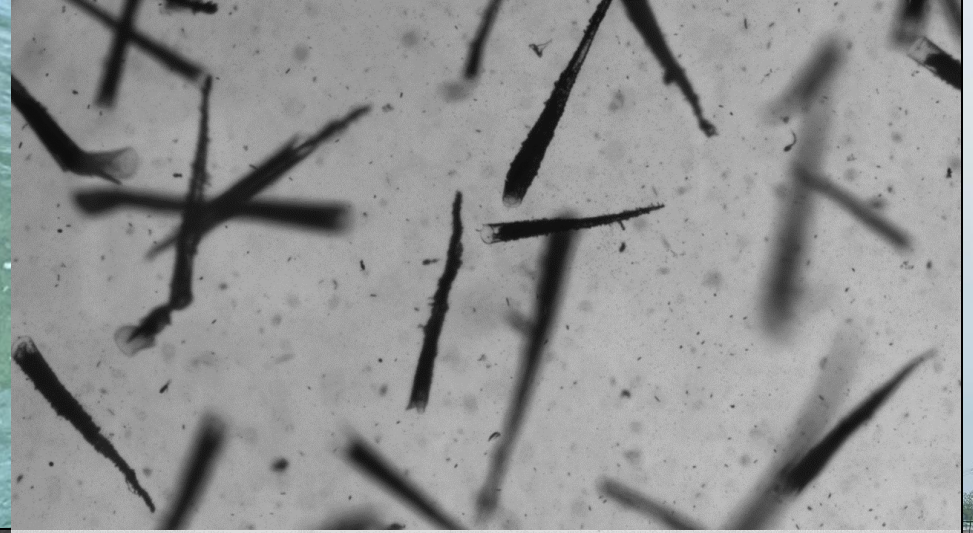
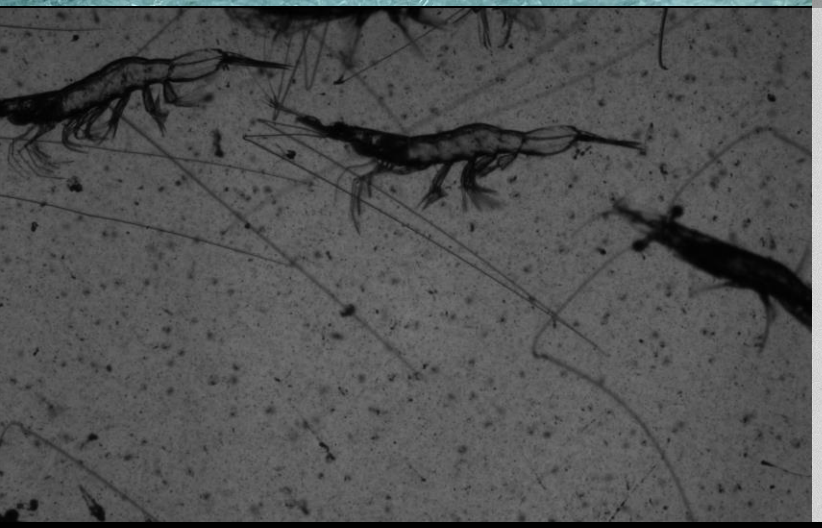




Unveiling the impact of winter storm on the dynamics of zooplankton populations in shallow estuaries

Hongsheng Bi, Jian Zhao, Wenjing Liu

University of Maryland
Center for Environmental Science

CONTENTS

1 Background

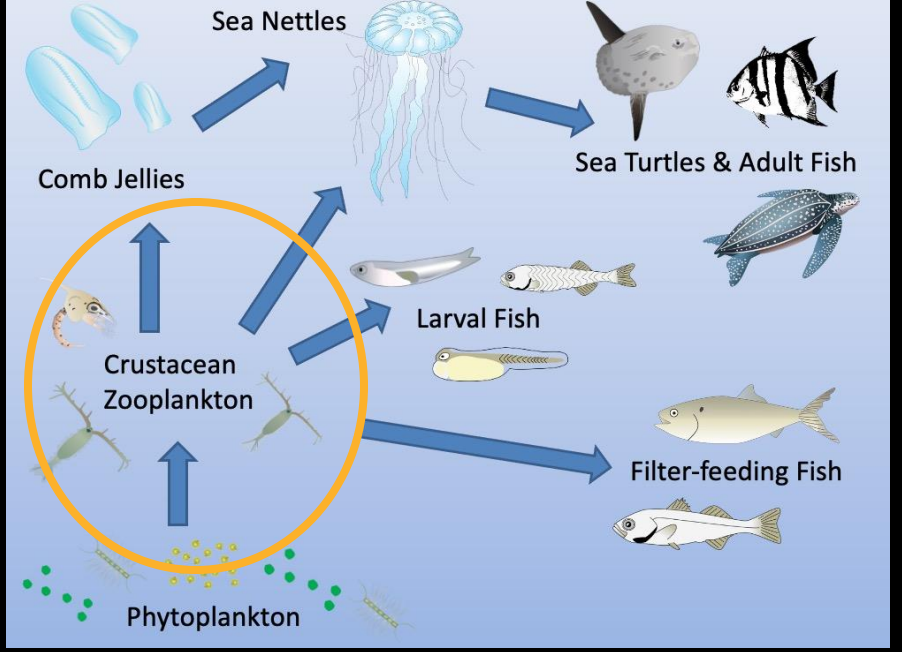
2 PlanktonScope & Image Processing

3 Deployment & Plankton dynamics

4 From monitoring to prediction: possible?

Importance of Plankton

Source: IAN



- Base for the marine food web
  - Ichthyoplankton & forage fish, e.g., critical period hypothesis
  - Affecting global fisheries
  - Ecosystem structure and functions, e.g., junk-food hypothesis
- In the Chesapeake Bay, the large copepod Eurytemora is a key prey for striped bass larvae, and their abundance and timing can affect the recruitment of striped bass

Source: CBP

- Excellent indicators for integrated ecosystem and climate assessment

Plankton Sampling

Net sampling

Discrete in time

Integrative in space

In situ imaging system

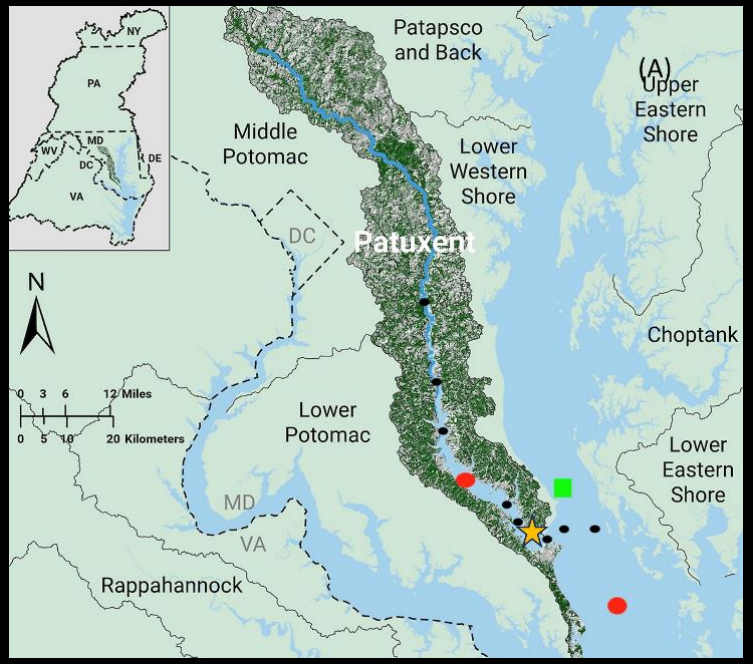
- No clogging or reduced filtering efficiency
- Nonintrusive, no damage to fragile organisms
- High spatial and temporal resolution
- Simultaneous measurements on a suite of plankton groups
- Size, behavior, bloom status etc.

02

PART TWO

PlanktonScope

Image Analysis



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CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

YPlanktonDetection3.11

Records

Train

Detect

Parameter

Curve

Stop

Exit

Reserve2

OutputMessage

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Detecting Img:20231021093124704.jpeg
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This data does not enter the database!
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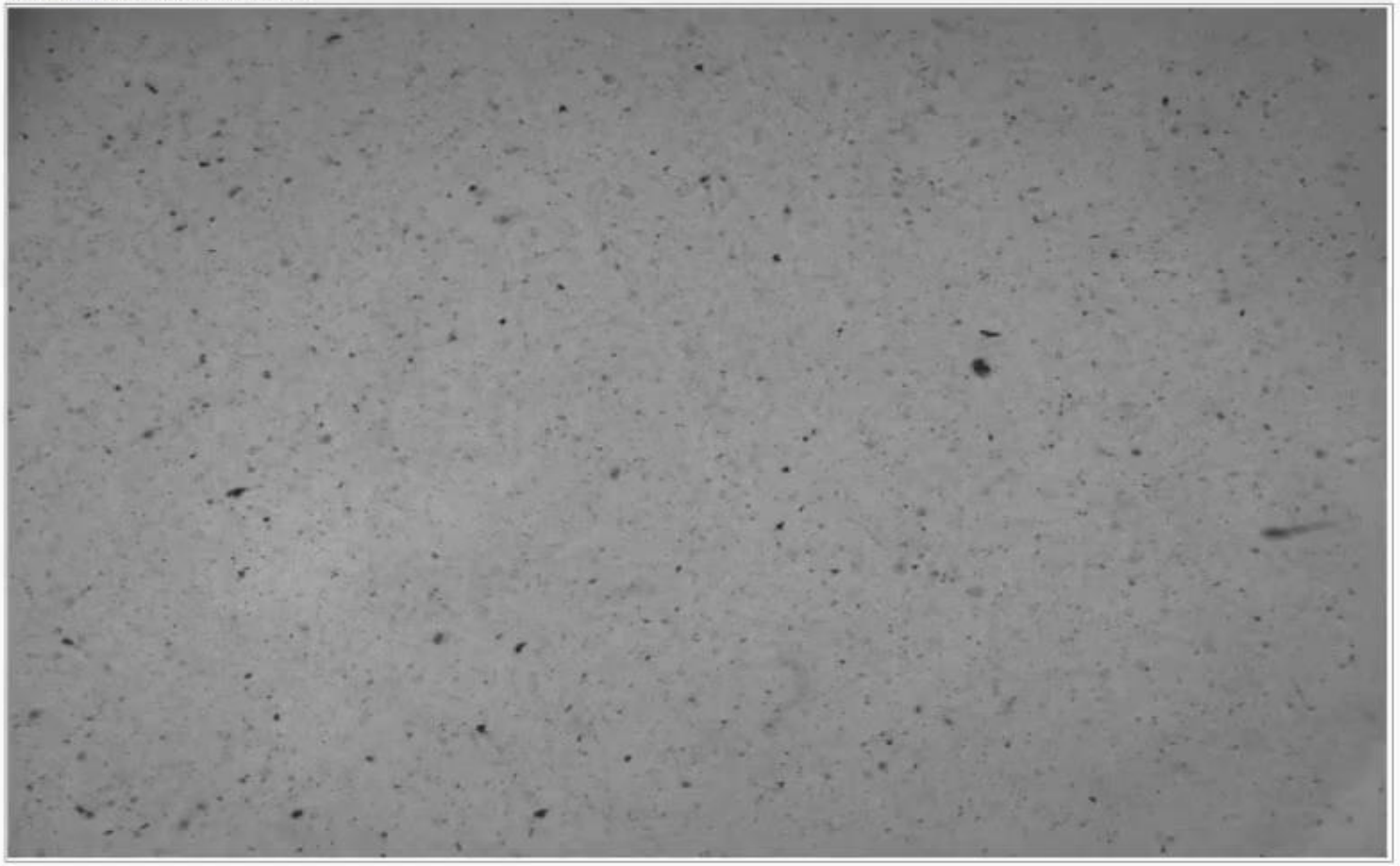
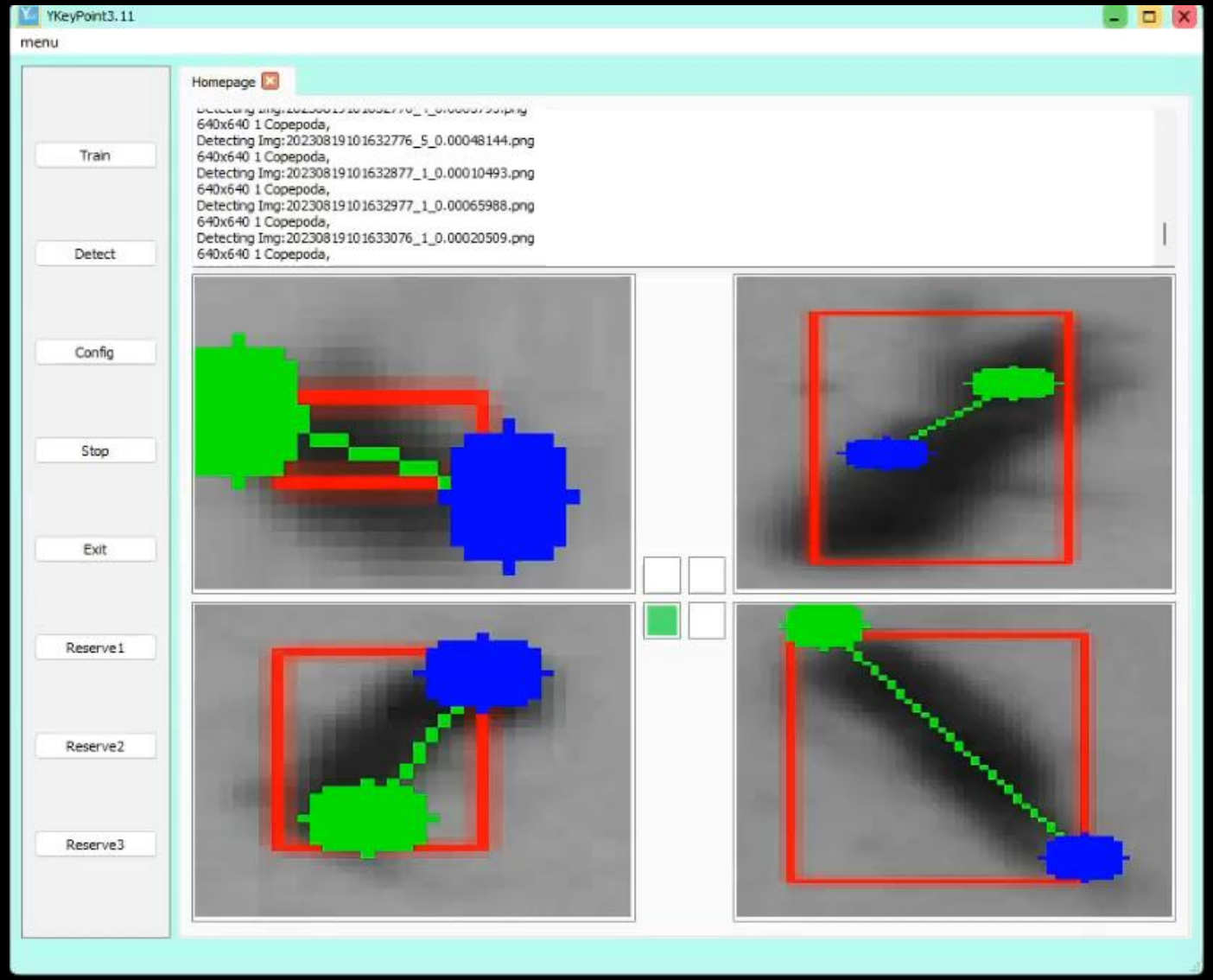


PlanktonScope

PlanktonScope



True value (ImageJ)

Measured value (Key point)

Difference

	A	B	G
91	15.70211	16.17	0.029798
92	28.12548	28.71	0.020782
93	33.75	34	0.007407
94	22.94754	23.3	0.015359
95	28.18499	28.85	0.023594
96	32.60383	31.77	0.025575
97	22.1109	22.89	0.035236
98	33.38345	33.75	0.01098
99	23.4375	23.27	0.007147
100	23.44265	23.54	0.004153
101			0.023422

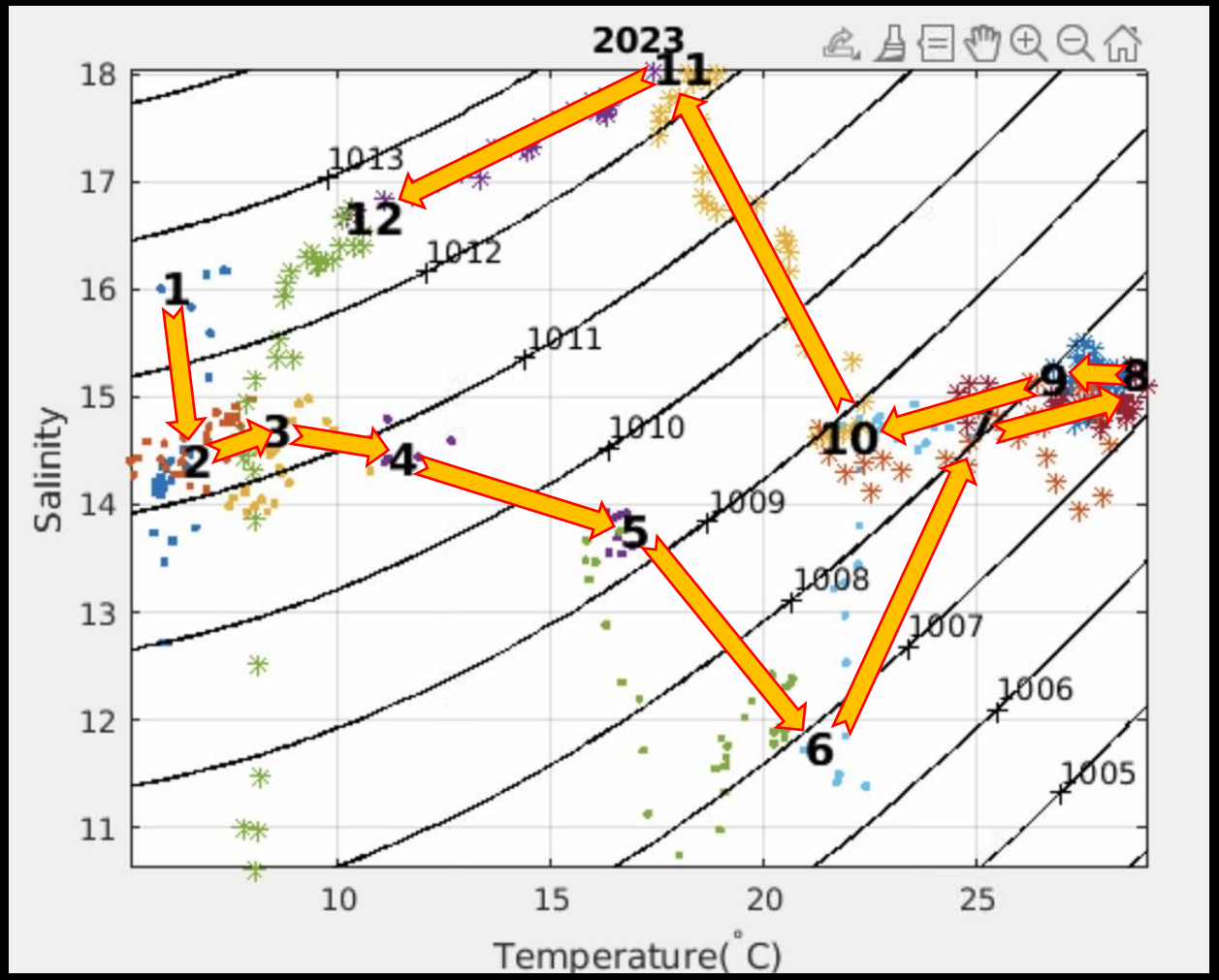
Mean error : **2.34%**

03

PART THREE

Deployment

Plankton dynamics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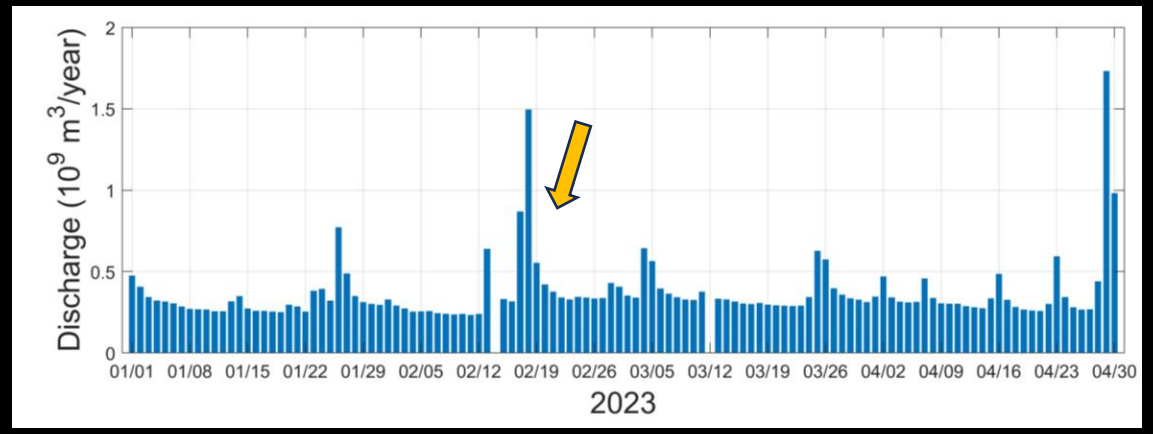
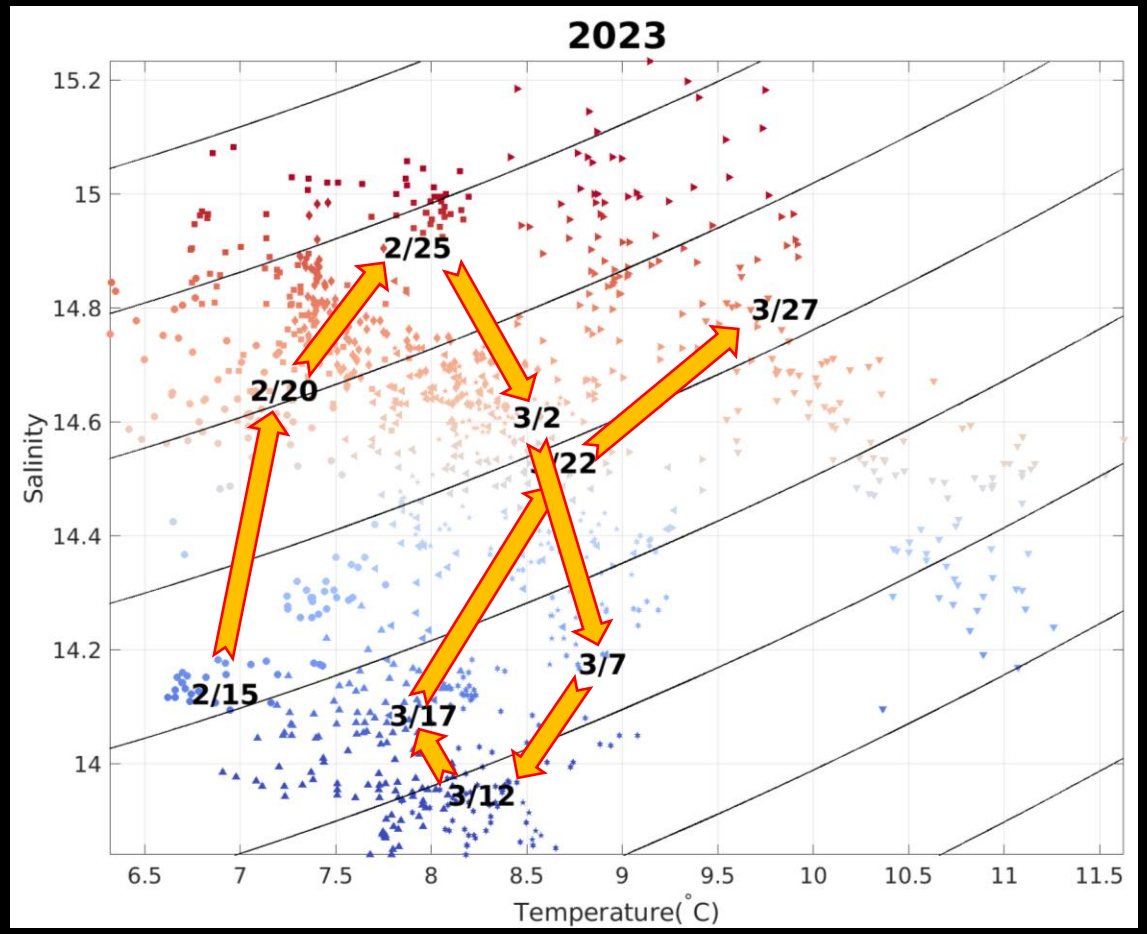
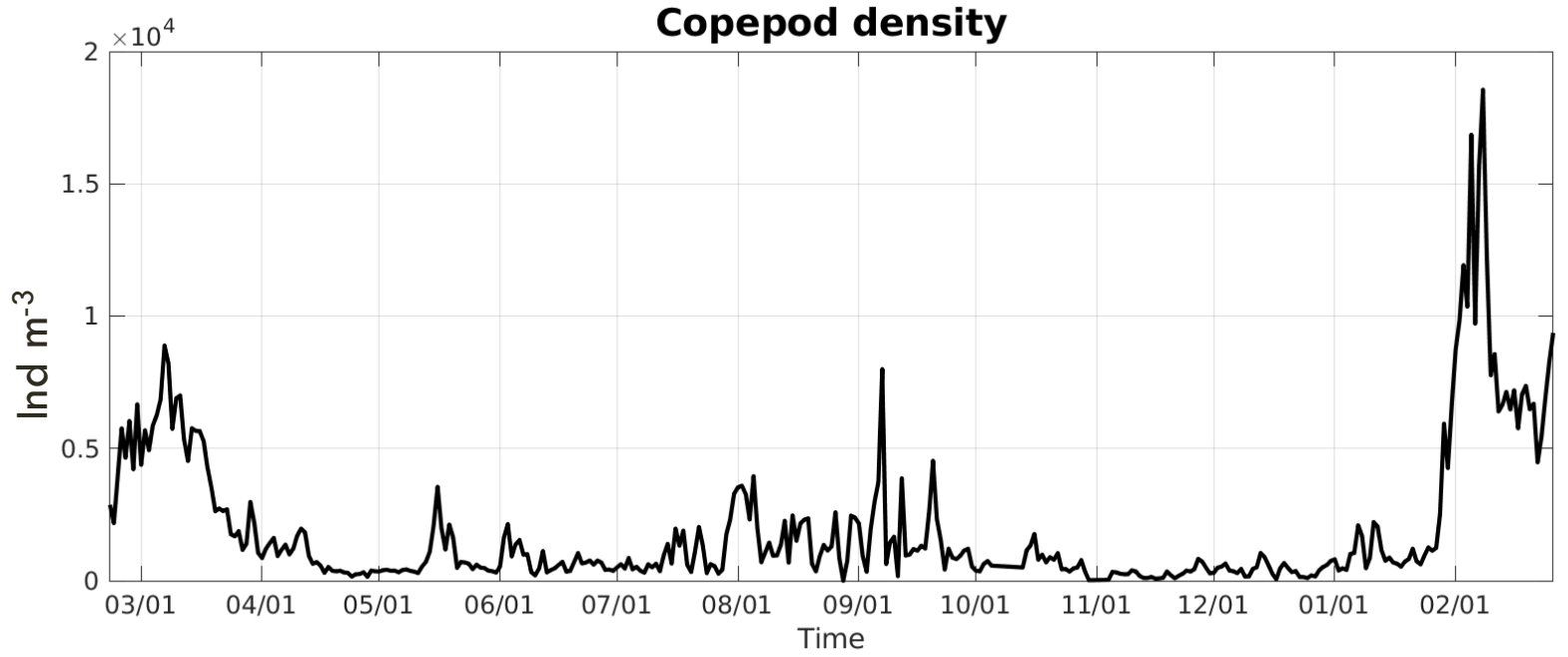
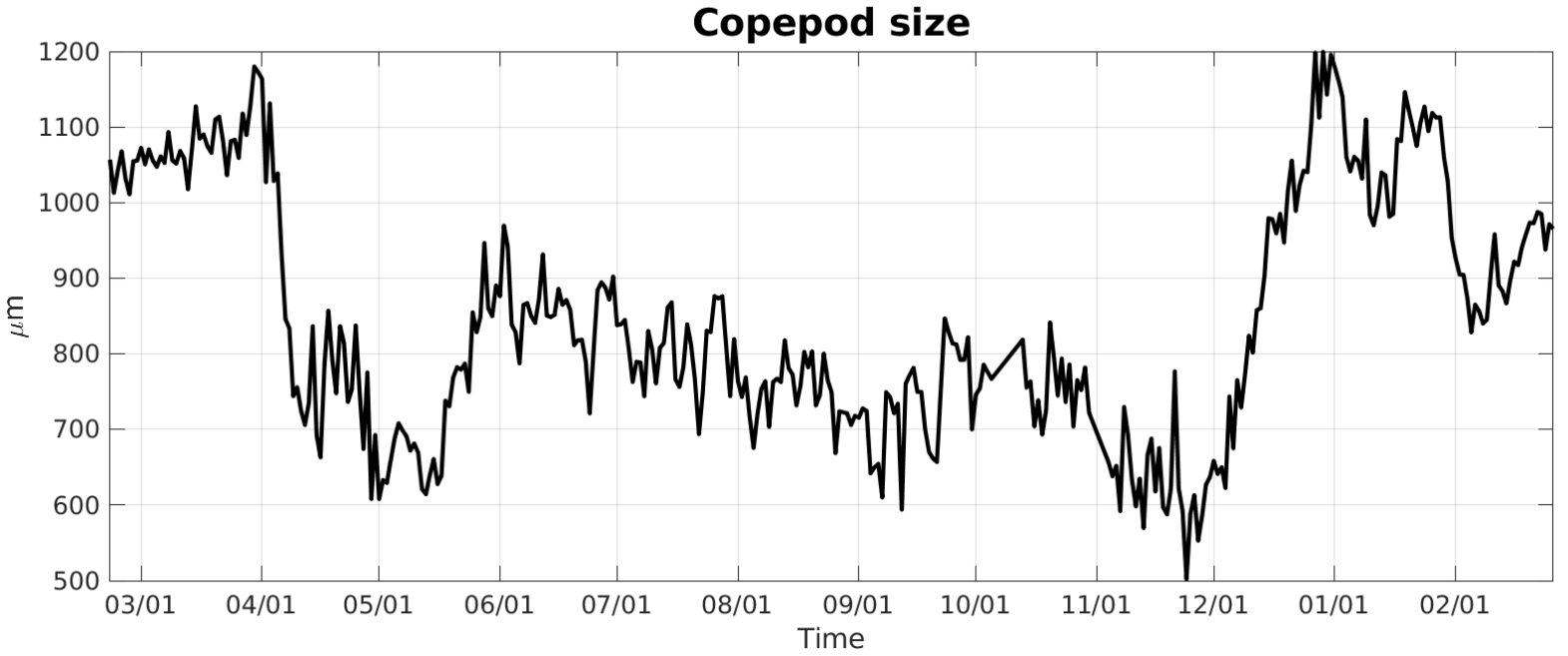
Salinity
Temperature(°C)
1
2
3
4
5
6
7
8
9
10
11
12
1013
1012
1011
1010
1009
1008
1007
1006
1005

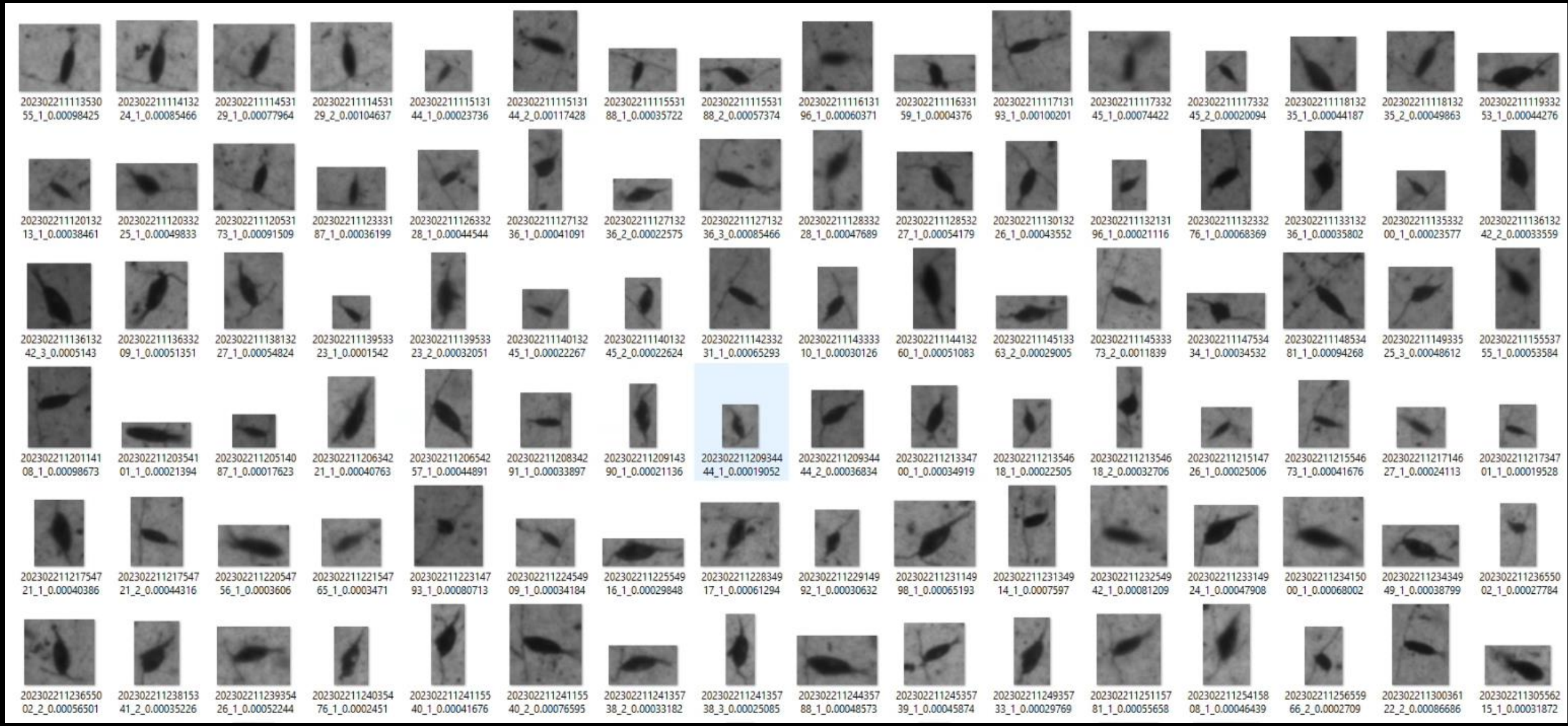

Discharge (10^9 m^3/year)
2023
01/01 01/08 01/15 01/22 01/29 02/05 02/12 02/19 02/26 03/05 03/12 03/19 03/26 04/02 04/09 04/16 04/23 04/30


2023
Salinity
Temperature(°C)
2/15
2/20
2/25
3/2
3/7
3/12
3/17
3/22
3/27

Chesapeake Bay: Winter Zooplankton



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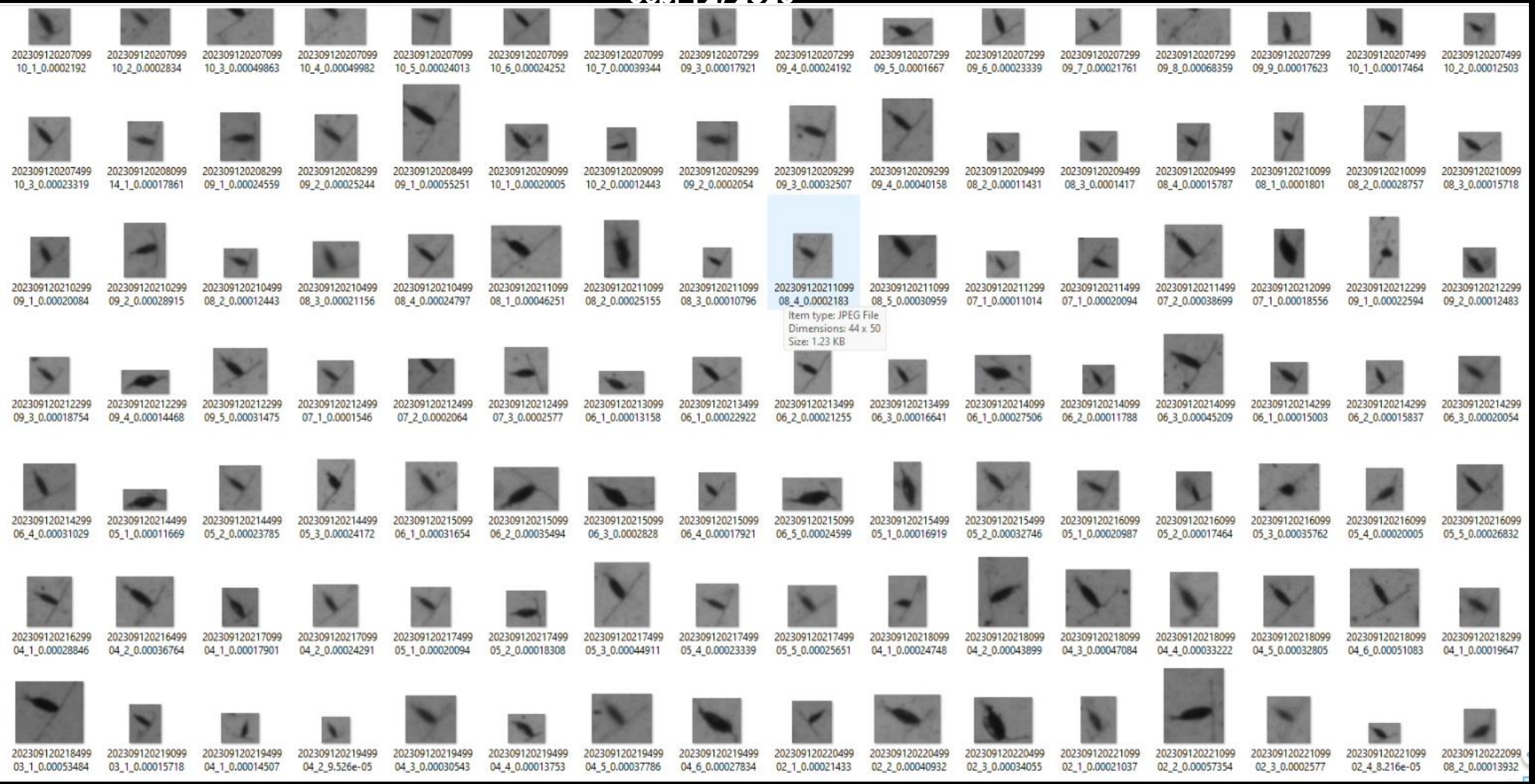
Feb 21, 2023

Sept 12, 2023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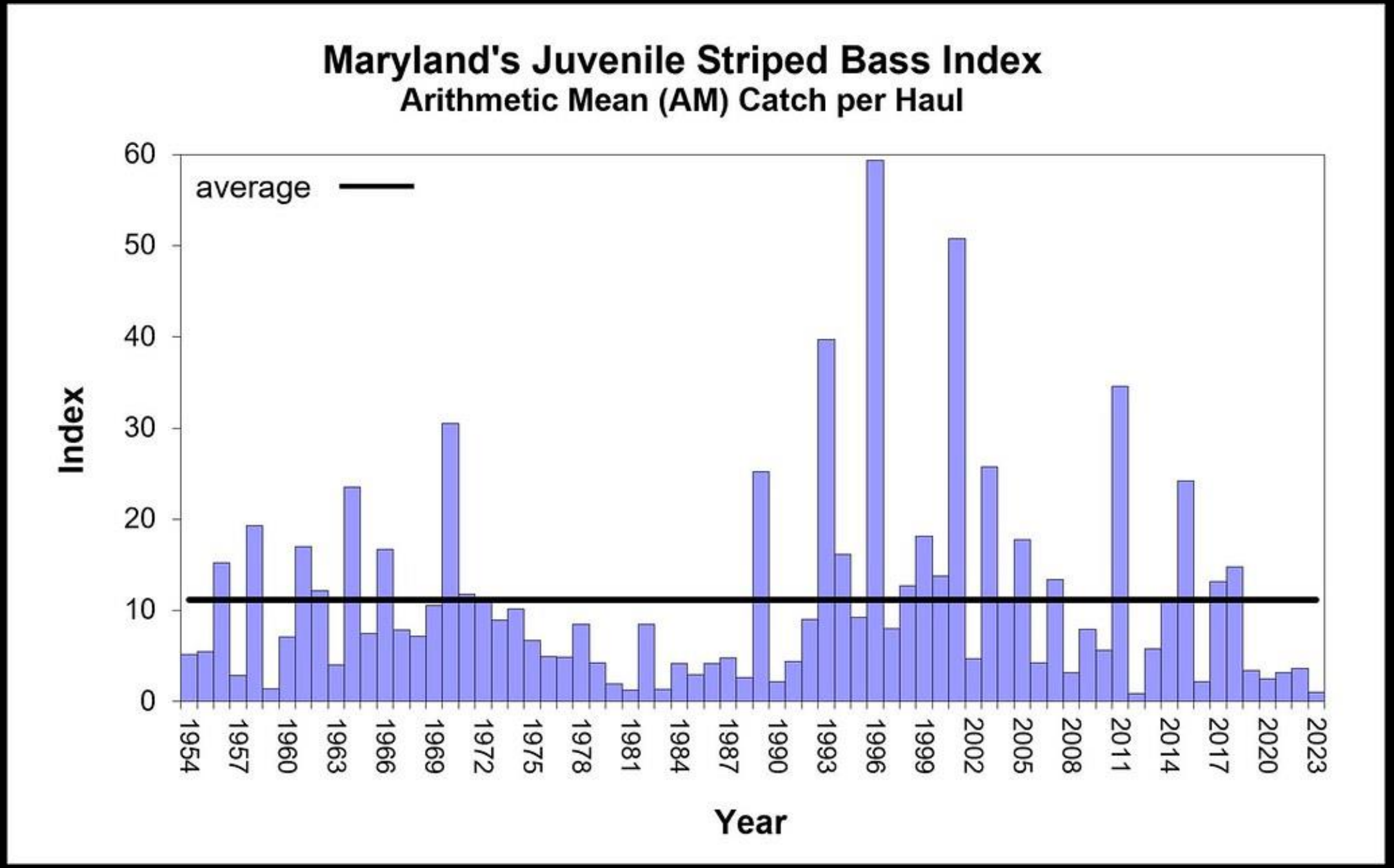


Maryland DNR

04

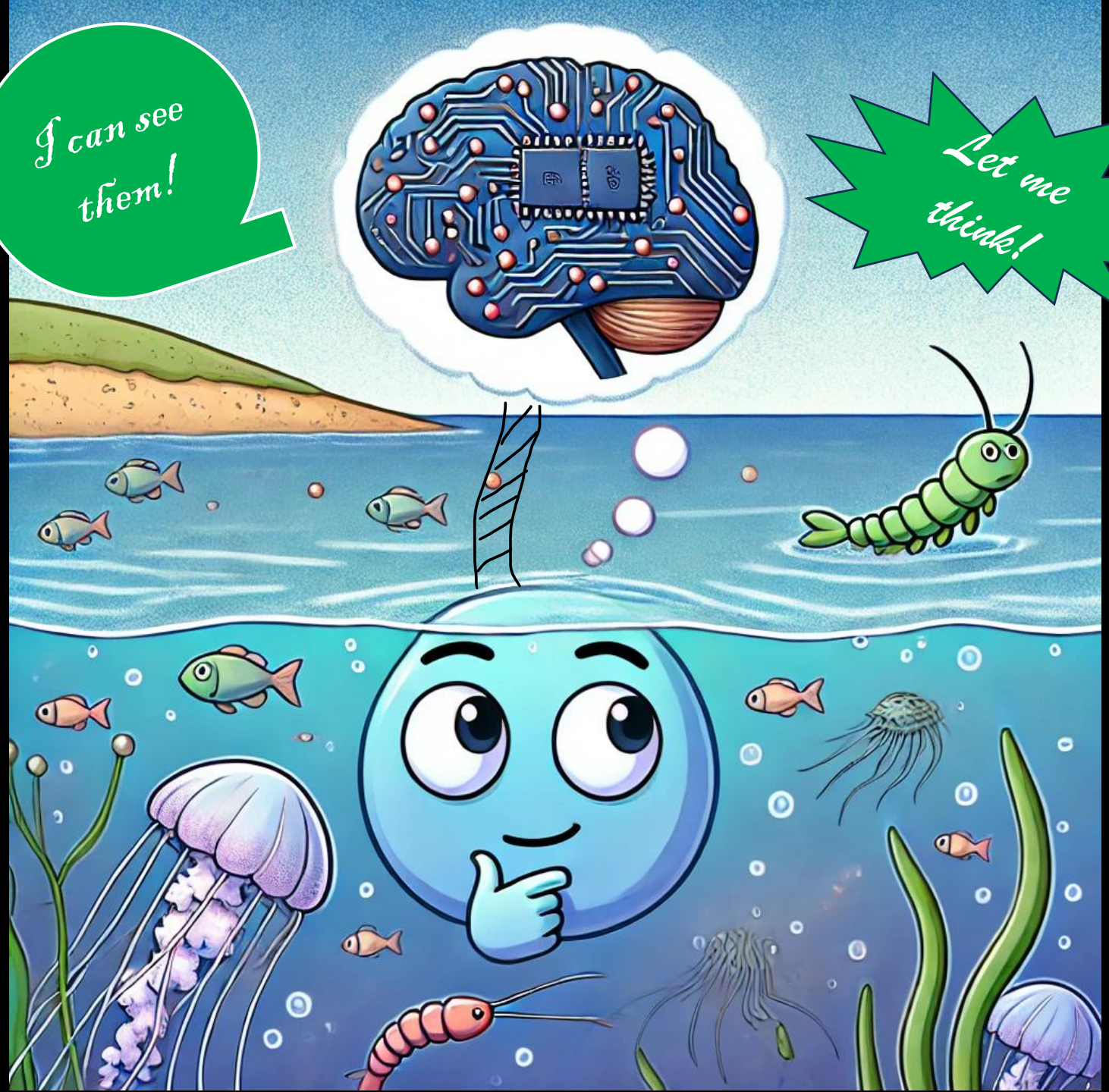
PART FOUR

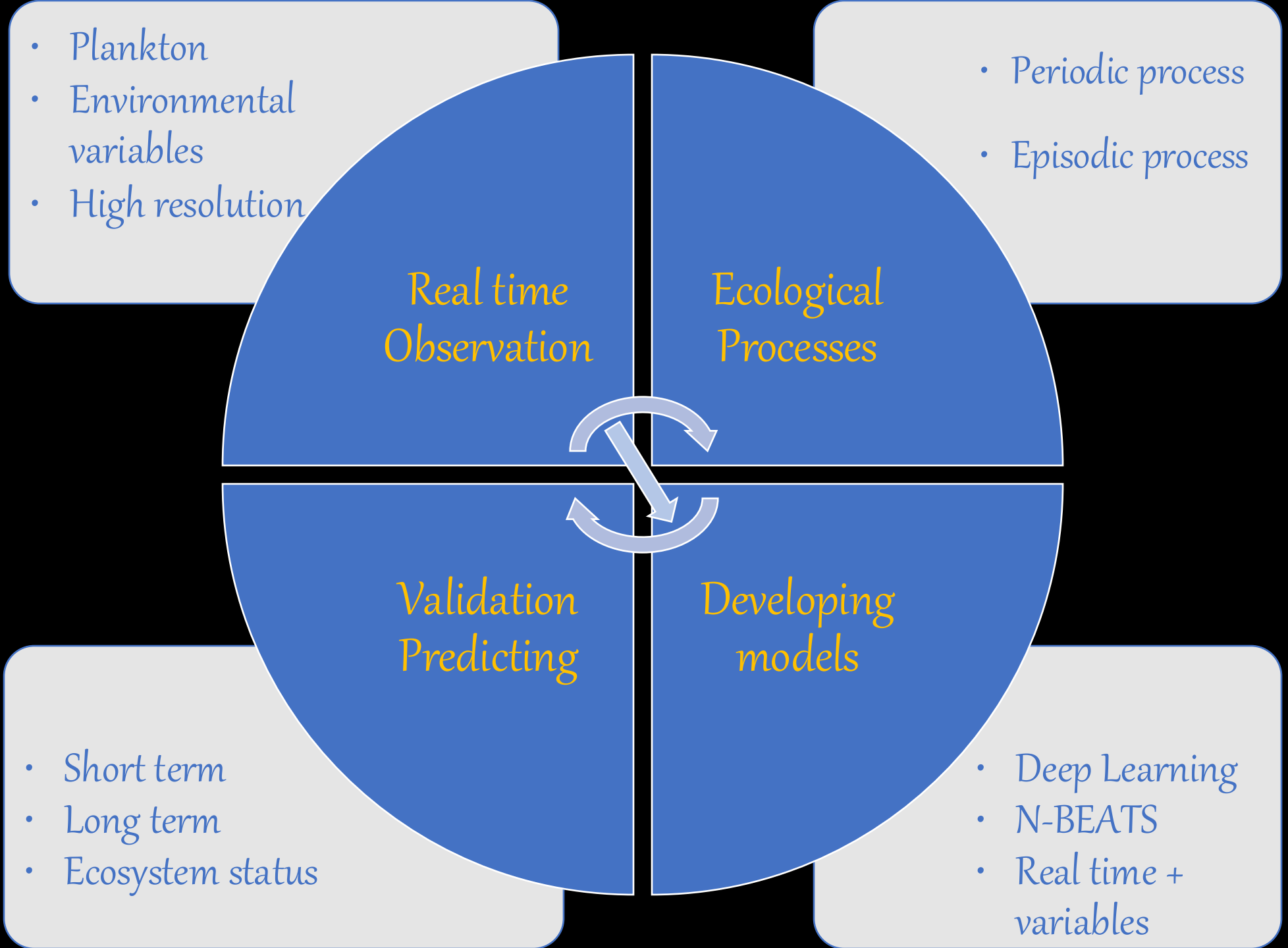
Prediction Possible?

But ocean is so big!

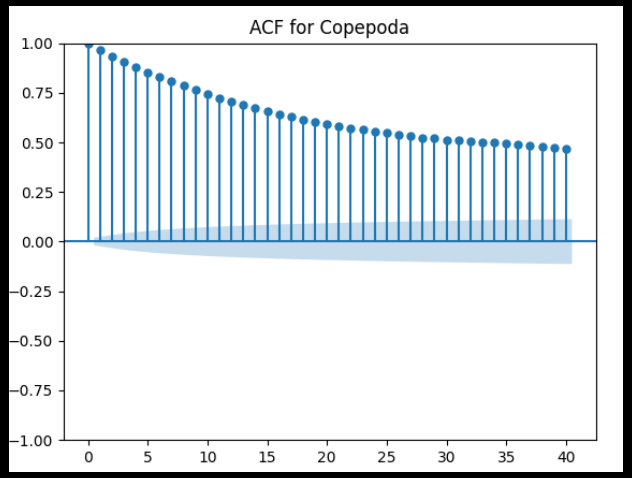
They are tiny!

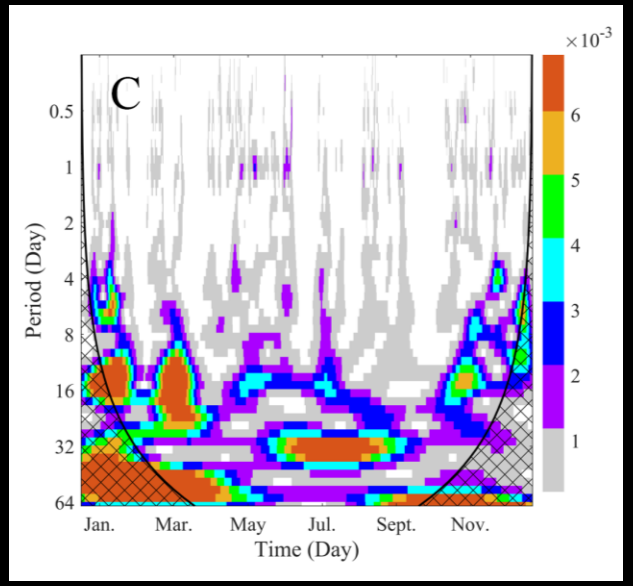
And so many stressors!



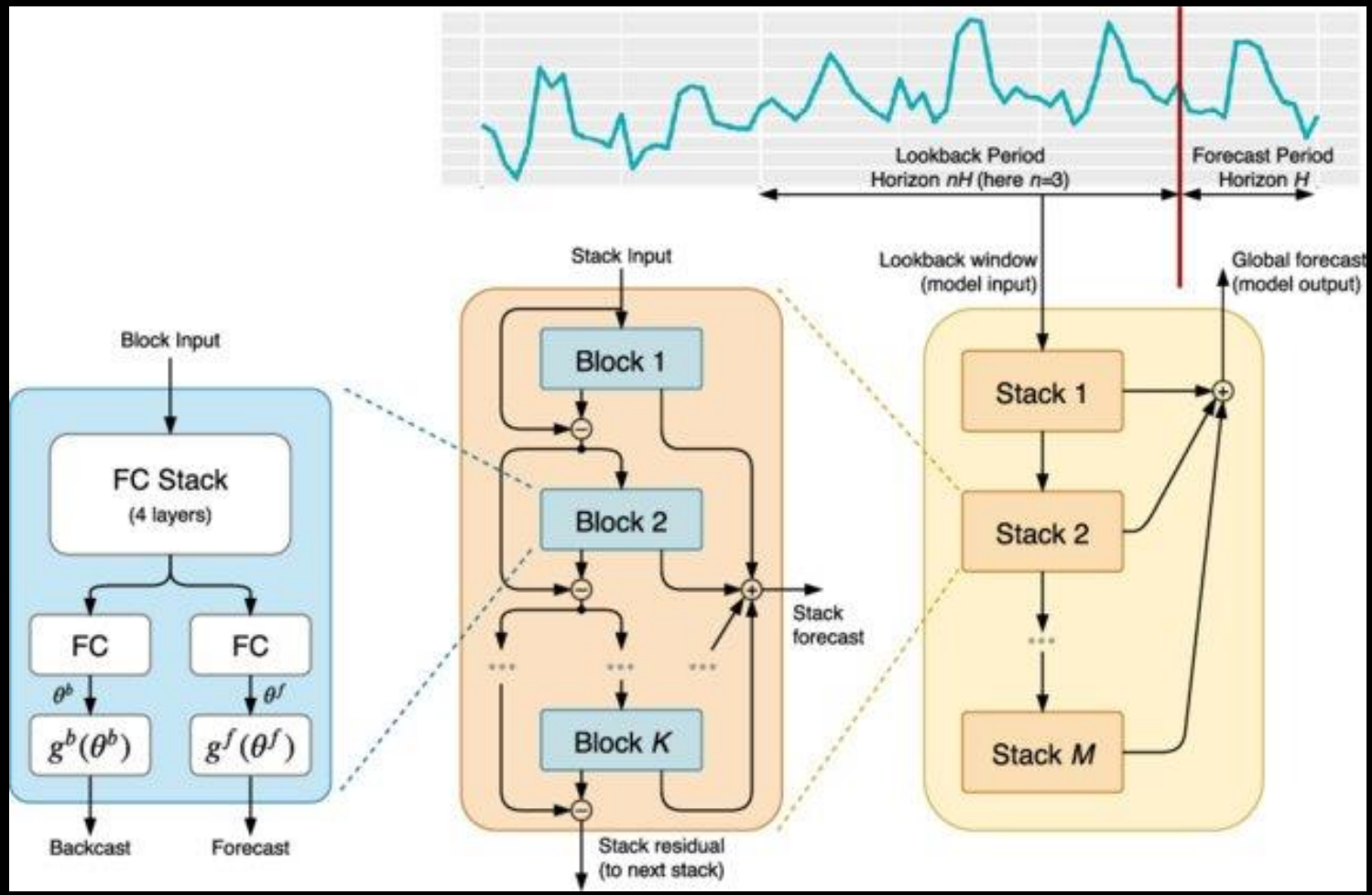

Plankton
Environmental variables
High resolution
Real time Observation
Periodic process
Episodic process
Ecological Processes
Validation Predicting
Short term
Long term
Ecosystem status
Developing models
Deep Learning
N-BEATS
Real time + variables

Traditional Stats Vs Deep learning





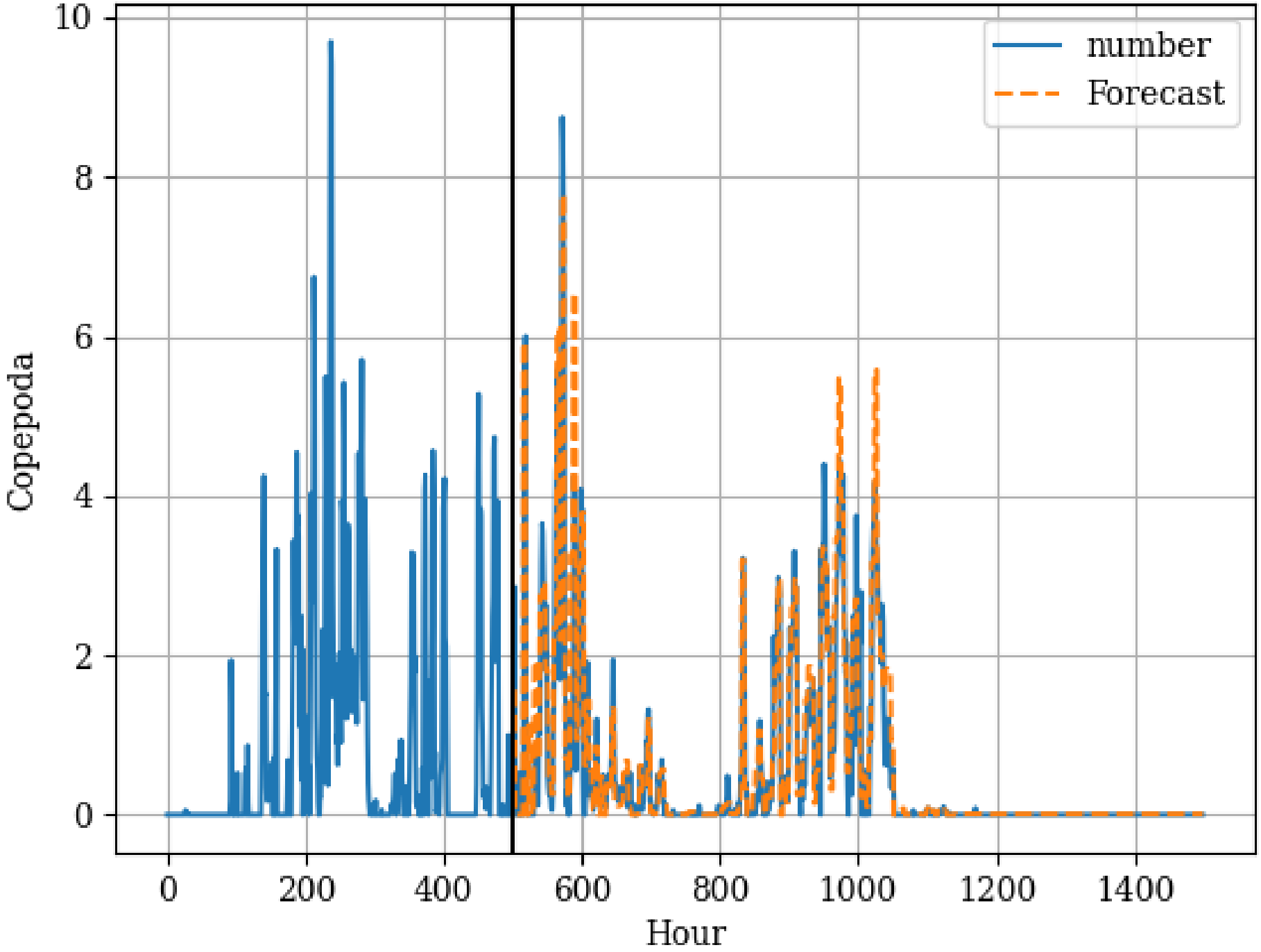
A zero-shot time-series forecasting



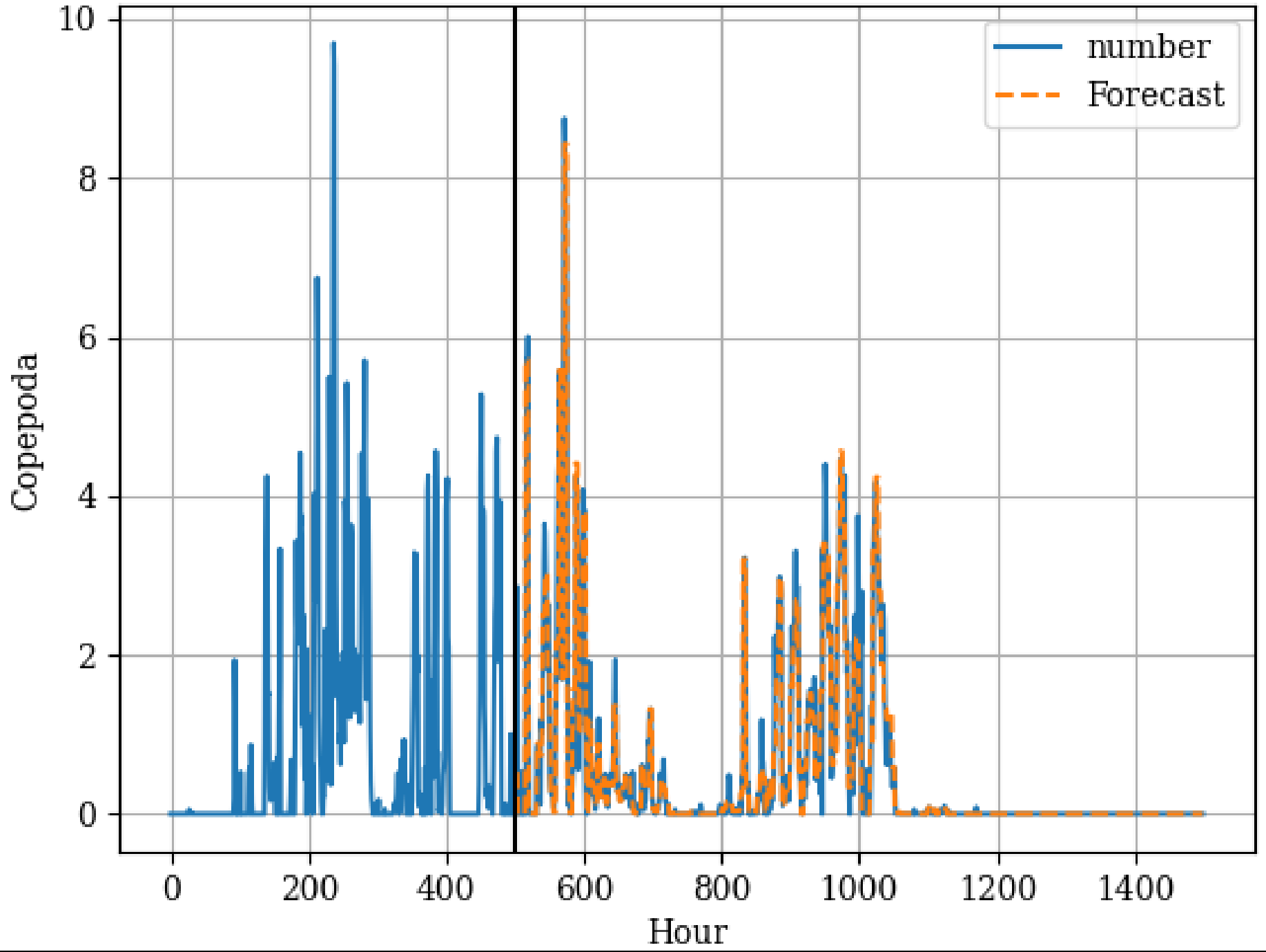
Stevenson et al. 2022

Simple density with season patterns

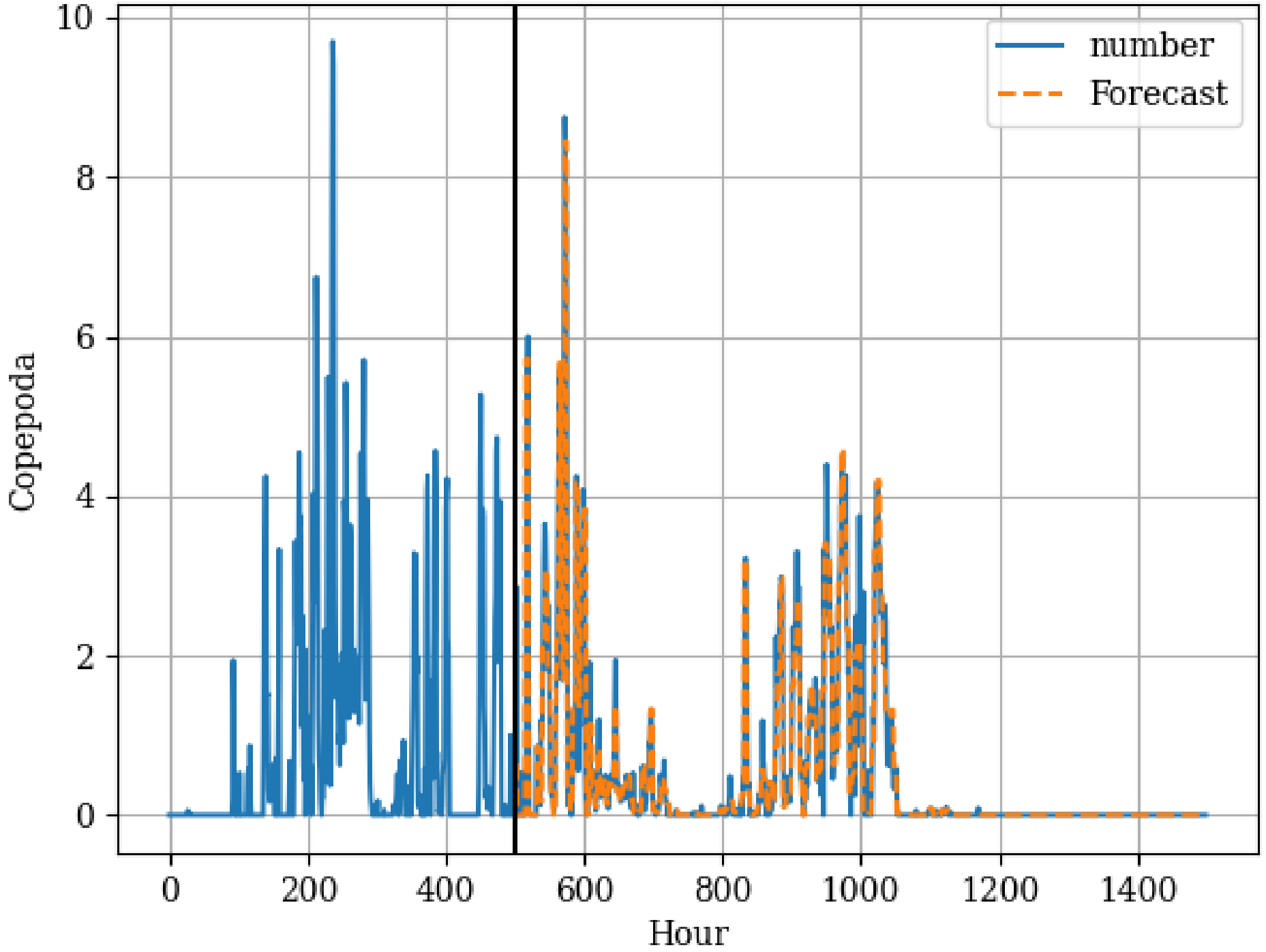
65.3%



Simple fully connected network 71%



Include smoothed temperature and salinity anomalies: Improved 50%



Conclusions

- Advanced underwater plankton imaging systems enable real-time observations.

- AI-powered image processing procedures enhance our ability to harness information.

- High-frequency data provide unprecedented insights into plankton and the underlying processes.

- The new deep learning-based time series approach enhances our ability to predict marine ecosystems.

- Students: Tingrui Zhang, Jialin Zhang, Junting Song, Dai Liu
- Collaborators
  - **Tsinghua SIGS**: Xuemin Cheng, Zhonghua Cai
  - **Shenzhen Photobio LLC**: Kezhen Ying, Duansheng Wang
  - Texas A& M Galveston: Hui Liu
  - Alaska Fisheries Science Center: David Kimmel, Julie Keister
  - Fish and Oceans Canada: Akash Sastria
  - Louisiana State University: Mark Benfield
- Funding: NOAA