A Satellite-Based Mobile Warning System to Reduce Atlantic Sturgeon Interactions in Delaware waters
Grant No. NNX17AG34G

Matthew Oliver, UD

Matthew Breece, UD

Dewayne Fox, DSU

Steven Bograd, SWFSC

Elliot Hazen, SWFSC
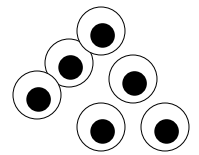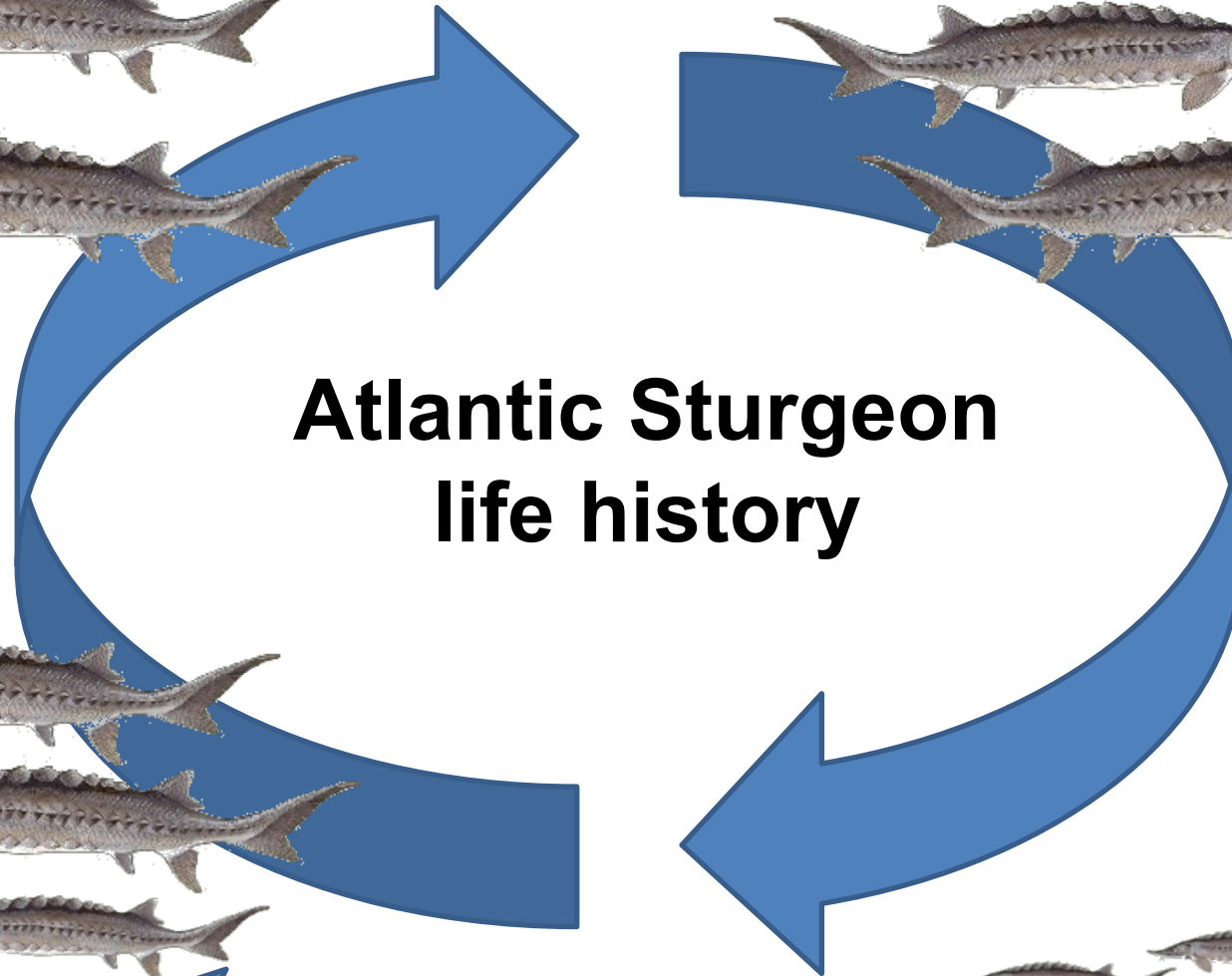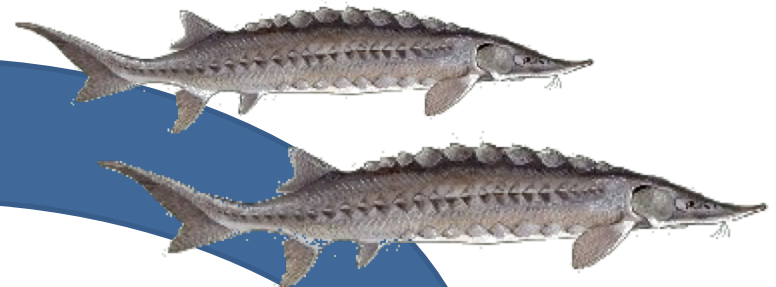
Ed Hale, DNREC

Marine

Estuary
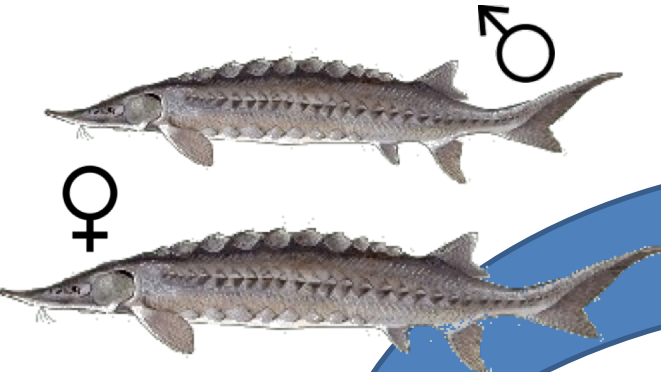
Fresh

♂

♀

**Atlantic Sturgeon
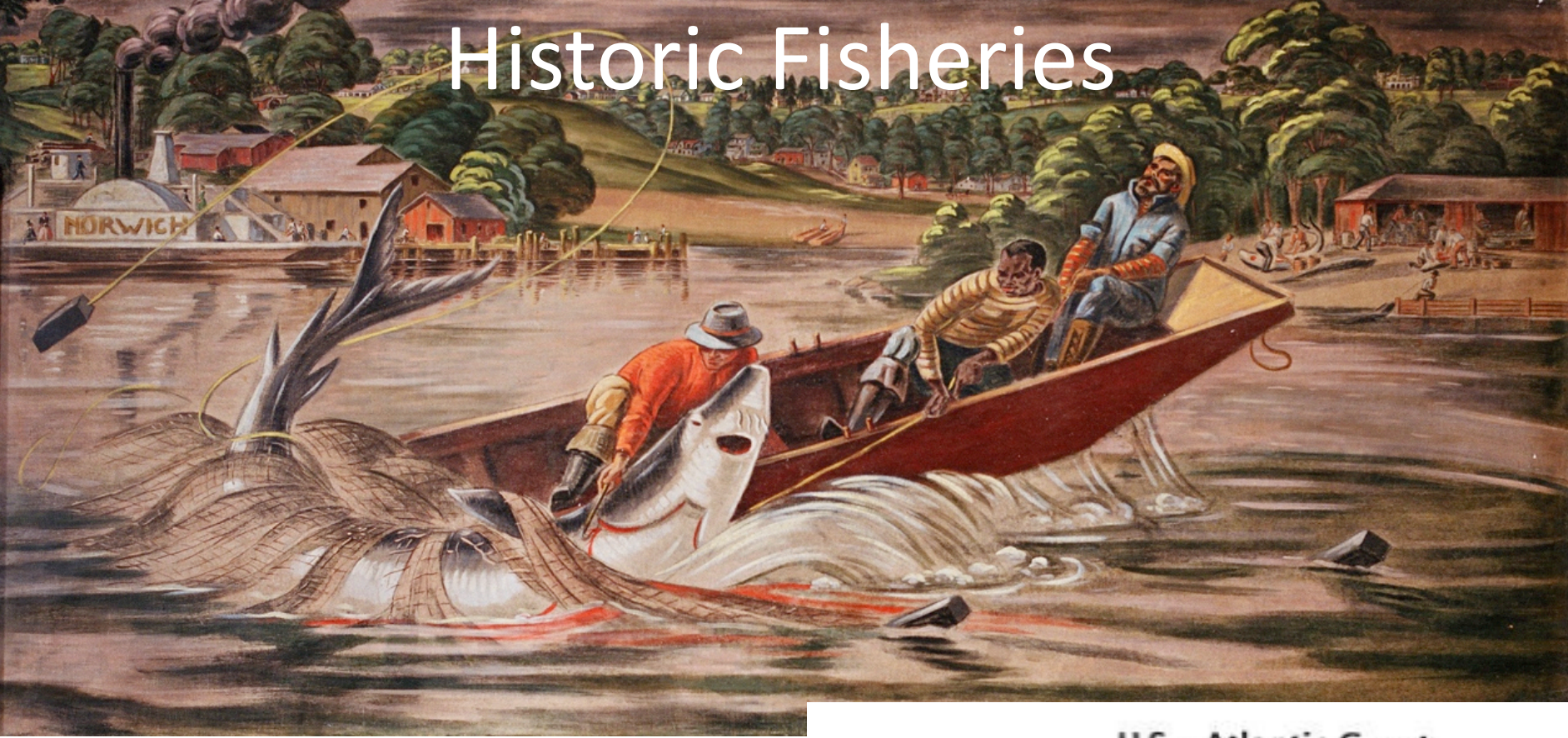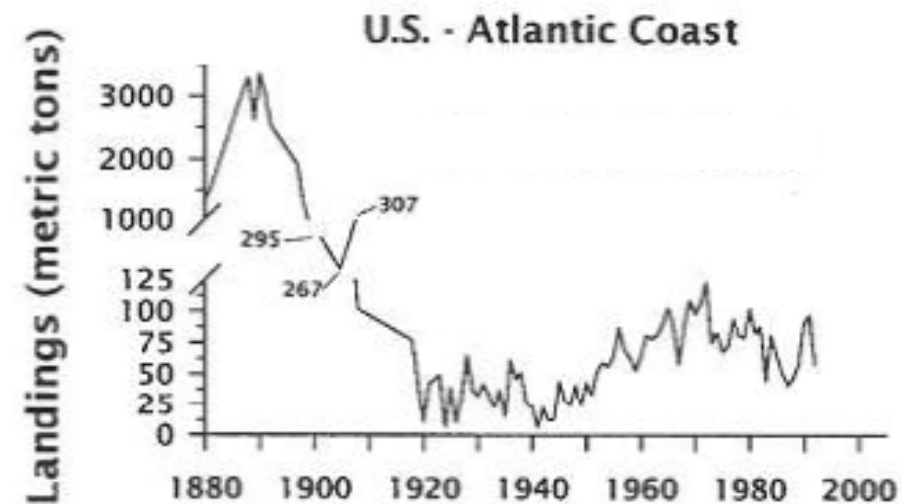life history**

Spawning

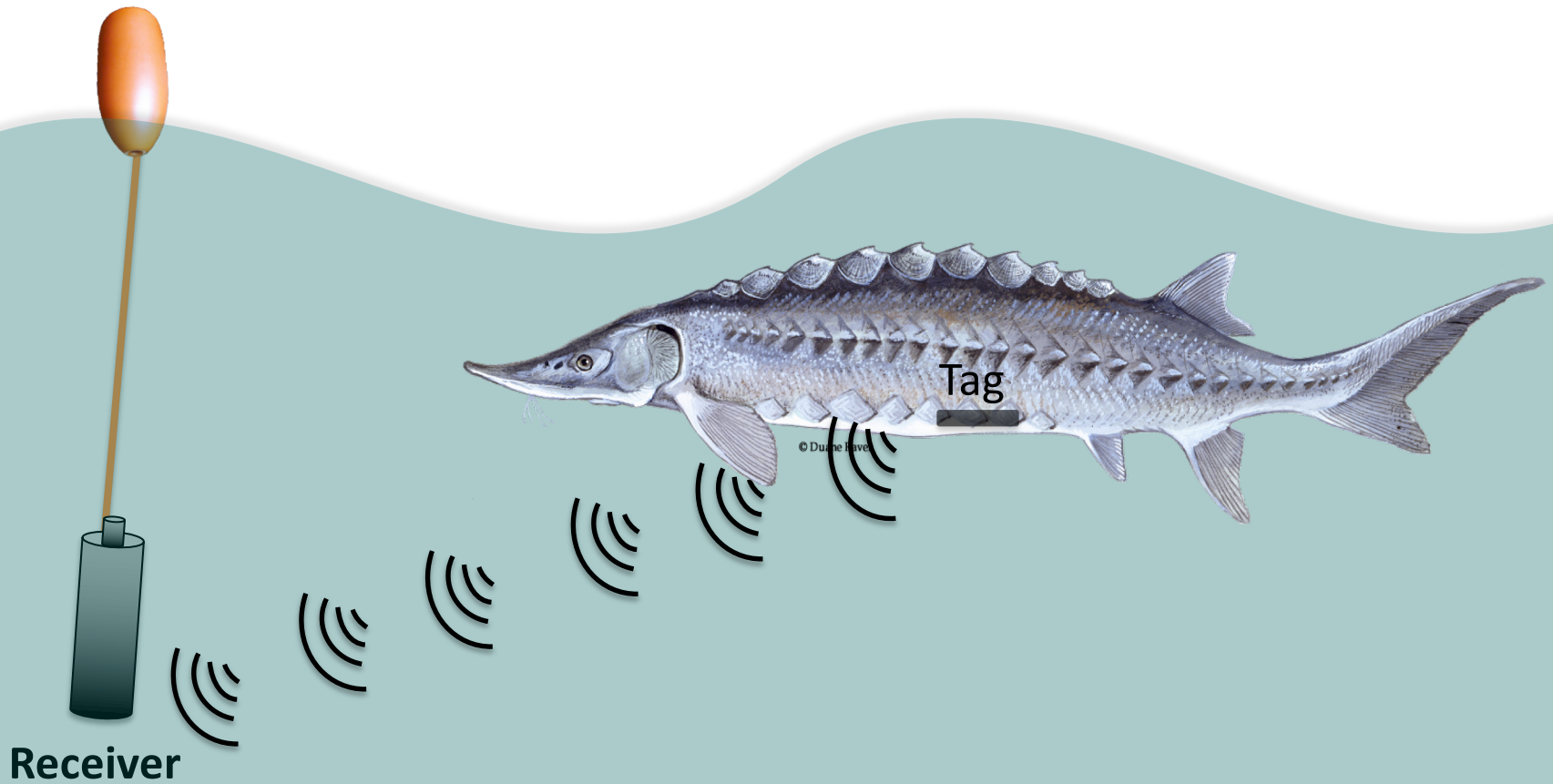**Development**

Historic Fisheries

- Delaware River Fishery
  - Peak of 2700mt harvest 1888
  - Largest sturgeon fishery in the United States (75% of landings)
  - Collapsed ~1900
- Minimal take, no recovery
  - Coast wide moratorium since 1998
  - Listed under the ESA in 2012

U.S. - Atlantic Coast

Landings (metric tons)

Acoustic Telemetry

Must download
Receivers

Tag

Receiver

Model Formulation

Response – Presence/Absence

- Atlantic Sturgeon
  - 301 individuals
  - 1,900 presences matched to 1 day Satellite data
 - 1,387,197 absences matched to 1 day Satellite data

Predictors

- One-Day MODIS Aqua
  - SST
  - Absorption
    - (12 wavelengths)
  - Seascapes
  - Day of year
- Bathymetry
- Variable reduction
  - Information valuation
  - Collinearity test
  - Future relevance
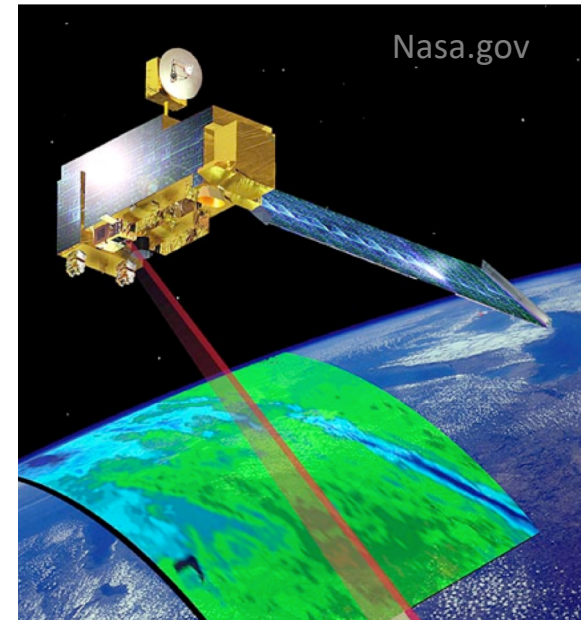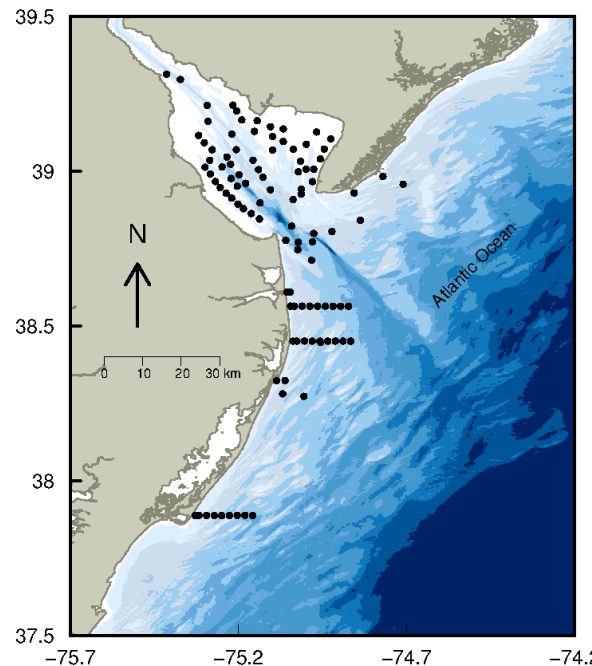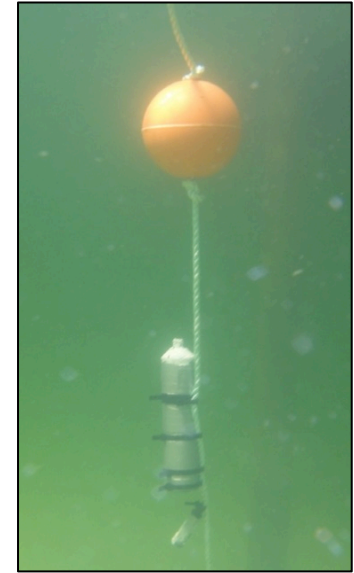
Satellite driven distribution models of endangered Atlantic sturgeon occurrence in the mid-Atlantic Bight

Matthew W. Breece[1*], Dewayne A. Fox[2], Danielle E. Haulsee[1], Isaac I. Wirgin[3], and Matthew J. Oliver[1]
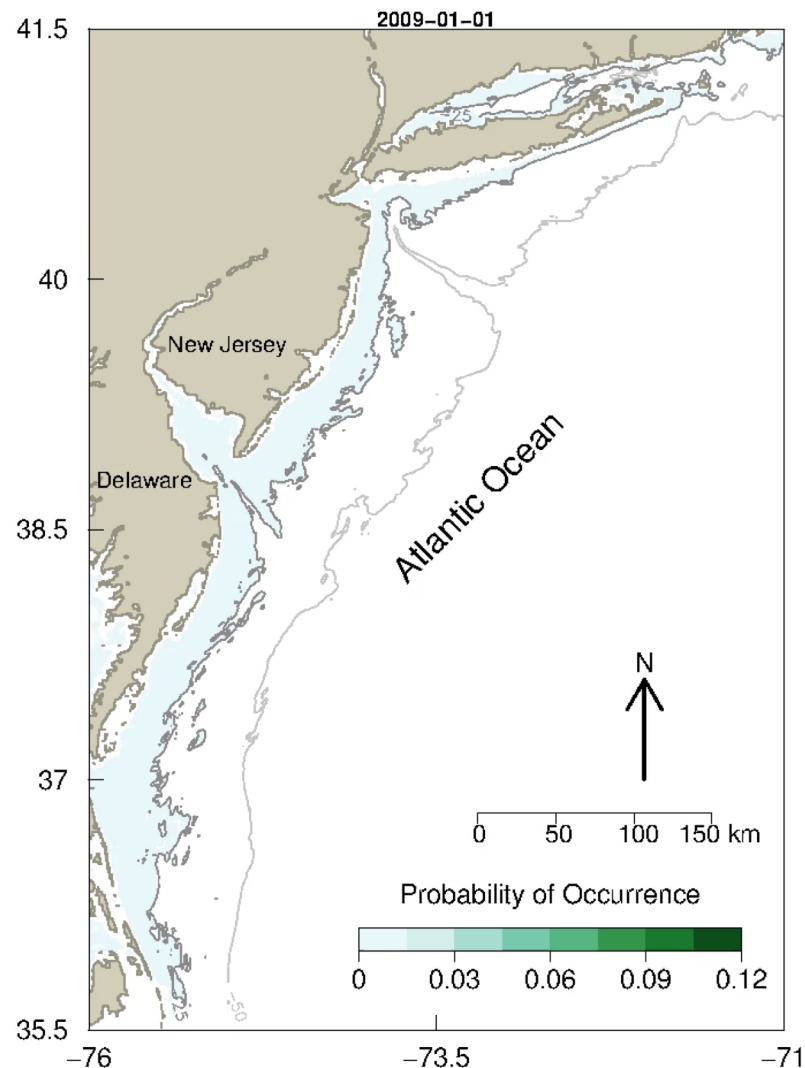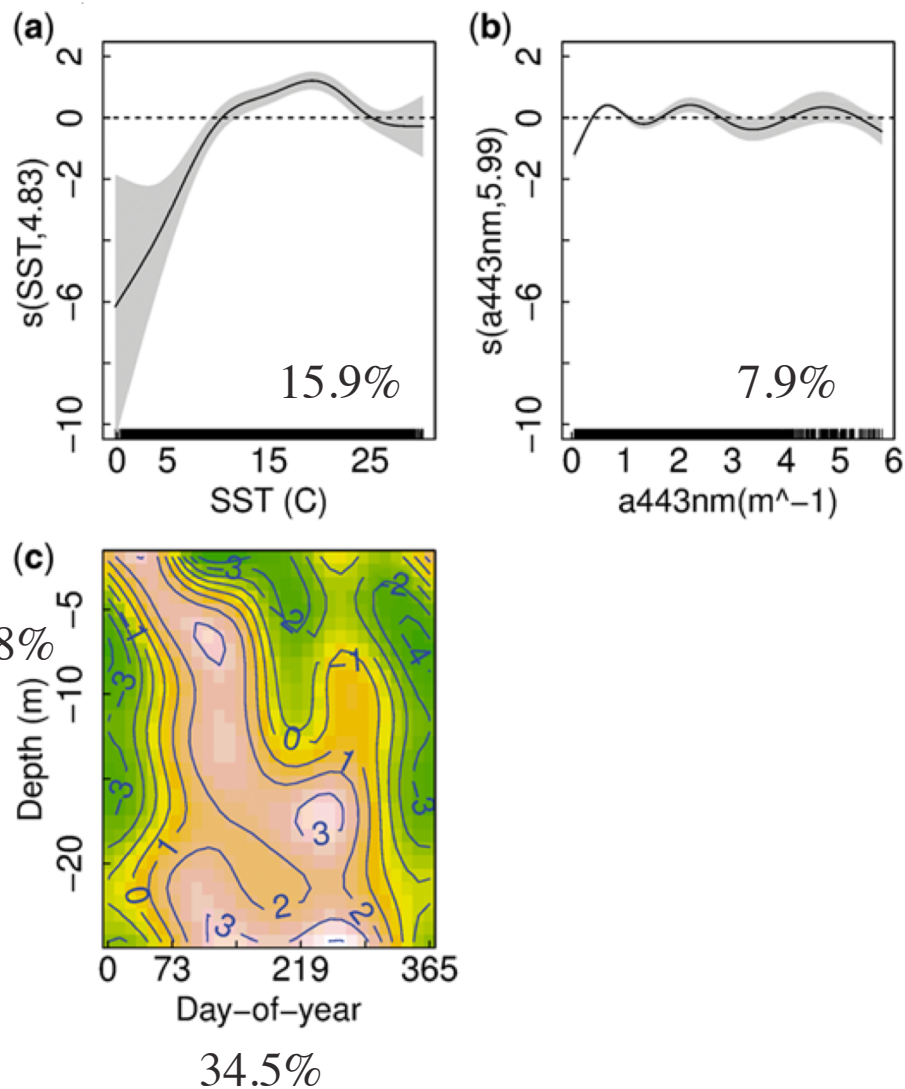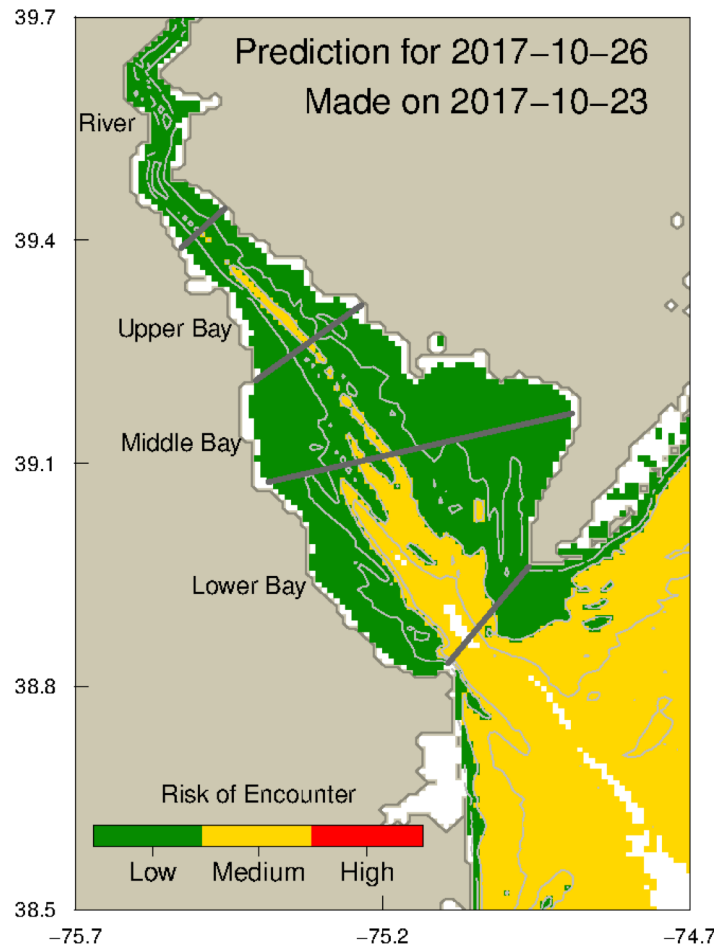
Atlantic Sturgeon Predicted Occurrence

Green indicates low risk of encountering Atlantic Sturgeon

Yellow indicates medium risk of encountering Atlantic Sturgeon

Red indicates high risk of encountering Atlantic Sturgeon

Prediction for 2017–10–26
Made on 2017–10–23

River

Upper Bay

Middle Bay

Lower Bay

Risk of Encounter

Low   Medium   High

This product is developed for mature Atlantic Sturgeon using historic telemetry observations matched to date, bathymetry, and sea surface temperature and ocean color from NASA's MODIS AQUA satellite. The five regions (Delaware River, Upper Delaware Bay, Middle Delaware Bay, Lower Delaware Bay, and Atlantic Ocean) are divided into 5 meter depth bins.

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Ed.hale@state.de.us Delaware Division of Fish and Wildlife 3002 Bayside Drive Dover, DE 19901

Breece, M. W., D. A. Fox, D. E. Haulsee, I. Wirgin, and M. J. Oliver. 2017. Satellite Driven Distribution Models of Endangered Atlantic Sturgeon Occurrence in the Mid-Atlantic. ICES Journal of Marine Science fsx187.
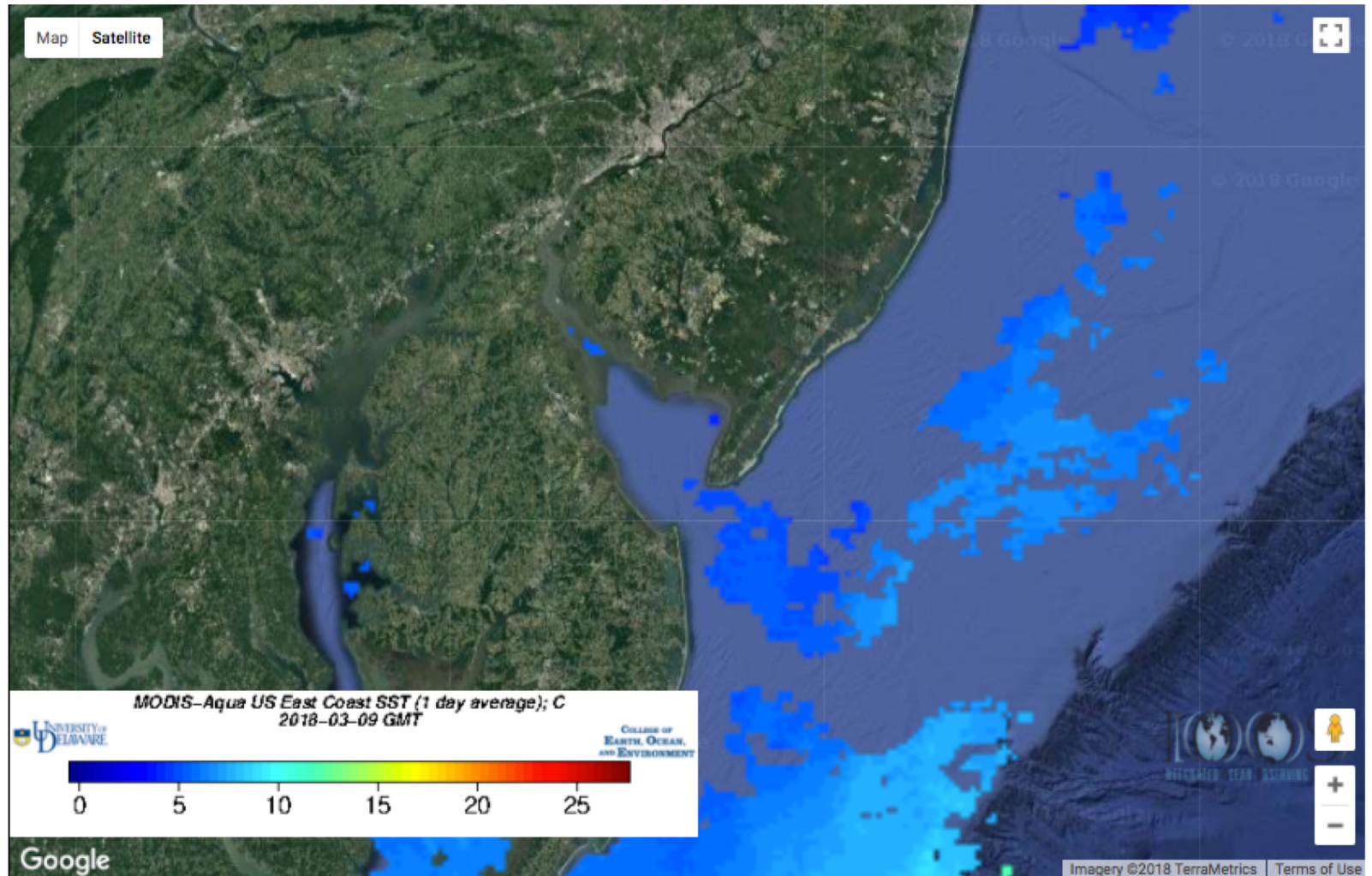
Users

DNREC – Permit Issuance, Enforcement

Gillnet fishers – Avoid fines, avoid costly entanglements
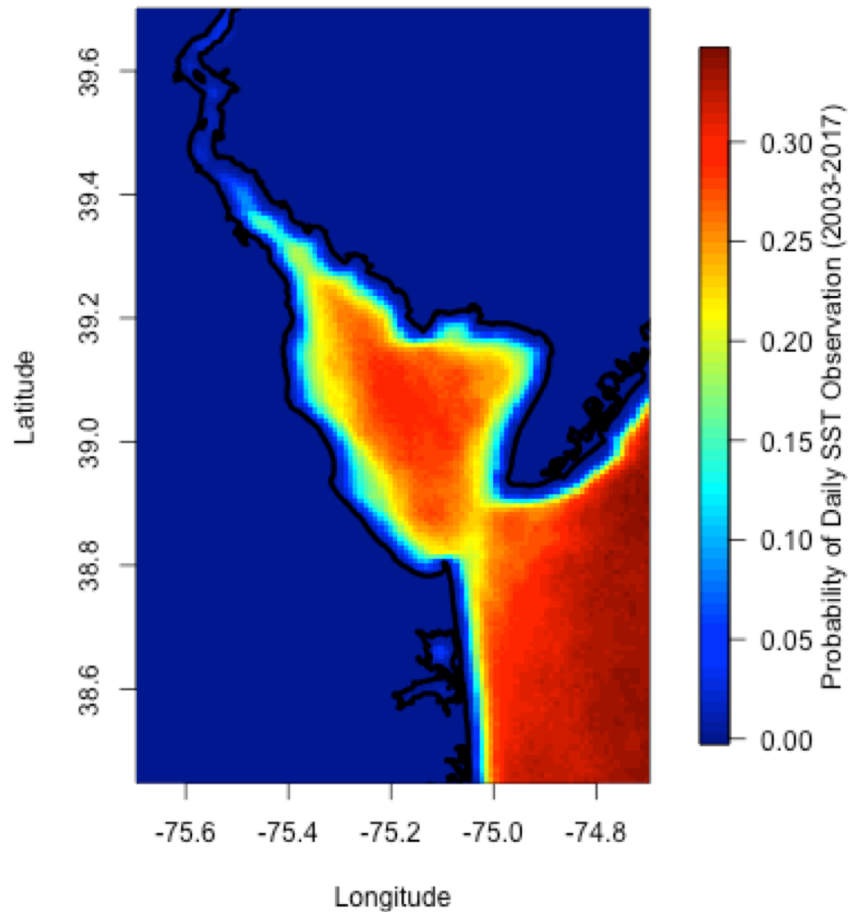
Wind Power Developers

The problem of the availability of satellite data

MODIS-Aqua US East Coast SST (1 day average); C
2018–03–09 GMT

The problem of the availability of environmental data

Daily observations from satellites are rare

Clouds are not random

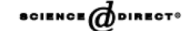Time between passes with > 50% coverage
Mean = 4.83 days
Median = 3.00 days

Gap Filling

DINEOF to gap-fill data
(Data INterpolating Empirical Orthogonal Functions)

Reconstruction of incomplete oceanographic data sets
using empirical orthogonal functions: application to the
Adriatic Sea surface temperature

A. Alvera-Azcárate [a,*], A. Barth [a], M. Rixen [b], J.M. Beckers [a]

[a] GHER, Department of AGO, University of Liège, Allée du 6 Août 17, B5, Sart Tilman, 4000 Liège, Belgium
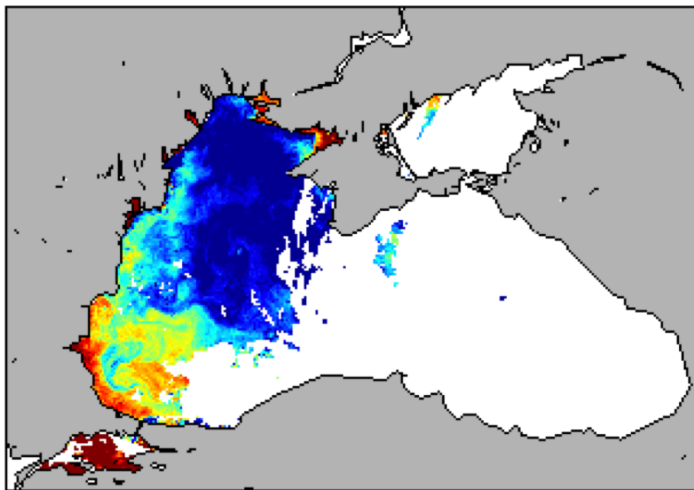[b] NATO/SACLANT Undersea Research Centre, Viale San Bartolomeo 400, 19138, La Spezia, Italy
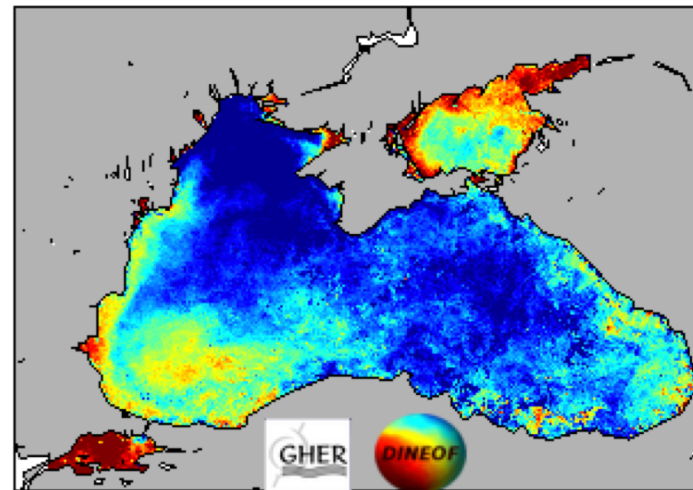
DINEOF daily cloud-free SST of the Black Sea
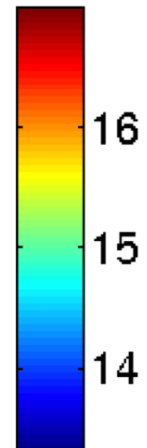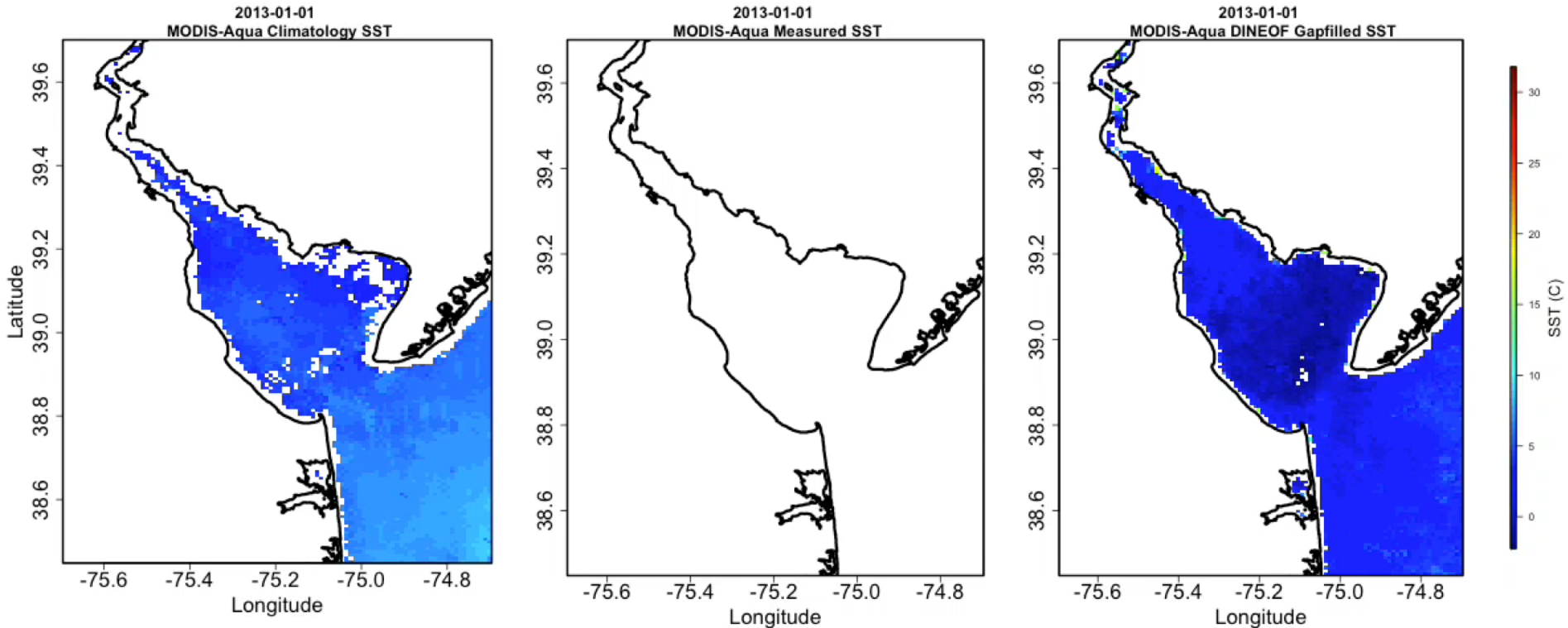
Gap Filling

Gap filled data based on previous 365 days, queried from
http://basin.ceoe.udel.edu/thredds/catalog.html

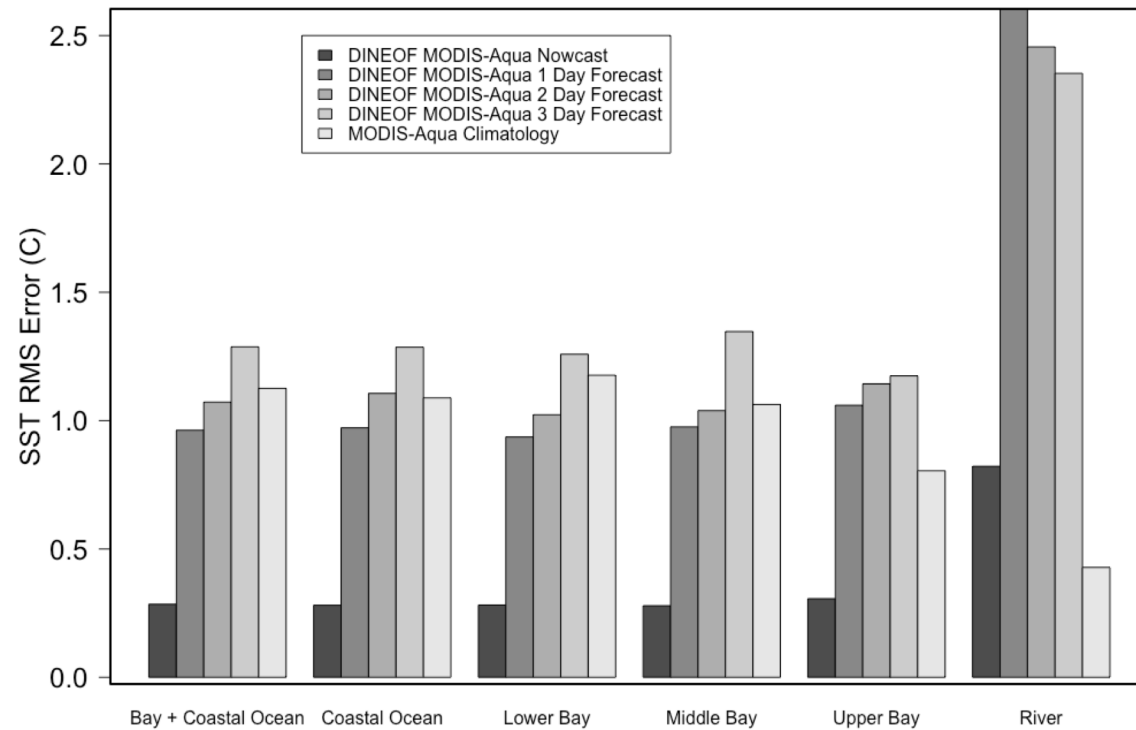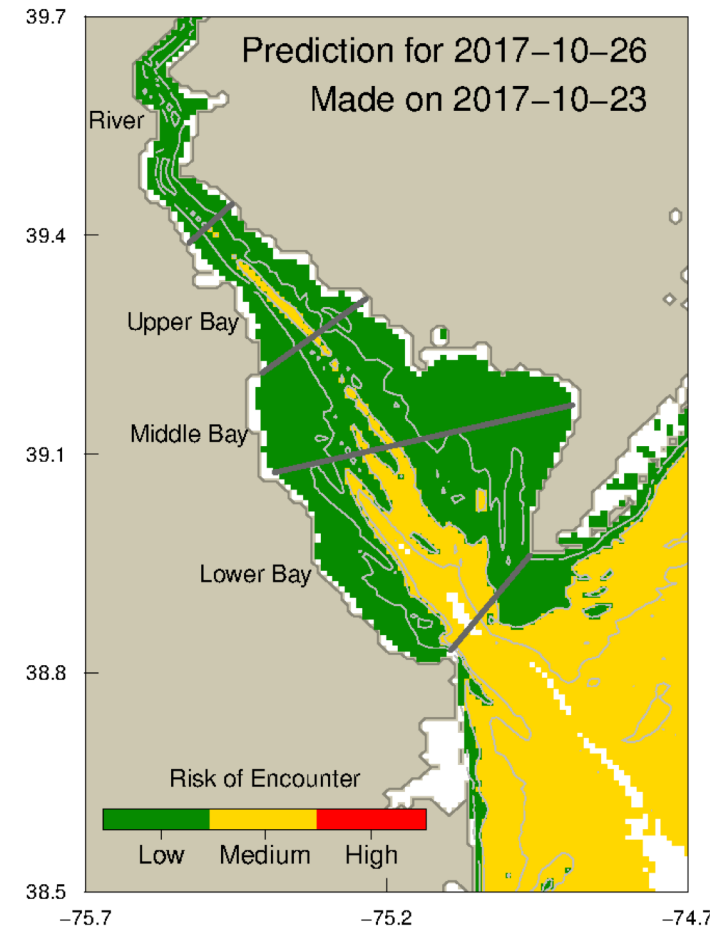# Gap Filling

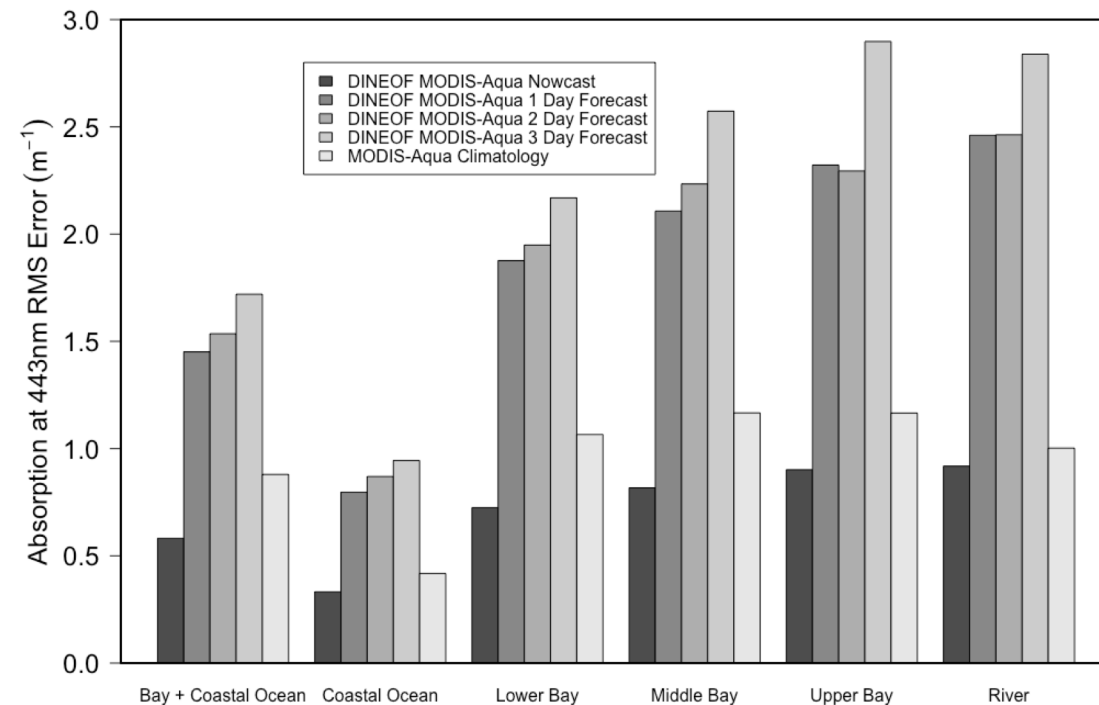Mean Delaware Bay SST
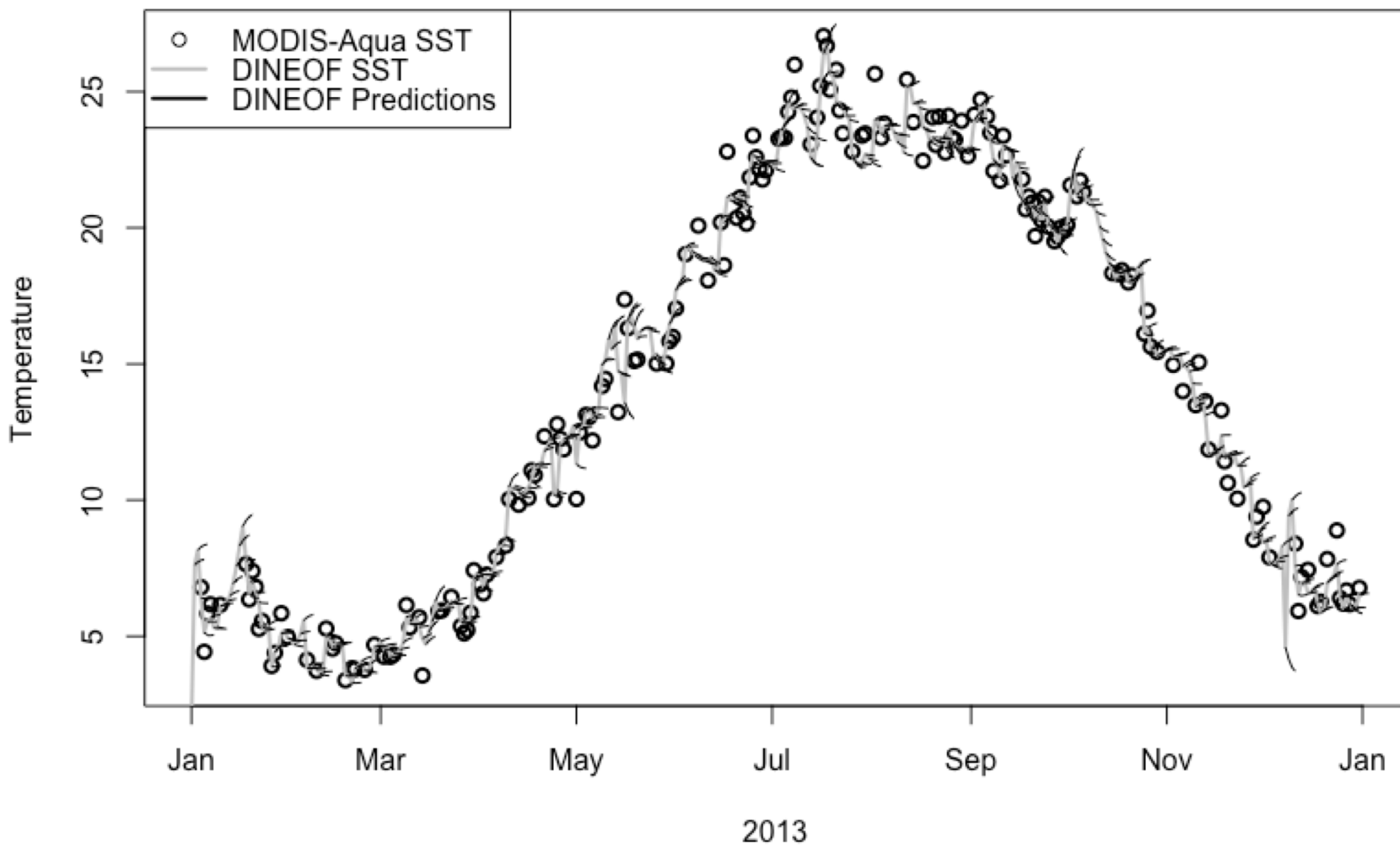
Gap Filling

Compared days with at least 50% coverage

Used it to forecast 3 days in the future.

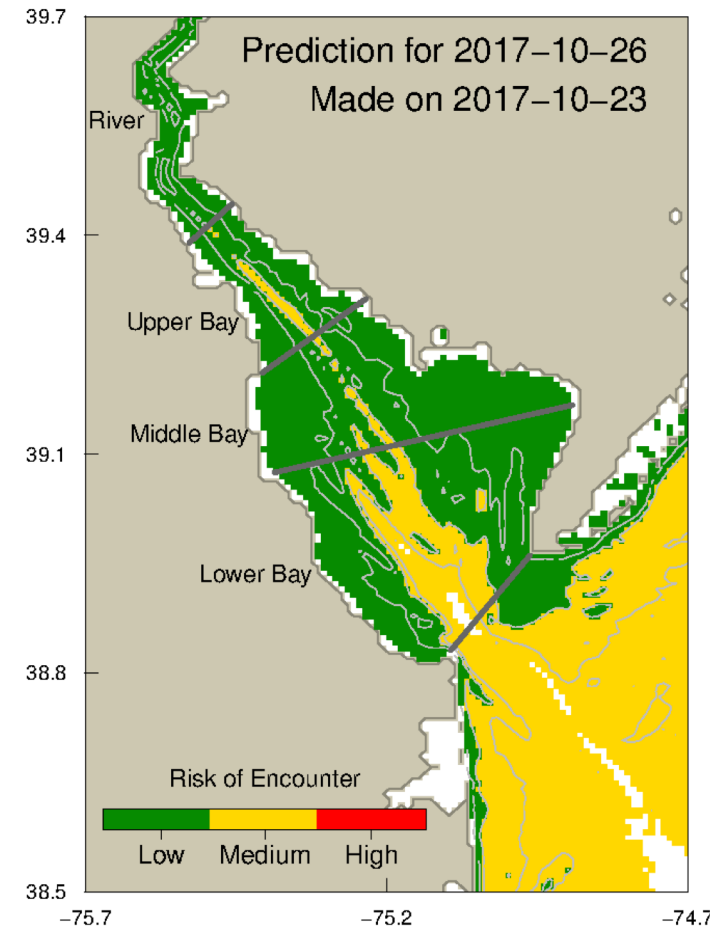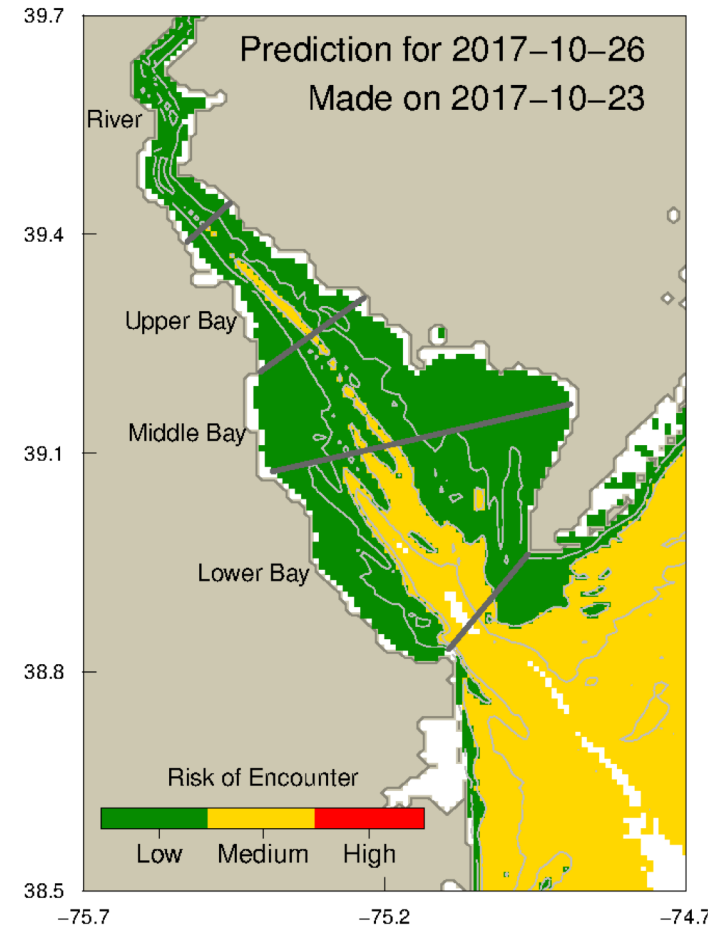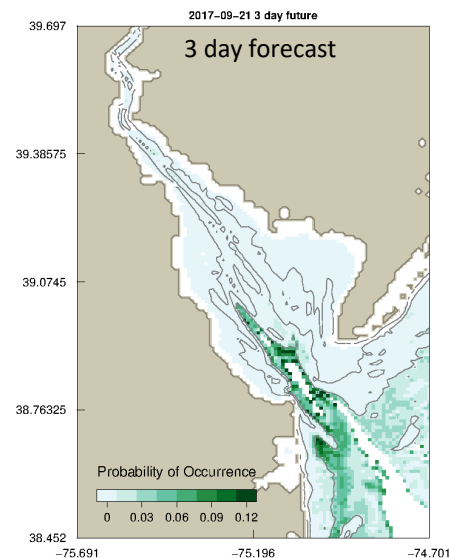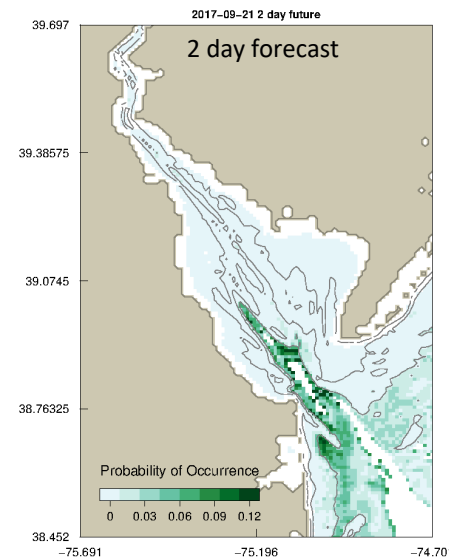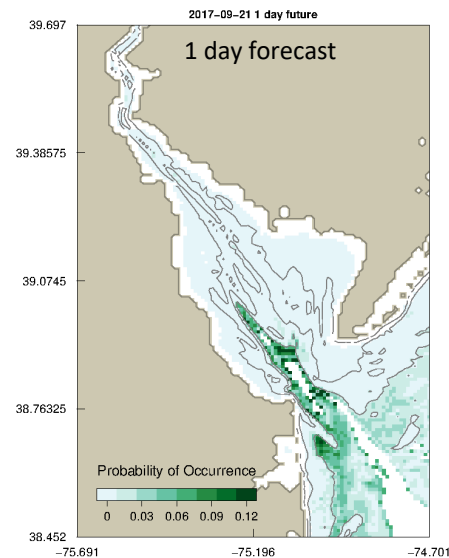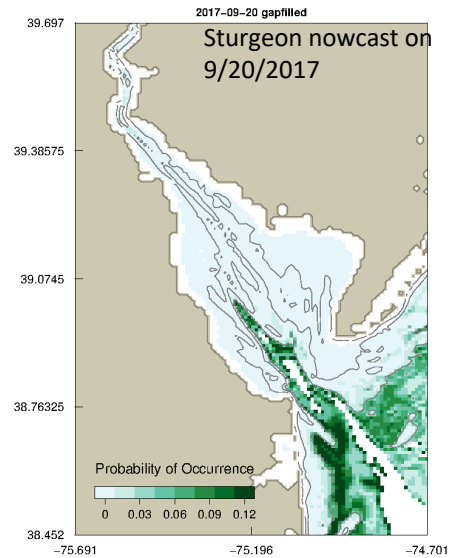# Gap Filling

Compared days with at least 50% coverage

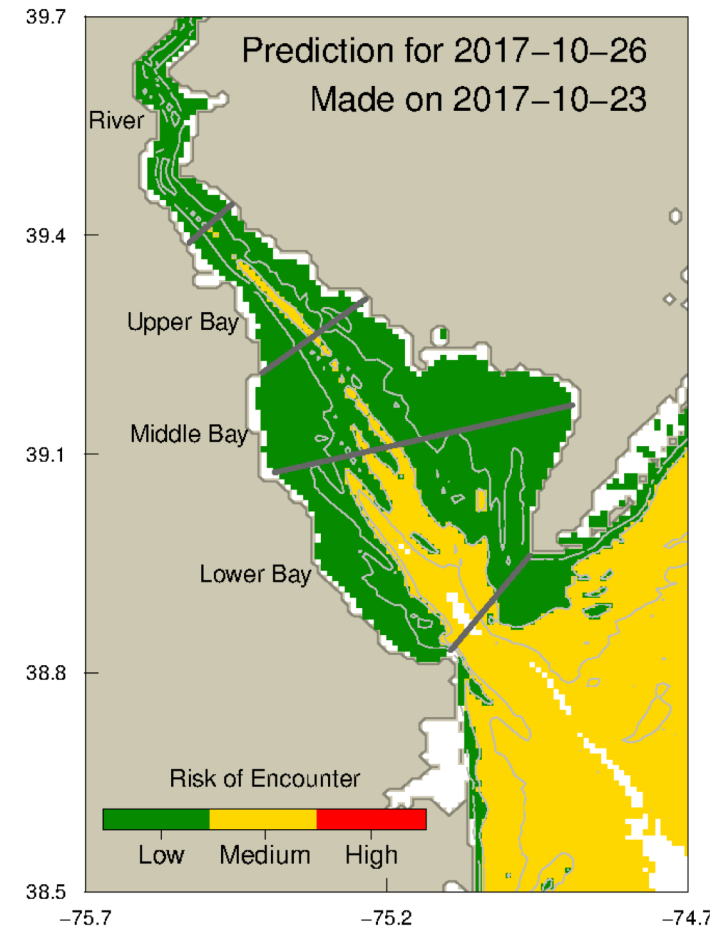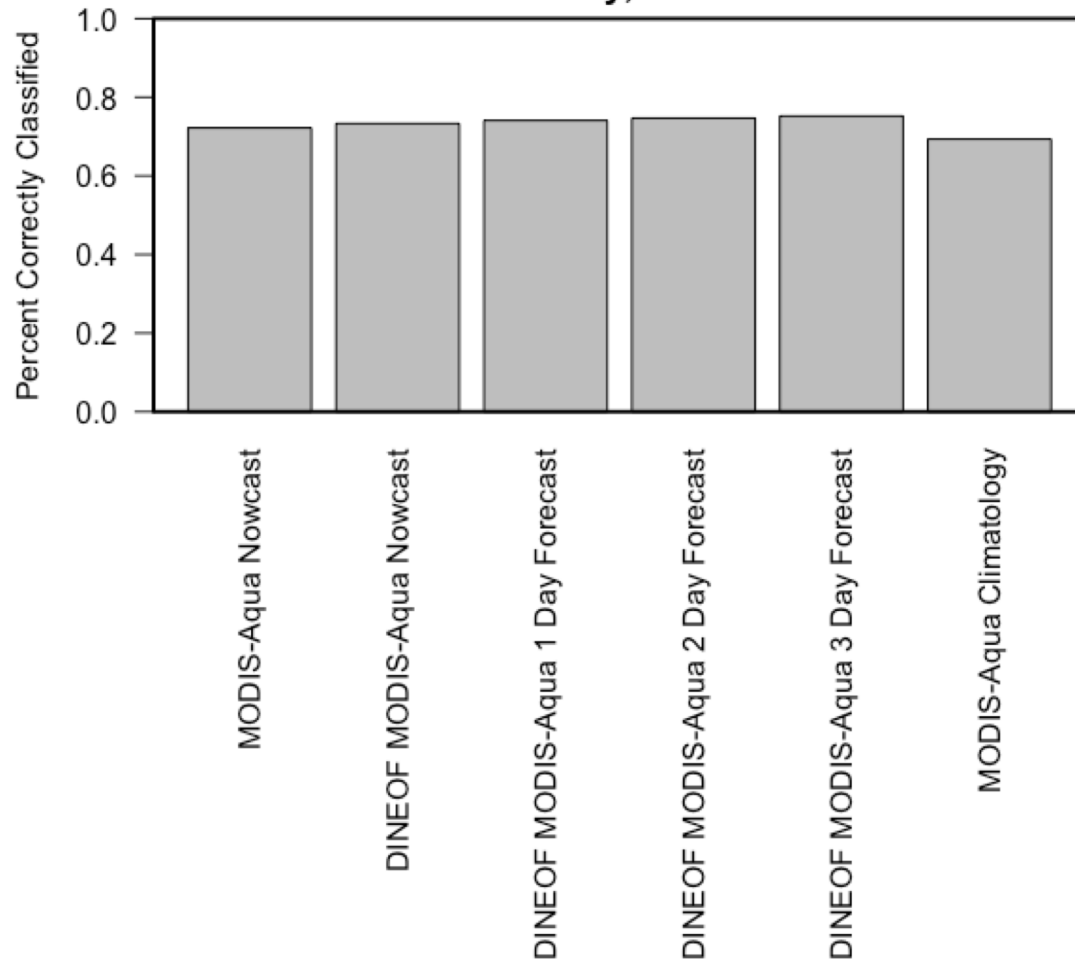Used it to forecast 3 days in the future.

Application

Sturgeon nowcast on 9/20/2017

1 day forecast

2 day forecast

3 day forecast

Prediction for 2017−10−26
Made on 2017−10−23

River

Upper Bay

Middle Bay

Lower Bay

Risk of Encounter

Low   Medium   High

Does it work for sturgeon?

Accuracy
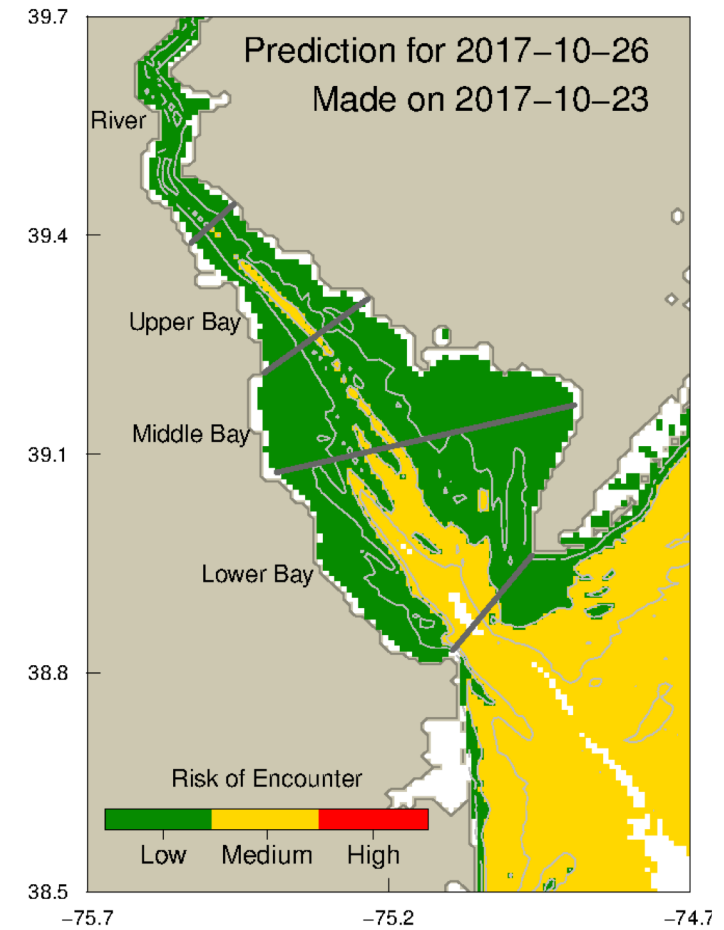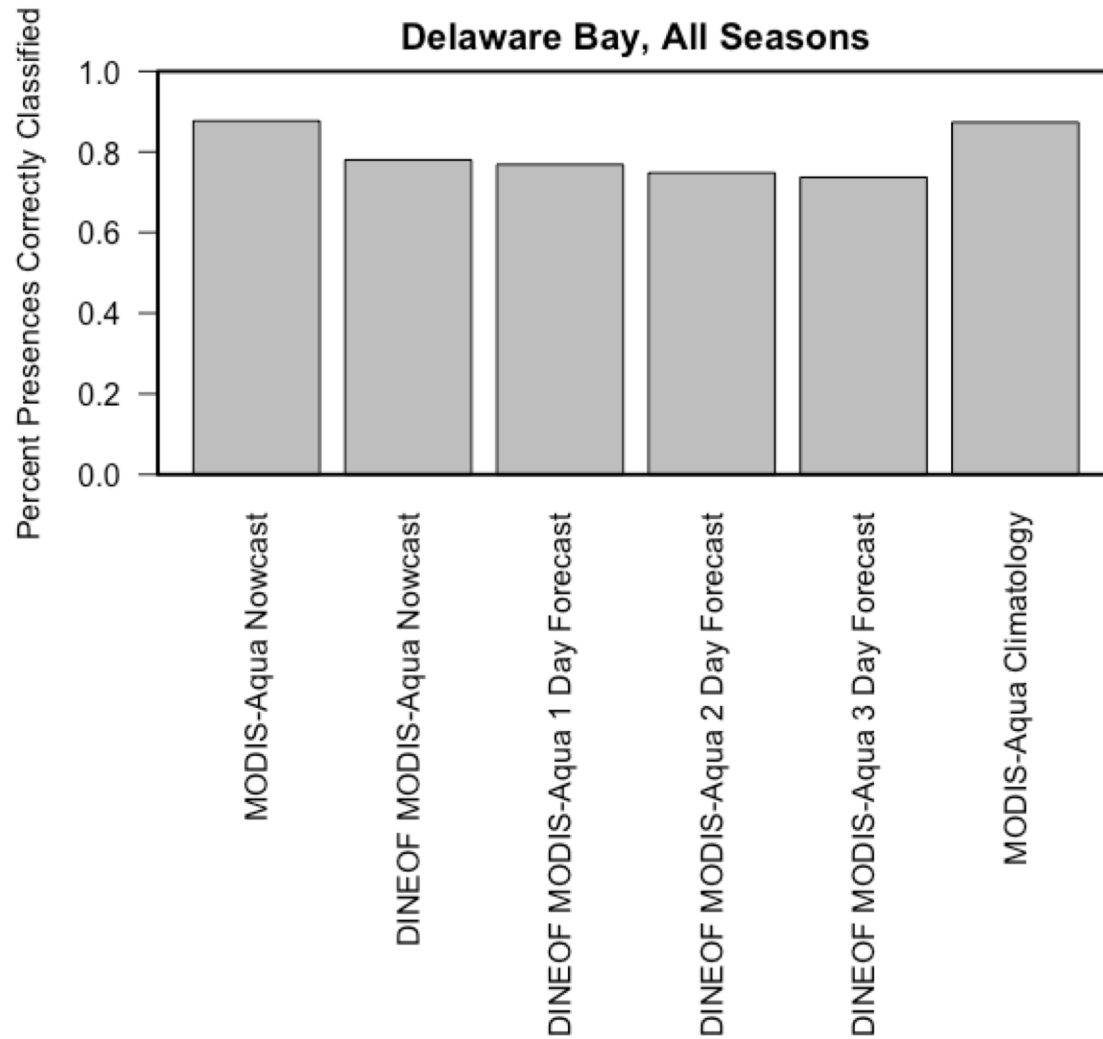
Accuracy

Delaware Bay, All Seasons
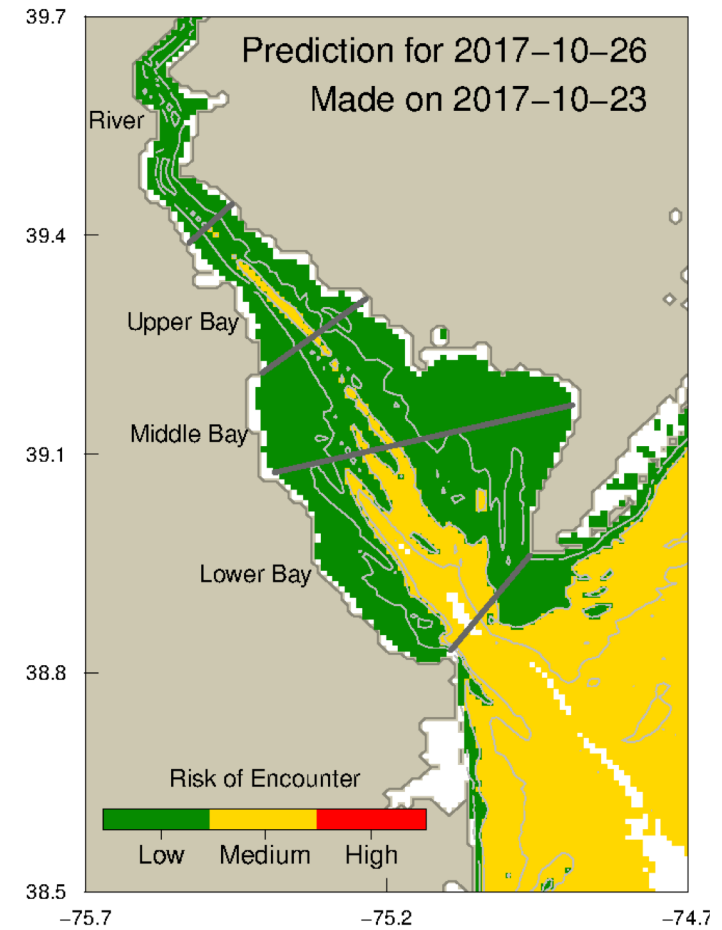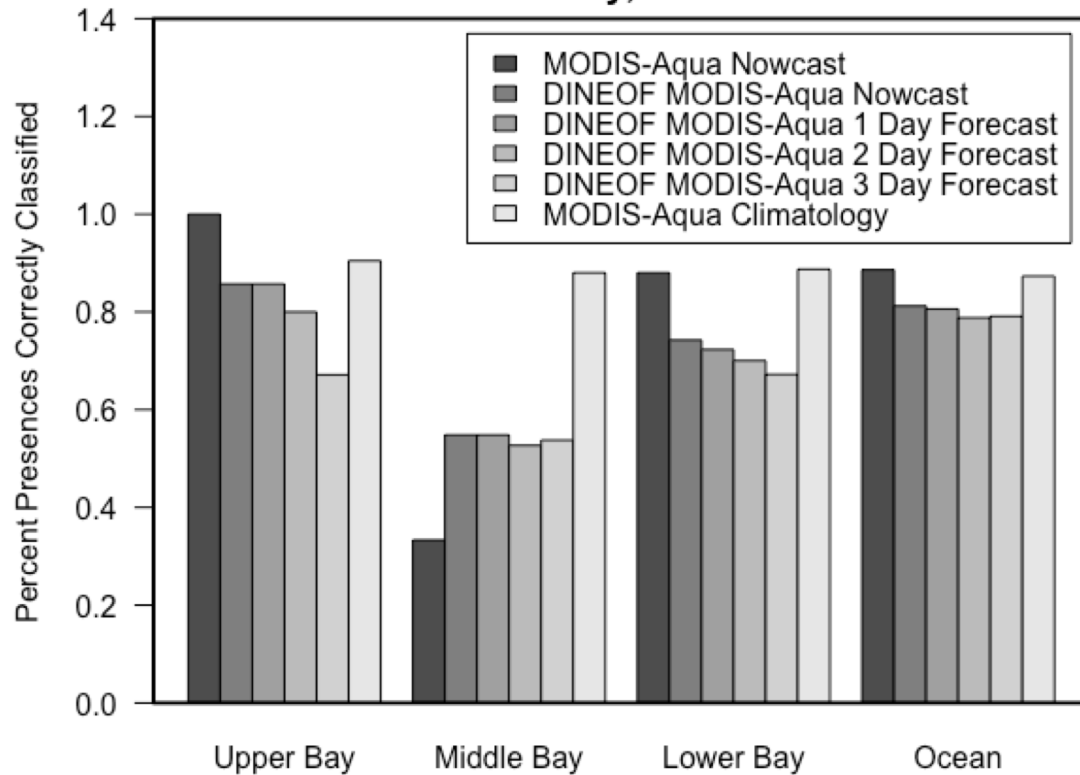
Prediction for 2017−10−26
Made on 2017−10−23

Risk of Encounter

Low   Medium   High

Accuracy

Delaware Bay, All Seasons

Legend:
- MODIS-Aqua Nowcast
- DINEOF MODIS-Aqua Nowcast
- DINEOF MODIS-Aqua 1 Day Forecast
- DINEOF MODIS-Aqua 2 Day Forecast
- DINEOF MODIS-Aqua 3 Day Forecast
- MODIS-Aqua Climatology

Y-axis: Percent Presences Correctly Classified

X-axis: Upper Bay, Middle Bay, Lower Bay, Ocean

Prediction for 2017-10-26
Made on 2017-10-23

River
Upper Bay
Middle Bay
Lower Bay

Risk of Encounter
Low   Medium   High

Application

http://basin.ceoe.udel.edu/shiny/sample-apps/sturgeon/
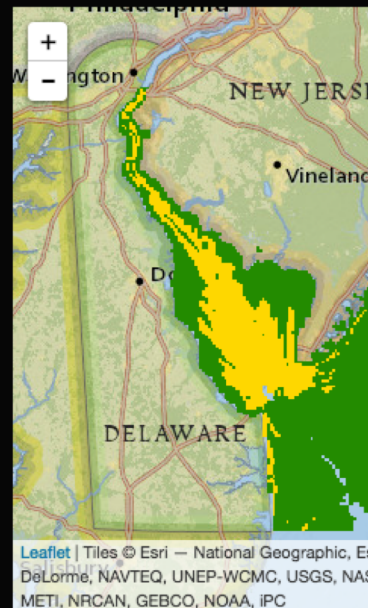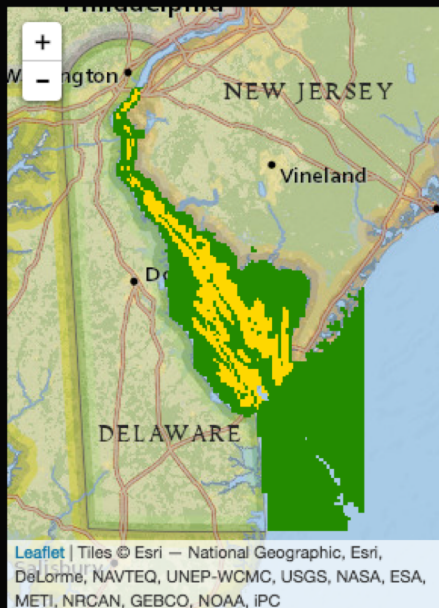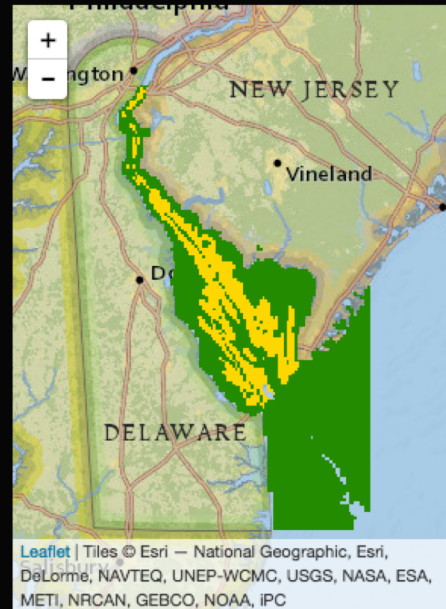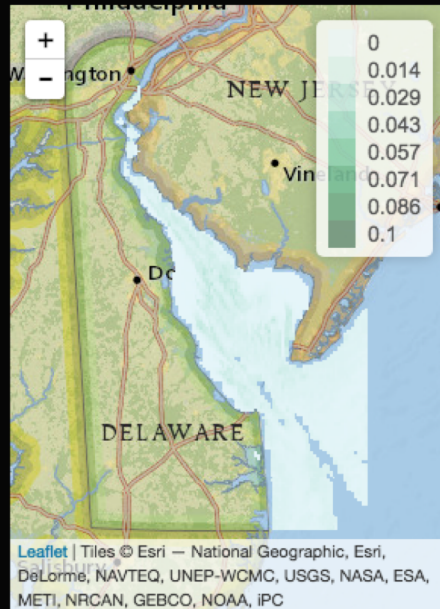
Application

From left to right, these maps display the Categorical Risk of Encounter, Continuous Probability of Occurrence, Gapfilled Sea Surface Temperature, and Risk Climatology for the date selected. You can choose a forecast for probability and temperature, see tab 1 for Risk Forecasts.
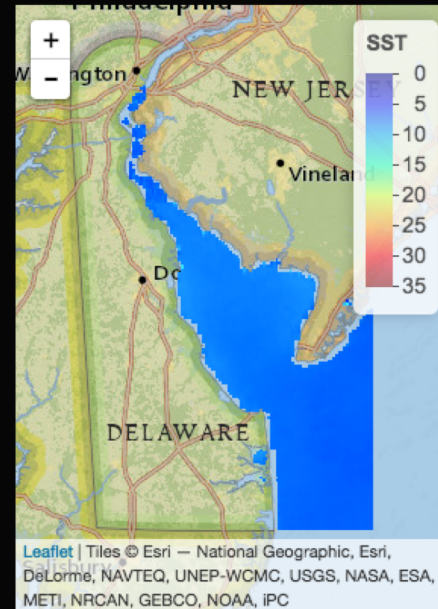
Risk Categories
2018-04-10

Continuous Model Prediction

0
0.014
0.029
0.043
0.057
0.071
0.086
0.1

Sea Surface Temperature

SST
0
5
10
15
20
25
30
35

Risk Climatology for Selected Date

Leaflet | Tiles © Esri — National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC

Select a Date for Predictions

2018-04-10

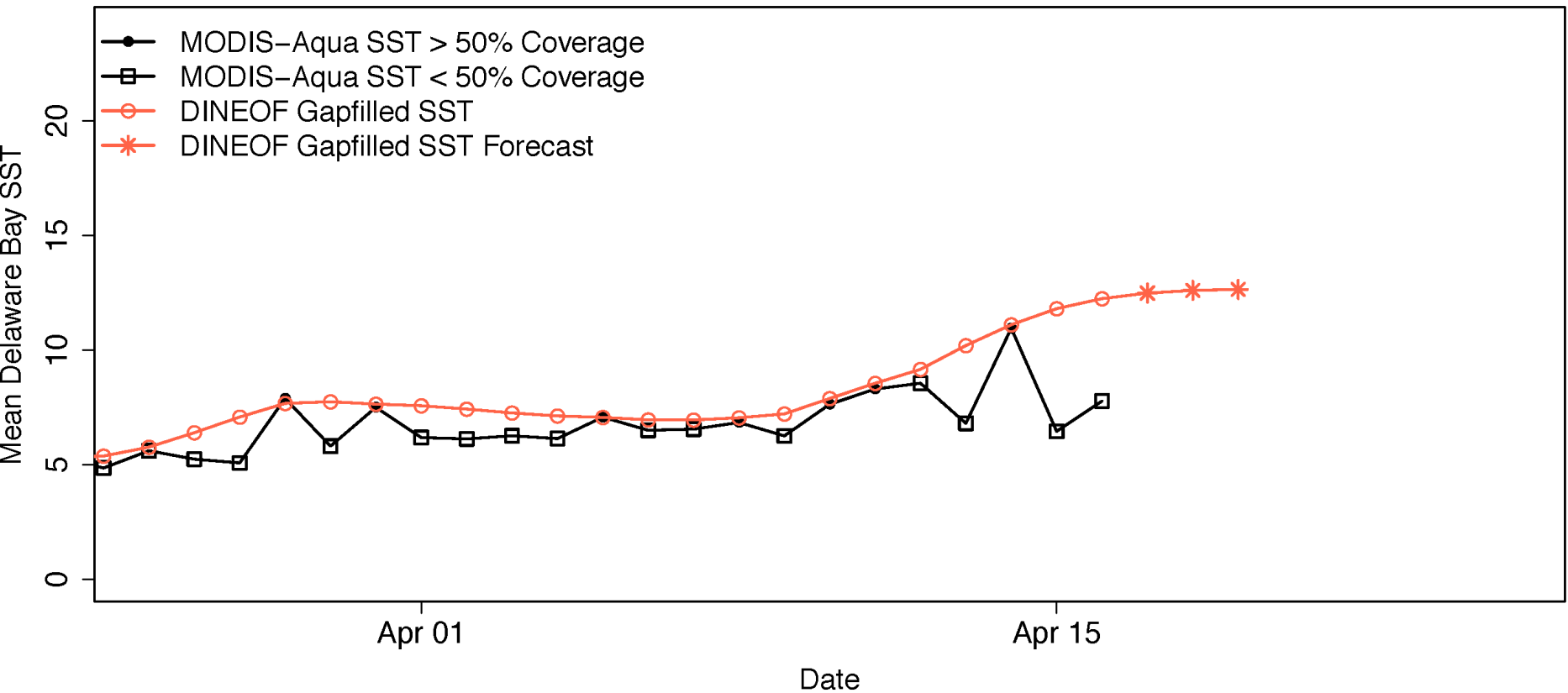**Select a Forecast to Plot**

Current

Select a Forecast to Plot

Current

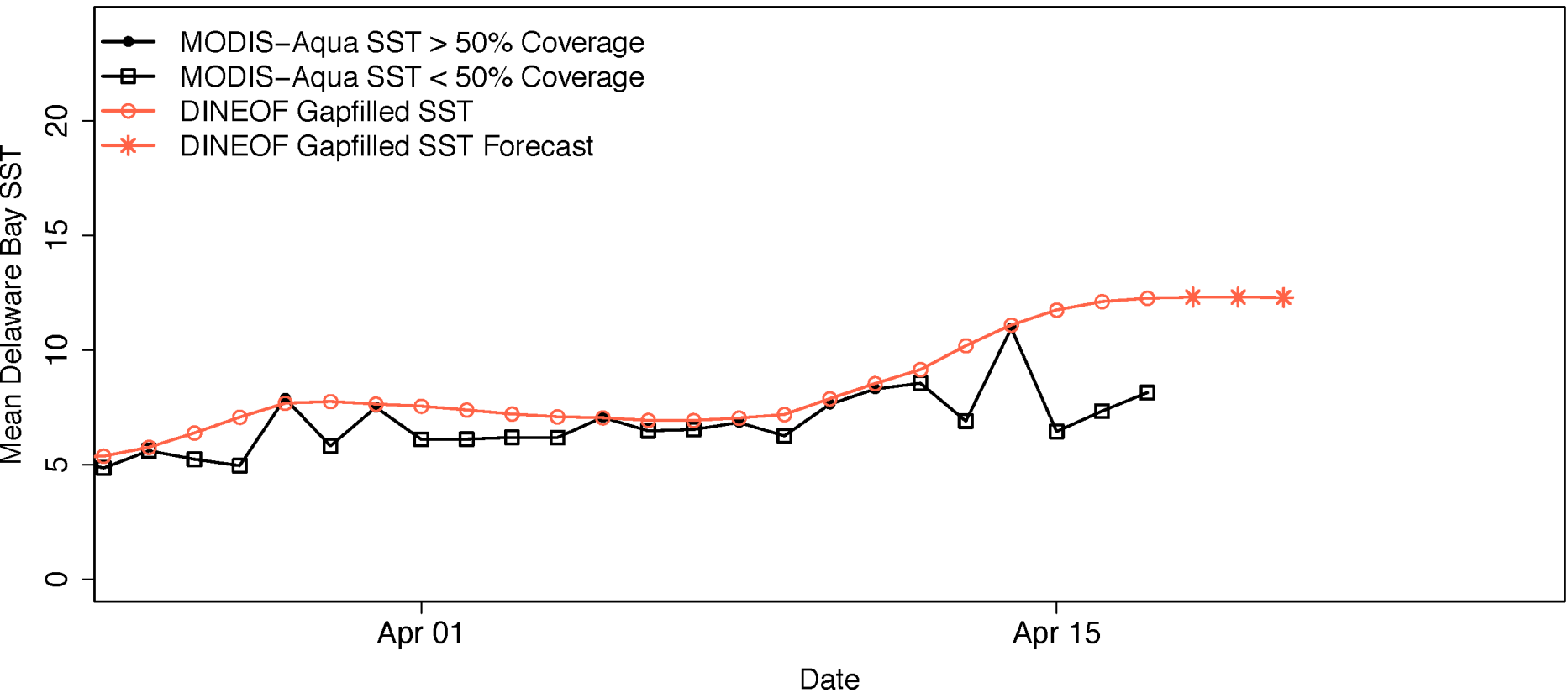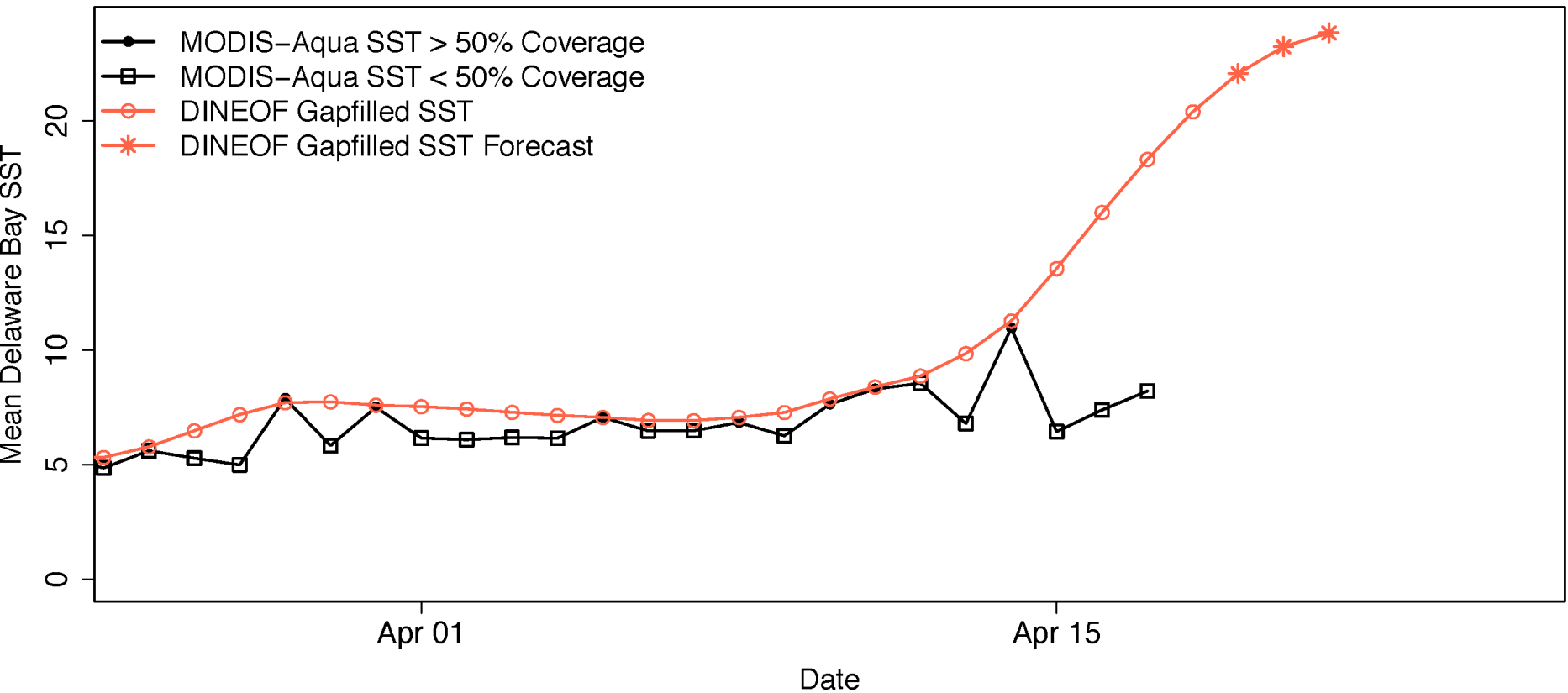Data used is available here

Bugs and Uh-ohs
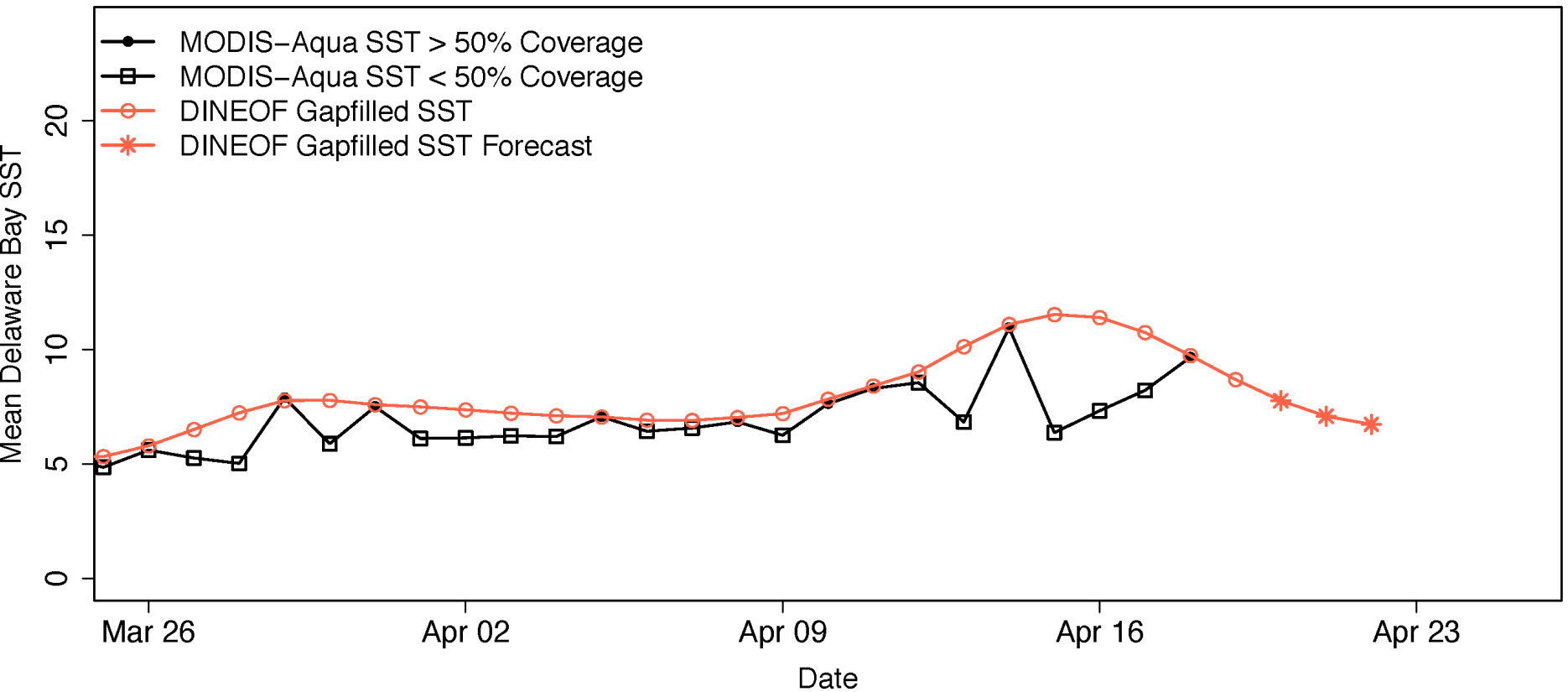

April 16, 2018

Bugs and Uh-ohs

April 17, 2018

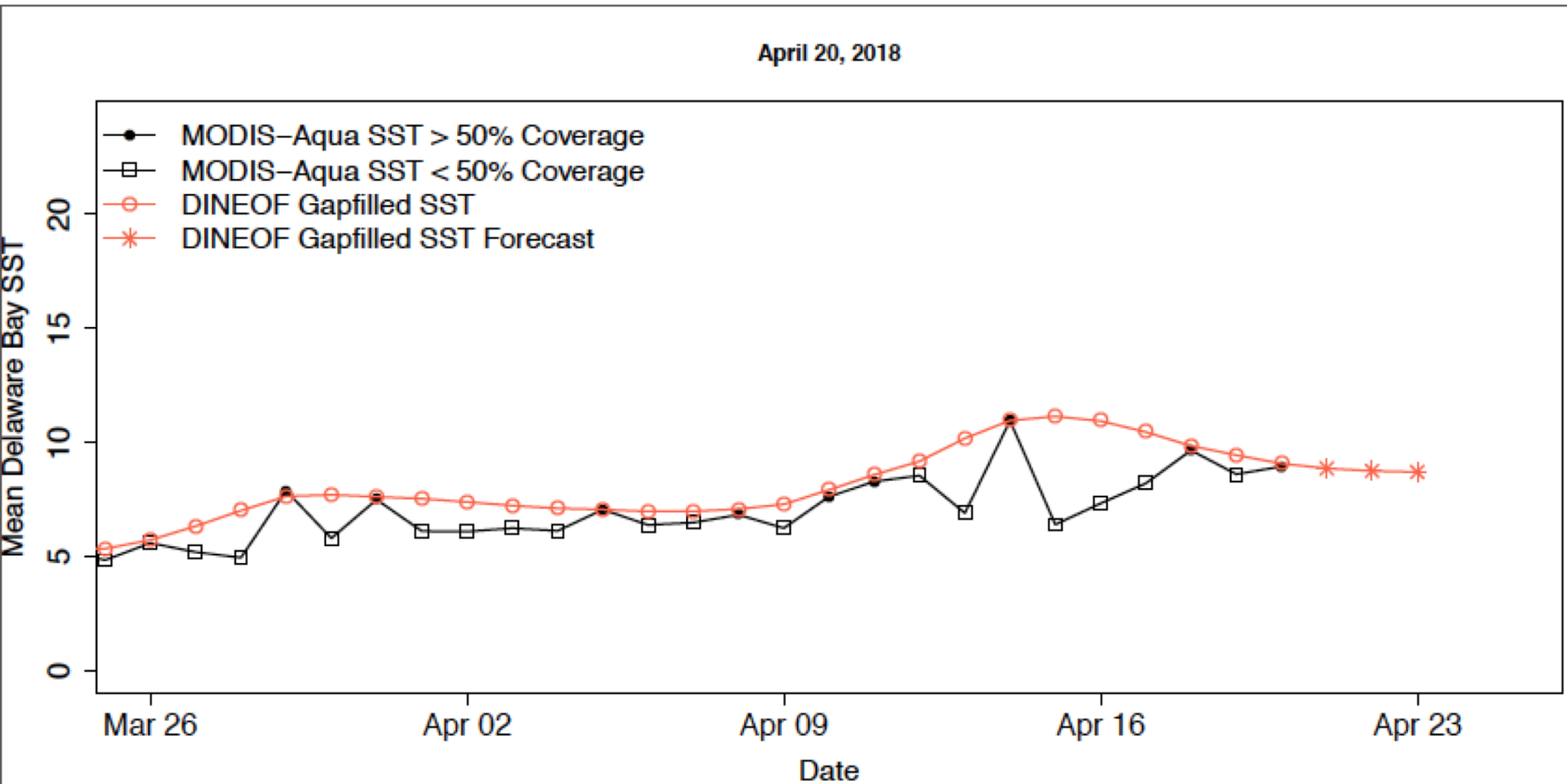# Bugs and Uh-ohs

April 18, 2018

Bugs and Uh-ohs

April 19, 2018

Legend:
- MODIS–Aqua SST > 50% Coverage
- MODIS–Aqua SST < 50% Coverage
- DINEOF Gapfilled SST
- DINEOF Gapfilled SST Forecast

Y-axis: Mean Delaware Bay SST

X-axis: Date

Bugs and Uh-ohs

April 20, 2018

Outreach and Coverage

Presented to:

Atlantic States Marine Fisheries Council

Delaware Tidal Fin Fish Advisory Council

New Jersey Marine Fisheries Council

18 Users (fishers and state biologists)

Covered by Local Cable (KJWP2-TV) and NPR Stations (WDDE)

NOAA Office of Protected Resources Web Ex

Responding to Users

Developing a Time of Year (TOY) permit restriction display

Transitioning to NPP and JPSS