State University of New York
College of Environmental Science and Forestry

PRESENTS:

Temporal Changes in Spawning Phenology of American Shad and Striped Bass in the Hudson River Estuary

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Part of Ramboll

Project Goals and Objectives

NYSDEC Stock Photo

GOAL

Project changes in spawning phenology of American Shad and Striped Bass in the Hudson River Estuary.

NYSDEC Stock Photo

OBJECTIVES

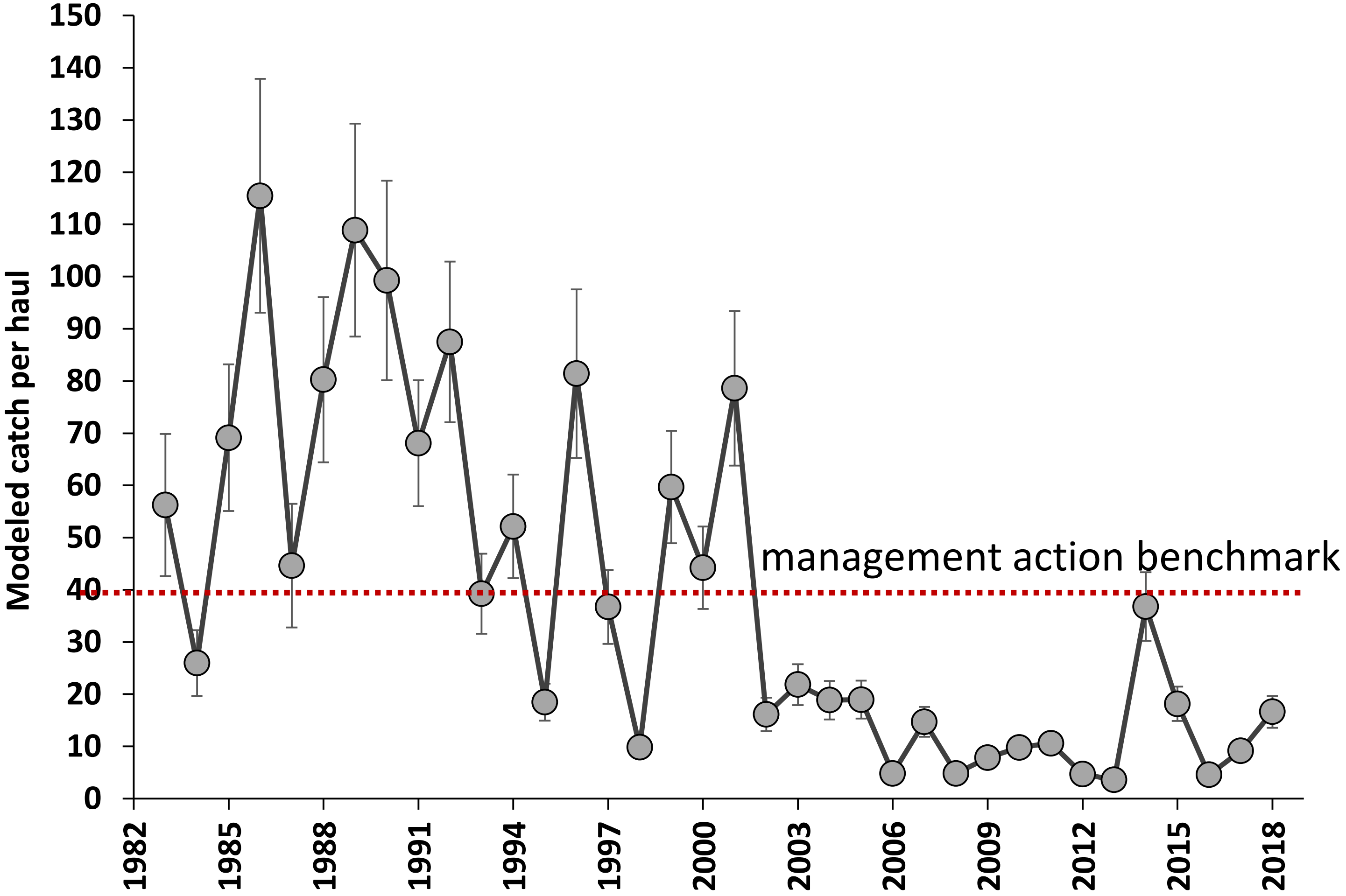
- Develop a model to project daily water temperature through 2099.
- Estimate the onset, cessation and duration of the spawning season of American Shad and Striped Bass through 2099.

Introduction – American Shad

An historic economically important fishery along the Hudson River

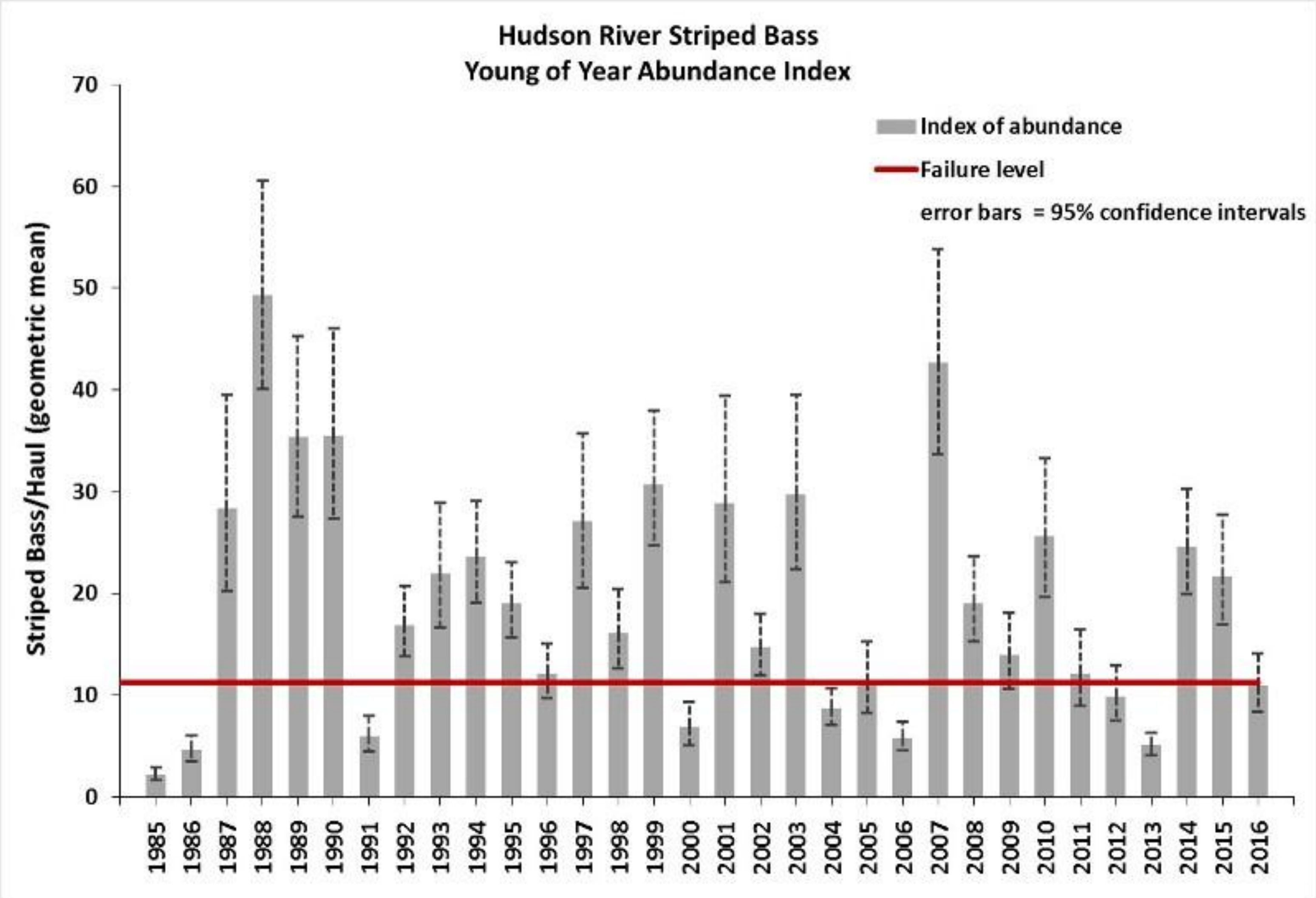
Population declines have been attributed
to several factors

Steady decline in spawning stock since the mid-1980's, with 2012 being the poorest year on record – the fishery was closed in 2010



Graph provided by NYSDEC and modified by Dr. Karin Limburg

Introduction – Striped Bass



Population at an all time low in the 1970's

Hudson River commercial fishery was closed in 1976

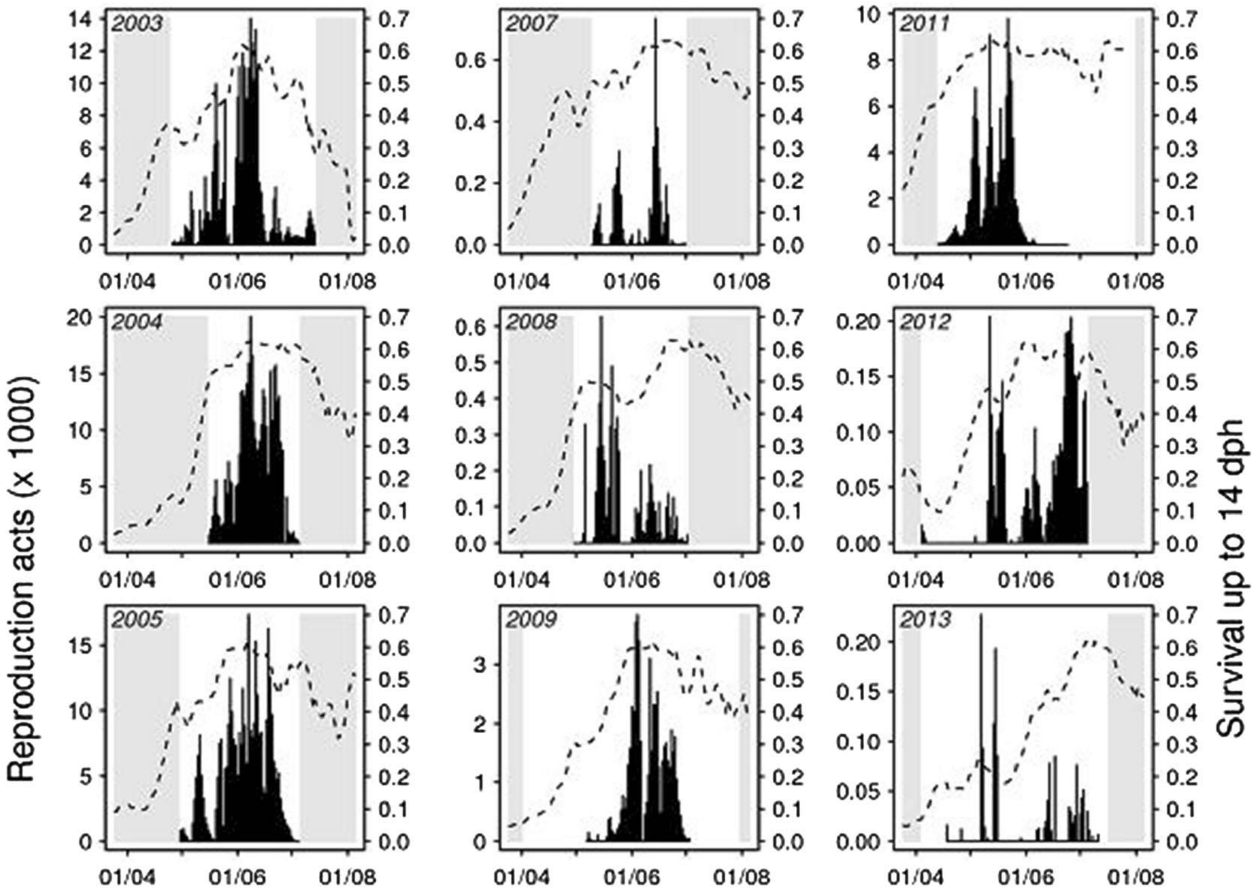
The Hudson River population recovered by the 1990's

Spawning Adaptability

Spawning tactics change dependent on temperature

Increased spawning success by spawning at temperatures more suitable for egg and larval survival.

Variability of spawning tactics for the Gironde-Garonne-Dordogne (south-west France) population of Allis Shad

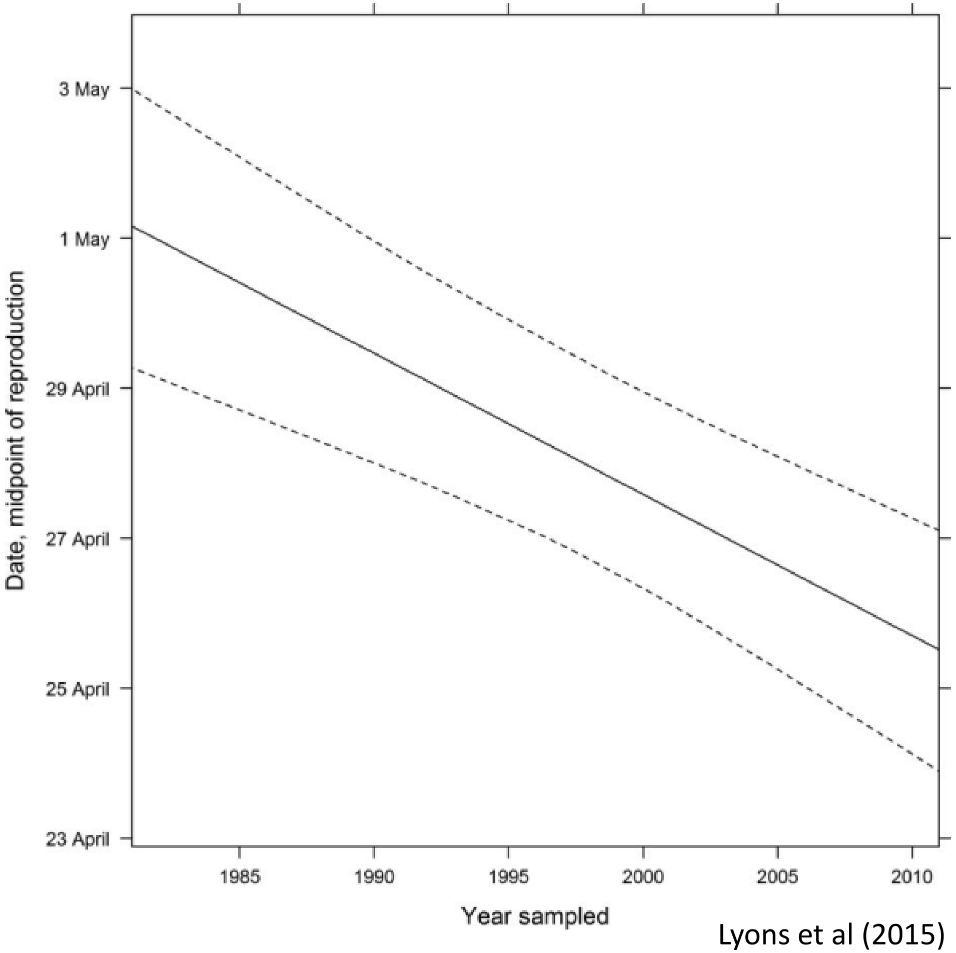


Lambert et al (2018)

Temperature/Spawning Relationship

- Changes in spawning phenologies have been associated with water temperature changes for several species
- Migration and spawning of anadromous fishes are well known to be associated with temperature

Changes in Yellow Perch Spawning Season

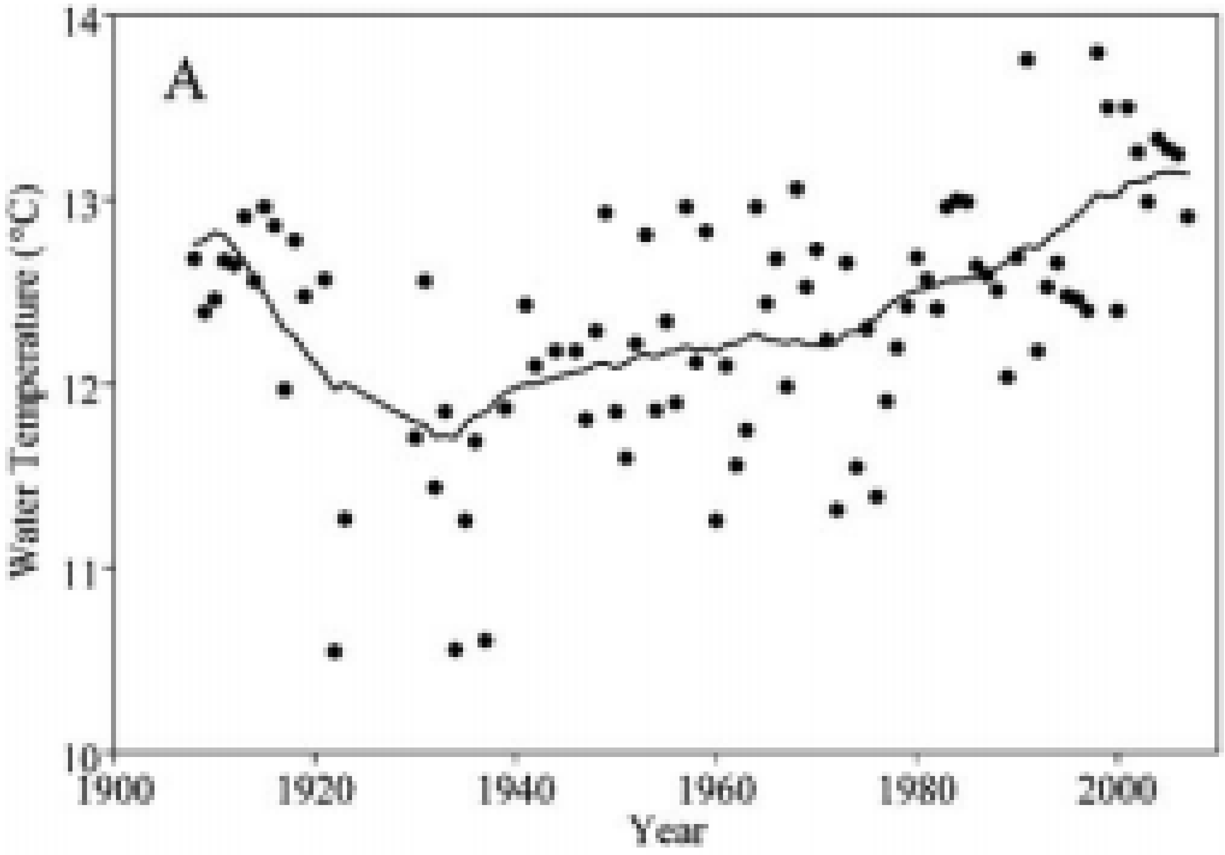


Lyons et al (2015)

Changes in Hudson River Water Temperature

- Mean annual temperatures have increased since the 1950's
- Increases in water temperature was greatest in the Spring and Summer months

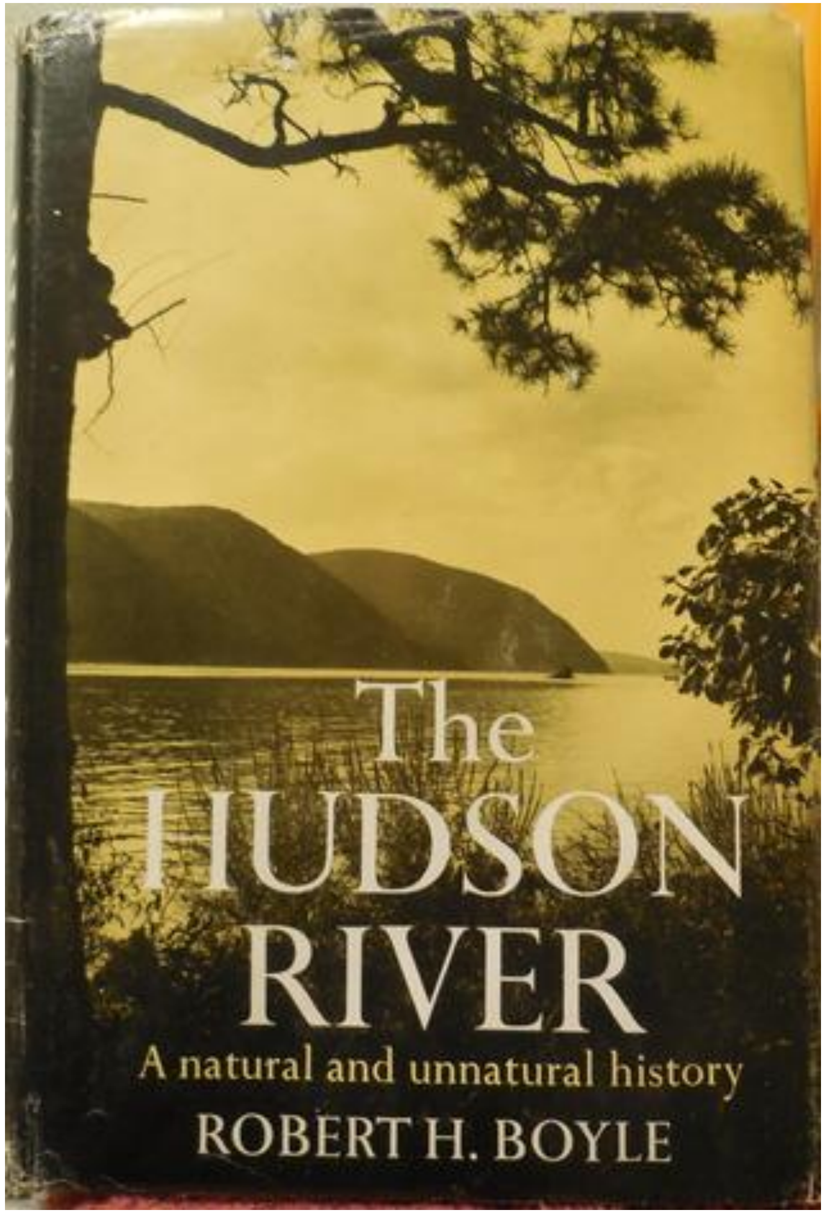
Mean Annual Temperatures



Seekell and Pace 2011

The Hudson River

An unnatural history of data



The Hudson River

An unnatural history of data

Long term monitoring program since 1976

- Hudson River Monitoring Program (also known as the “Utilities’ data sets” because a consortium of utility companies sponsored the research as part of regulatory compliance)
- Annually monitors the productivity of several fish species in the Hudson River by collecting information on the abundance of their early life stages (from egg to juvenile)

Historical water temperature series since 1920

- 1921-2007 water temperatures were collected by the Poughkeepsie Water Treatment Facilities (latitude 41^o 43' 26"N, longitude 73^o 56' 11"W) at Poughkeepsie, NY
- 1993 – 2013 water temperatures were acquired from the United States Geologic Survey (USGS) station in Poughkeepsie, NY (latitude 41^{o}39' 03"N, longitude 73^o 56' 42"W)

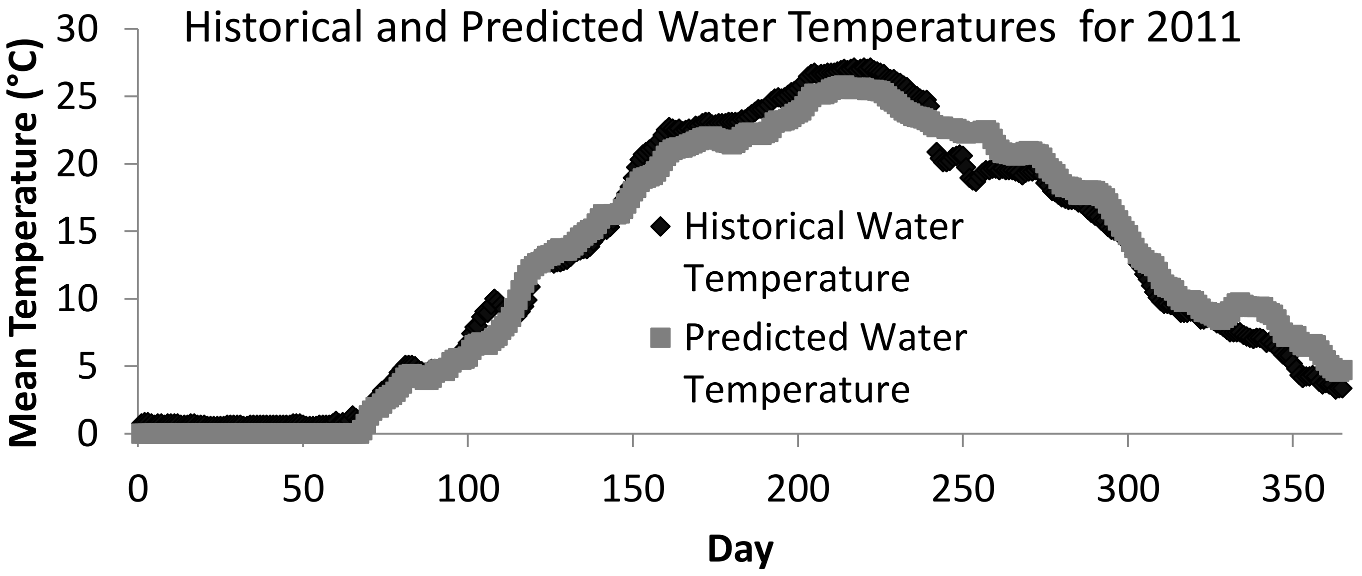
Future Water Temperature Modeling

Linear Regression Model

Developed using daily mean historical water temperature and air temperature (North Atlantic Land Data Assimilation System) data series from 1979 – 2013.

Coefficient of determination (R^2 value = 0.992) was maximized by smoothing air temperature data using a 30 day mean air temperature.

To prevent water temperature prediction from falling below 0°C, if the model produces a value below 0°C, then water temperatures are set to 0 °C.

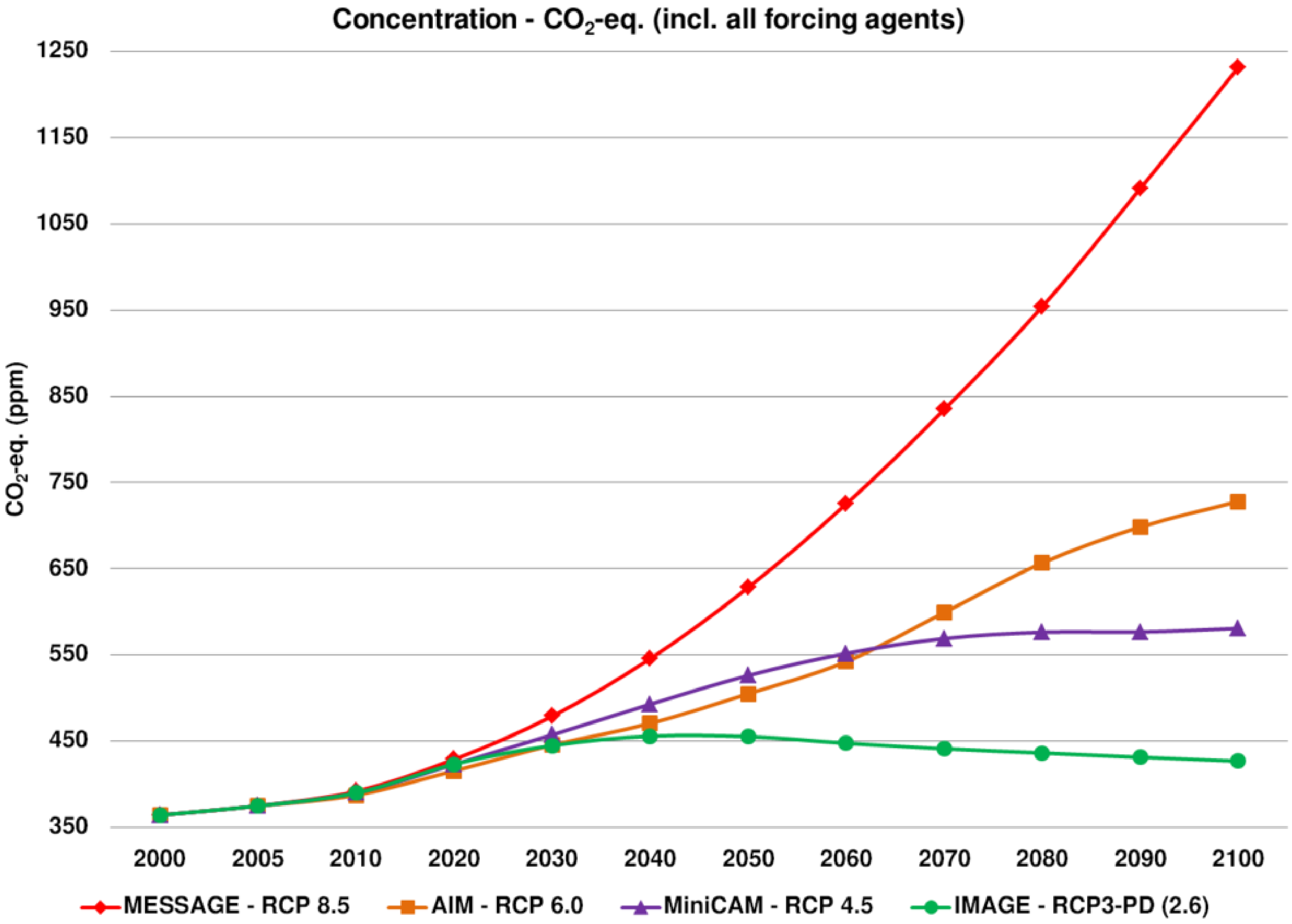


IPCC Air Temperature Modeling

Used 4 RCP Scenarios

- RCP 2.6
- RCP 4.5
- RCP 6.0
- RCP 8.5

The number of models varies between the scenarios and ranges from 13 (RCP6.0) to 42 (RCP4.5) models.



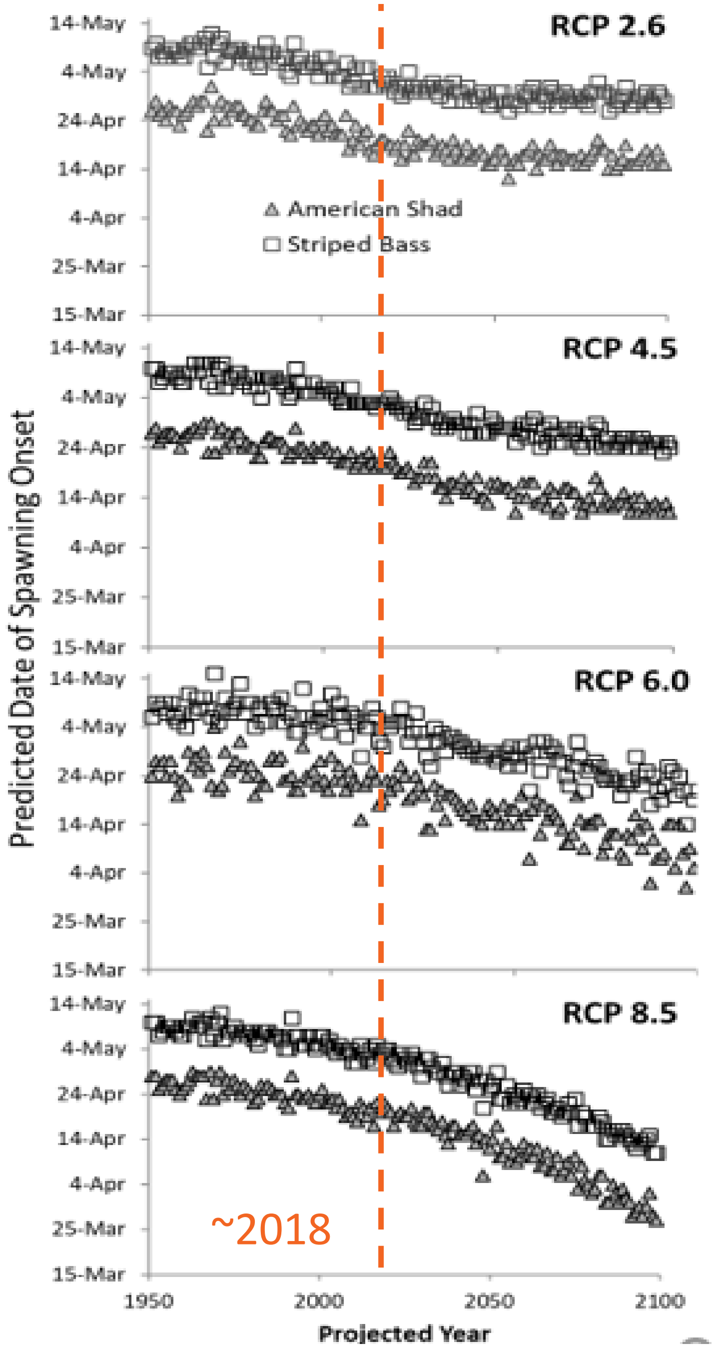
Estimating Spawning Phenology Parameters

Water temperature projections were used to estimate the Onset, Cessation(end) and duration of spawning for both species

Historical egg count data were used to determine the average heating degree days (GDD) sum: $GDD = T_{mean} - T_{th}$

Key Findings

- ✓ American Shad and Striped Bass spawning seasons are predicted to occur up to a month earlier
- ✓ The spawning season would be similar to what we see in the Chesapeake.
- ✓ Changes in the onset and cessation of spawning were significantly (P-value < 0.0001) earlier in the year for all RCP scenarios



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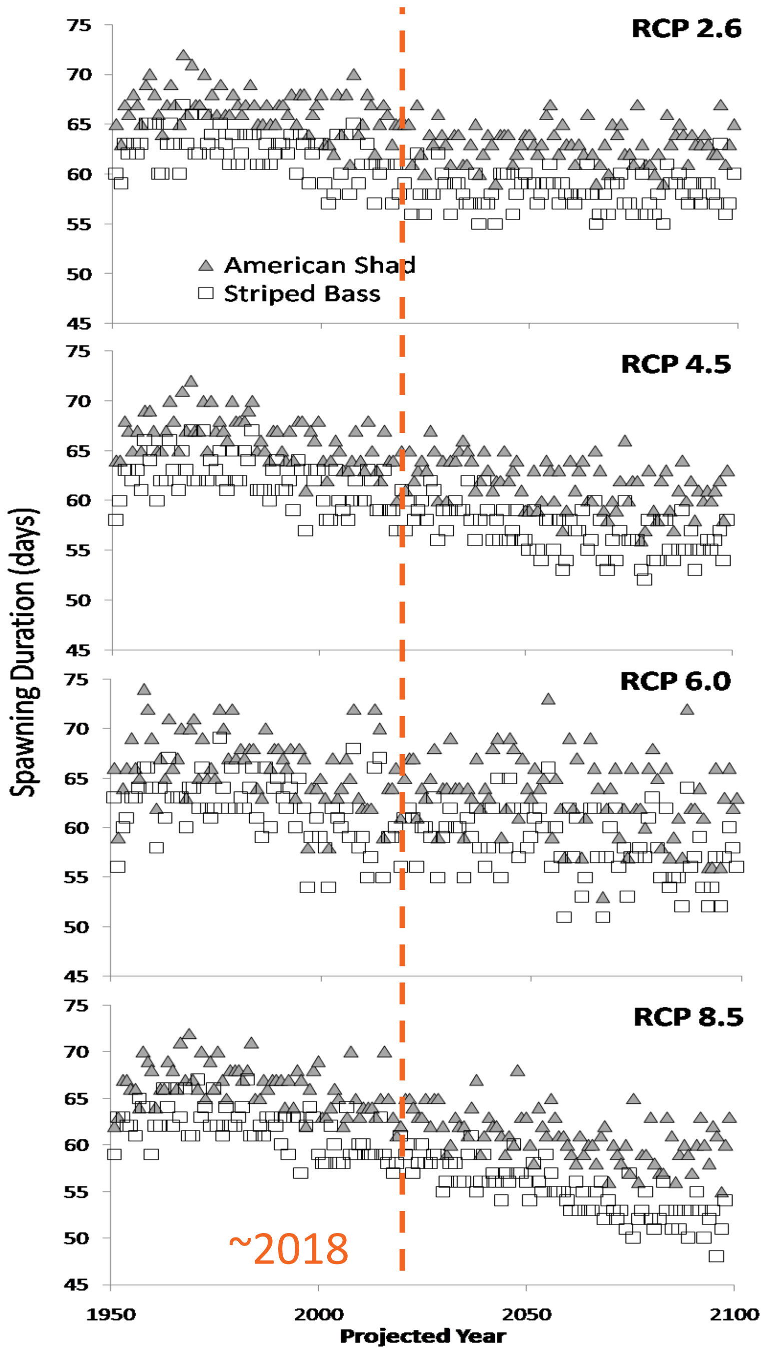
Key Findings

- ✓ Spawning season may be up to 10-20% reduced by 2099
- ✓ Changes in the duration of spawning for American Shad and Striped Bass were significantly shorted for the RCP4.5 and RCP8.5 scenarios

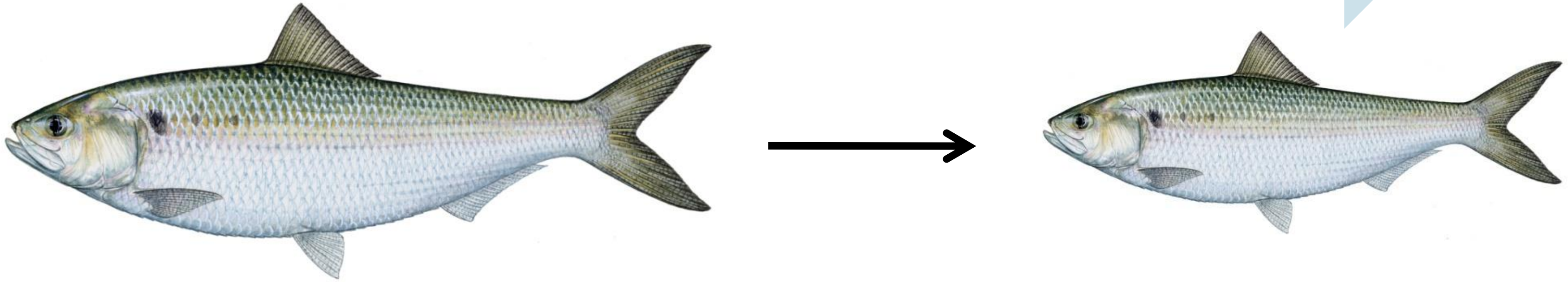


Possible Morphological Changes

Reduced spawning size

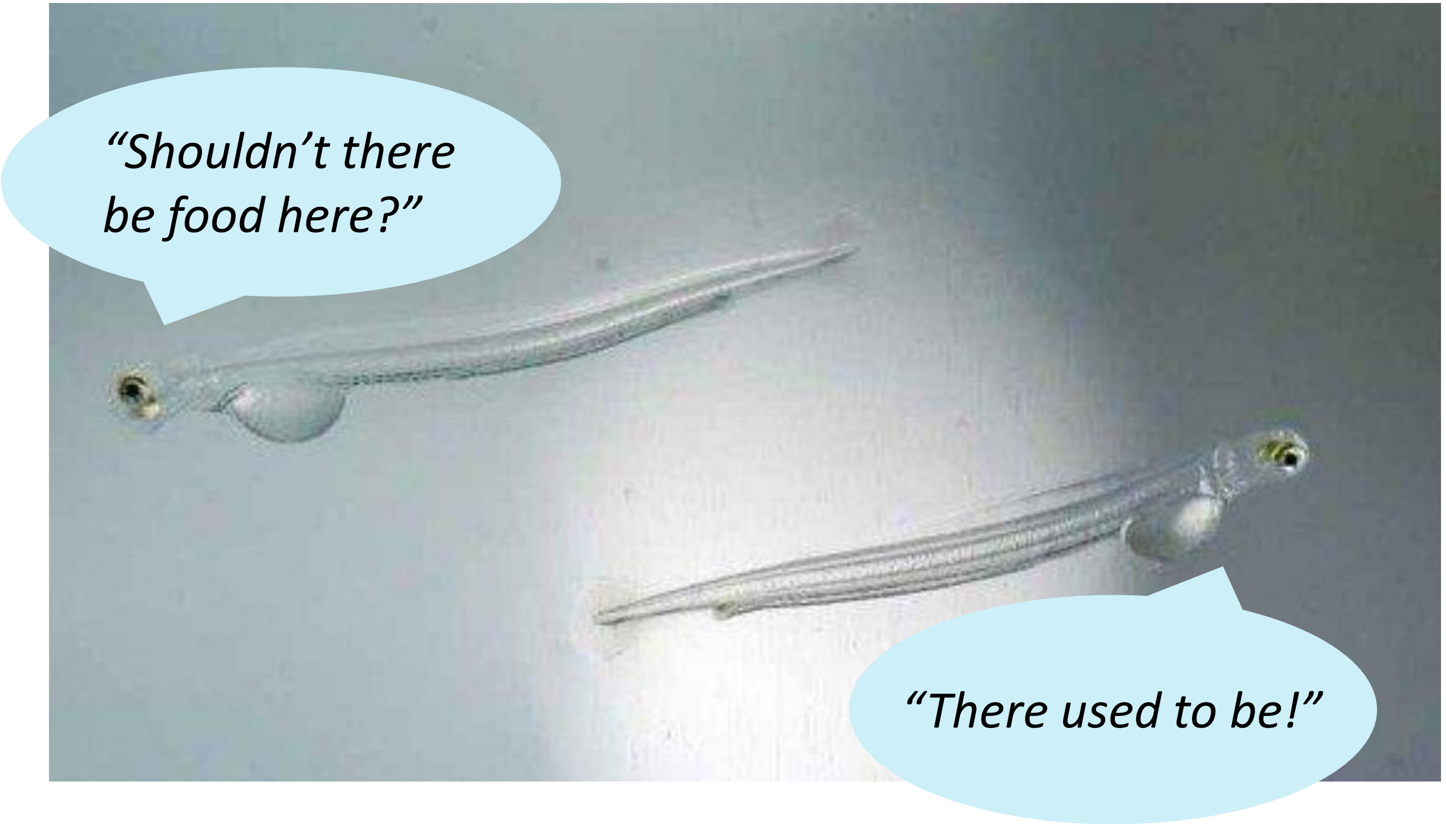
Changes in the number of eggs per fish

Fewer number of respawners



Possible Ecological Changes

- Predator Prey Mismatch
- Greater impact of weather related mortality



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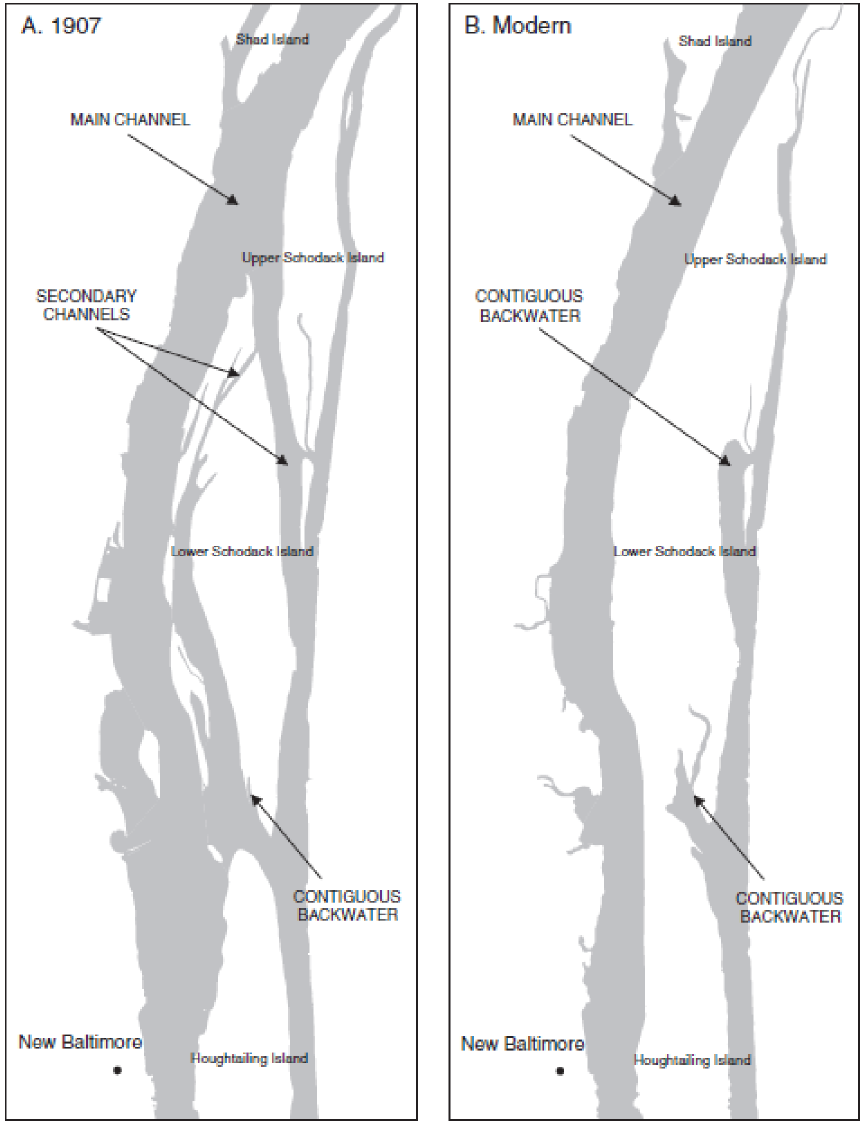
Need for increased habitat diversity

Extensive loss of side channel habitat over the last century.

Habitat diversity increases resiliency of larval American shad during with higher flows (Nack 2015).



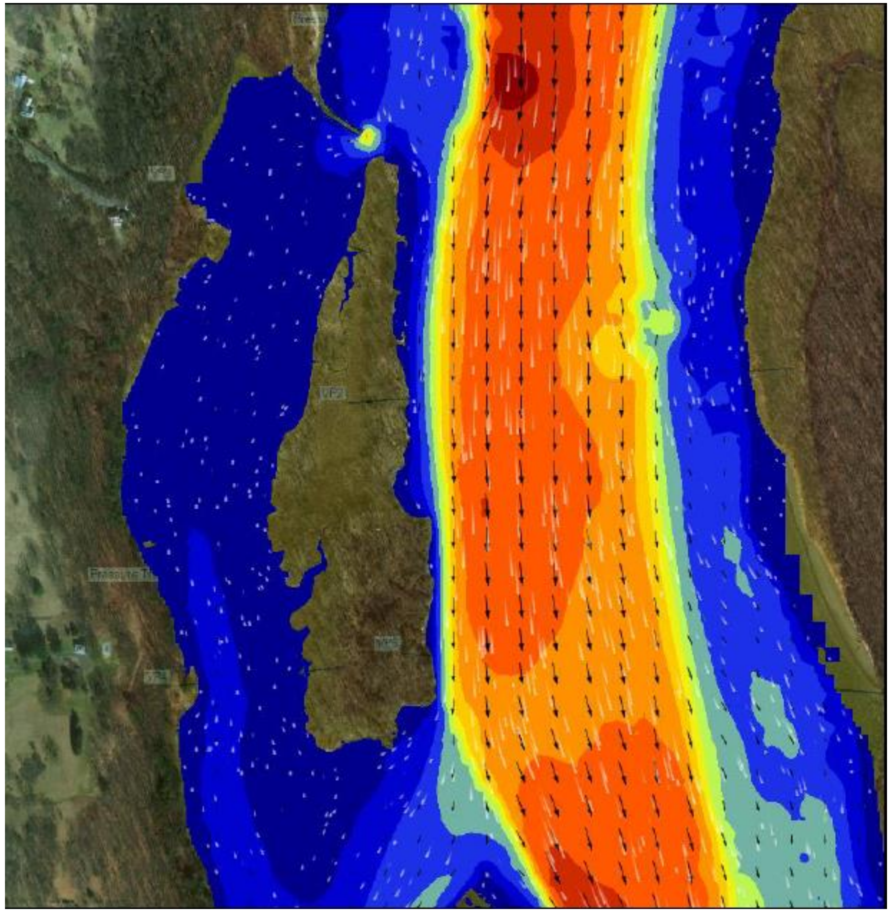
Collins and Miller 2011

Ongoing Restoration Efforts

Nutton Hook Restoration

Photos curtesy of Brian DeGasperis

Rattlesnake Island Hydrological Modeling



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Thank you!

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