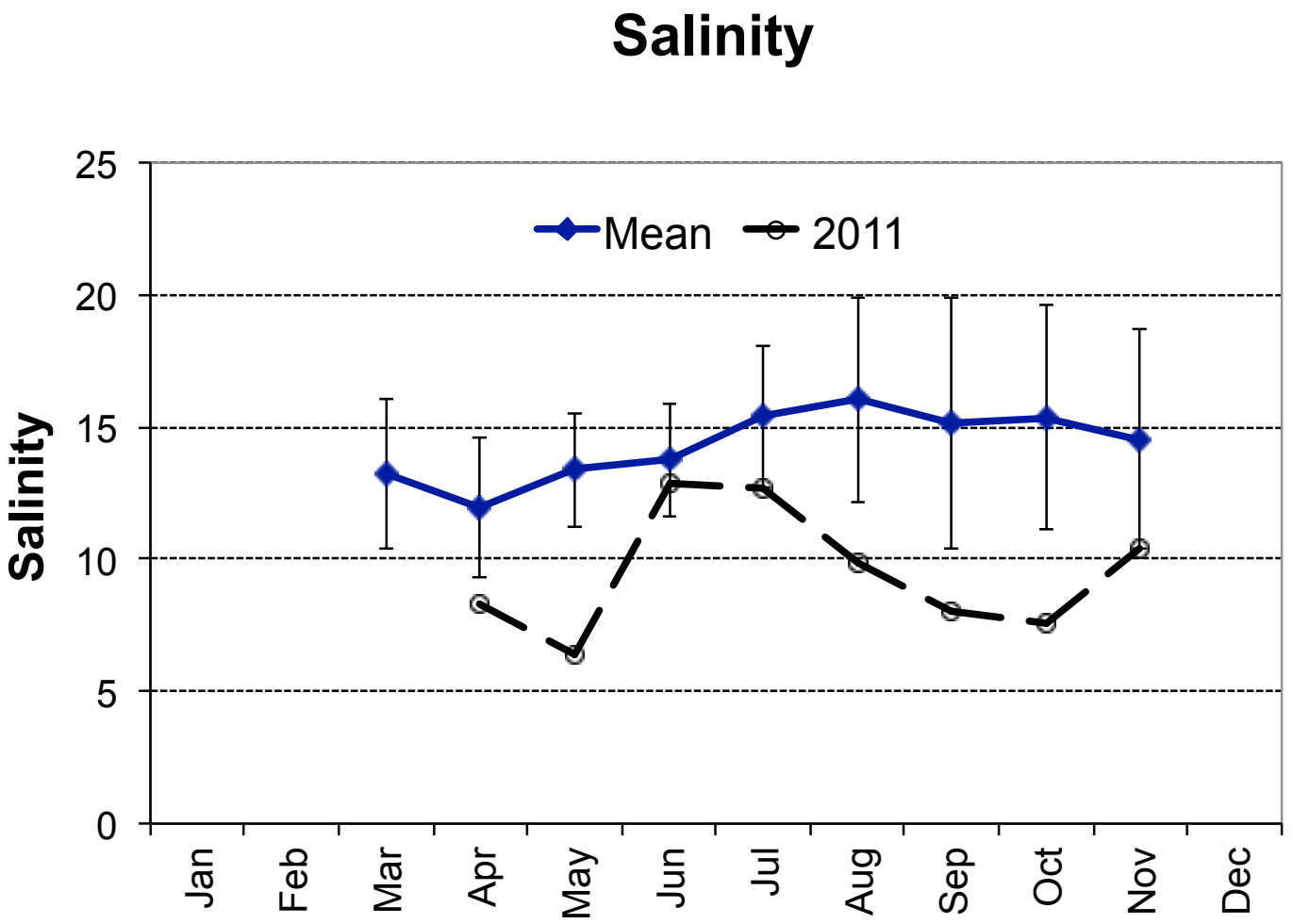
No storm surge



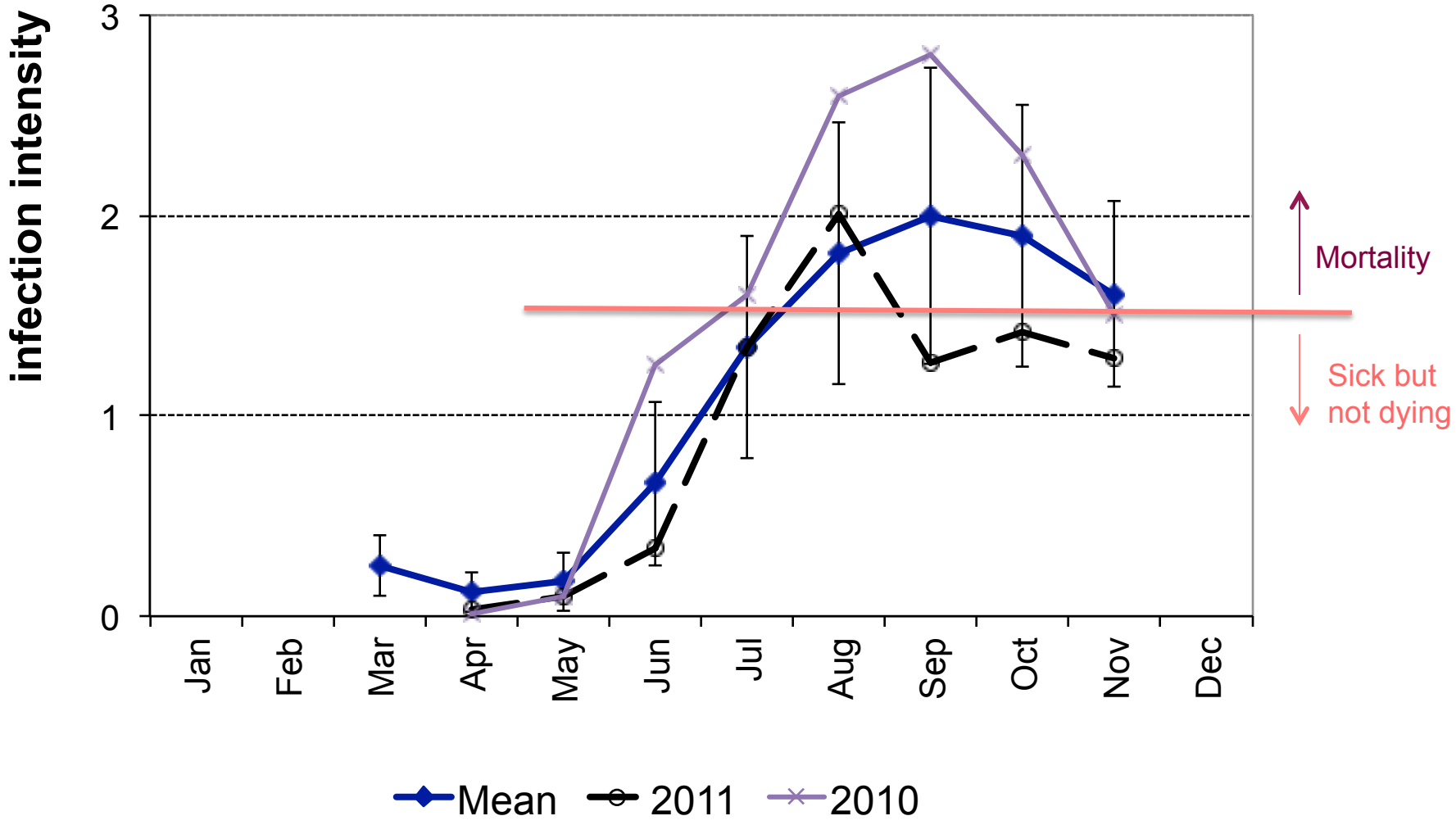
Rainfall after Irene and Lee in 2011

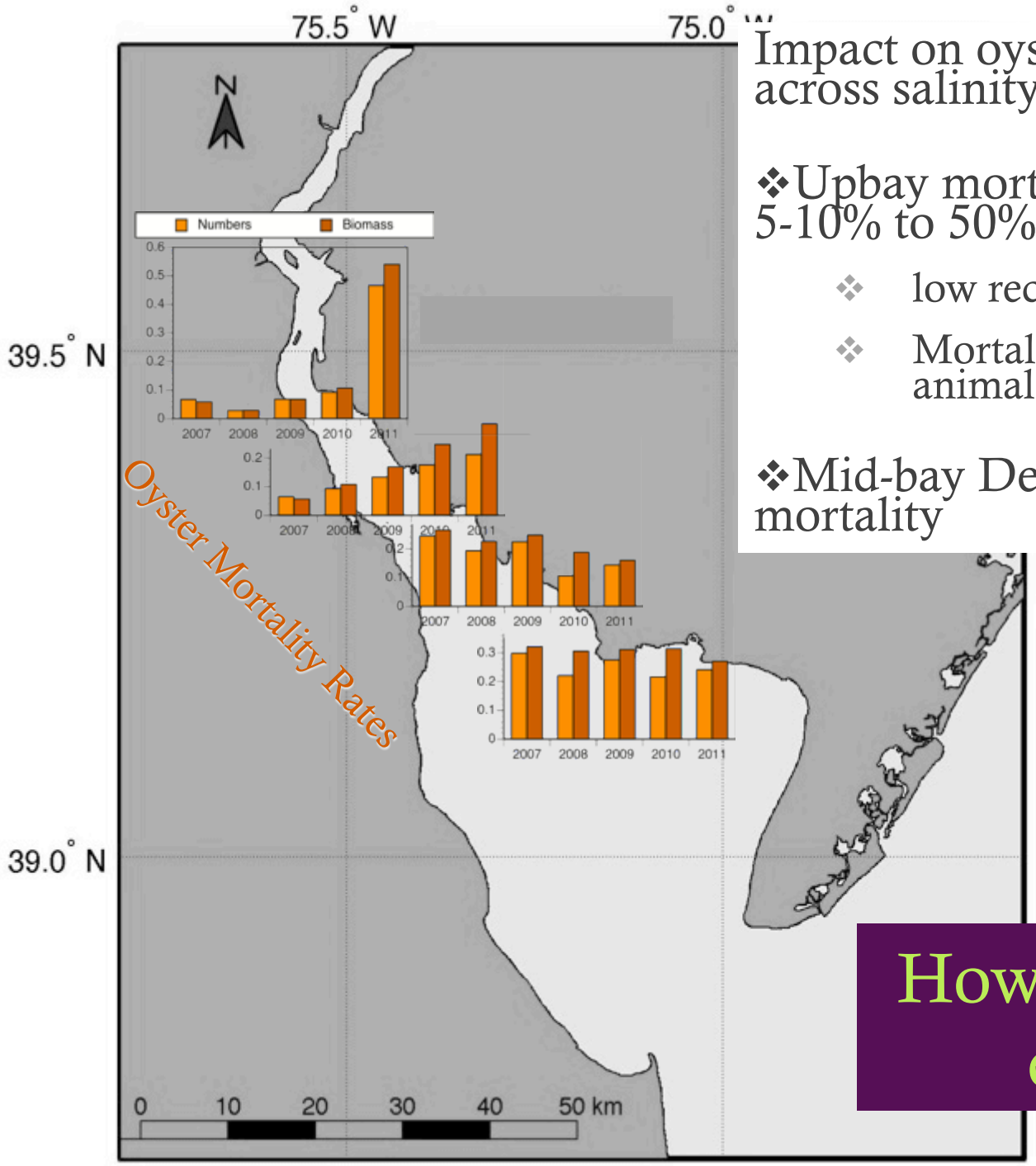


Unusually low salinity year



Seasonal Dermo Cycle





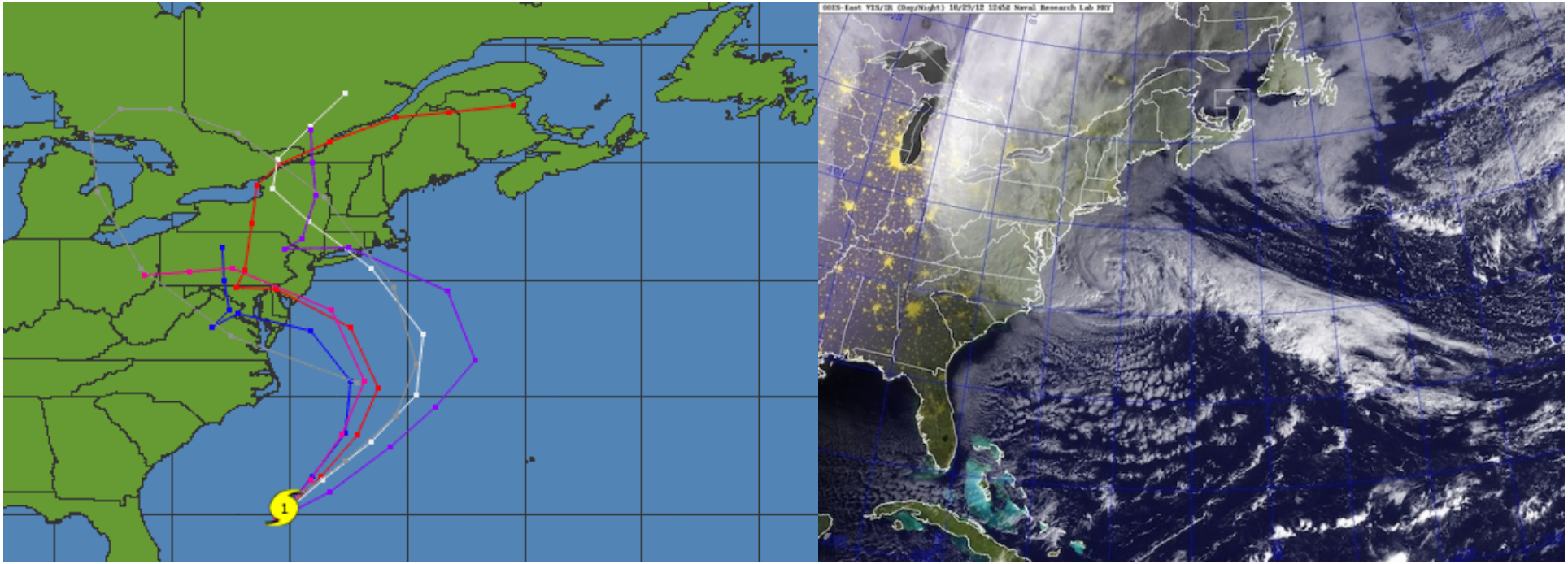
Impact on oyster mortality varied across salinity gradient:

- Upbay mortality increased from 5-10% to 50%-70%
  - low recruitment area
  - Mortality biased toward large animals
- Mid-bay Dermo decrease reduced mortality

How long will these effects last?

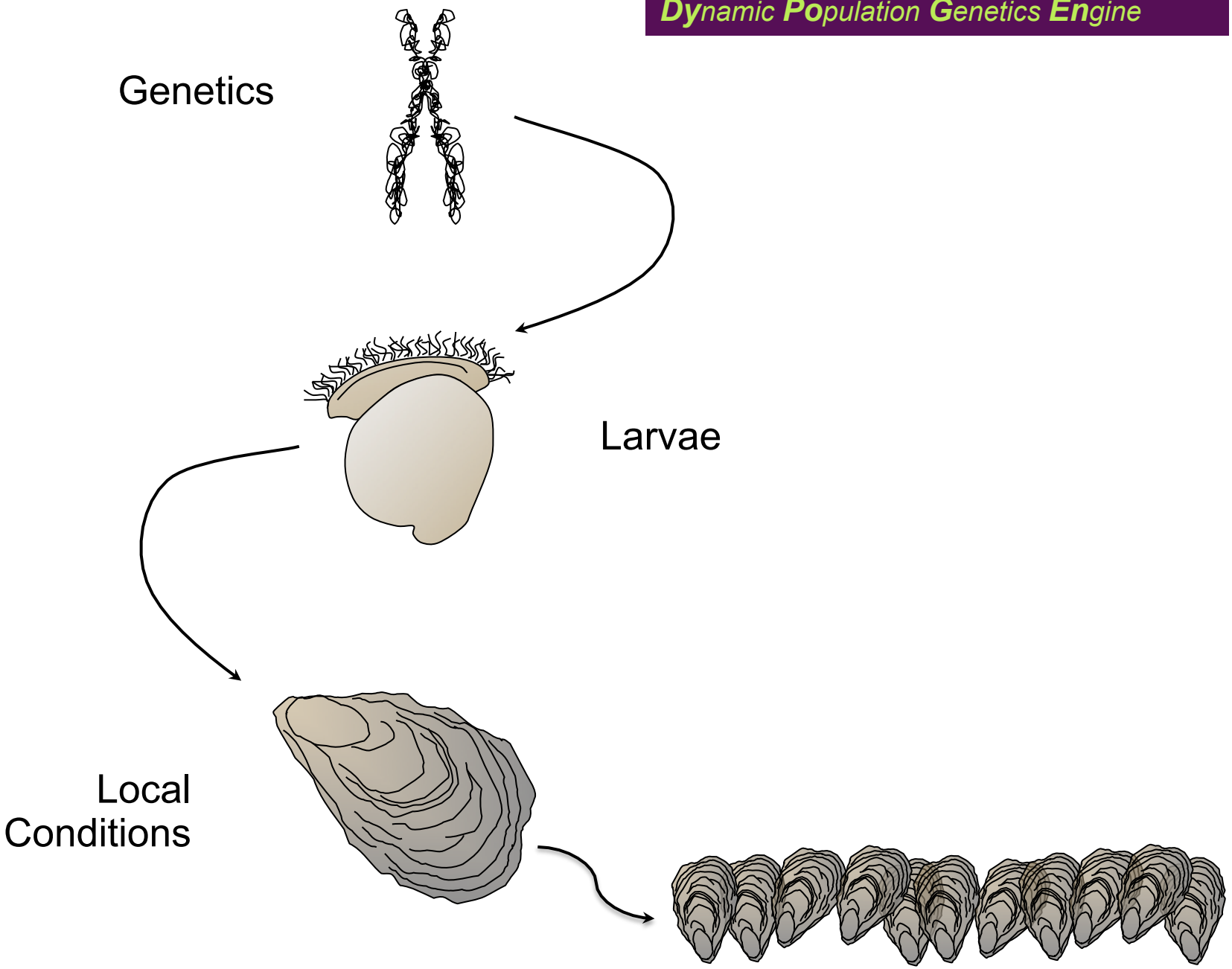
How to Forecast Biology?

- What would you put in a model?

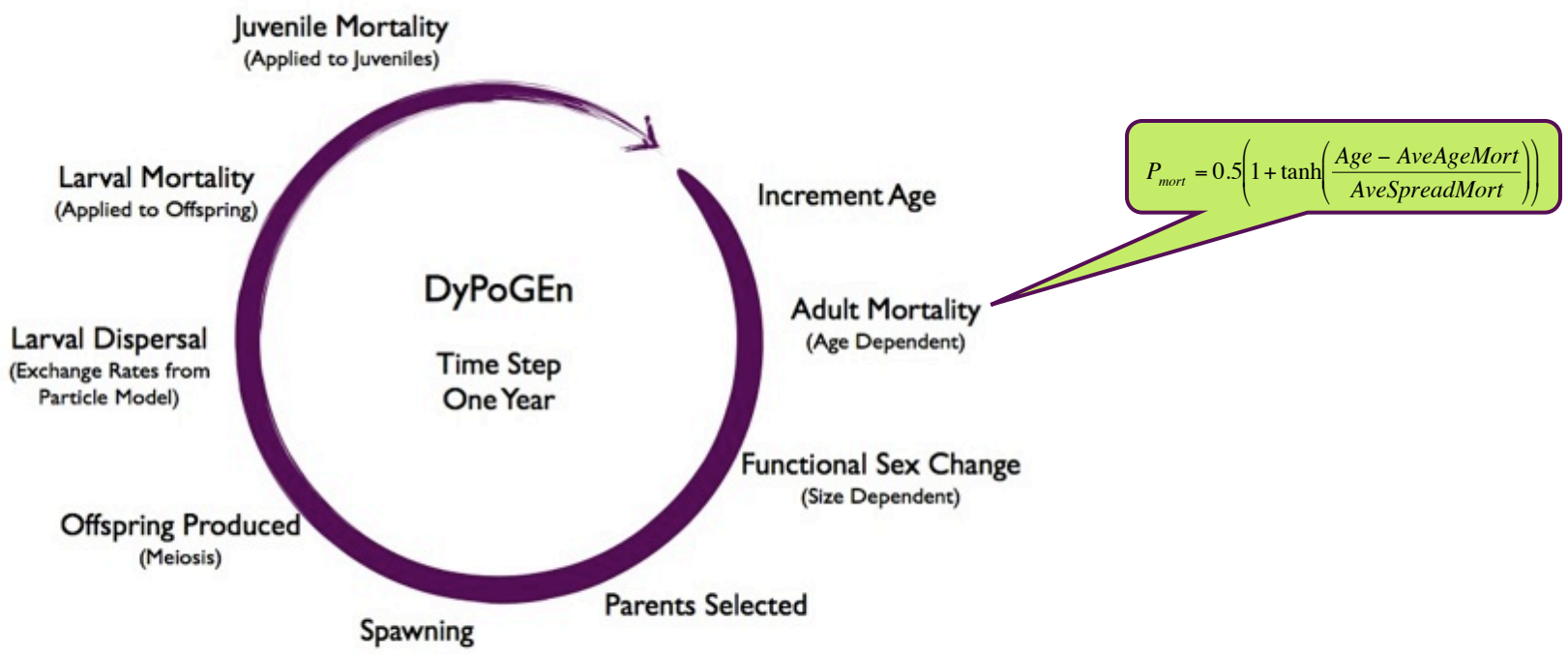


DyPoGEn

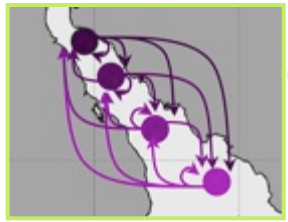
***Dy**namic **Po**pulation **G**enetics **En**gine*



DyPoGEn Formulation



DyPoGEn Formulation



DyPoGEn

Time Step
One Year

Juvenile Mortality
(Applied to Juveniles)

Increment Age

Adult Mortality
(Age Dependent)

Functional Sex Change
(Size Dependent)

Parents Selected

Spawning

Offspring Produced
(Meiosis)

Larval Mortality
(Applied to Offspring)

Larval Dispersal
(Exchange Rates from
Particle Model)

$$P_{mort} = 0.5\left(1 + \tanh\left(\frac{Age - AveAgeMort}{AveSpreadMort}\right)\right)$$

$$LarvSurv = (0.5 + 1.5R)\frac{K}{nOff \;\; nParents}$$

$$P = 1 - LarvSurv$$

$$P_{mort} = 0.5\left(1 + \tanh\left(\frac{Age - AveAgeMort}{AveSpreadMort}\right)\right)$$

$$Ff = \alpha e^{\beta e^{(\gamma \cdot Age)}}$$

$$Df = \frac{dFf}{dAge} = \alpha\beta\gamma e^{\left((\gamma \cdot Age) + \left(\beta e^{(\gamma \cdot Age)}\right)\right)}$$

$$P_{sex\Delta} = \min\left(1, \frac{Df}{1 - Ff}\right)$$

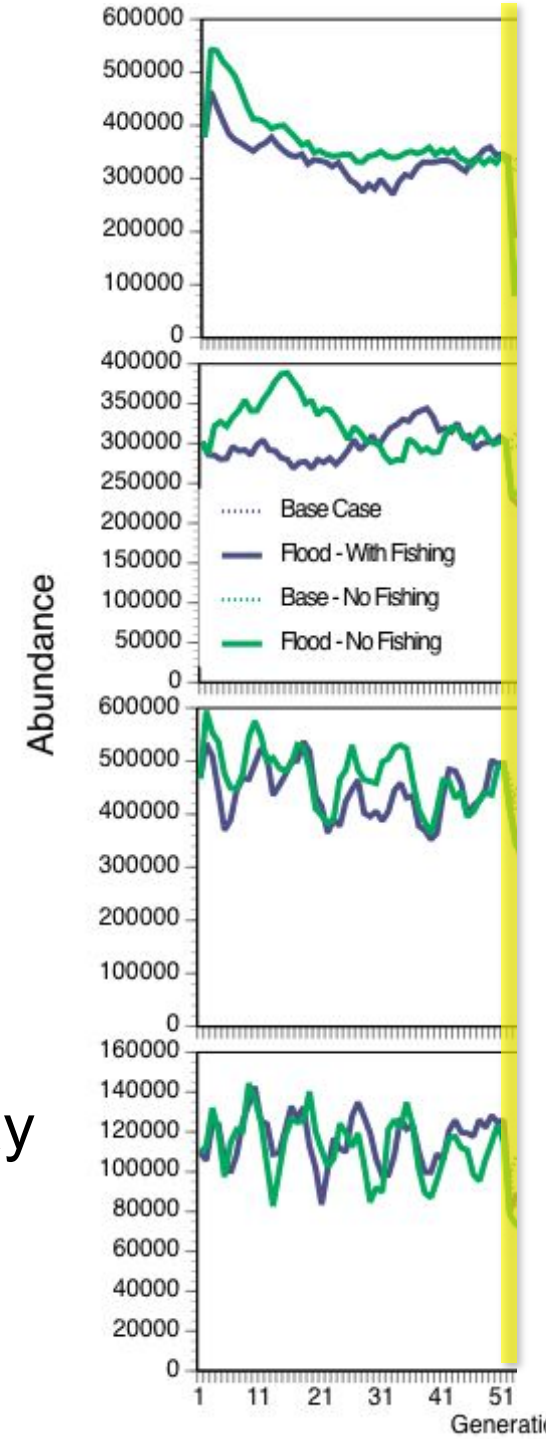
$$W = W_{\infty}\left(1 - e^{-k(Age - Age_0)}\right)^{b}$$

$$nOff = \frac{W_{\infty}}{W_{76}}\left(1 - e^{-k(Age - Age_0)}\right)^{b} MaxOff$$

$$FrParents = FracParents \cdot 10^{(N \cdot FracParentsVar)}$$

$$nParents = \max(0.5 \cdot FrParents \cdot LastAnimal, minParent)$$

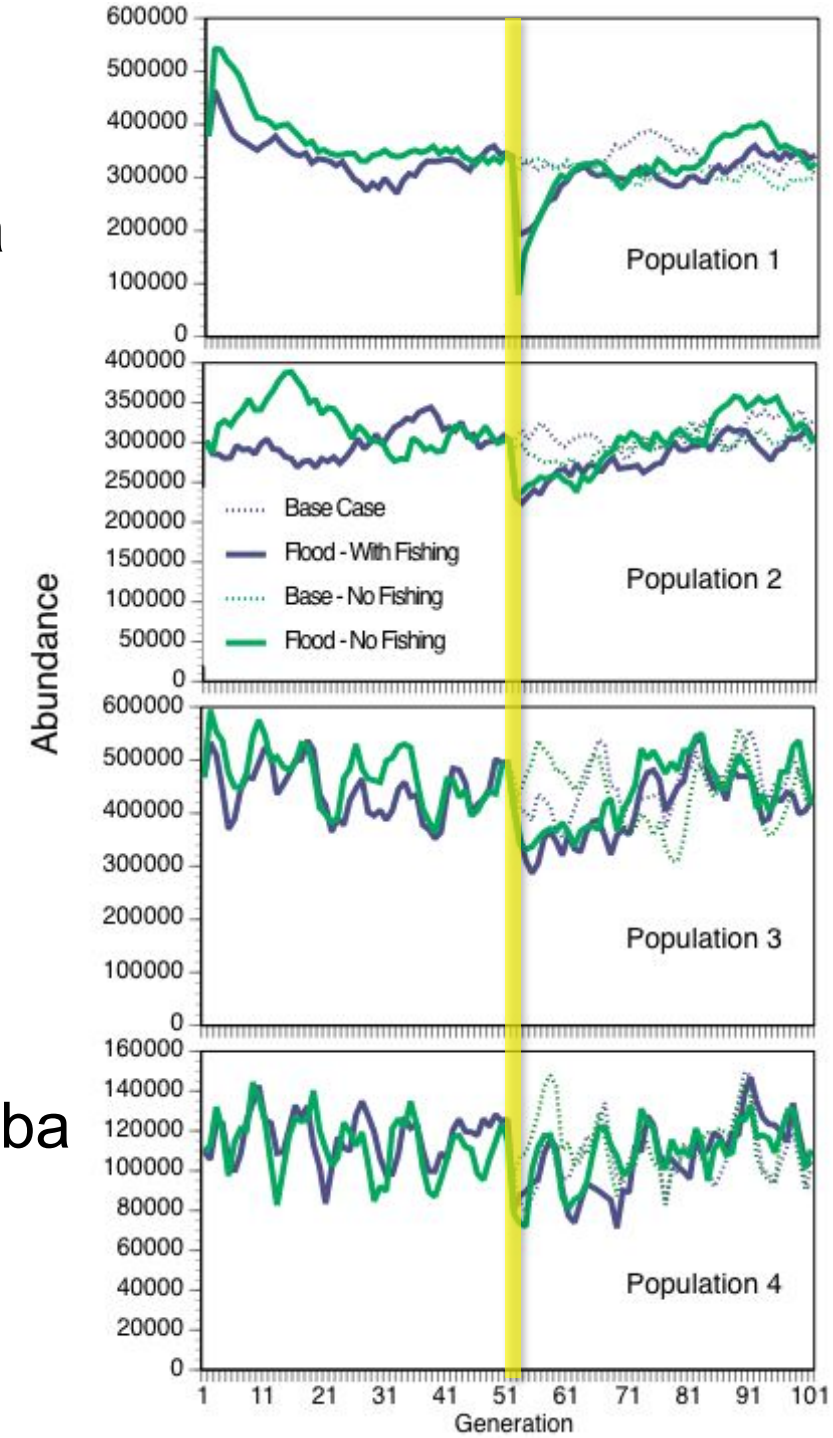
Upbay



?

Downbay

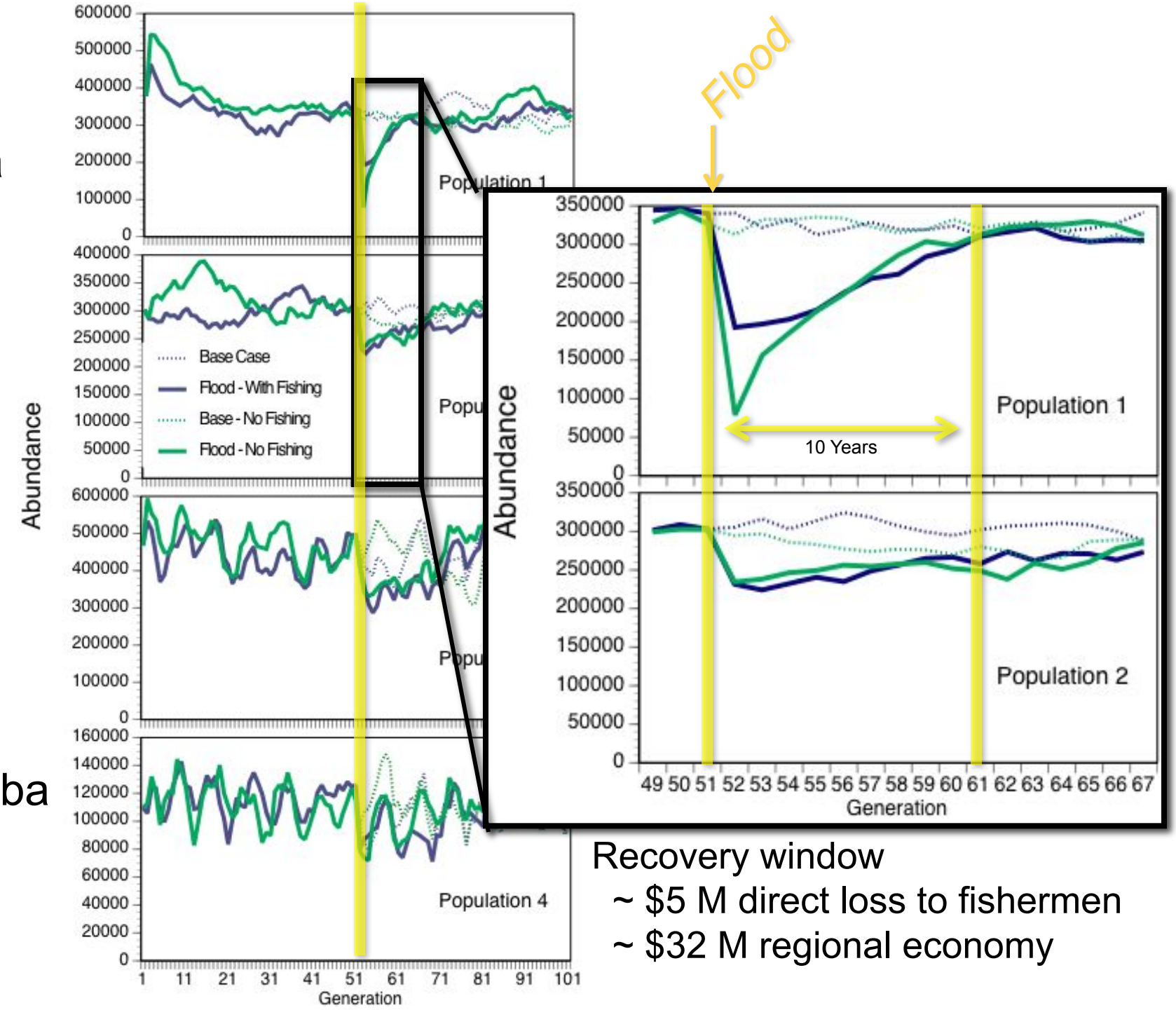
Upbay



Downbay

Upba
y

Downba
y

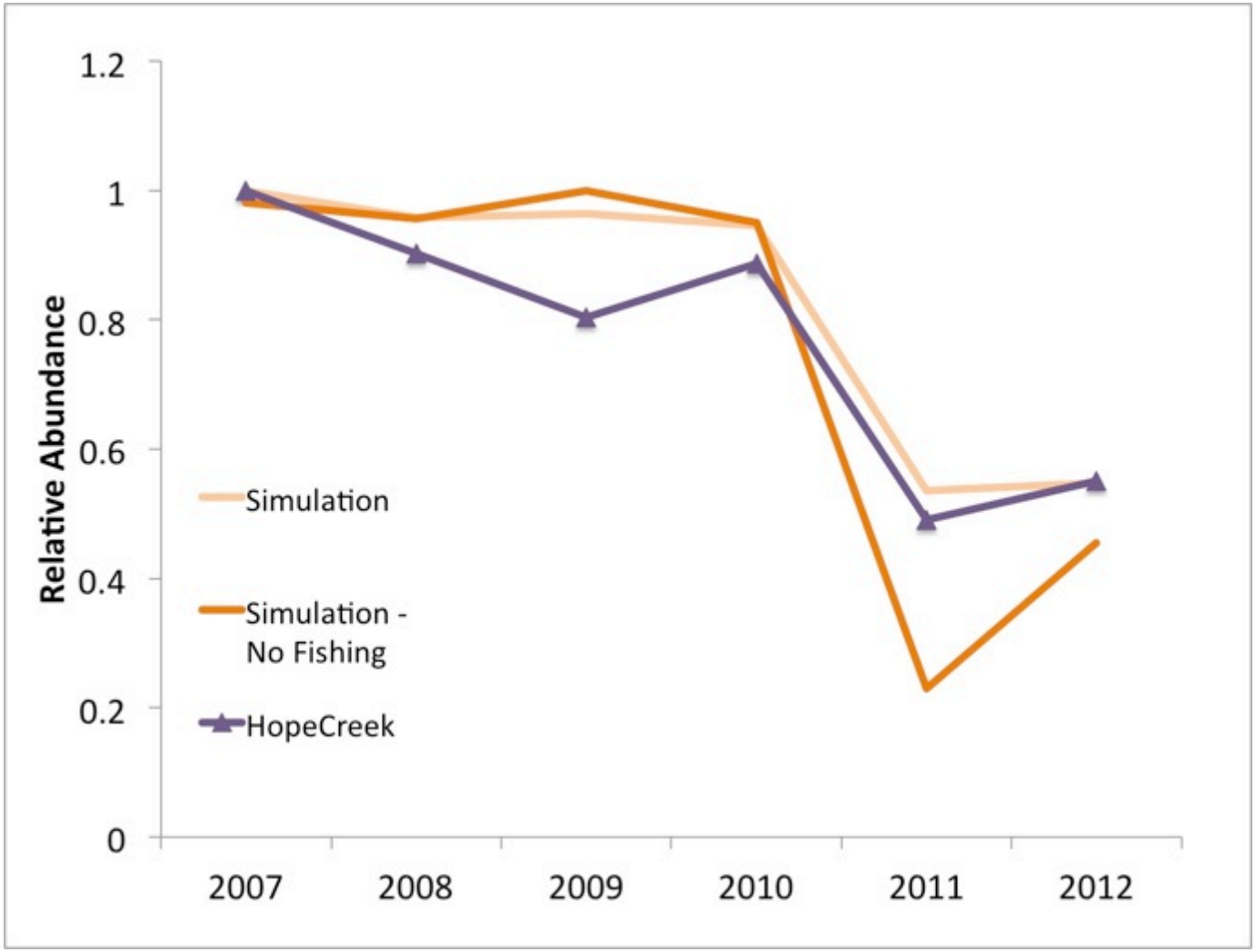


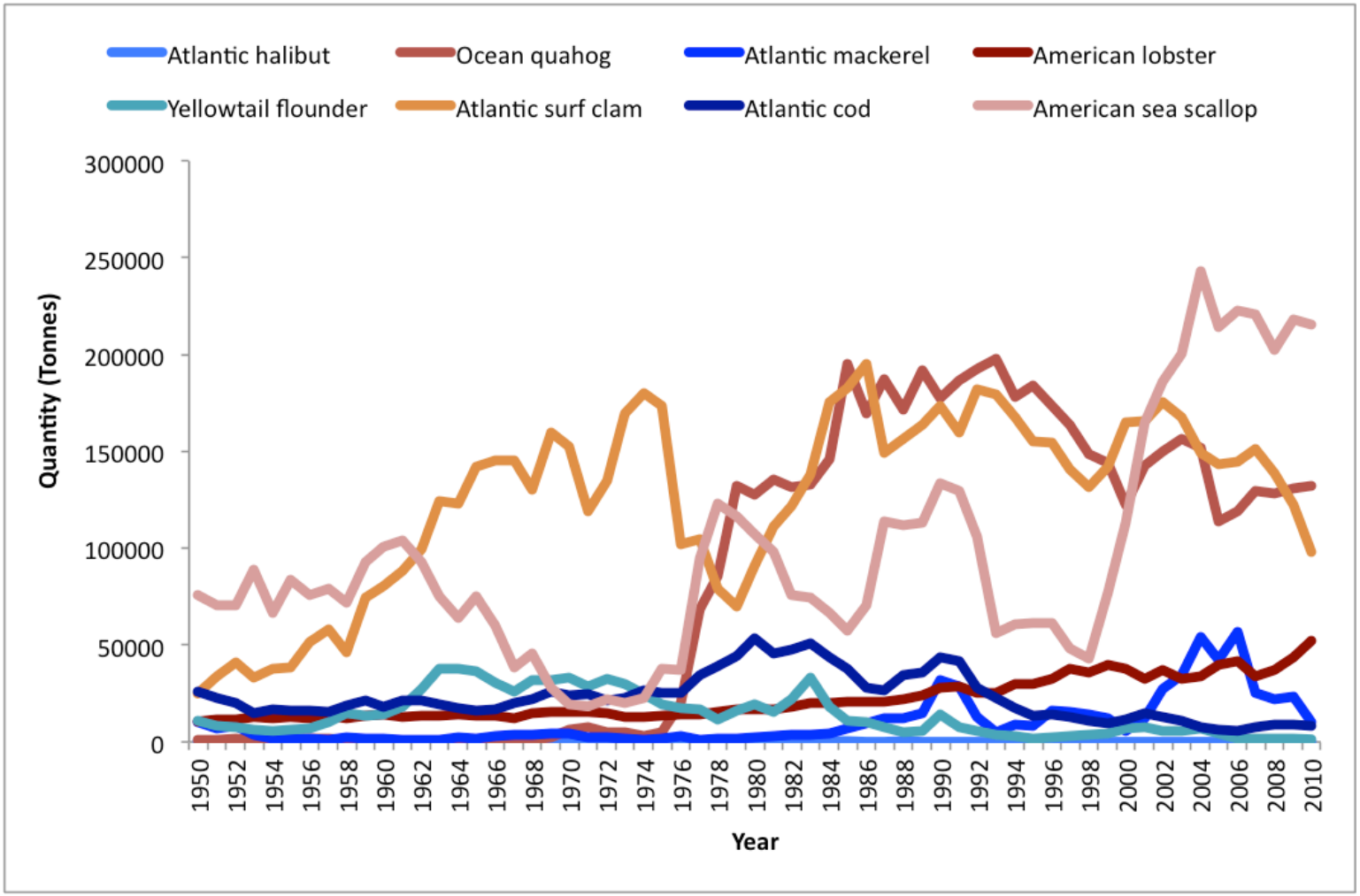
Recovery window

~ $5 M direct loss to fishermen

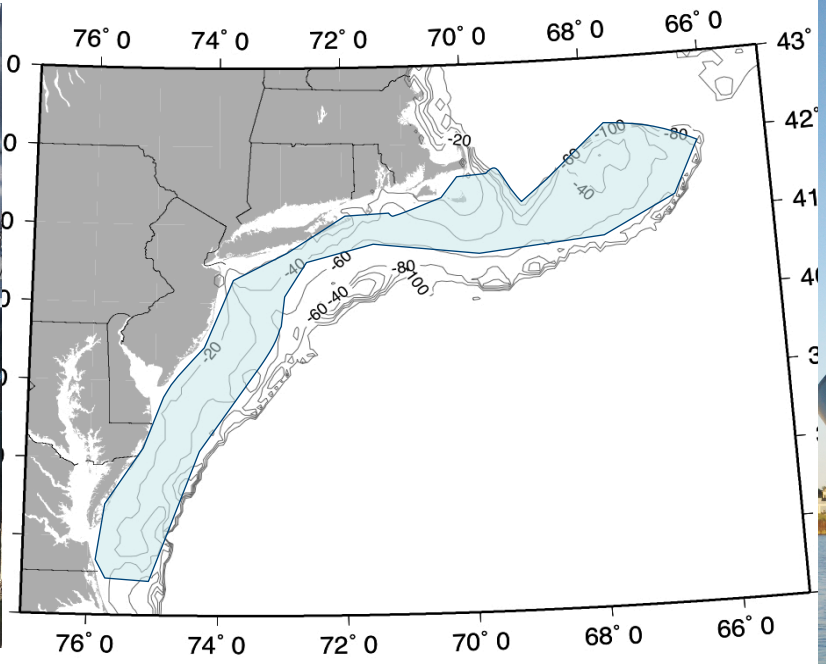
~ $32 M regional economy

Compare with Current Stock Assessment Data





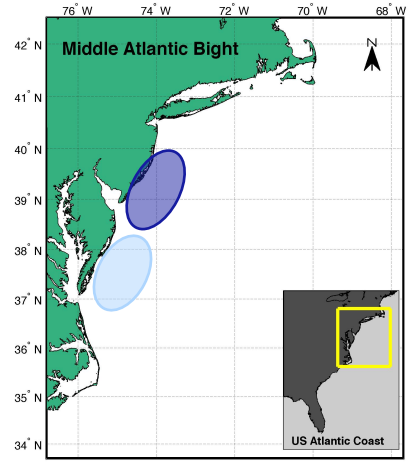
Data: FAO FishstatJ

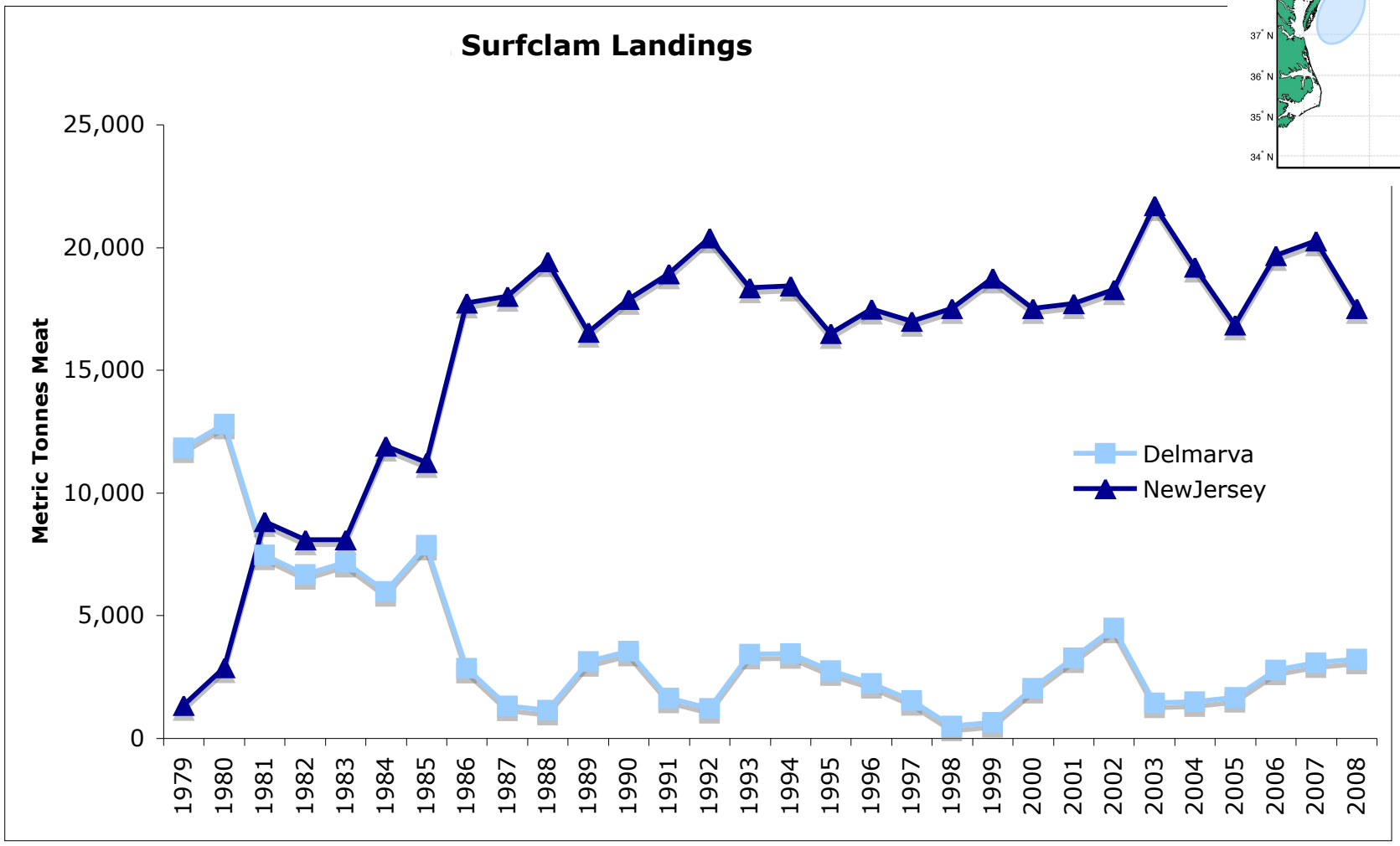


- Operates along the MAB in federal waters
- Large vessels (165 ft)
- Hydraulic dredges
- Clams are large, in dense beds on sandy bottoms
- High value fishery

Photo Credit:
Daniel Mohr

Range Shift





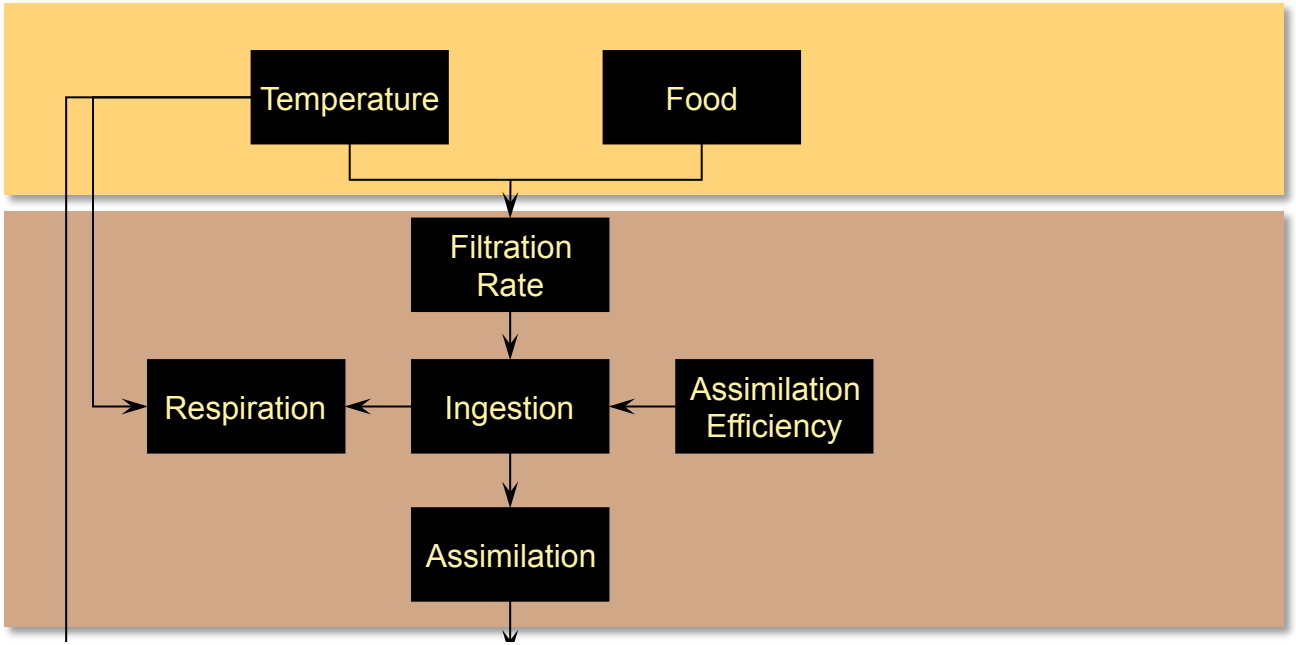
Trends in clam landings based on the 49th Northeast Regional Stock Assessment Workshop Report (NFSC Reference Doc # 10-01)

Individual Surfclam Model

Environment

adapted from Hofmann et al. 2006. J. Shellfish Res. 25: 417-444.

Individual Surfclam Model

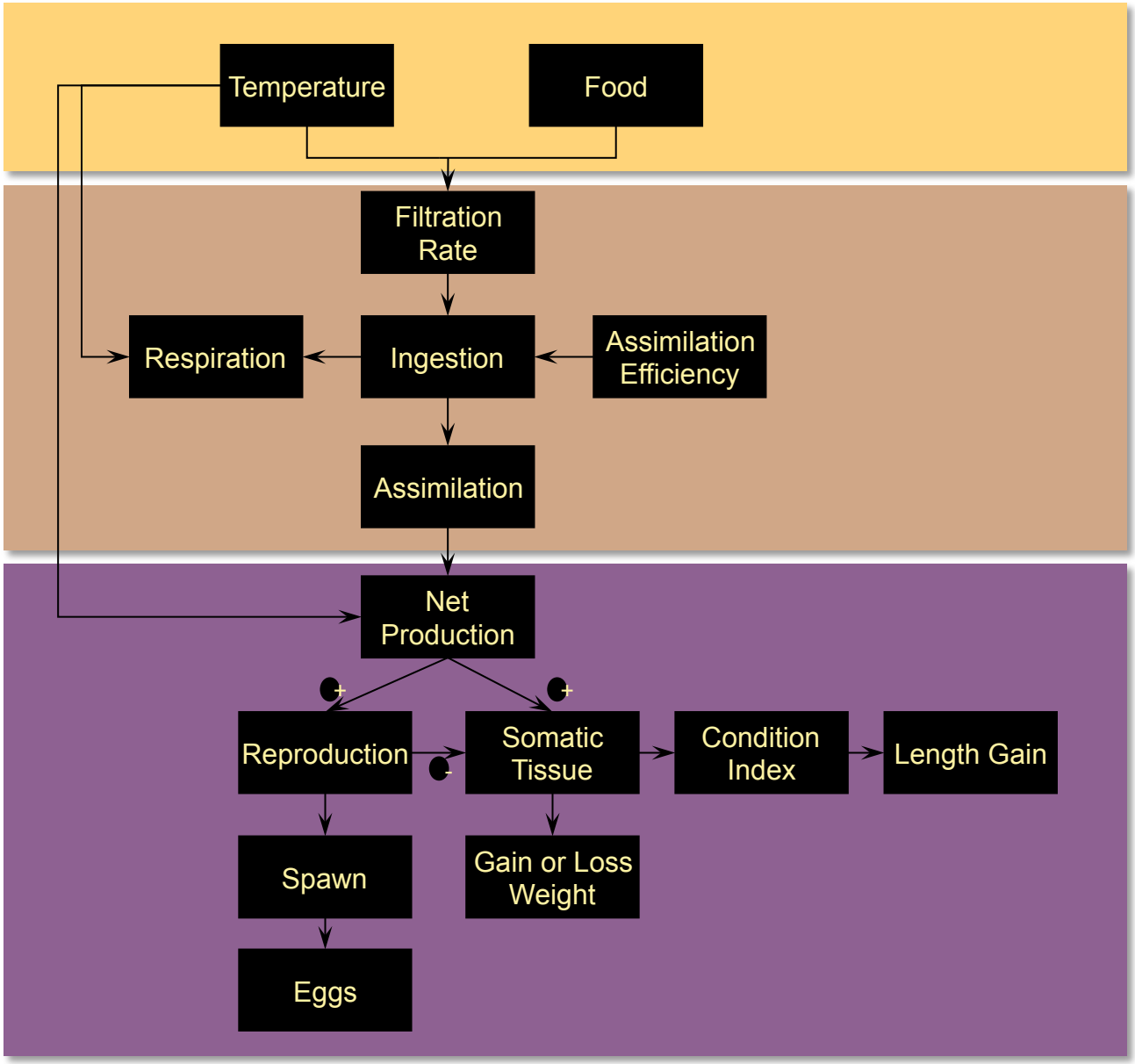


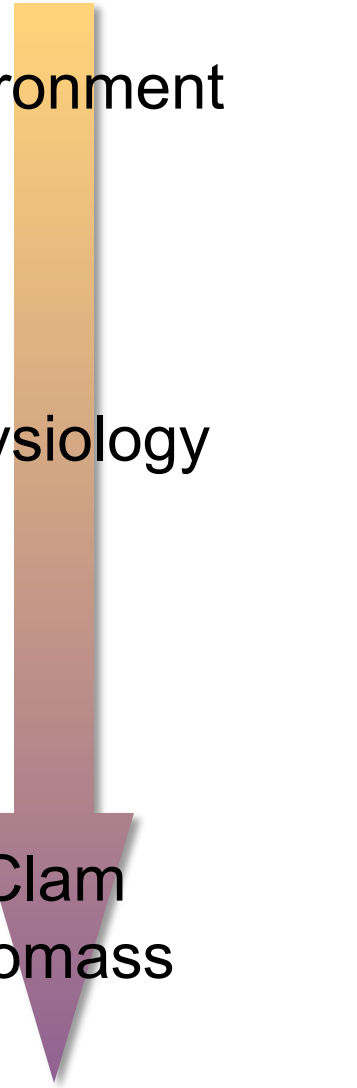
Environment

Physiology

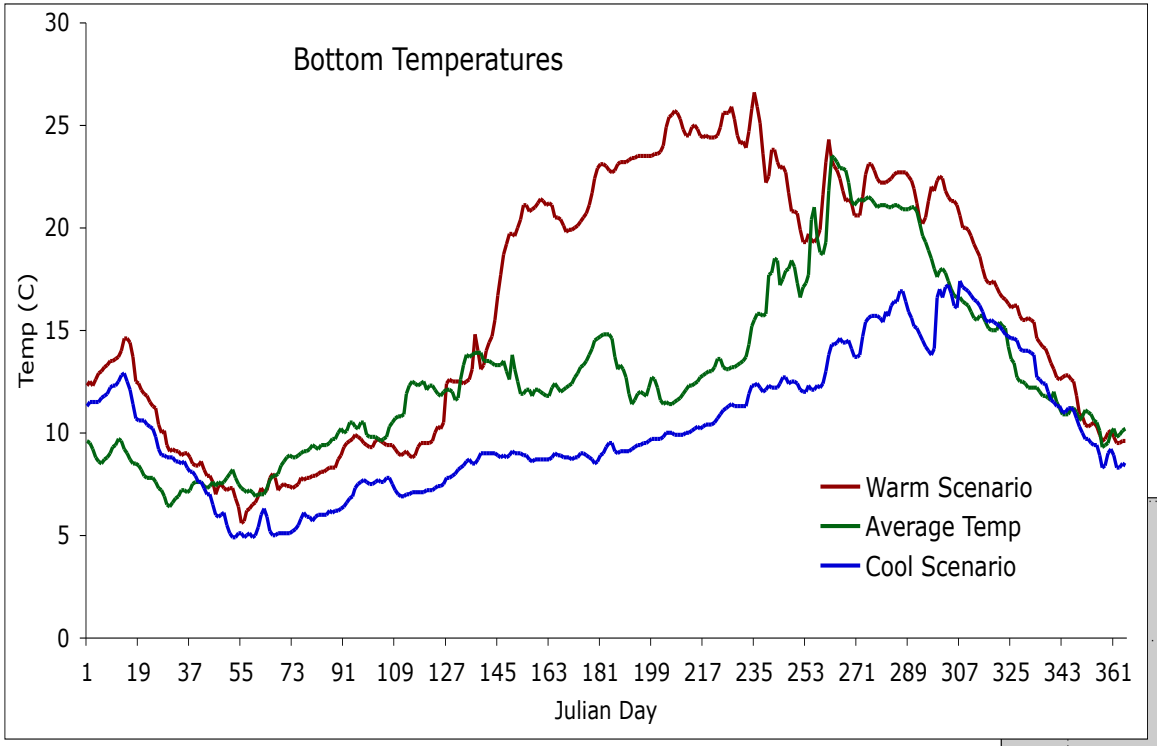
adapted from Hofmann et al. 2006. J. Shellfish Res. 25: 417-444.

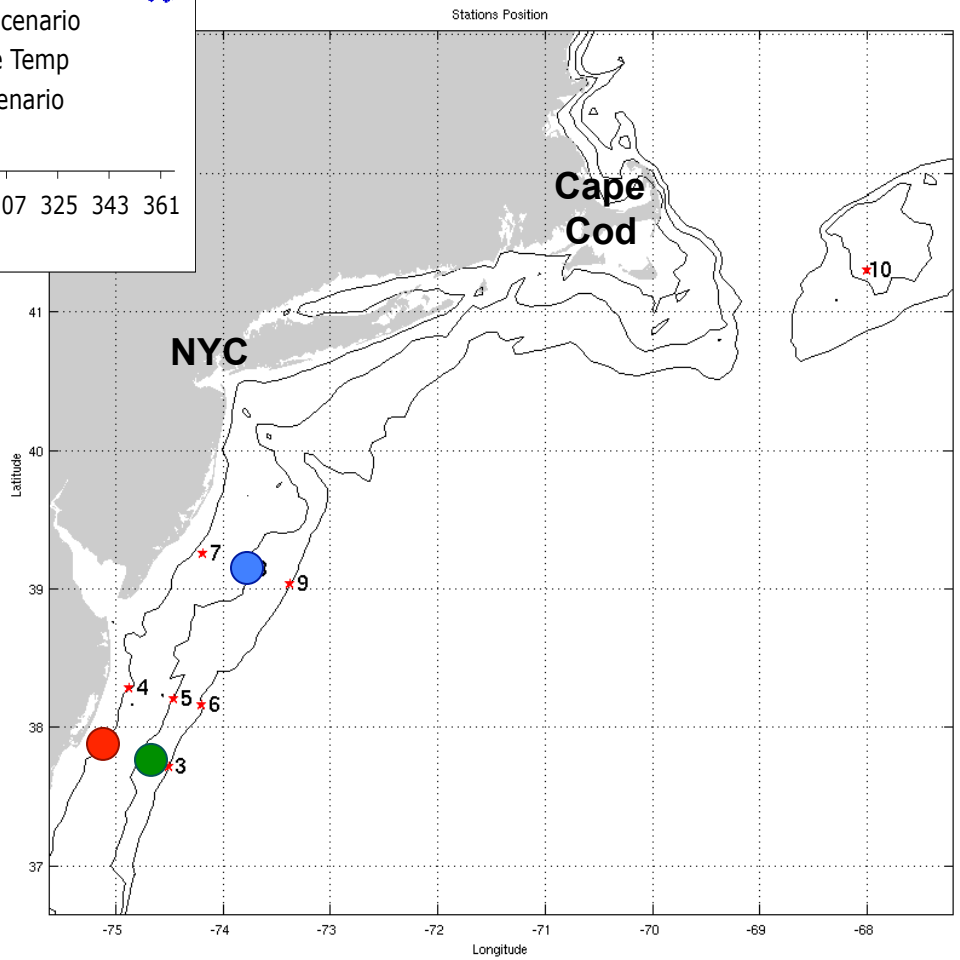
Individual Surfclam Model



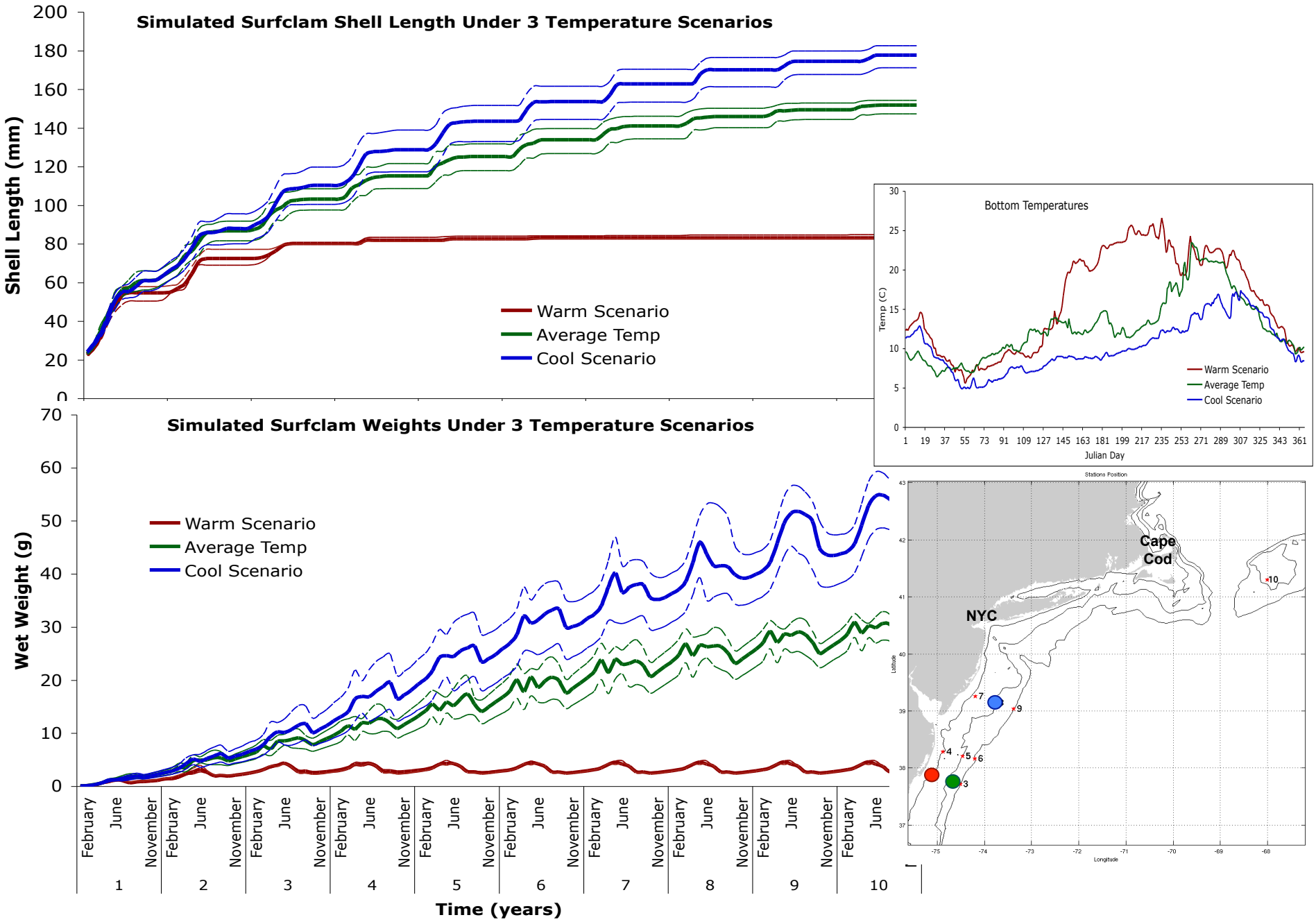


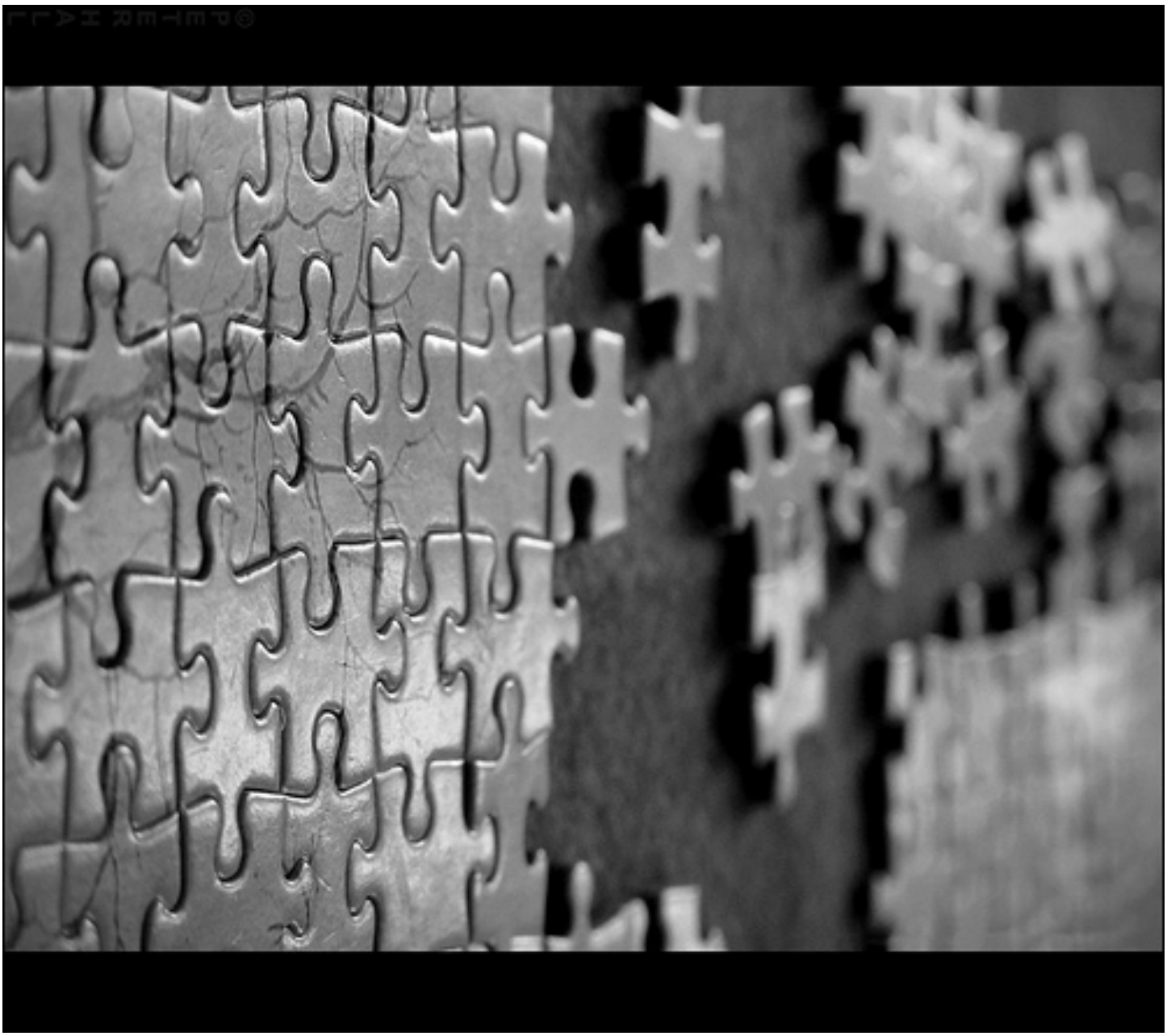
adapted from Hofmann et al. 2006. J. Shellfish Res. 25: 417-444.





Annual Bottom Temperatures (2007)


Simulated Surfclam Shell Length Under 3 Temperature Scenarios
Shell Length (mm)
Warm Scenario
Average Temp
Cool Scenario
Bottom Temperatures
Temp (C)
Julian Day
Simulated Surfclam Weights Under 3 Temperature Scenarios
Wet Weight (g)
Time (years)
February
June
November
1
2
3
4
5
6
7
8
9
10
Stations Position
Cape Cod
NYC
Latitude
Longitude



Thanks!