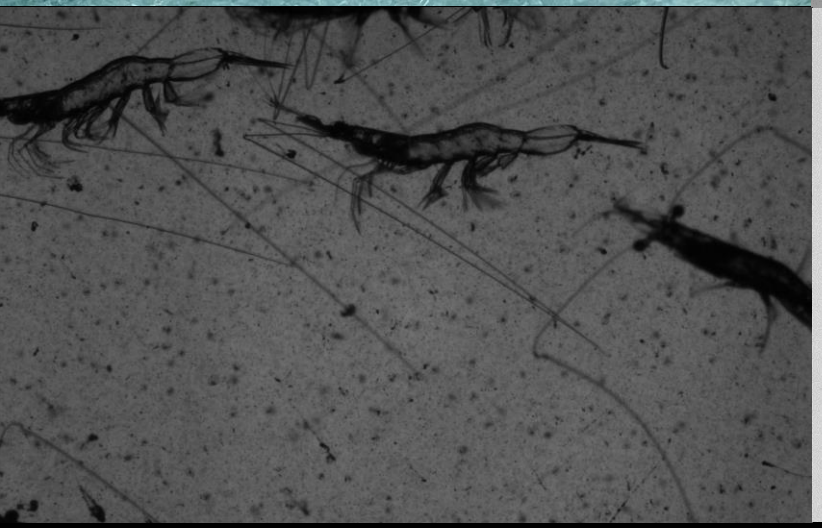
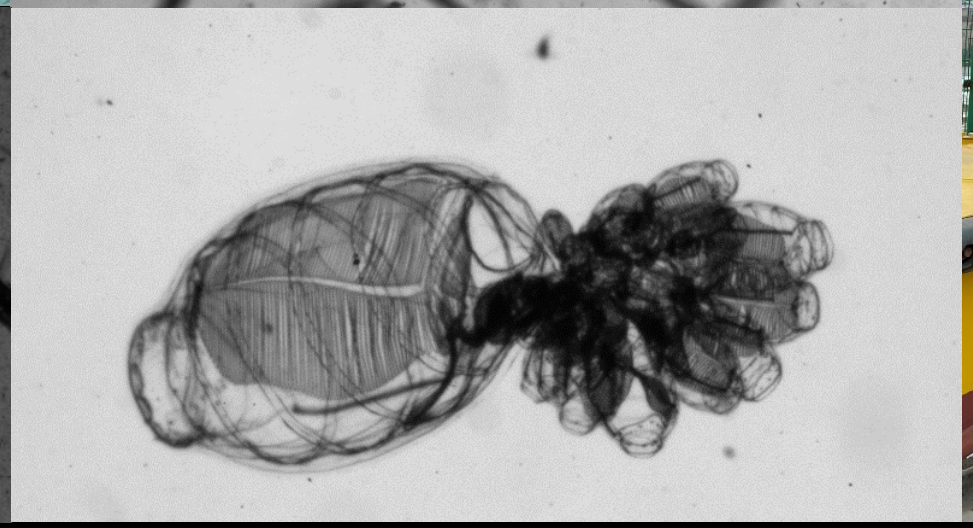




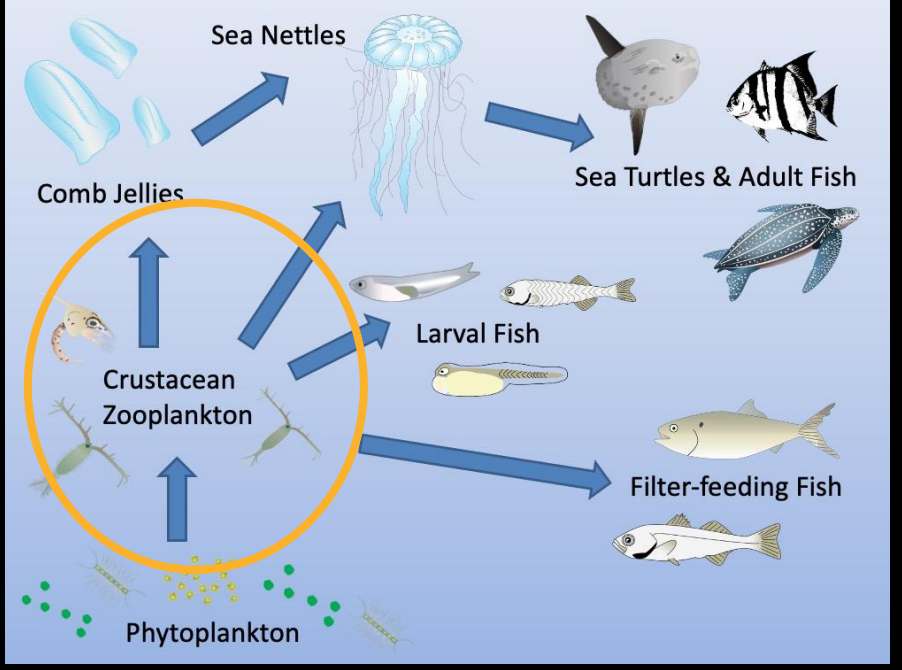
Striped bass spawning habitat: impact of winter storms on the dynamics of zooplankton populations

Hongsheng Bi, Jian Zhao, Wenjing Liu

University of Maryland
Center for Environmental Science

CONTENTS

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

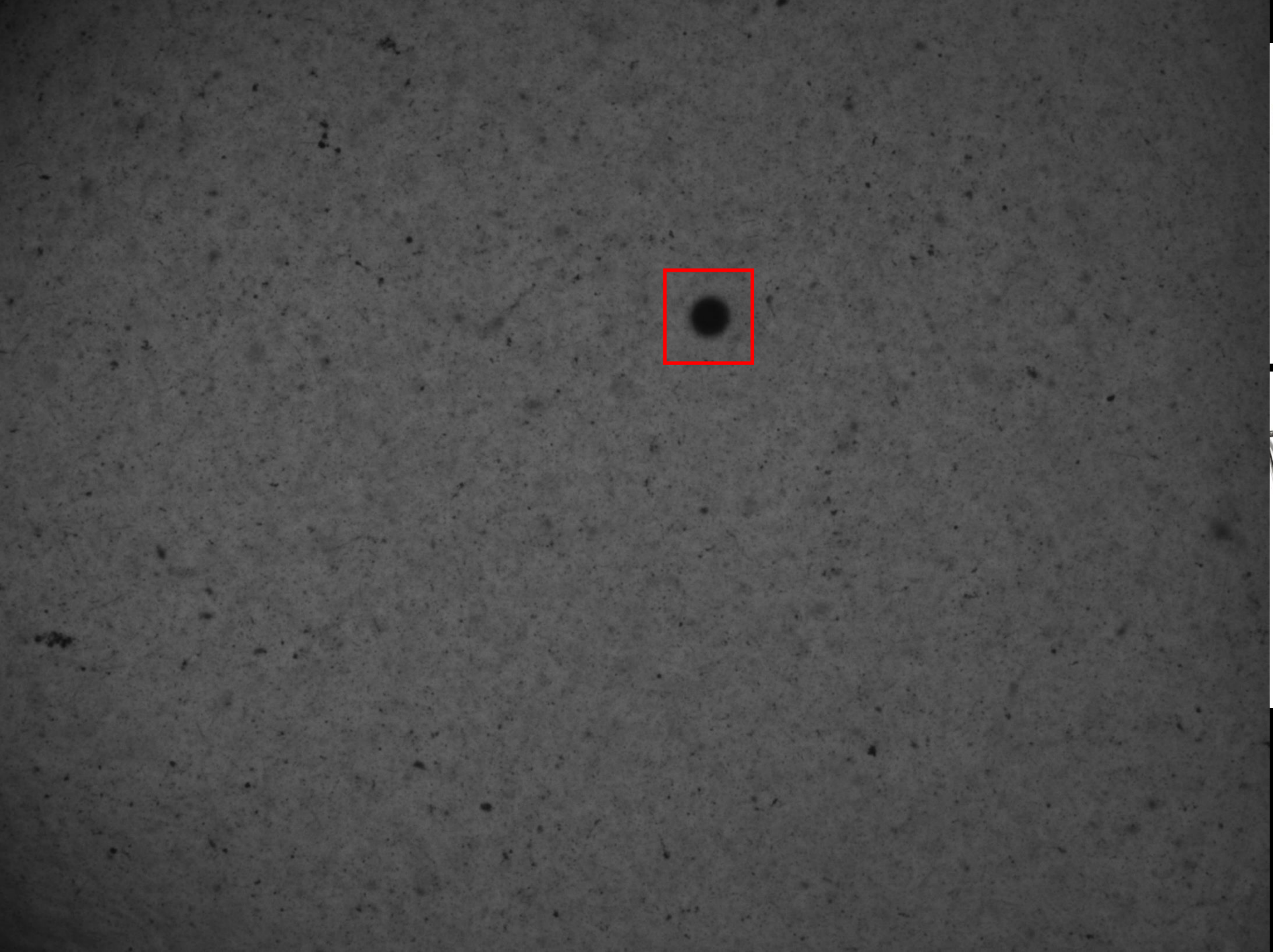
Net sampling

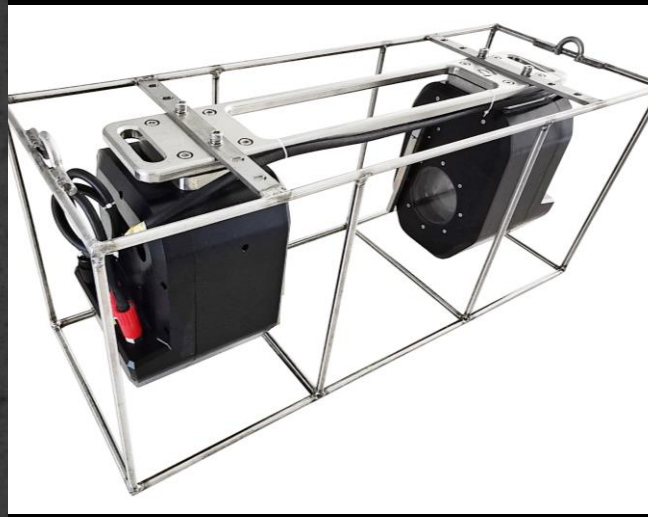
Discrete in time

Integrative in space

In situ imaging system

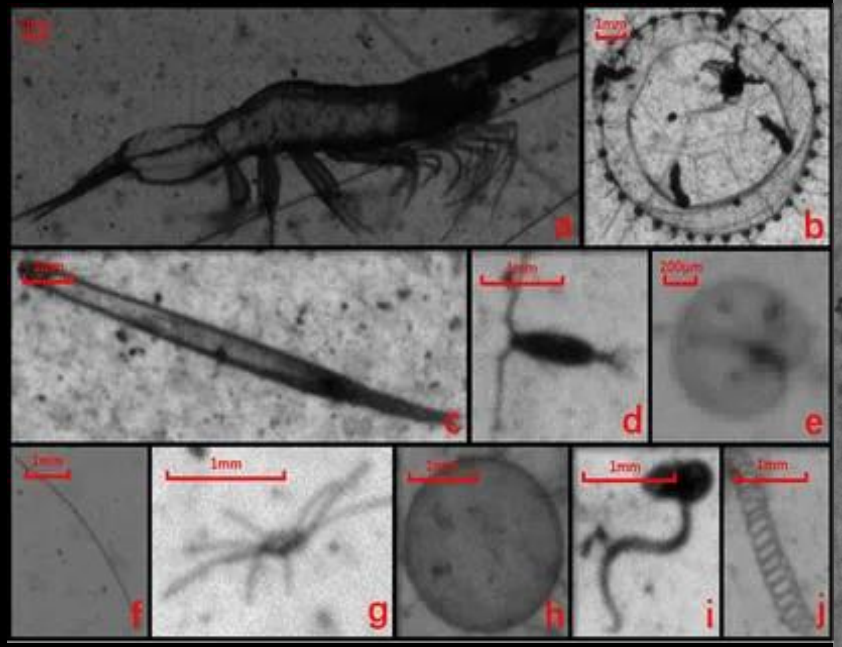
- No clogging or reduced filtering efficiency
- Nonintrusive, no damage to fragile organisms
- High spatial and temporal resolution
- Simultaneous measurements on a suite of plankton groups
- Size, behavior, bloom status etc.





Striped bass spawning habitat

Hongsheng Bi
Ryan Woodland
Jian Zhao
Jim Uphoff

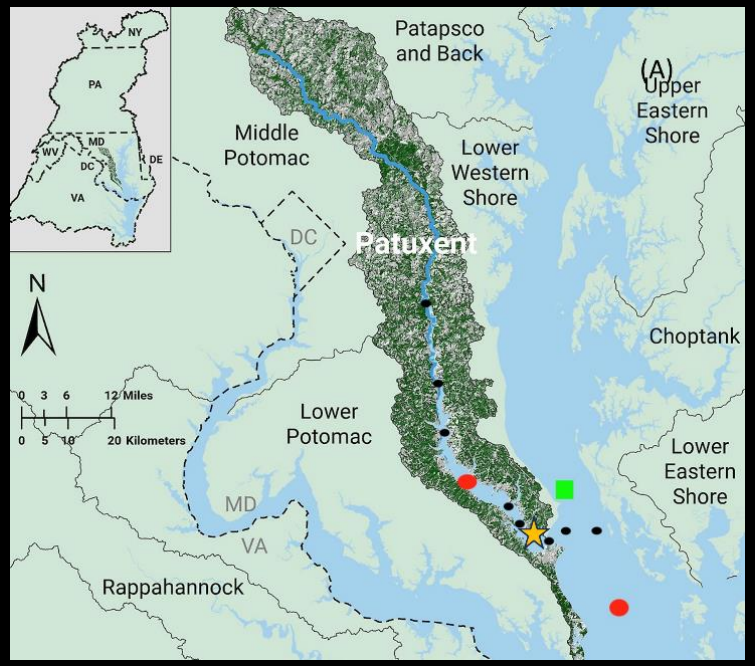

a
1mm
b
200μm
c
d
200μm
e
1mm
f
1mm
g
1mm
h
1mm
i
1mm
j

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
{'Copepoda': '1'}
This data does not enter the database!
Detecting Img:20231021093144703.jpeg
{}
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Detecting Img:20231021093204704.jpeg
{}
This data does not enter the database!
Detecting Img:20231021093224703.jpeg
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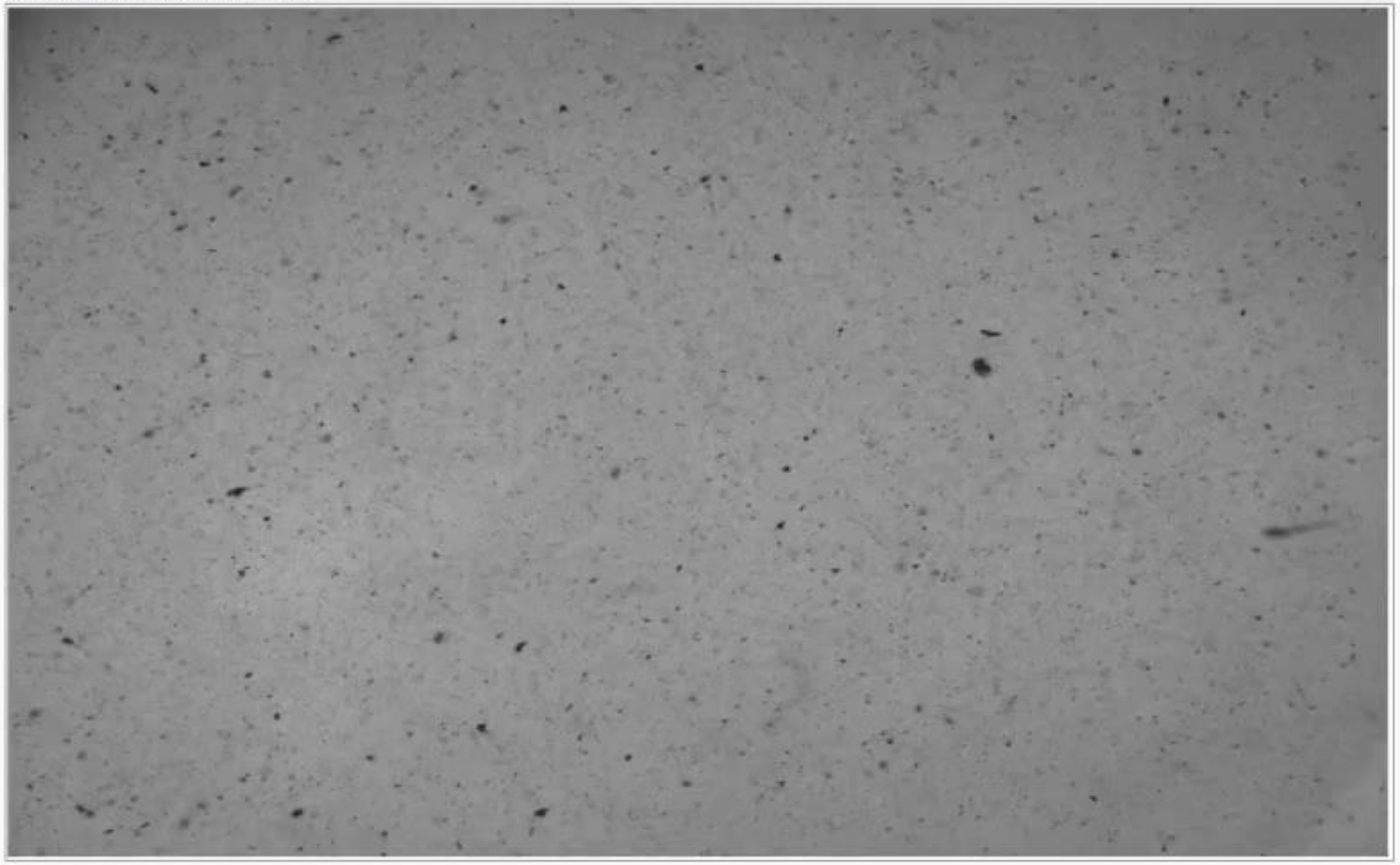
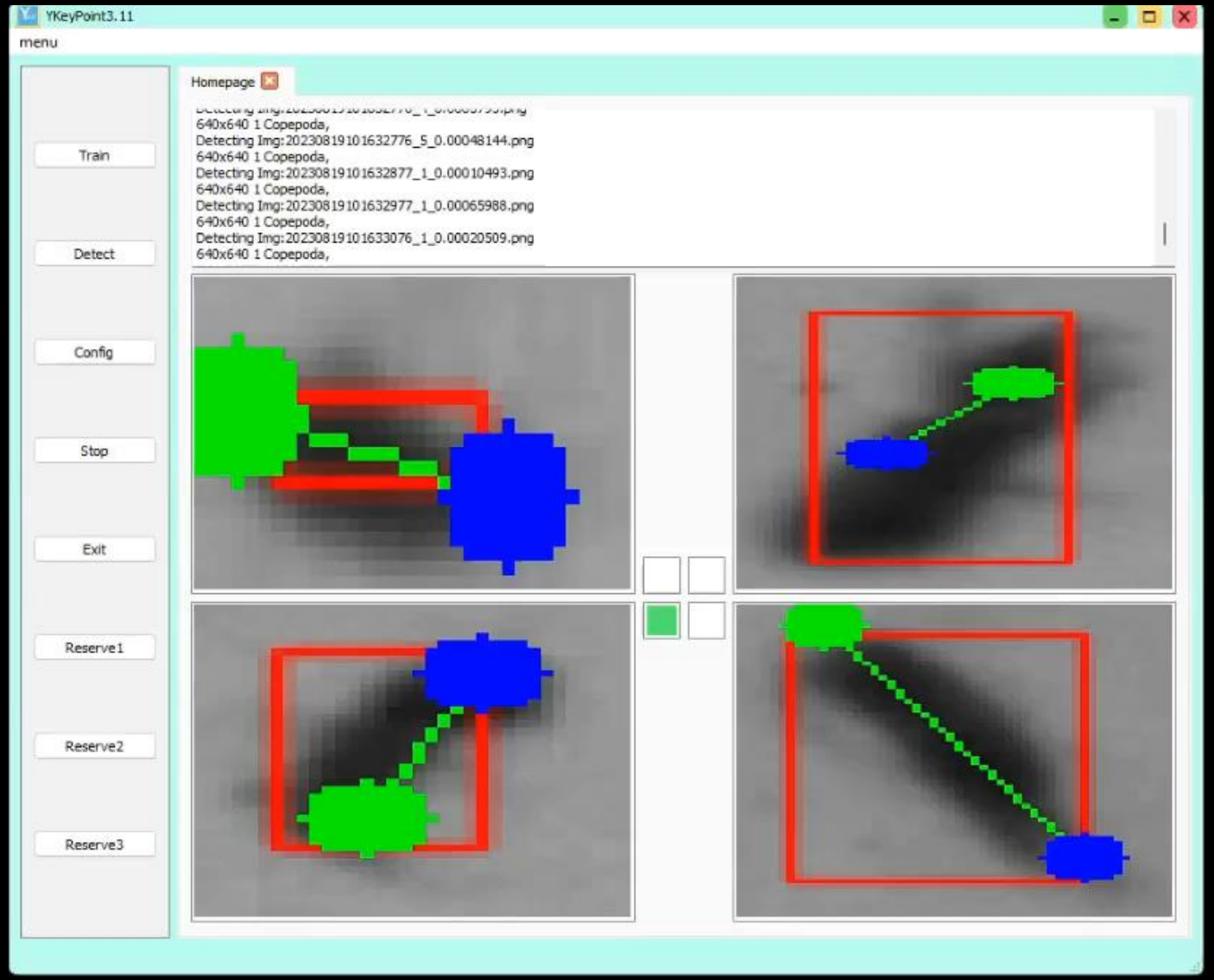




Difference

	True value (imageJ) A	Measured value (Key point) 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

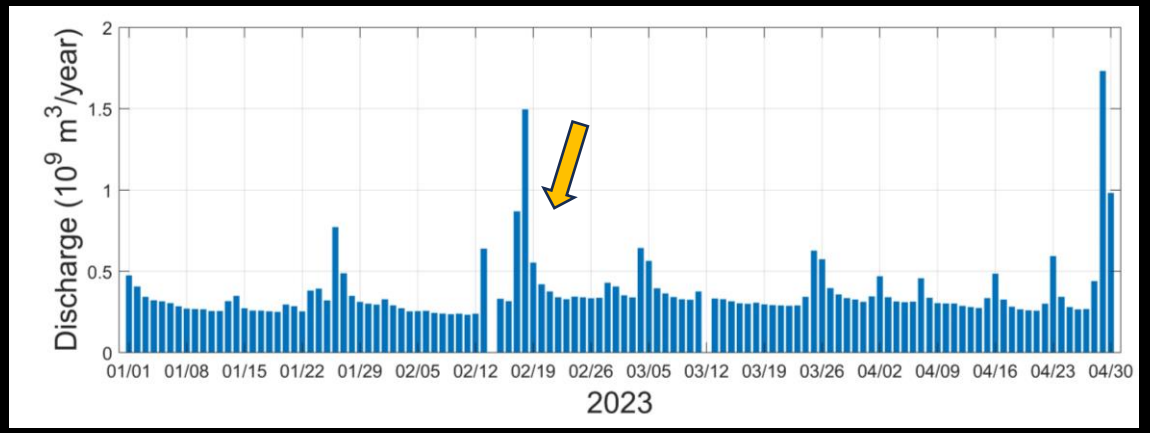
Mean error : **2.34%**

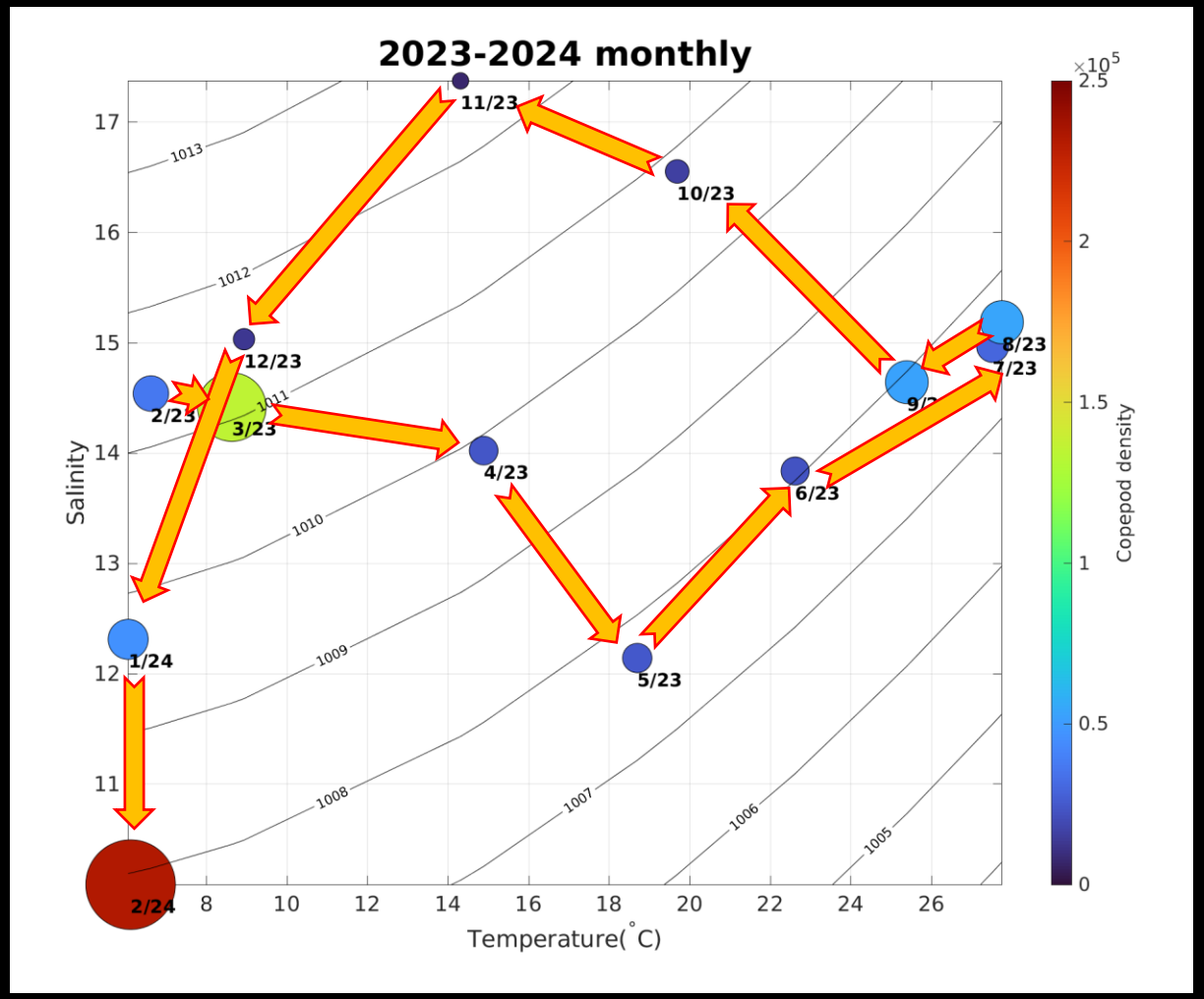
03

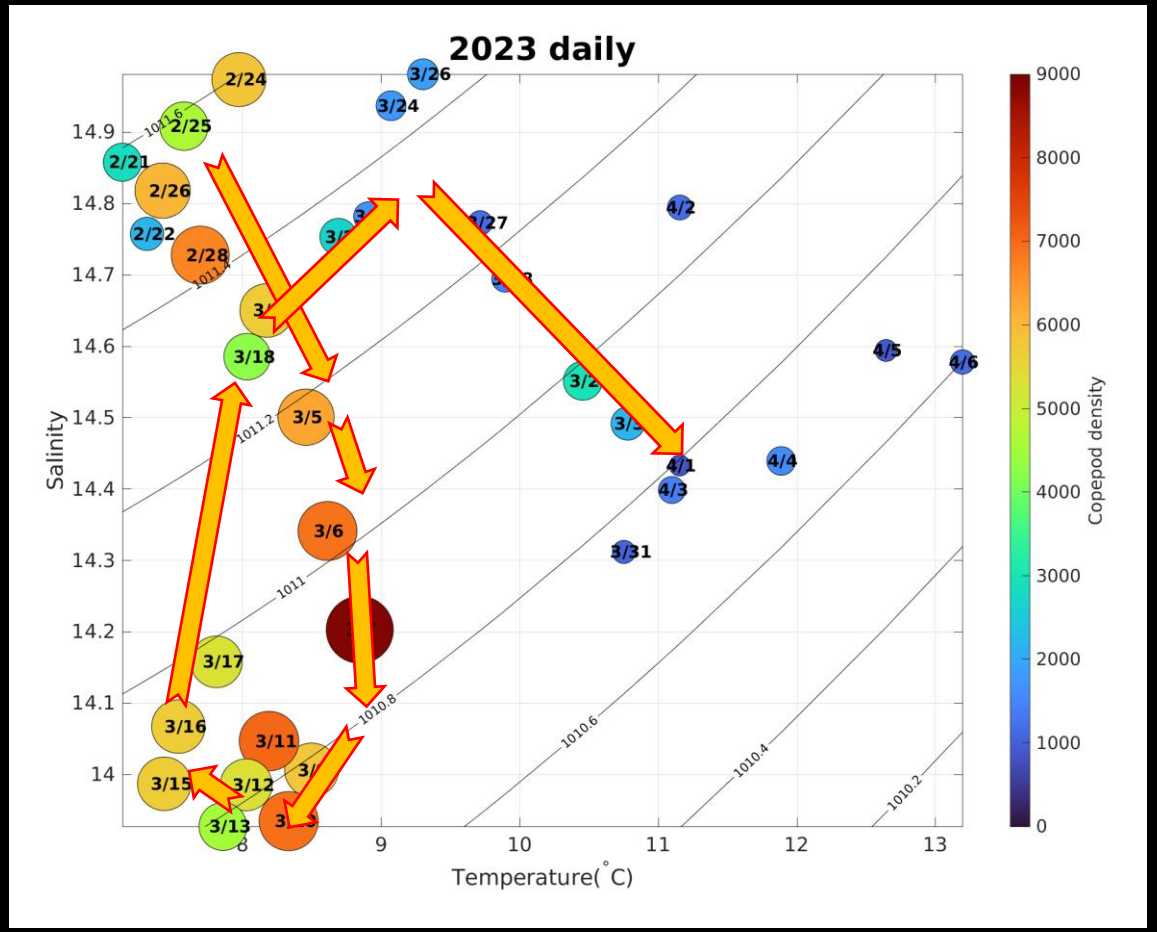
PART THREE

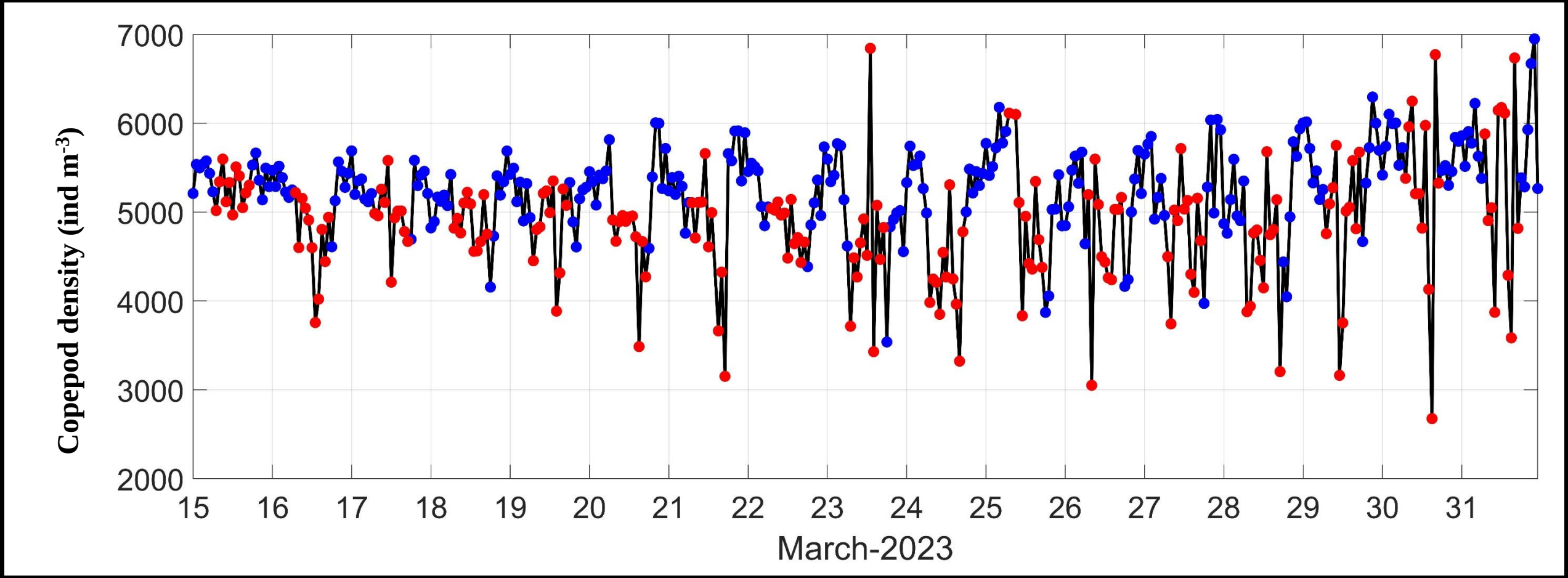
Deployment

Plankton dynamics


Discharge (10^9 m^3/year)
2
1.5
1
0.5
0
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


2023-2024 monthly
Salinity
Temperature(°C)
Copepod density
×10^5
2.5
2
1.5
1
0.5
0
11/23
10/23
12/23
2/23
3/23
4/23
5/23
6/23
8/23
7/23
1/24
2/24
1013
1012
1011
1010
1009
1008
1007
1006
1005

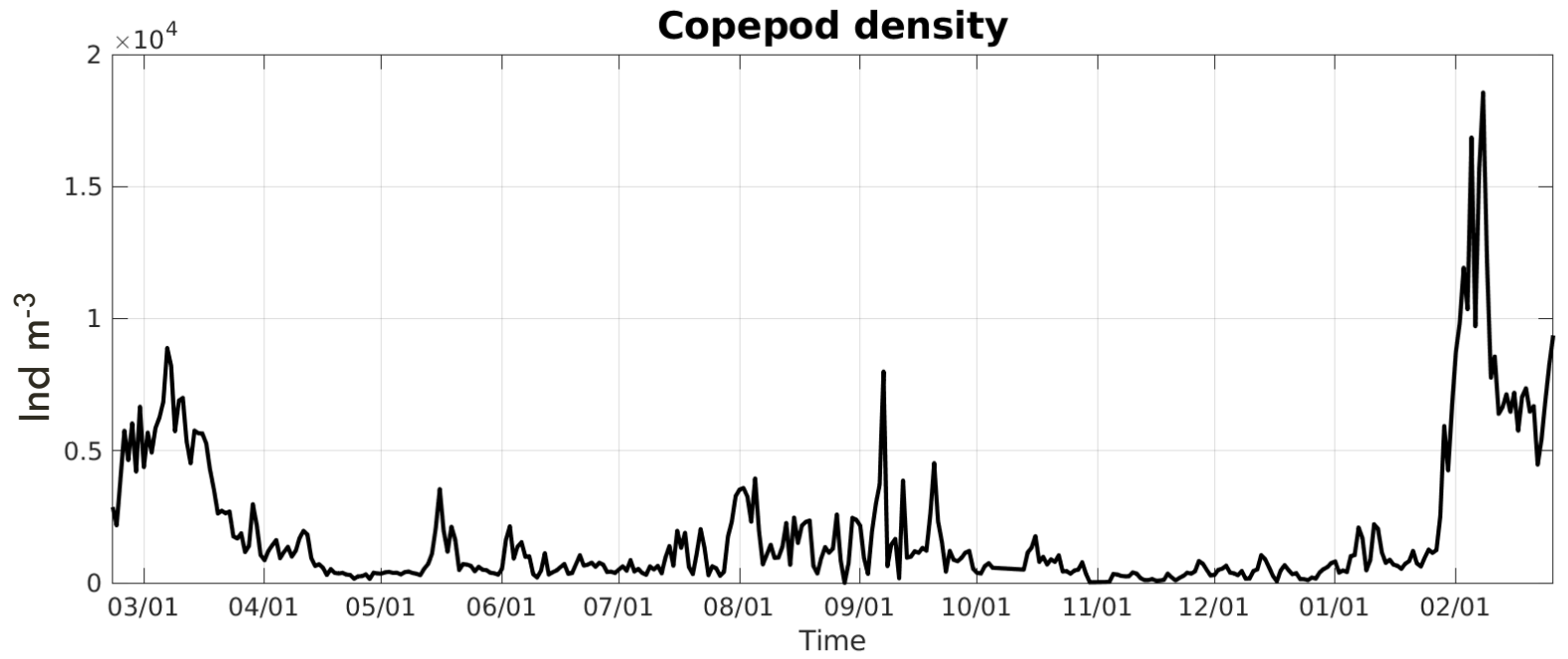

2023 daily
Salinity
Temperature(°C)
Copepod density
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2/24
3/26
3/24
2/25
2/21
2/26
2/22
2/28
3/18
3/5
3/6
3/17
3/16
3/11
3/15
3/12
3/13
4/2
4/5
4/6
4/1
4/3
4/4
3/31
1011.6
1011.4
1011.2
1011
1010.8
1010.6
1010.4
1010.2

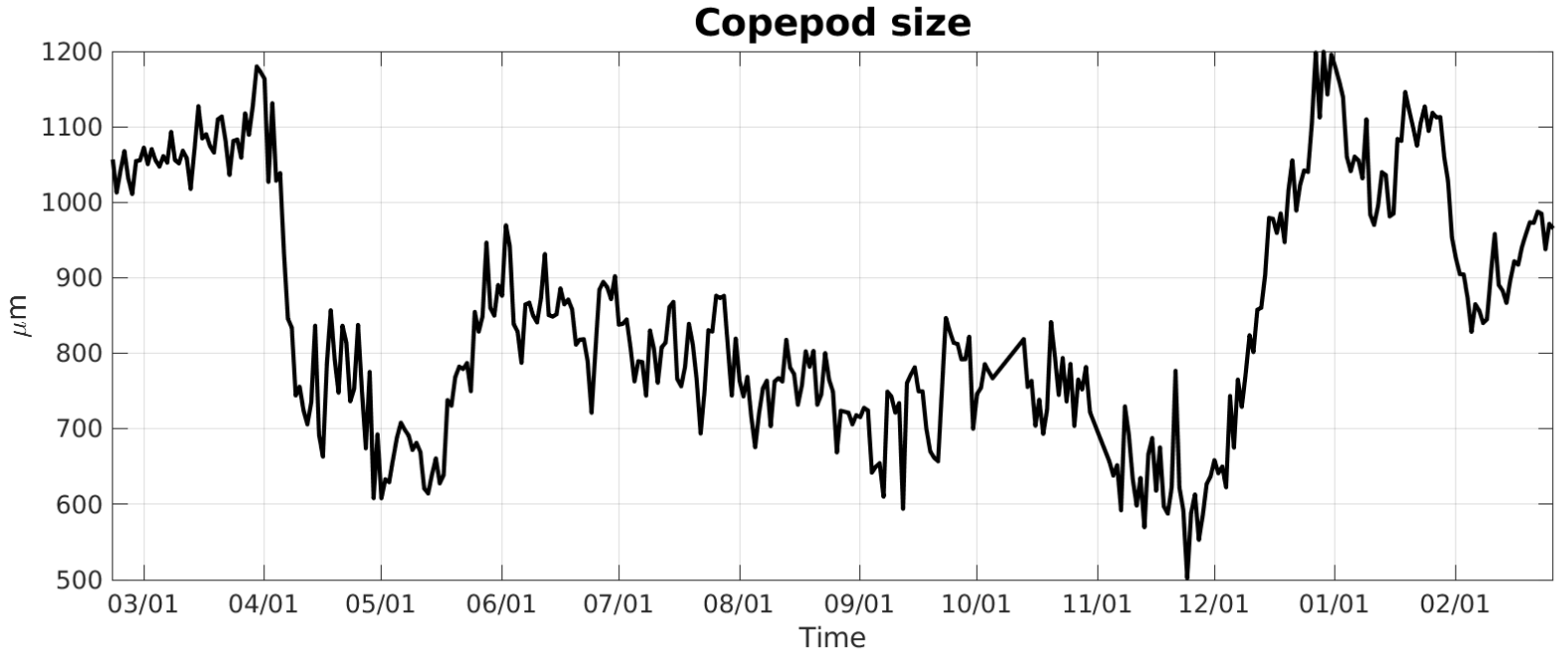


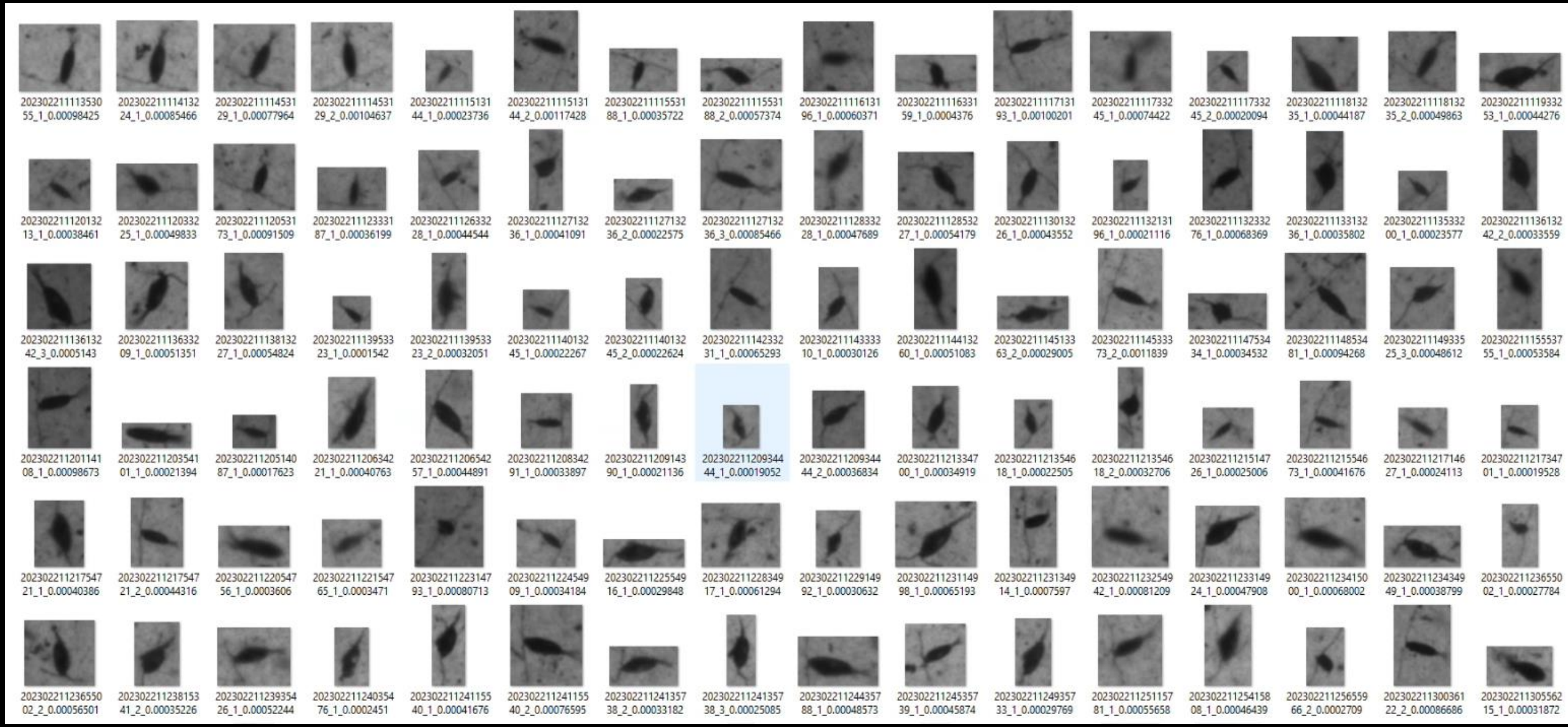
Hourly data
Red dots: daytime
Blue dots: nighttime

Nighttime: Higher density on average
Daytime: Larger variation

Chesapeake Bay: Winter Zooplankton



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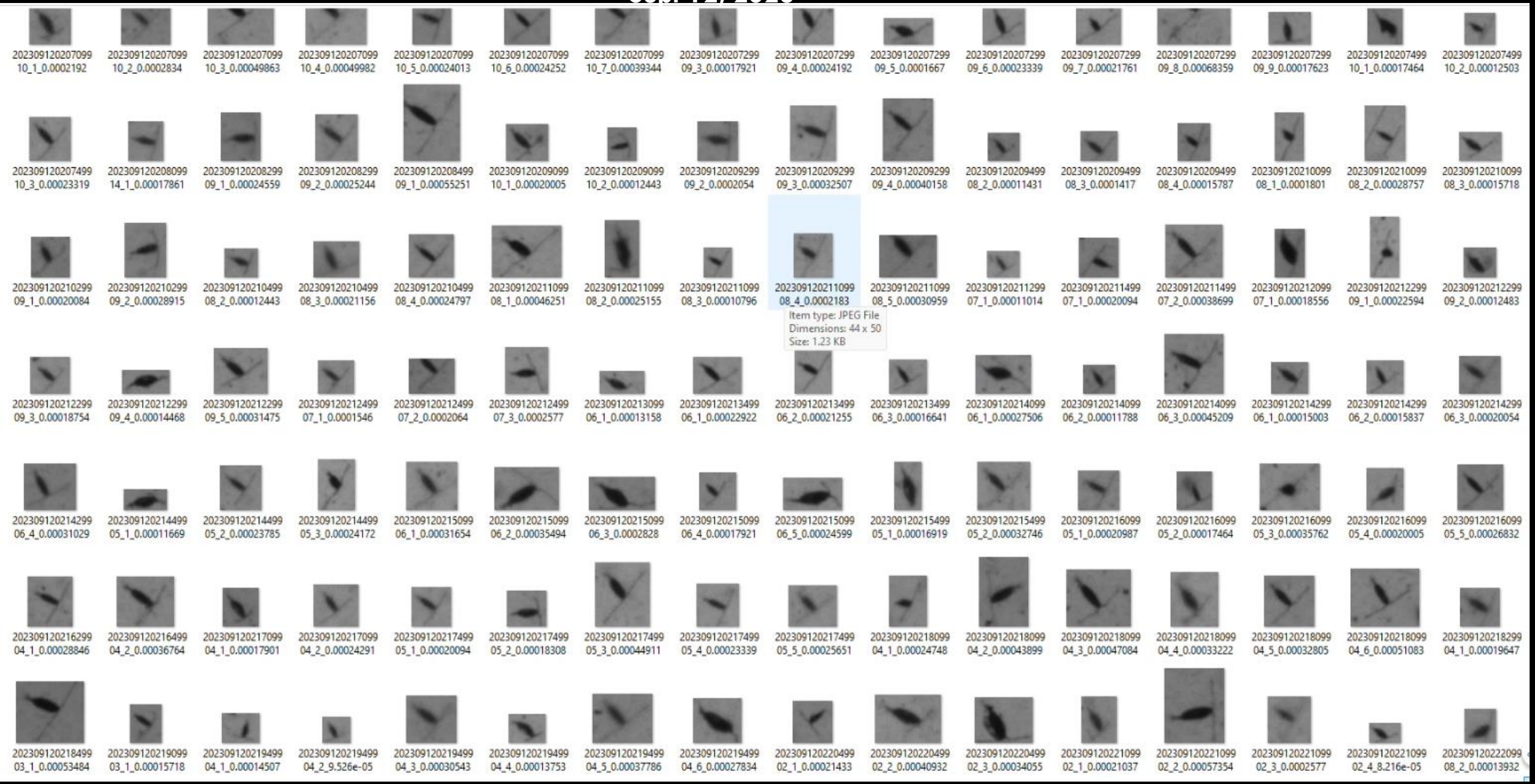
Feb 21, 2023

Sept 12, 2023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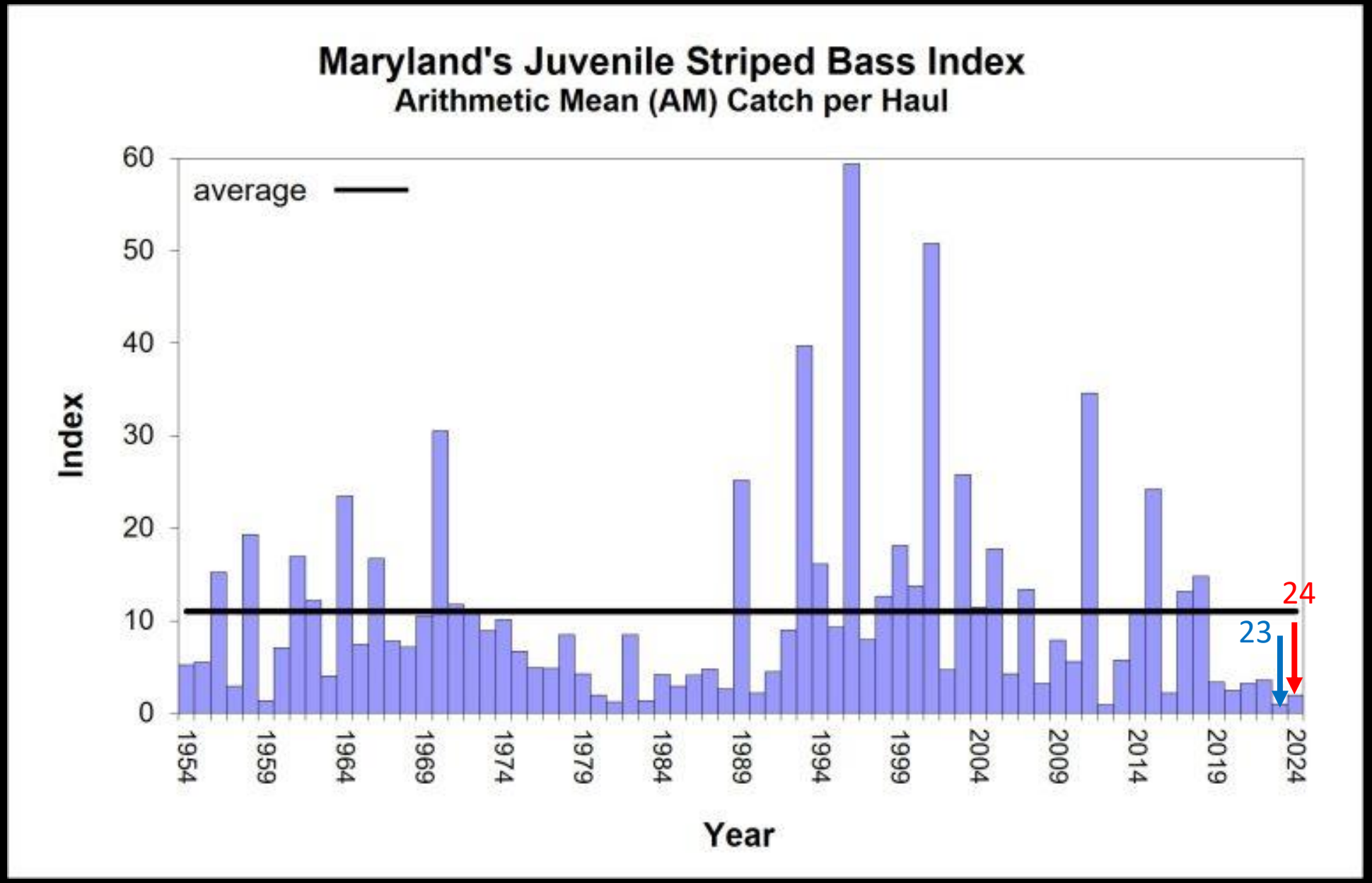

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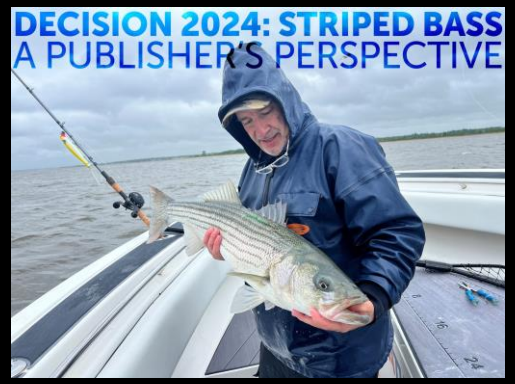
2020: 2.5
2021: 3.2
2022: 3.6
2023: 1.0
2024: 2.0

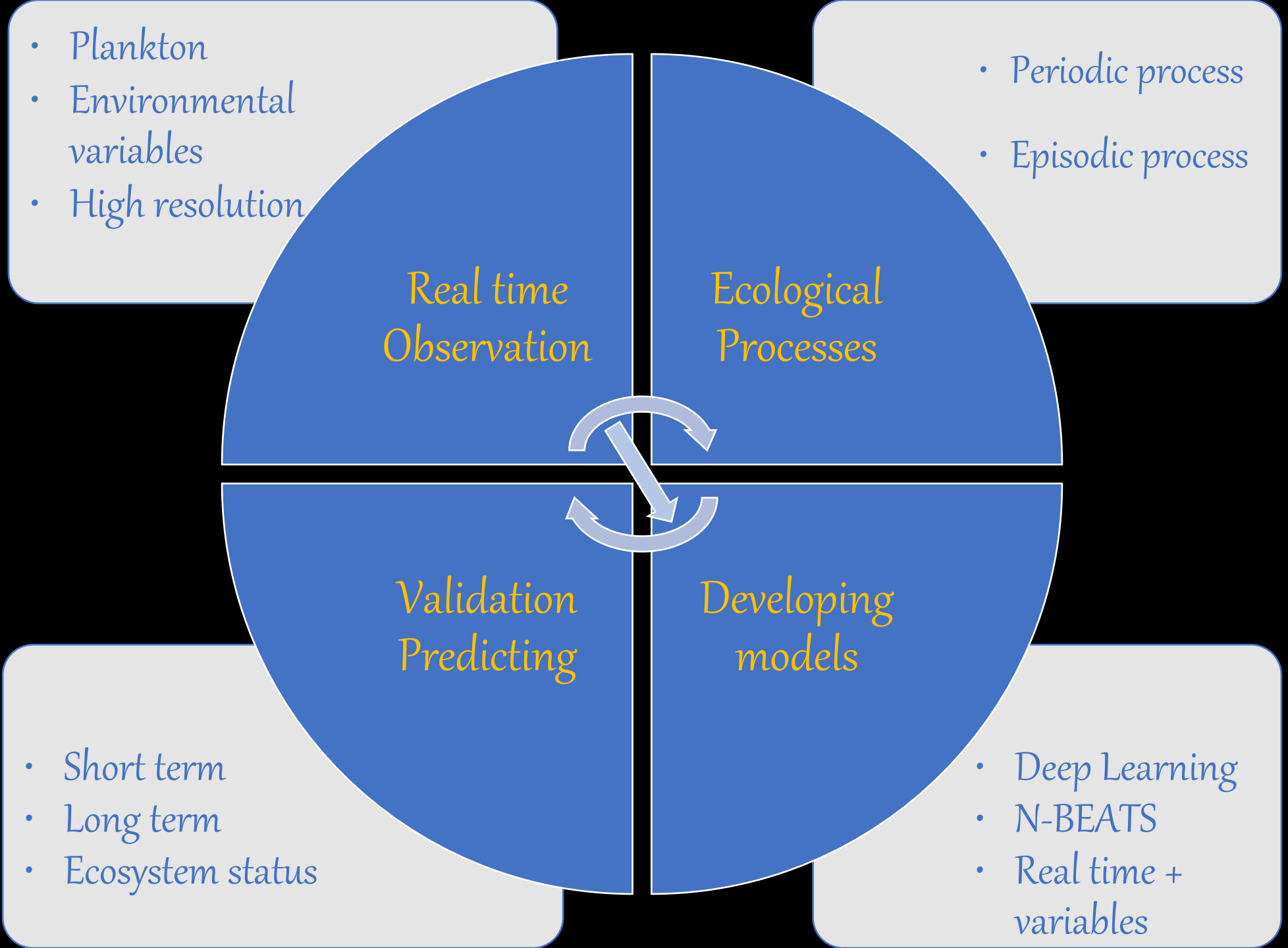
Maryland DNR

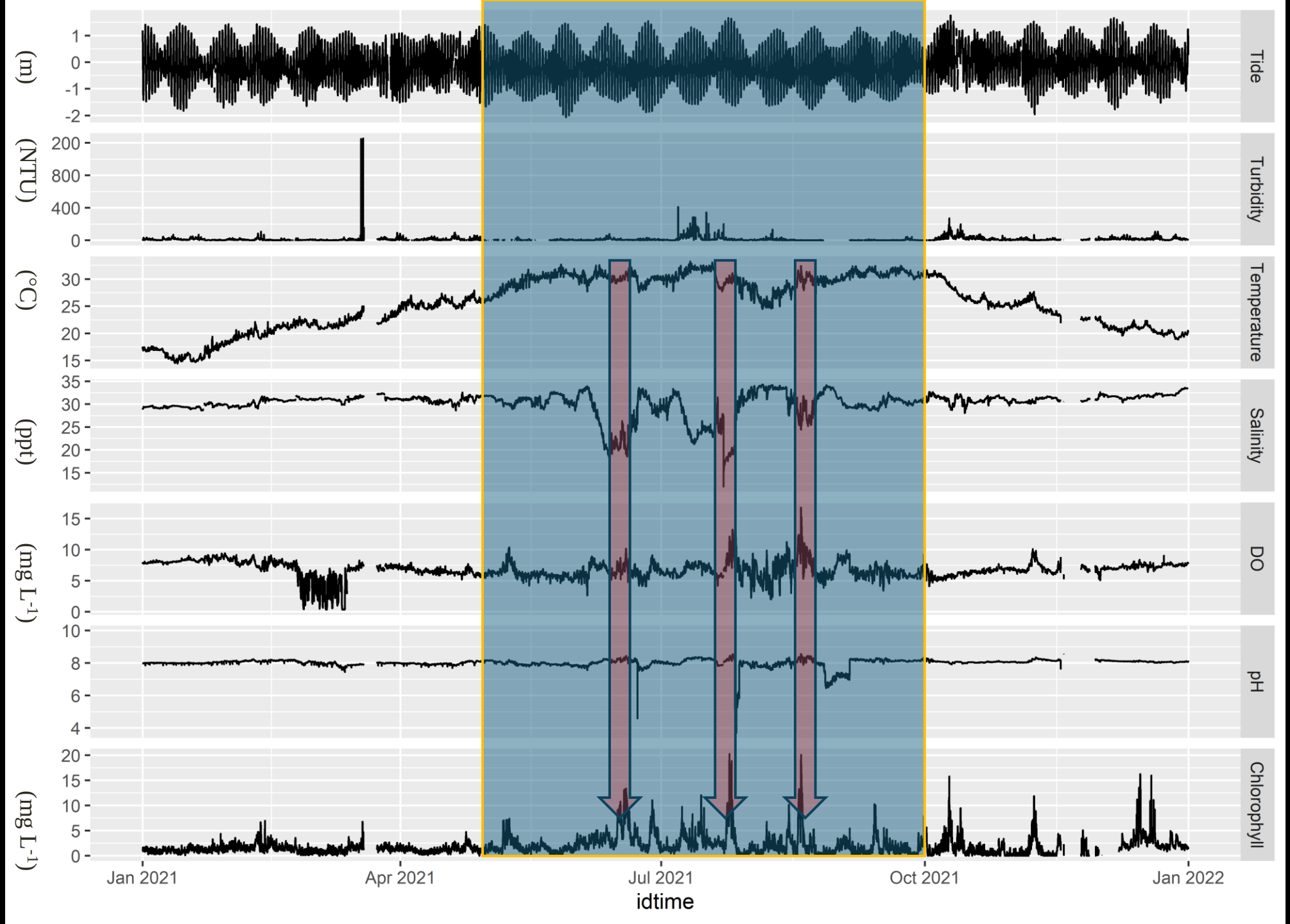


04

PART FOUR

Prediction Possible?


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

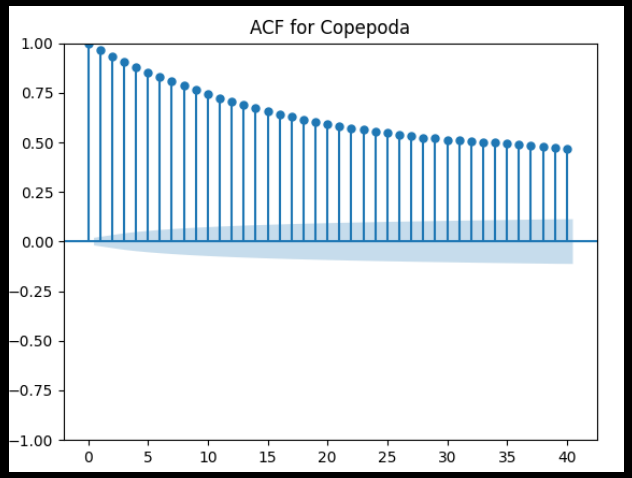


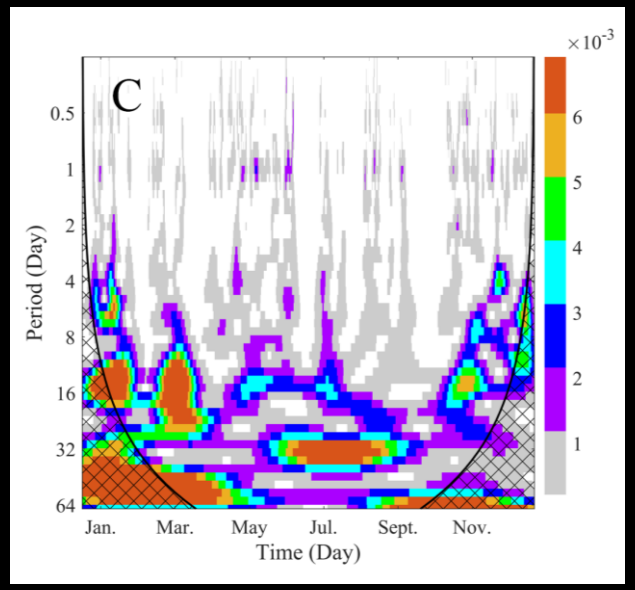
Diurnal

Seasonal

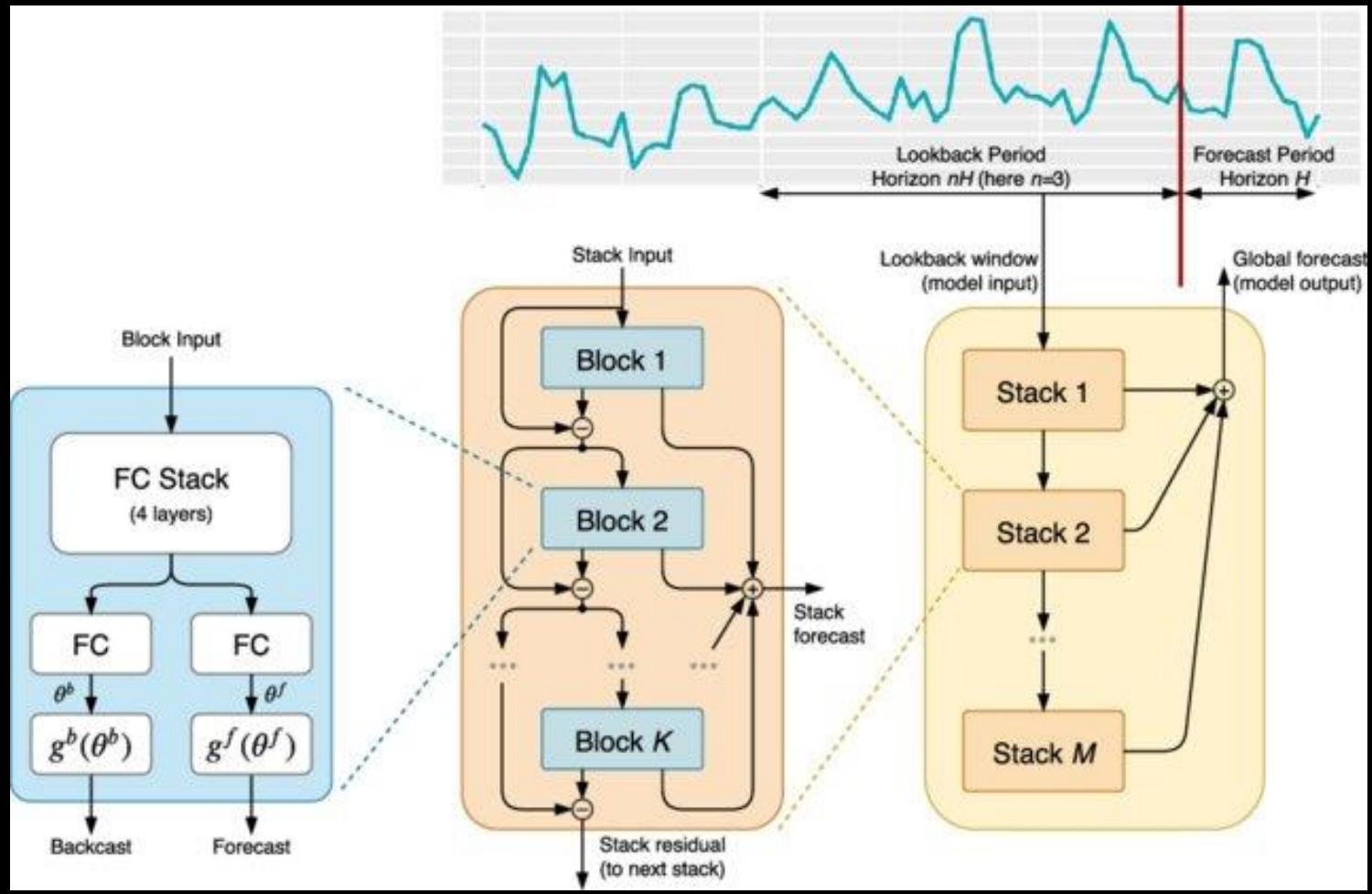
Typhoon

Traditional Stats Vs Deep learning





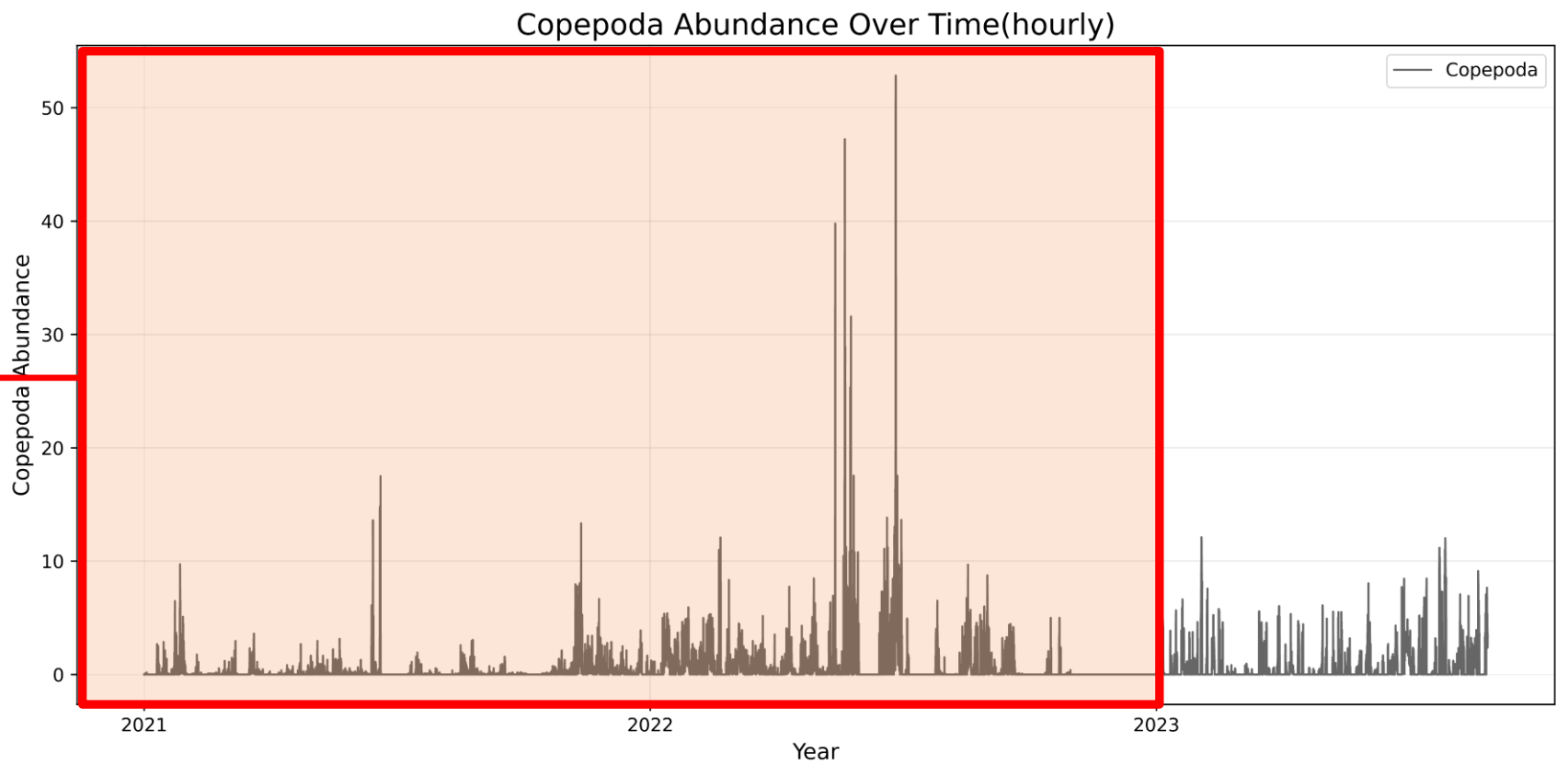
A zero-shot time-series forecasting

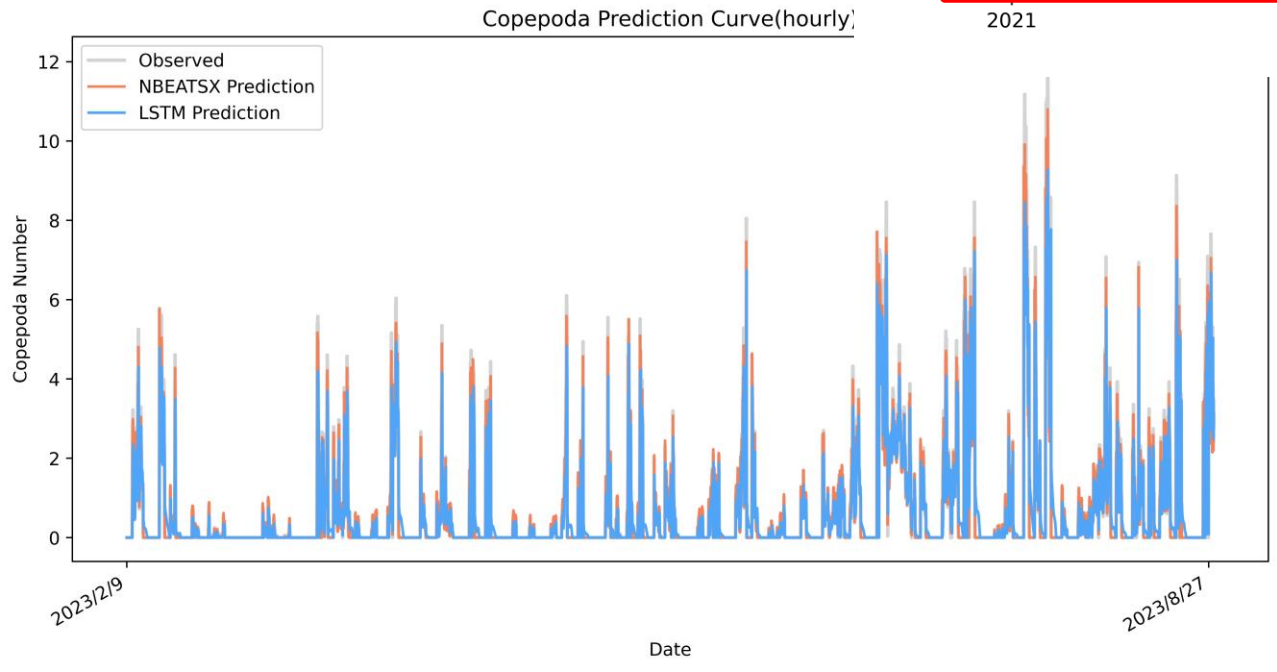


Stevenson et al. 2022

Use 2021-2022 data. >17,500 hourly data points to train the deep learning model

Predict 2023: input 6 hours and forecast 1 hour.

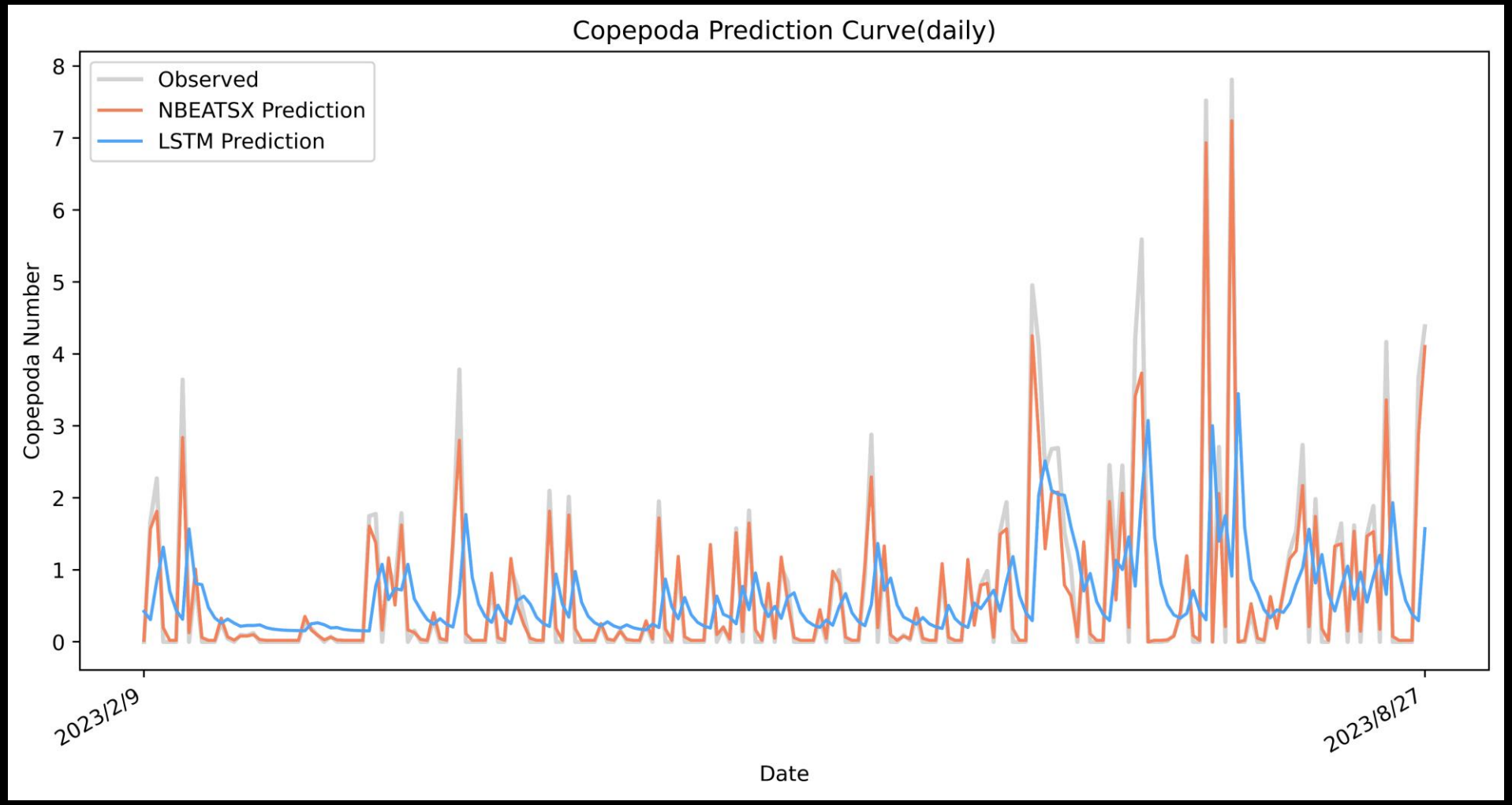




LSTM model : R^2 = 0.86

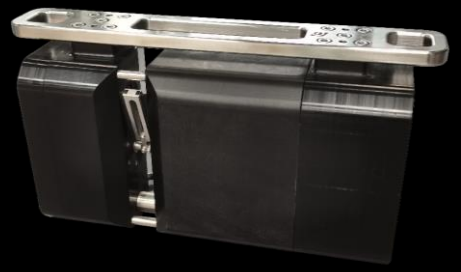
BEATS-x model R^2 = 0.99

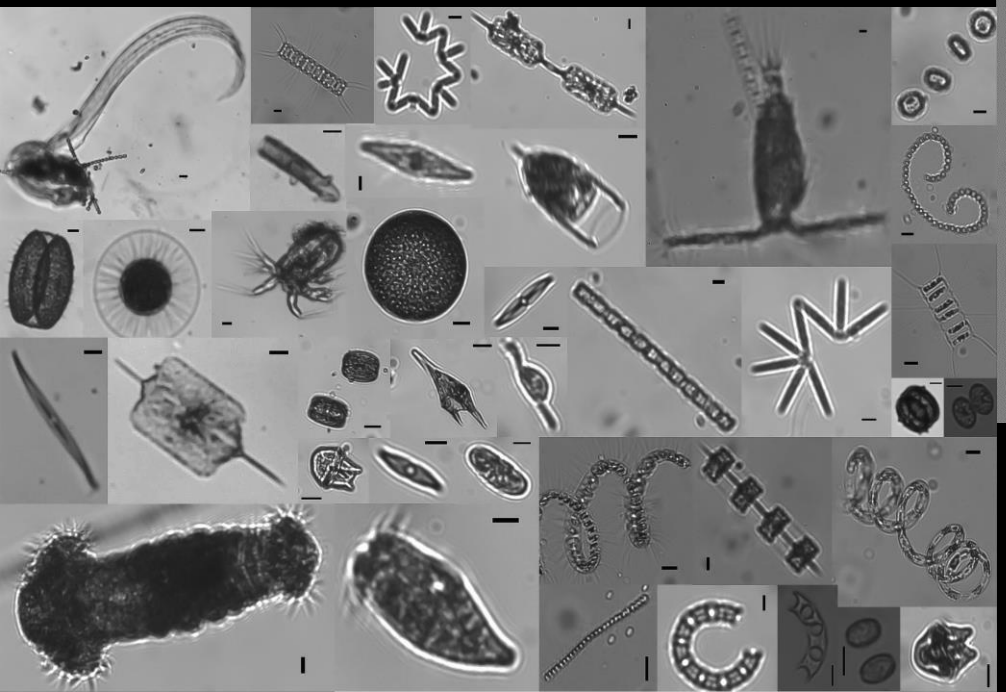
1. Periodic components: quadratic term and wavelet
2. External variables



LSTM model : R^2 = 0.16

BEATS-x model R^2 = 0.98





From Observing to Predicting Plankton

- Model selection
  - Traditional biophysical models require intensive computation and are characterized by high uncertainty in biological processes, primarily predicting bulk measurements such as chlorophyll.
  - Satellite data have sub-optimum spatial and temporal resolution, no species-specific information
- Deep learning models
  - New deep learning models like NBEATS-x and Transformer with attention network are promising
  - For short-term predictions, such as hourly to daily, environmental factors play a minor role, emphasizing the importance of in situ biological observations
  - The performance of traditional deep learning models like LSTM declined rapidly
  - Environmental factors, particularly forward-looking or indicative variables, are likely to play critical roles in long-term predictions

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  - 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