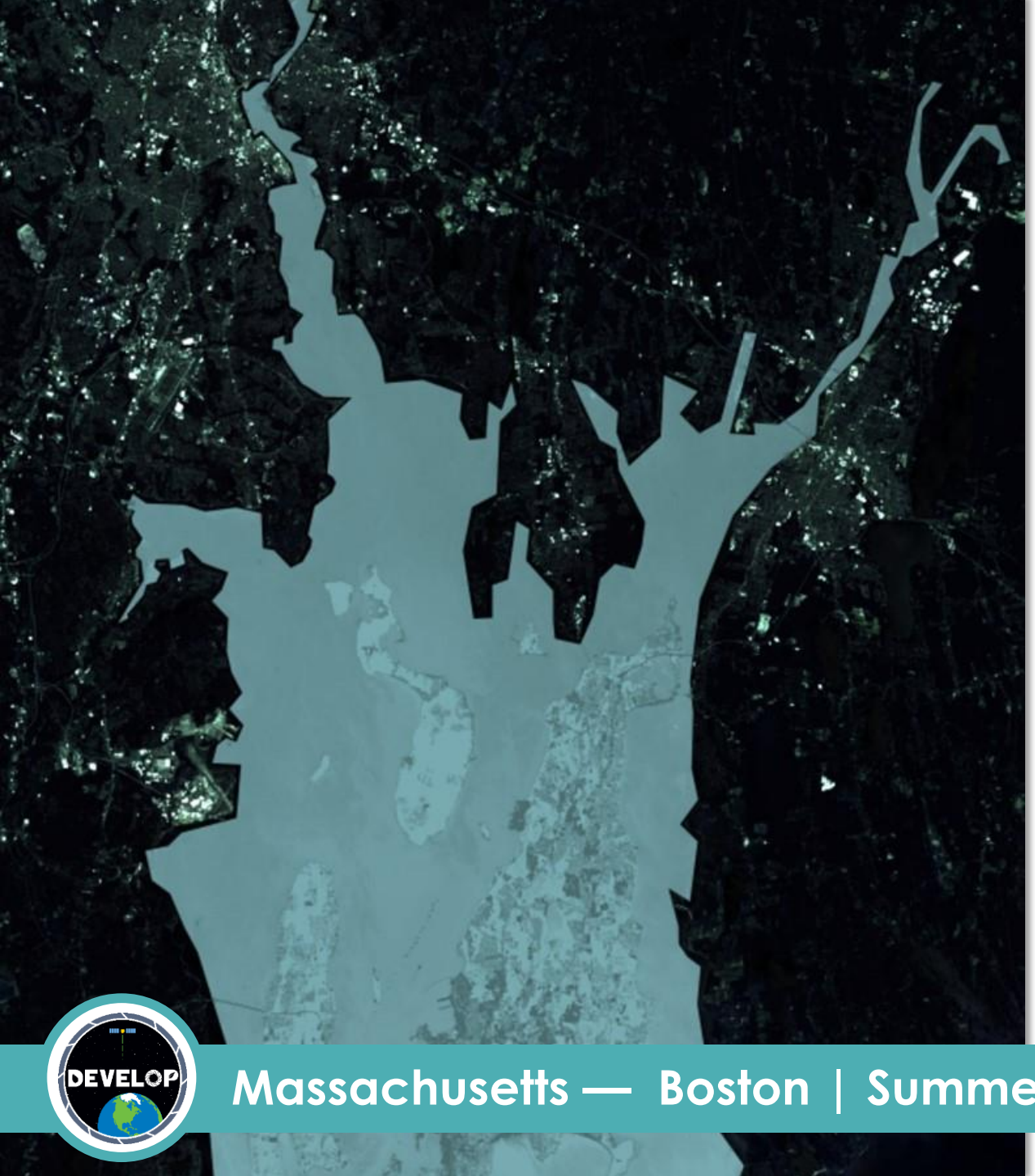


National Aeronautics and Space Administration

Narragansett Bay Water Resources

Using Earth Observations to Identify Trends in Harmful Algal Blooms in Narragansett Bay

Isabella Giordano

Mahnoor Naeem

Chloe Rowen

Samuel Millay

DEVELOP

Massachusetts — Boston | Summer 2024

The Team

Mahnoor Naeem

Isabella Giordano

Chloe Rowen

Samuel Millay

Outline

1. Introduction
Introducing the team, the partners, and the study site

2. Community Concerns
Exploring the problem and how it has impacted the community

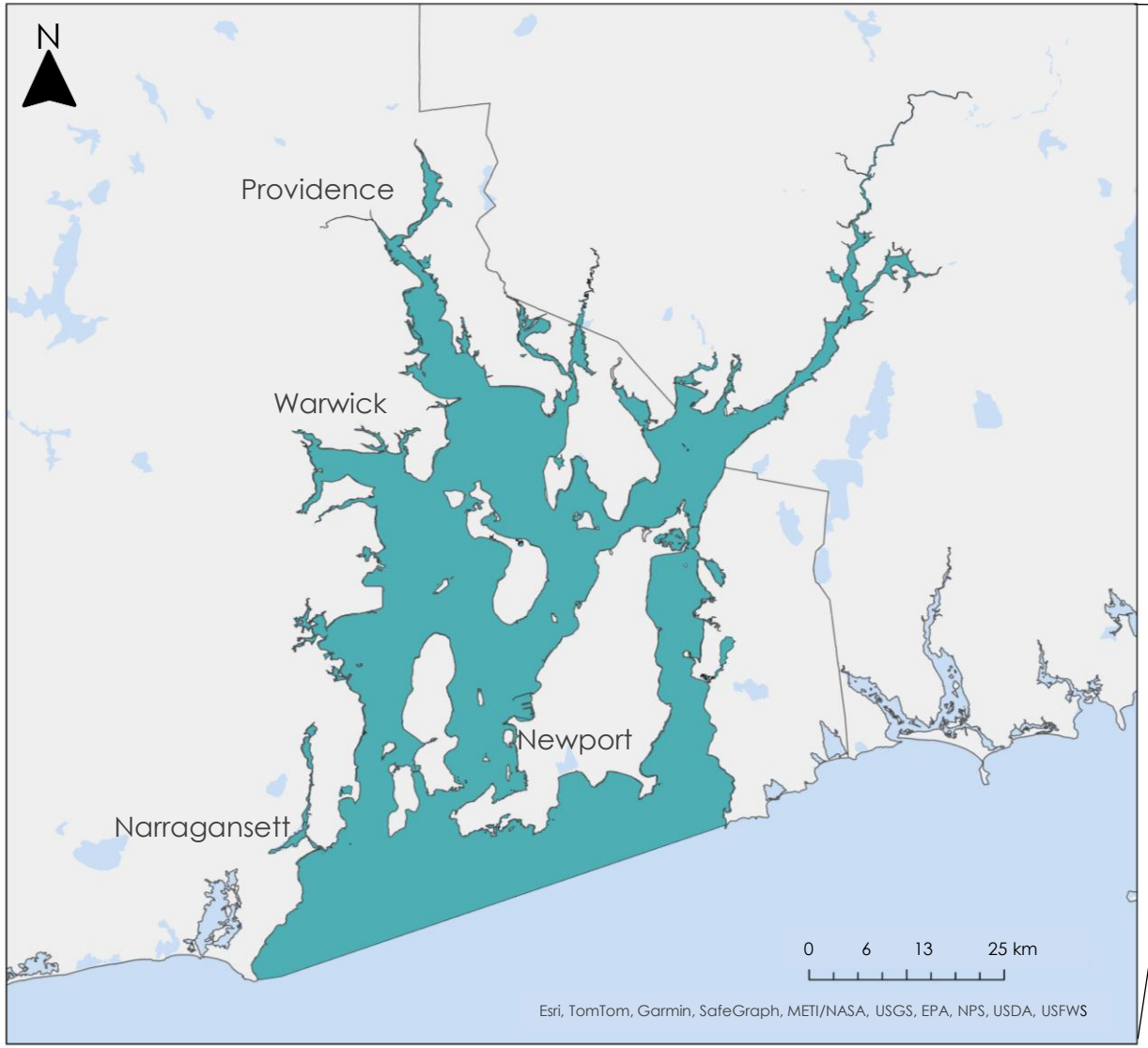
3. Objectives
Creating project objectives based on the partners' needs

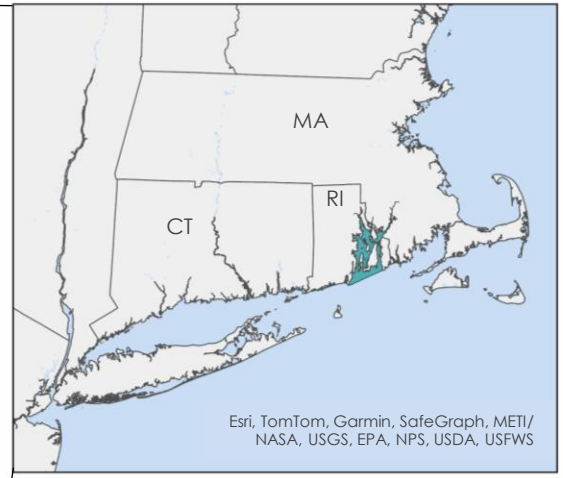
4. Methodology
Using Earth observations and other data to analyze the study area

5. Results
Our findings as well as errors and uncertainties

6. Conclusion
Future work and acknowledgements

Study Area & Period





Narragansett Bay

Study Area:
Narragansett Bay, RI

Study Period:
June to Oct,
2016 to 2023

Partners

United States Environmental Protection Agency (EPA) National Health and Environmental Effects Research Laboratory

Research human and ecosystem health

Rhode Island Department of Environmental Management (RIDEM) Shellfish Water Quality Program

Support and monitor water quality as it relates to shellfish

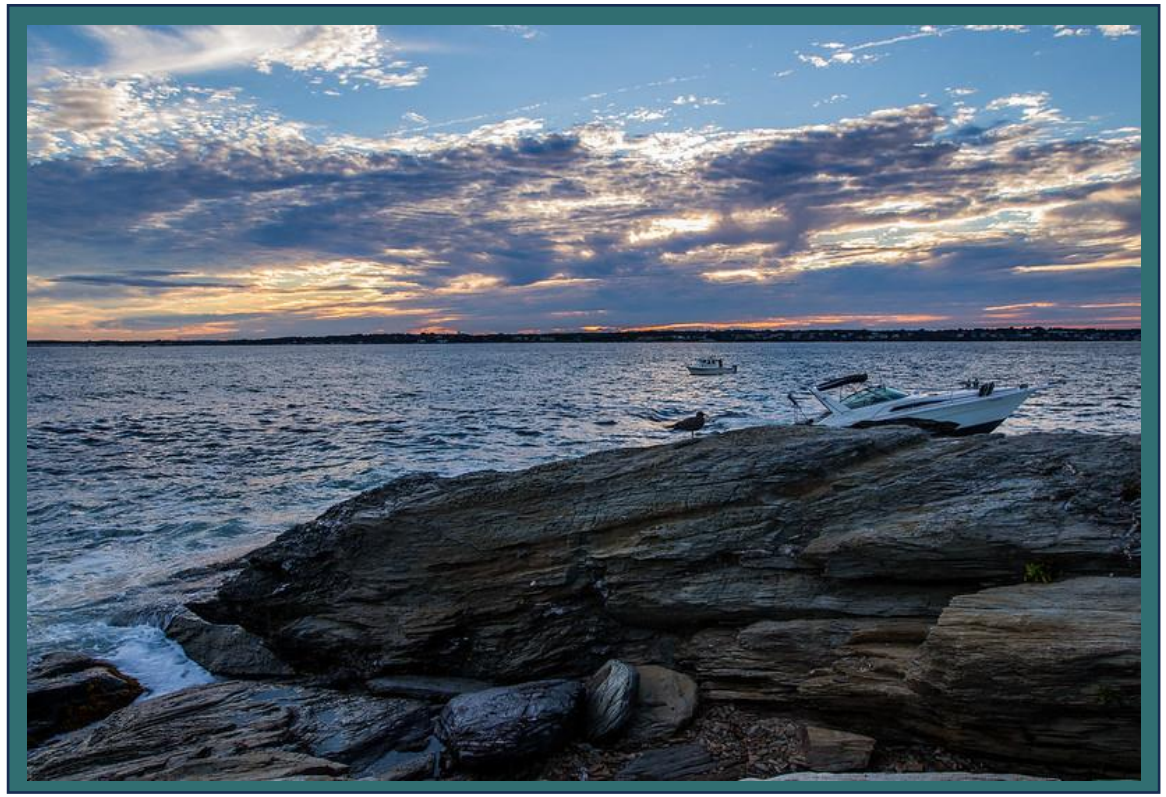


Image Credit: Ayla Fox for NBEP

Community Concerns

Public Health Concerns

- High plankton biomass
- Ecosystem and human health

Economic Concerns

- Quahog populations
- Shellfishery closures
- Impact on tourism

Image Credit: David Borkman, Ayla Fox for NBEP

Objectives

Identify proxy parameters for remote sensing models of phytoplankton biomass

Analyze the presence of phytoplankton both spatially and temporally

Investigate the feasibility of remote sensing products to identify small scale HABs

Earth Observations

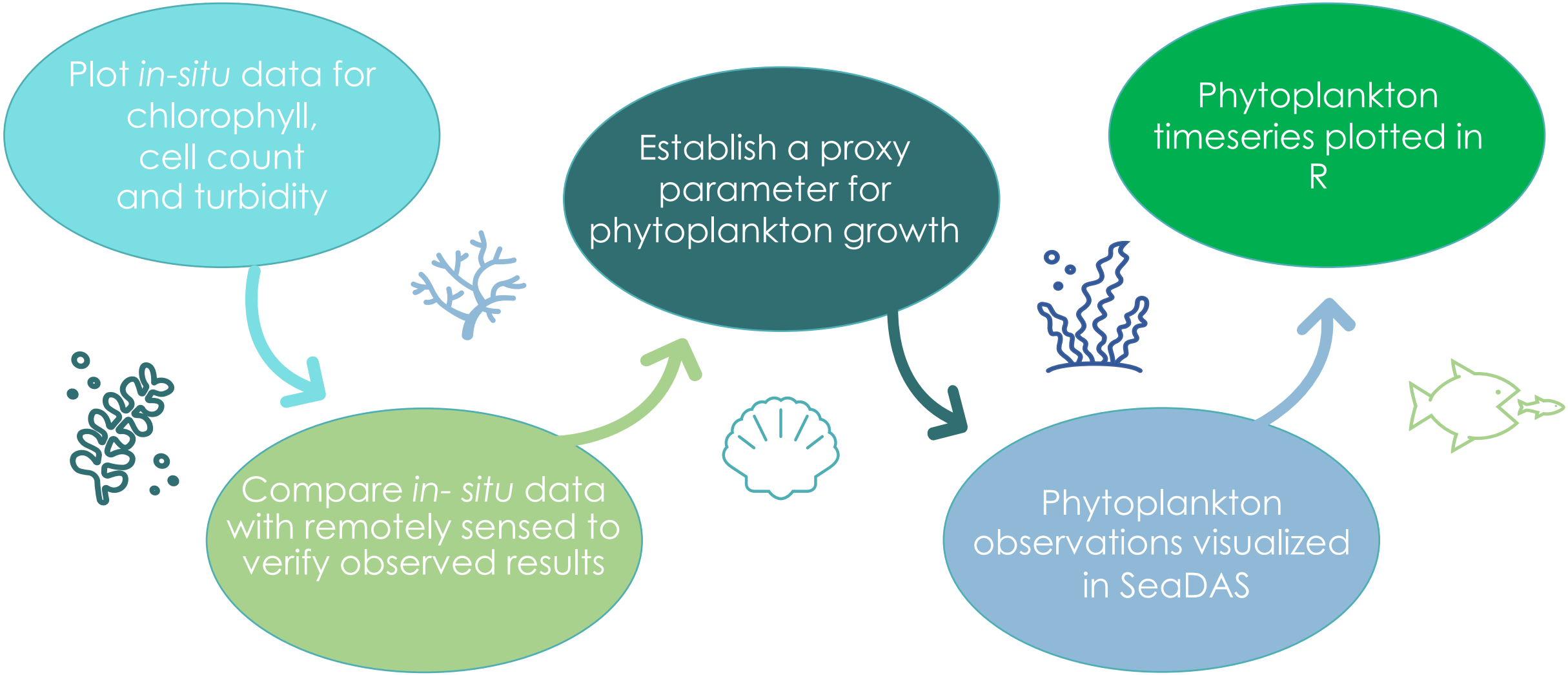
Sentinel-3 OLCI

Landsat-8 OLI

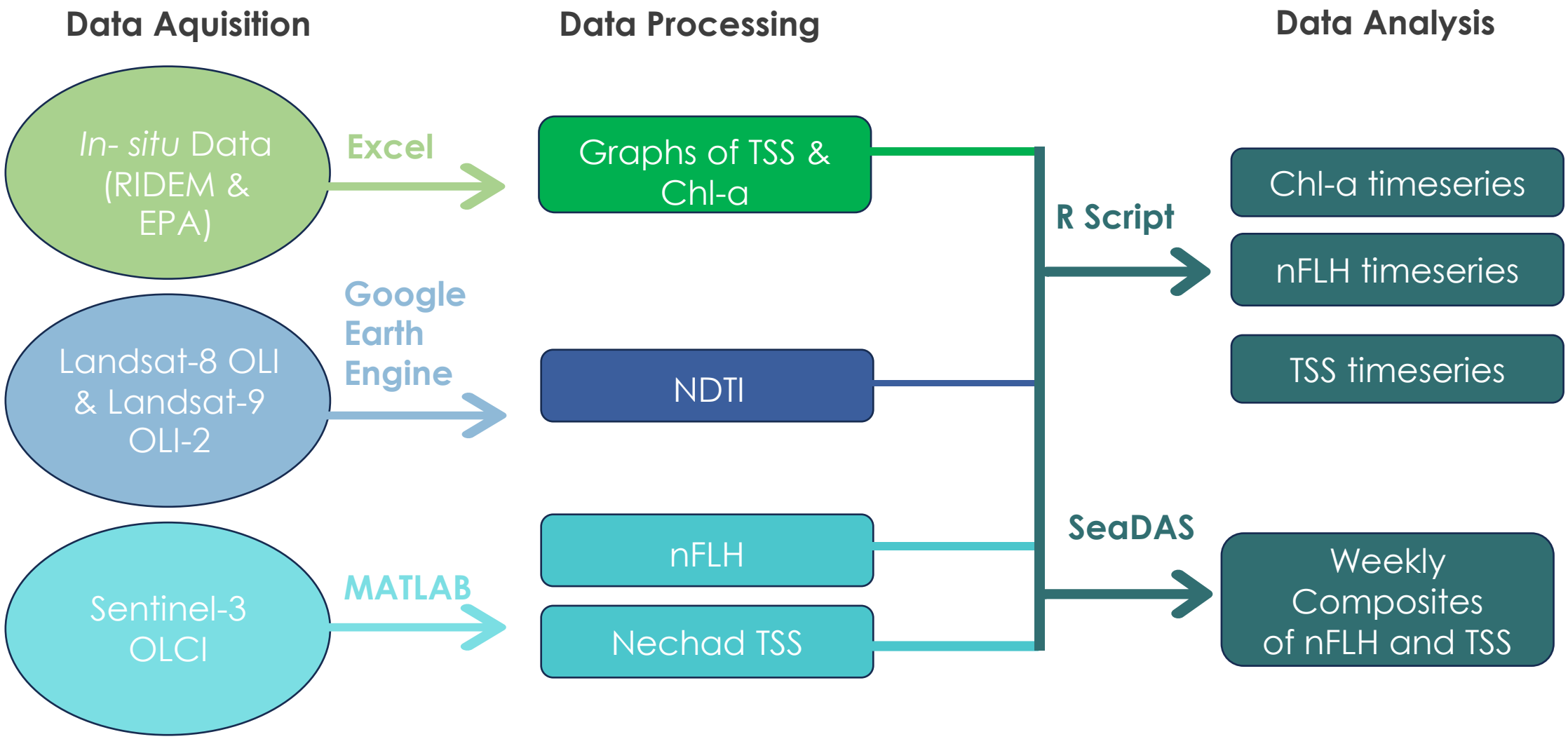
Landsat-9 OLI-2

Image Credit: NASA, ESA

Methodology



Workflow


Data Aquisition
Data Processing
Data Analysis
In- situ Data (RIDEM & EPA)
Excel
Graphs of TSS & Chl-a
Landsat-8 OLI & Landsat-9 OLI-2
Google Earth Engine
NDTI
Sentinel-3 OLCI
MATLAB
nFLH
Nechad TSS
R Script
SeaDAS
Chl-a timeseries
nFLH timeseries
TSS timeseries
Weekly Composites of nFLH and TSS

nFLH Overview

Chlorophyll is a measurement that reflects the concentration of phytoplankton (microscopic algae) in the water. Elevated chlorophyll can be a signal of declining water quality.

In Situ

Units: micrograms/liter

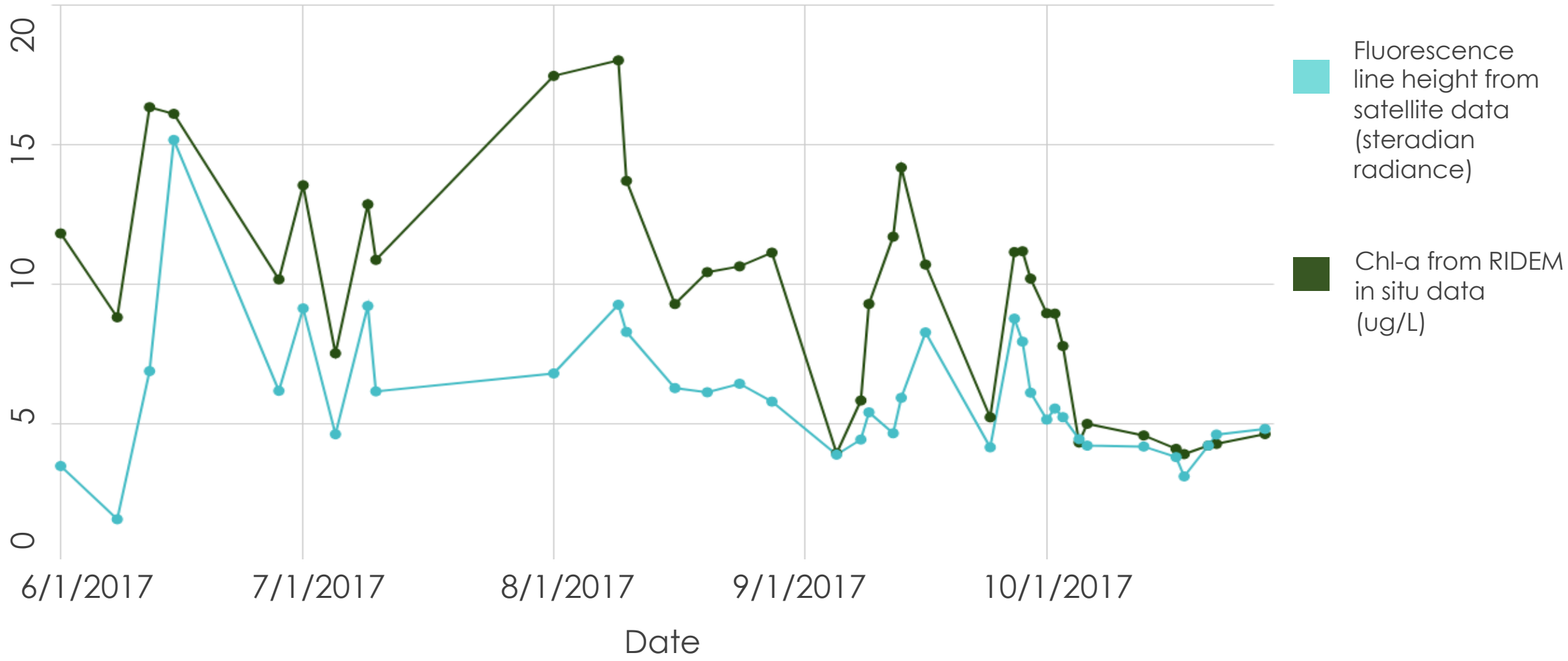
Remote Sensing

Fluorescence line height (FLH) is a relative measure of the amount of radiance leaving the sea surface in the chlorophyll fluorescence emission band.

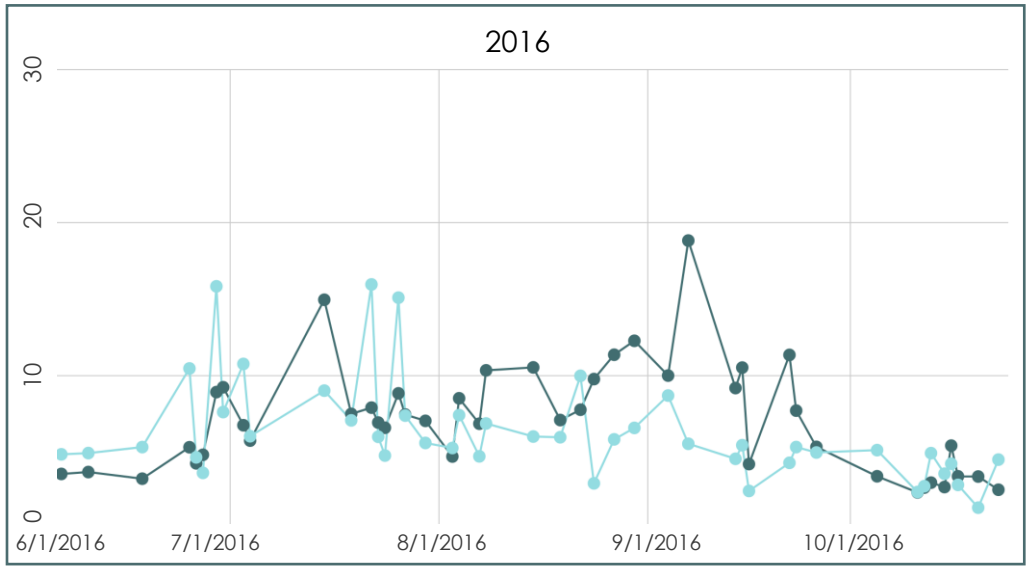
Units: Per steradian (sr-1)

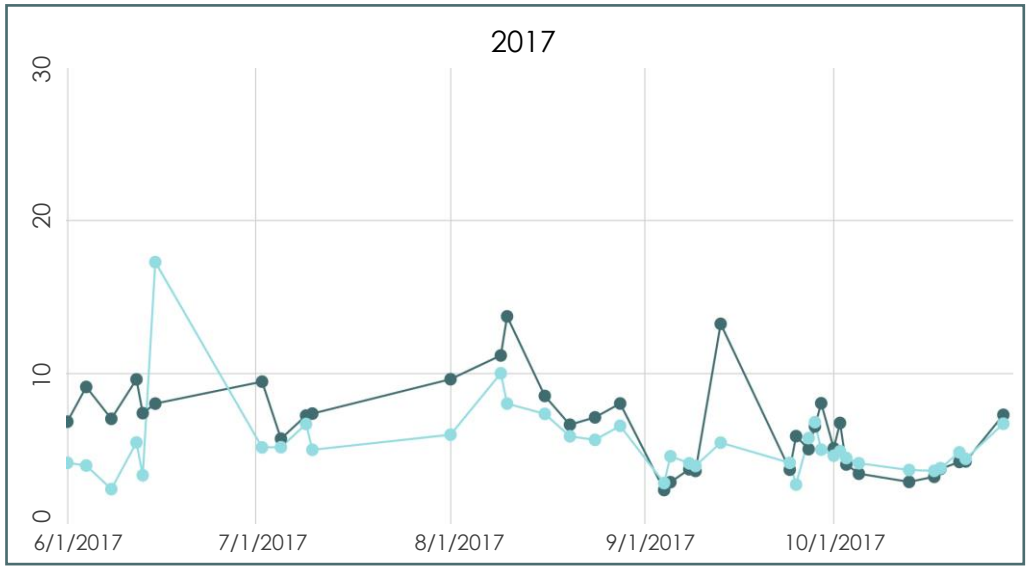
In Situ vs Remote Sensing: Chlorophyll

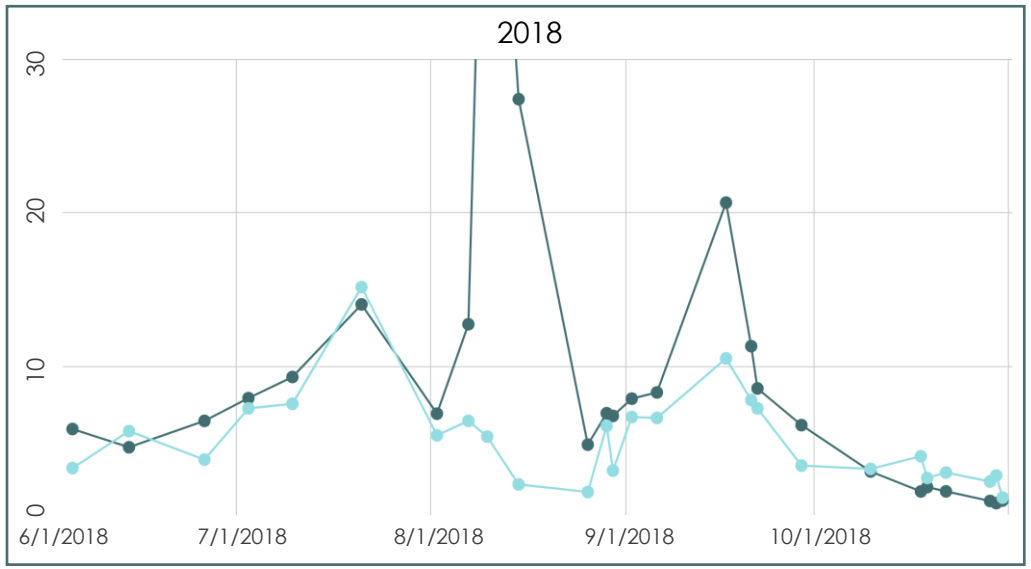
Station B3 - Conimicut Point (Upper Bay – West Passage) 2017

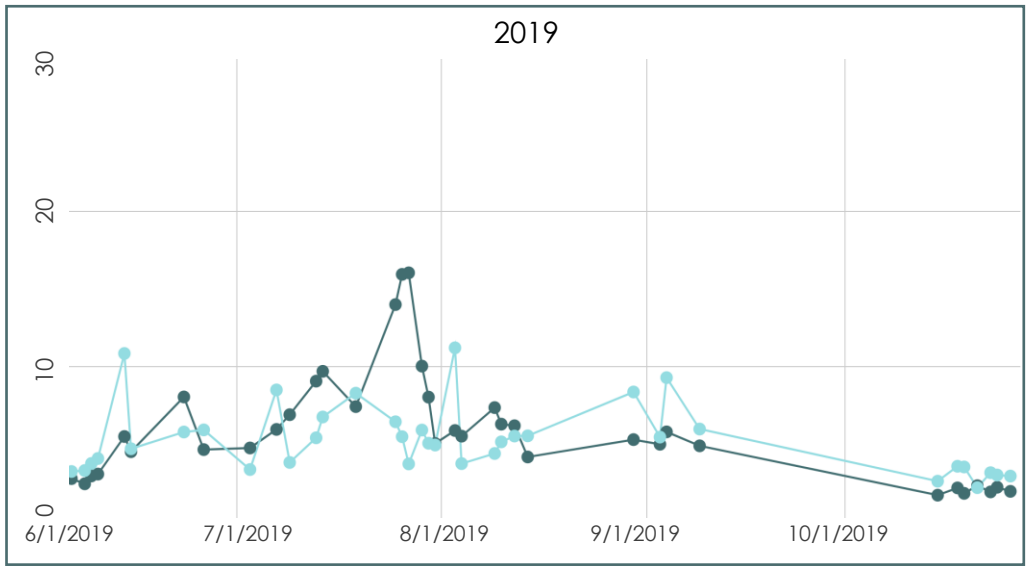


Chlorophyll-a VS nFLH Timeseries







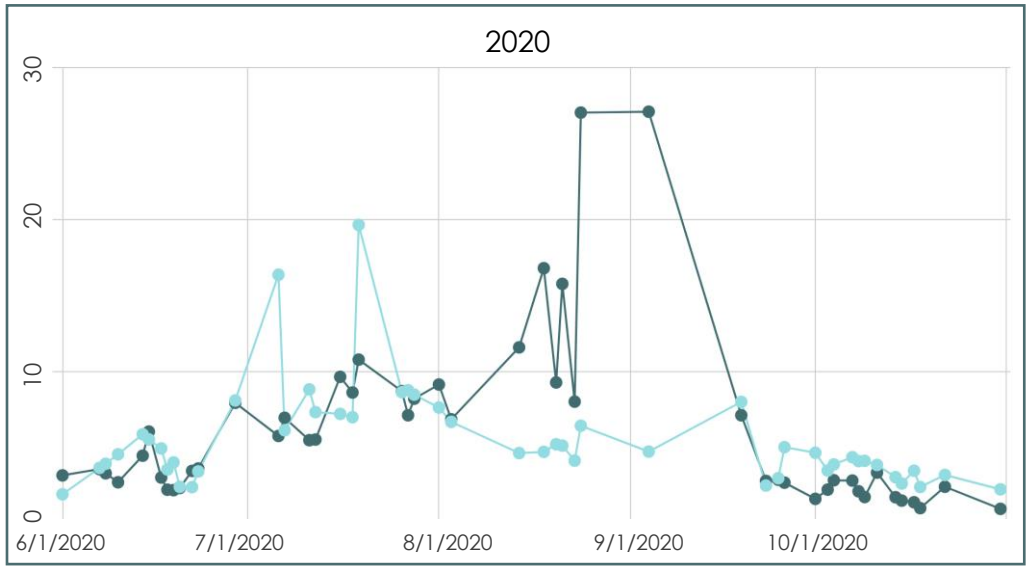


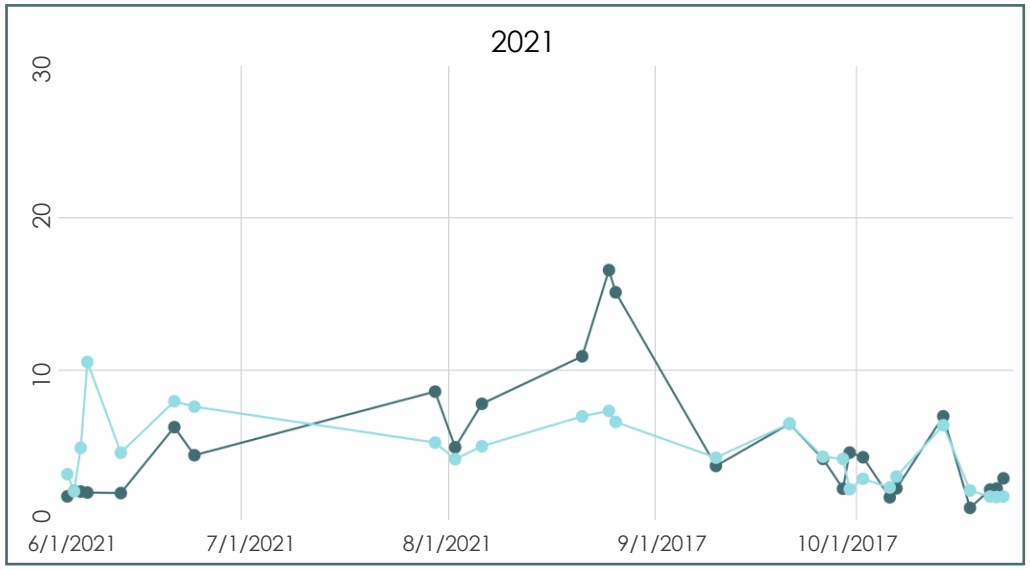
Station B6 - Mountain View (Mid-Bay)

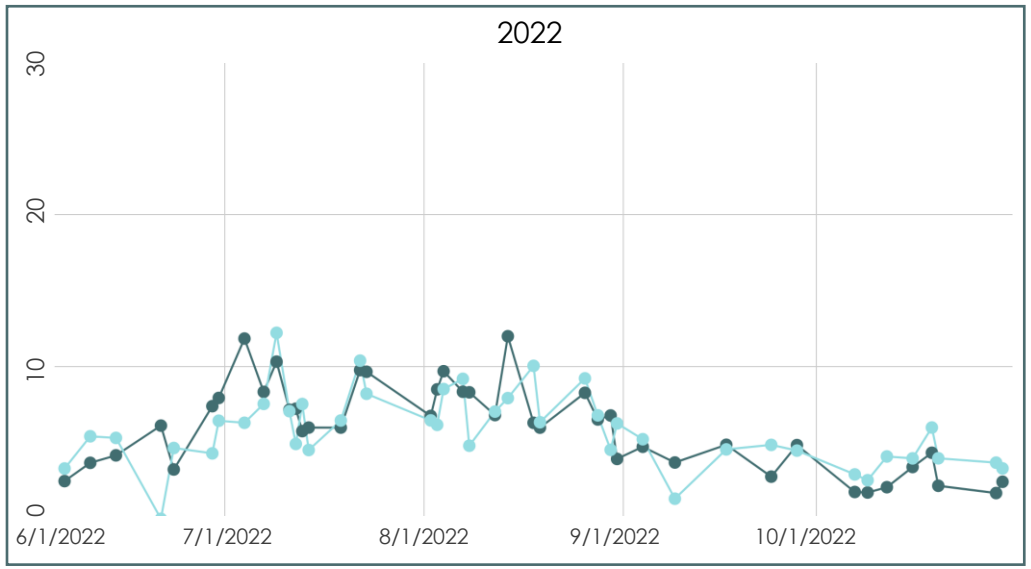
In situ Chl-a (ug/L)

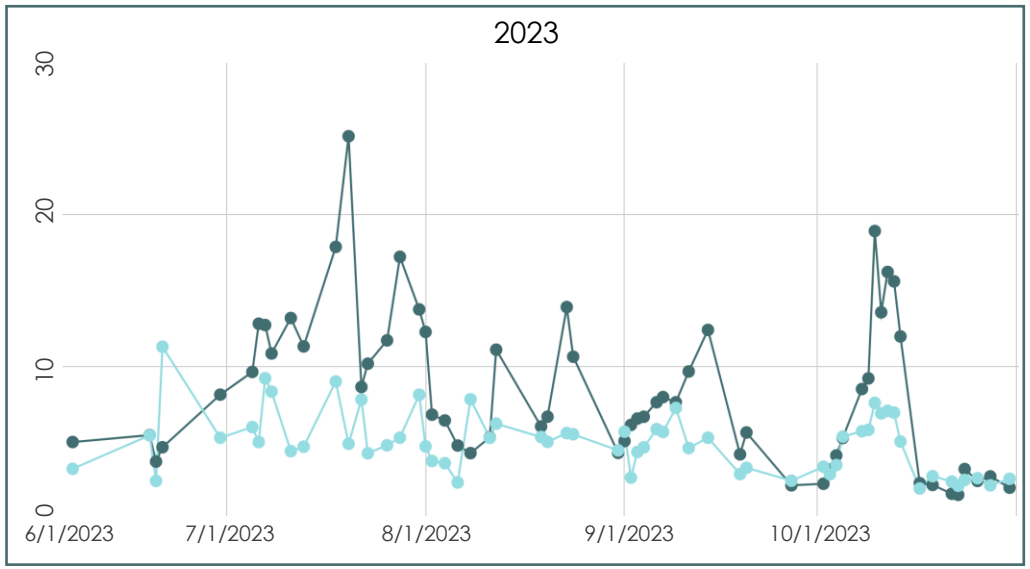
nFLH (steradian radiance)

Chlorophyll-a VS nFLH Timeseries







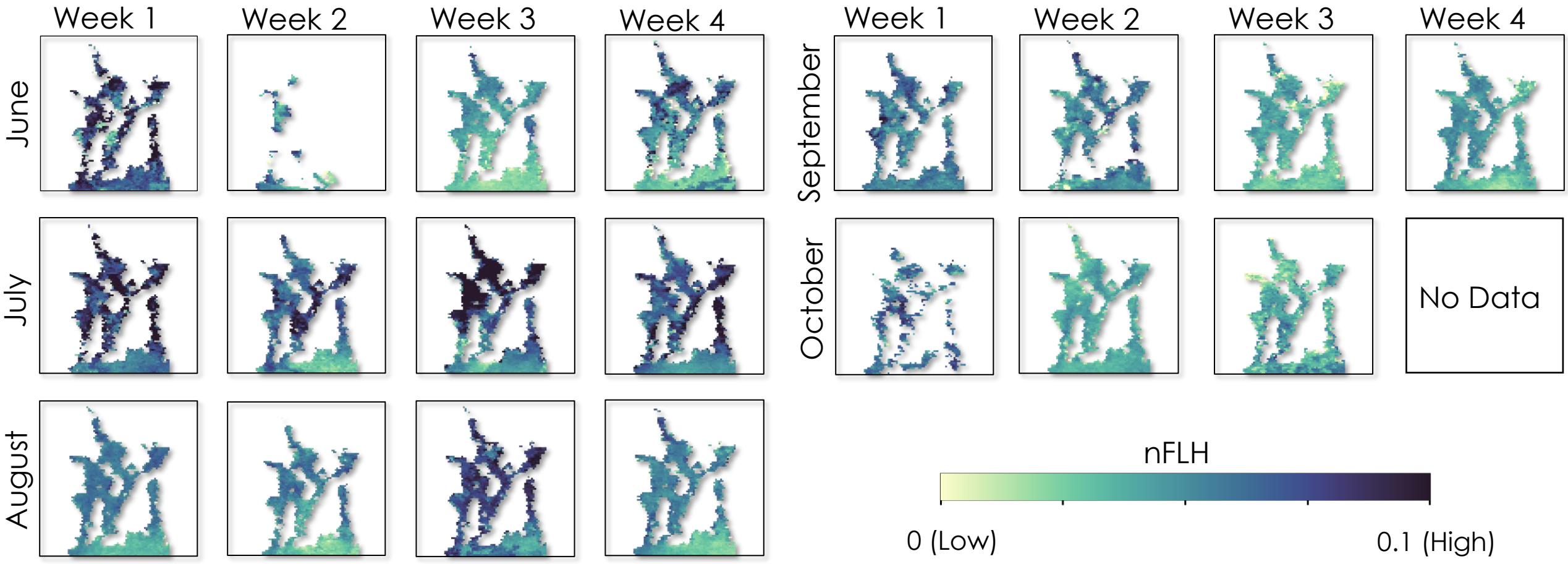


Station B6 - Mountain View (Mid-Bay)

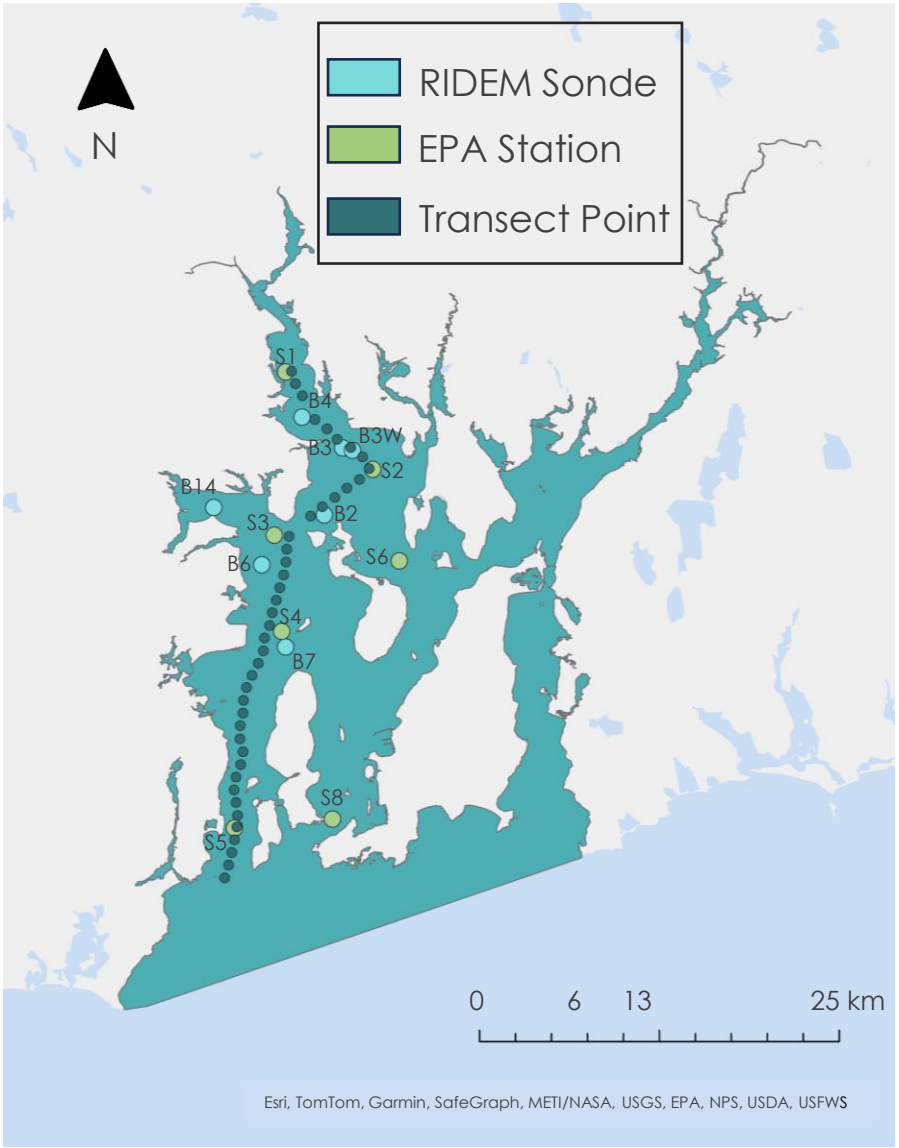
In situ Chl-a (ug/L)

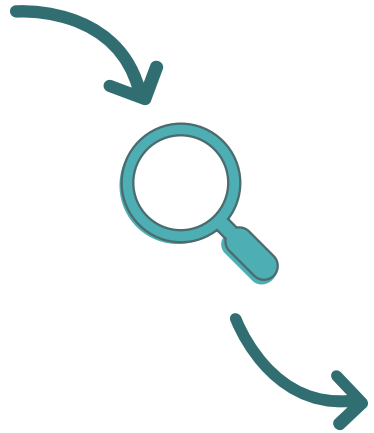
nFLH (steradian radiance)

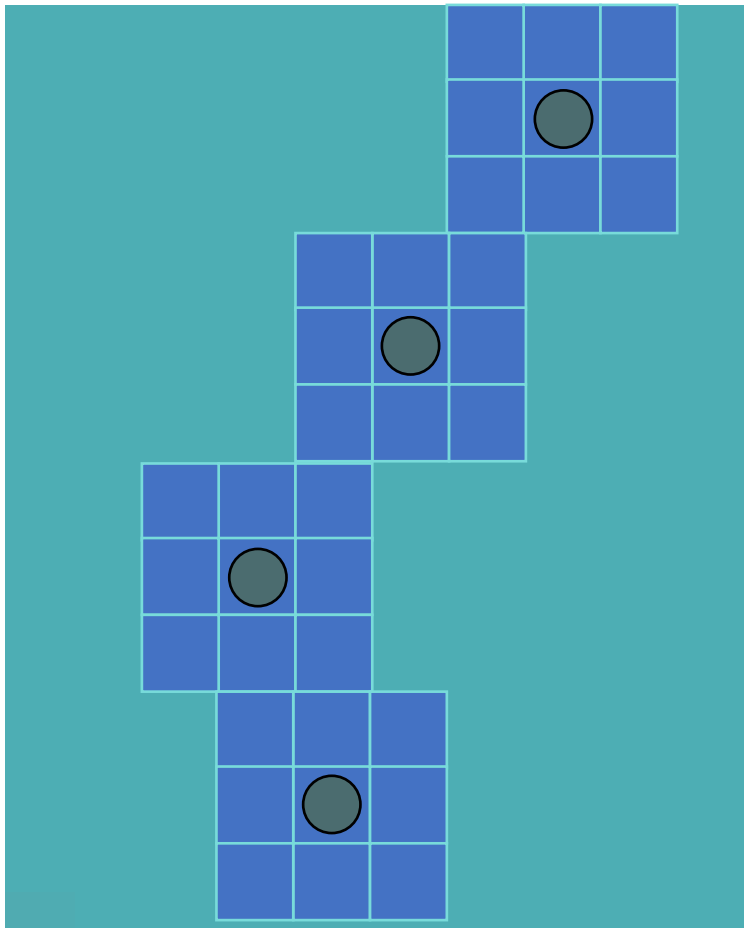
Weekly Composite Normalized Fluorescence Line Height (nFLH) - June to October 2016

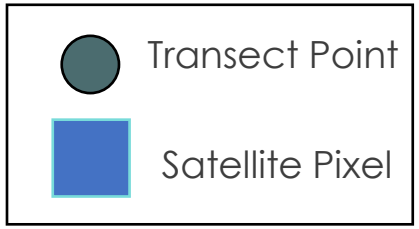


Results: Transect

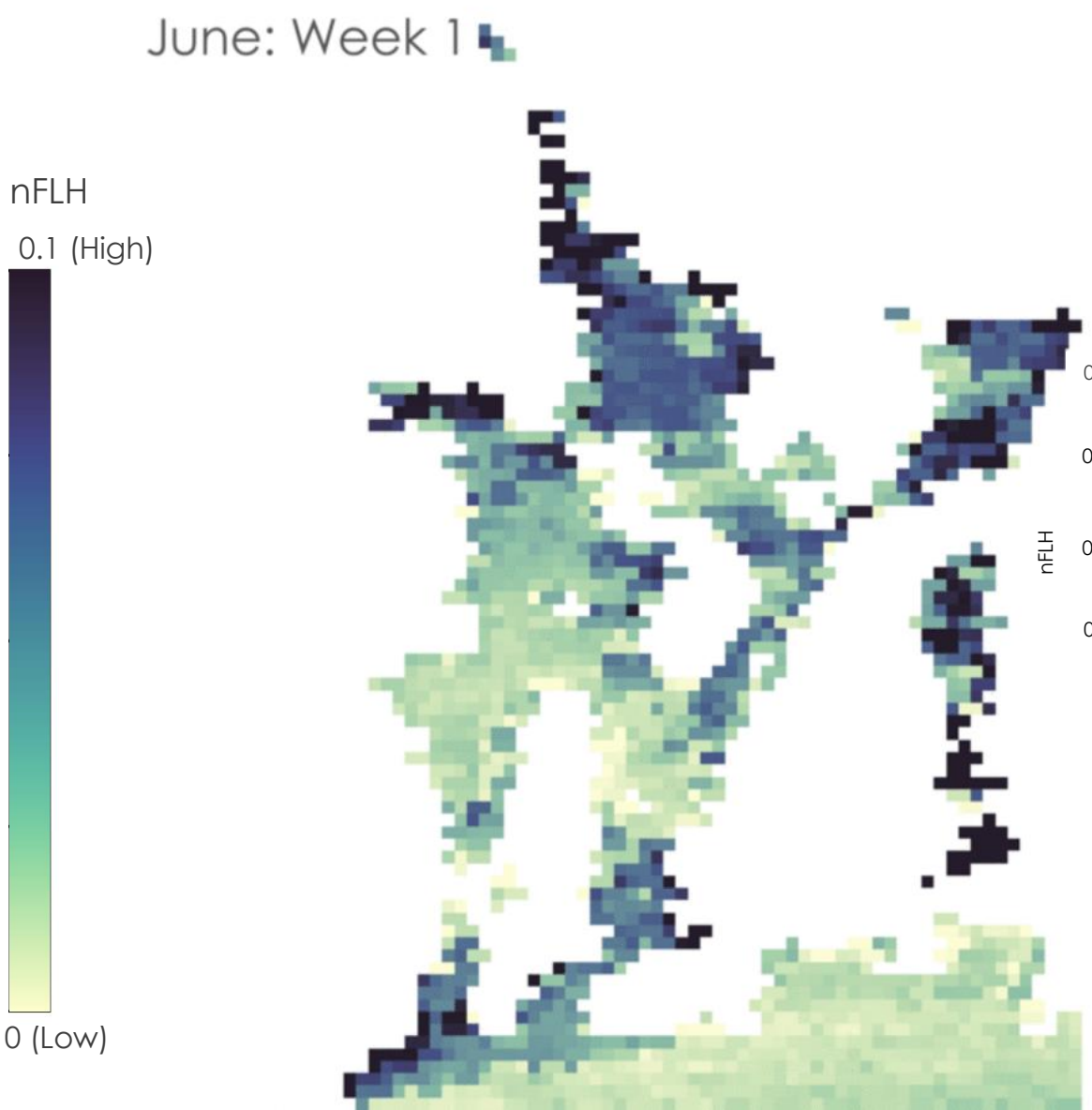


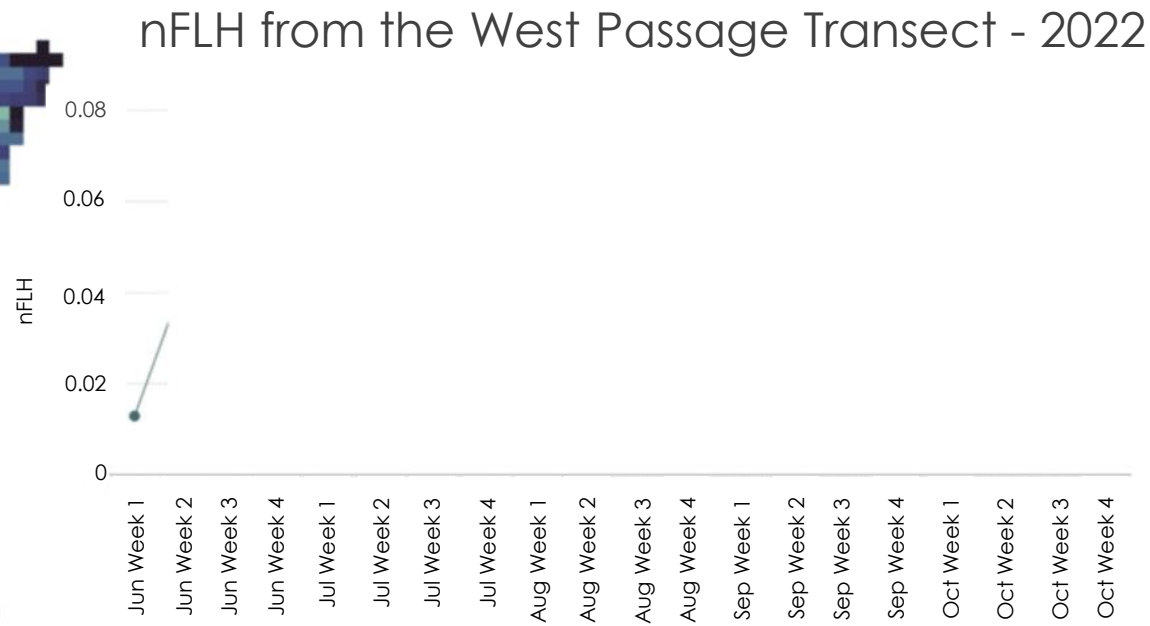






Weekly nFLH, June to October 2022





Nechad Algorithm Overview

Turbidity and **TSS** are the most visible indicators of water quality. These suspended particles can come from soil erosion, runoff, discharges, stirred bottom sediments or algal blooms.

In Situ

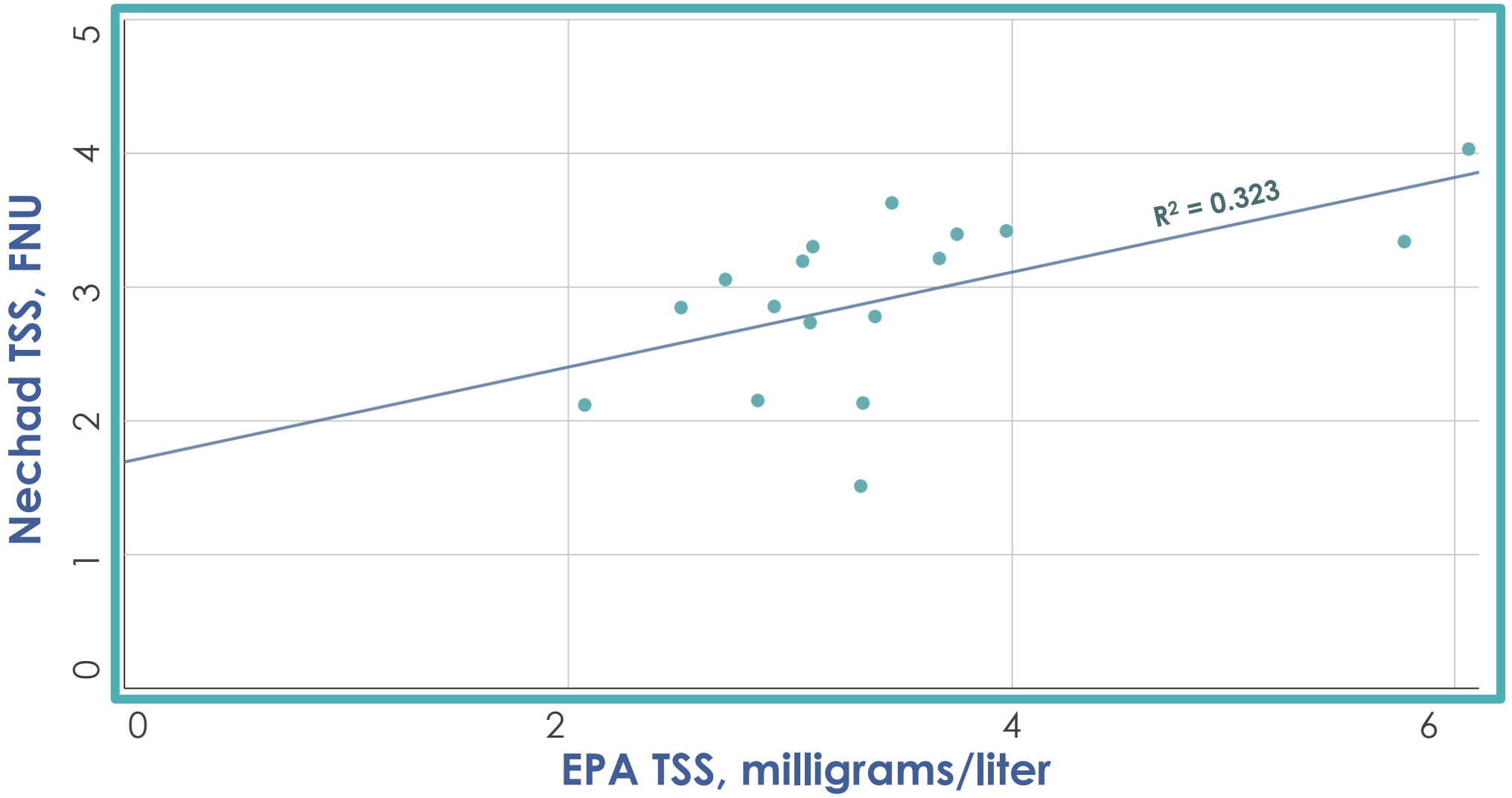
Units: milligrams/liter

Remote Sensing

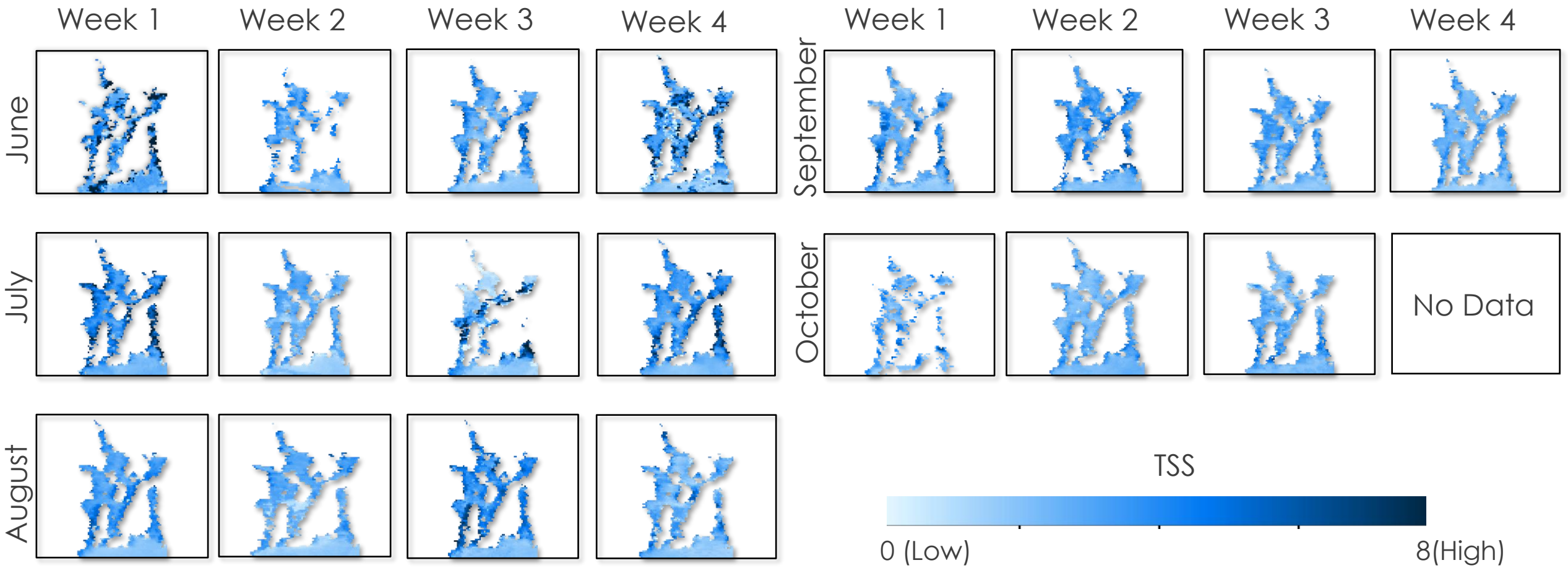
The **Nechad algorithm** estimates Total Suspended Solids (TSS) in water by using satellite-derived reflectance data to establish a relationship between the observed reflectance and TSS concentration.

Units: FNU (Formazin Nephelometric Unit)

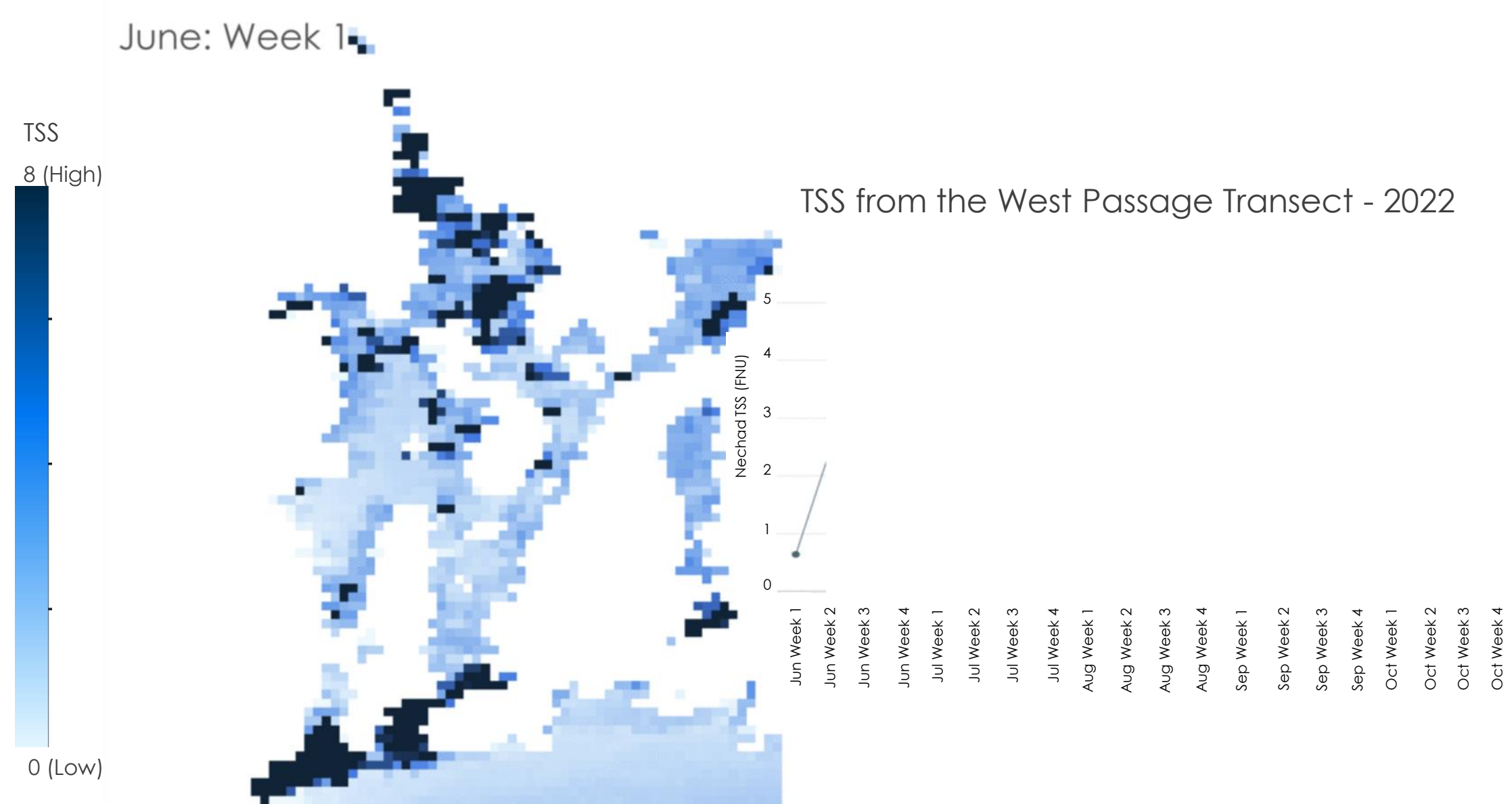
EPA TSS In situ VS Nechad TSS Algorithm Correlation



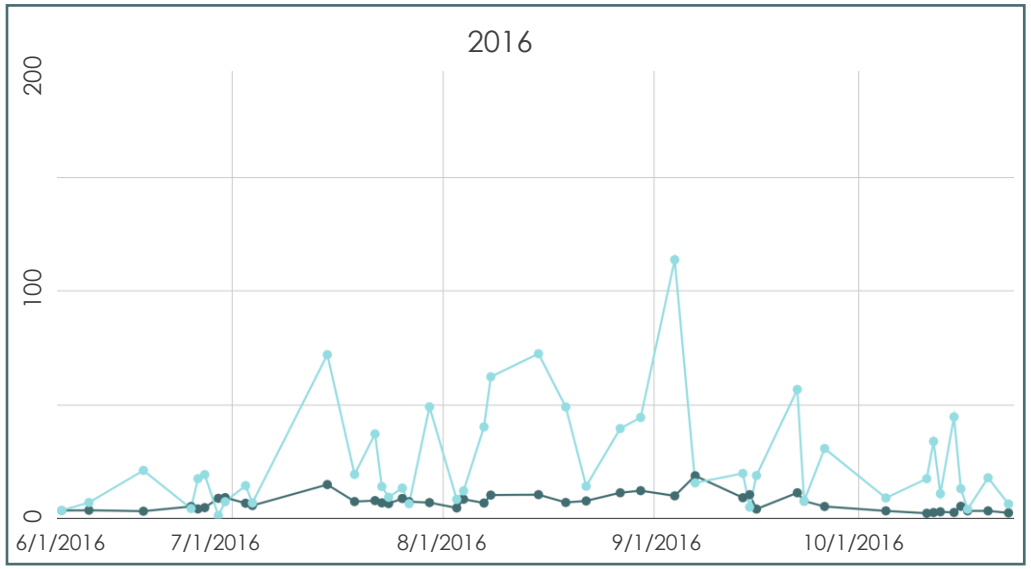
Weekly Composite Nechad TSS Algorithm - June to October 2016

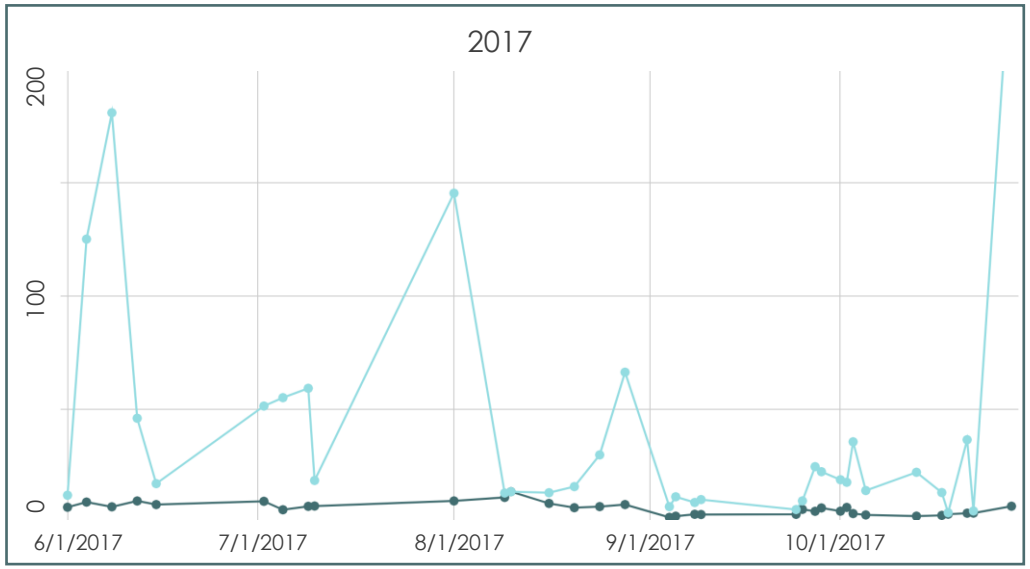


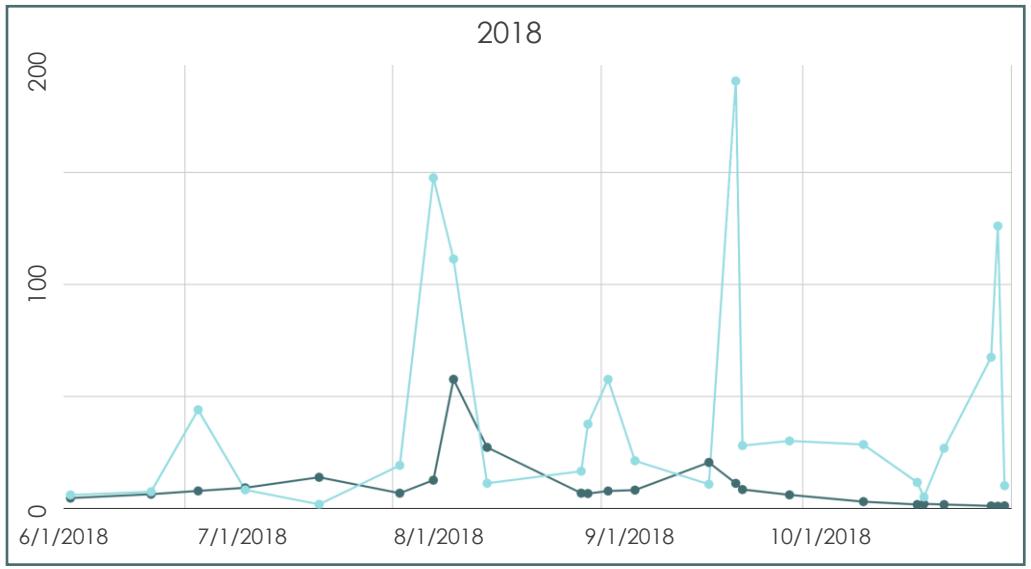
Weekly Nechad TSS, June to October 2022

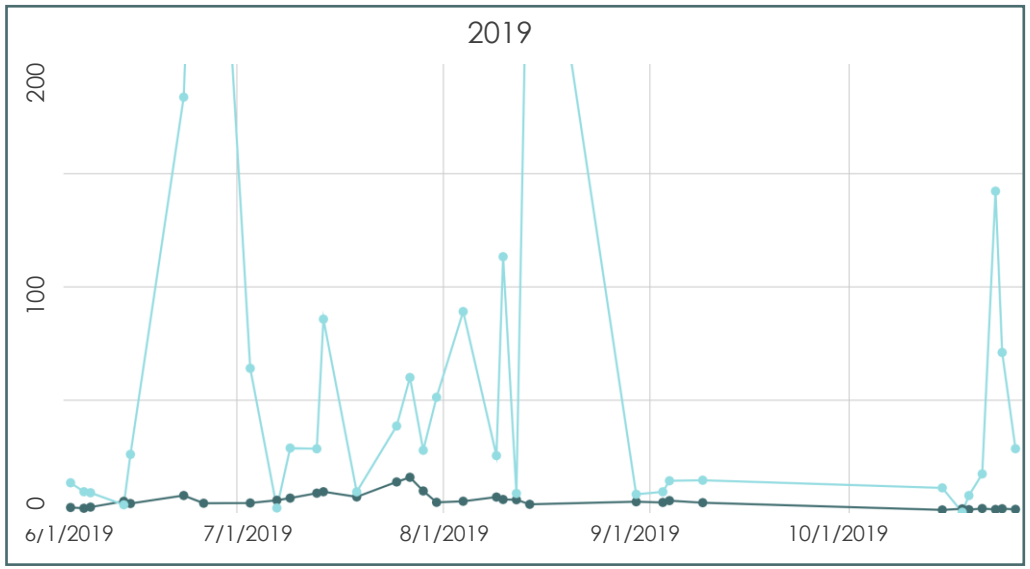


Chlorophyll-a VS OLCI Chl-a Timeseries







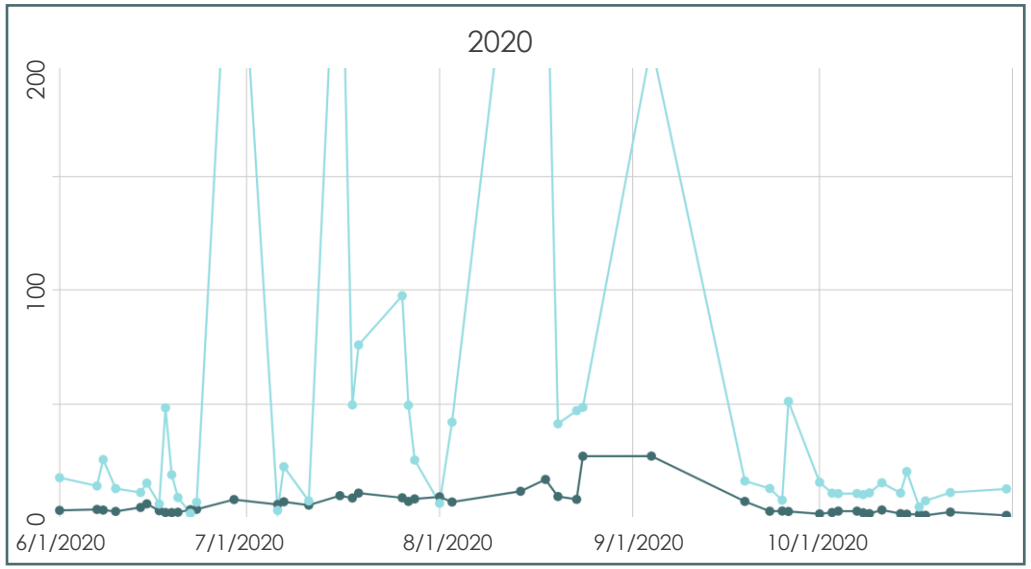


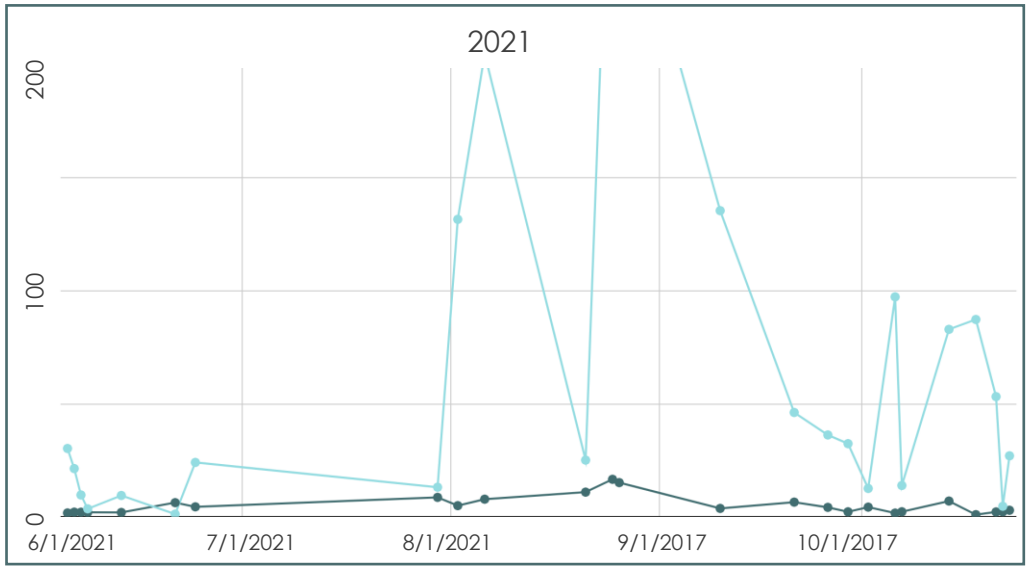
Station B6 - Mountain View (Mid-Bay)

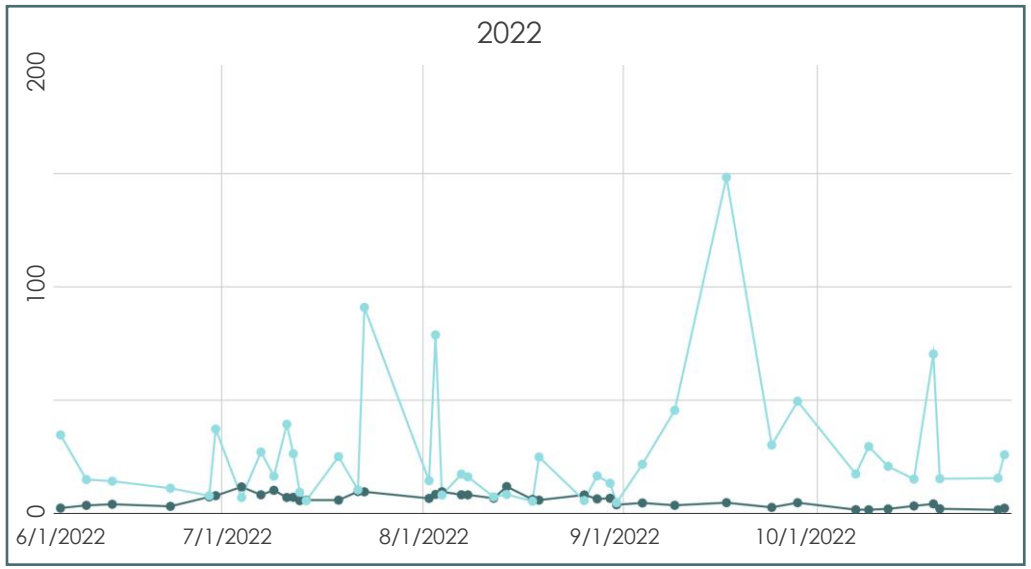
In situ Chl-a (ug/L)

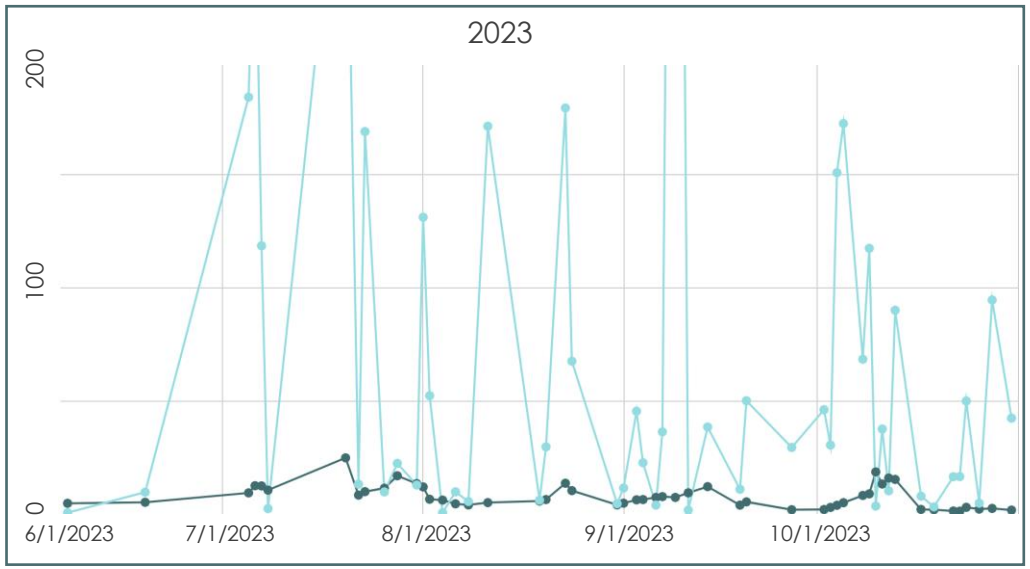
Sentinel-3 OLCI Chl-a (mg/m^3)

Chlorophyll-a VS OLCI Chl-a Timeseries









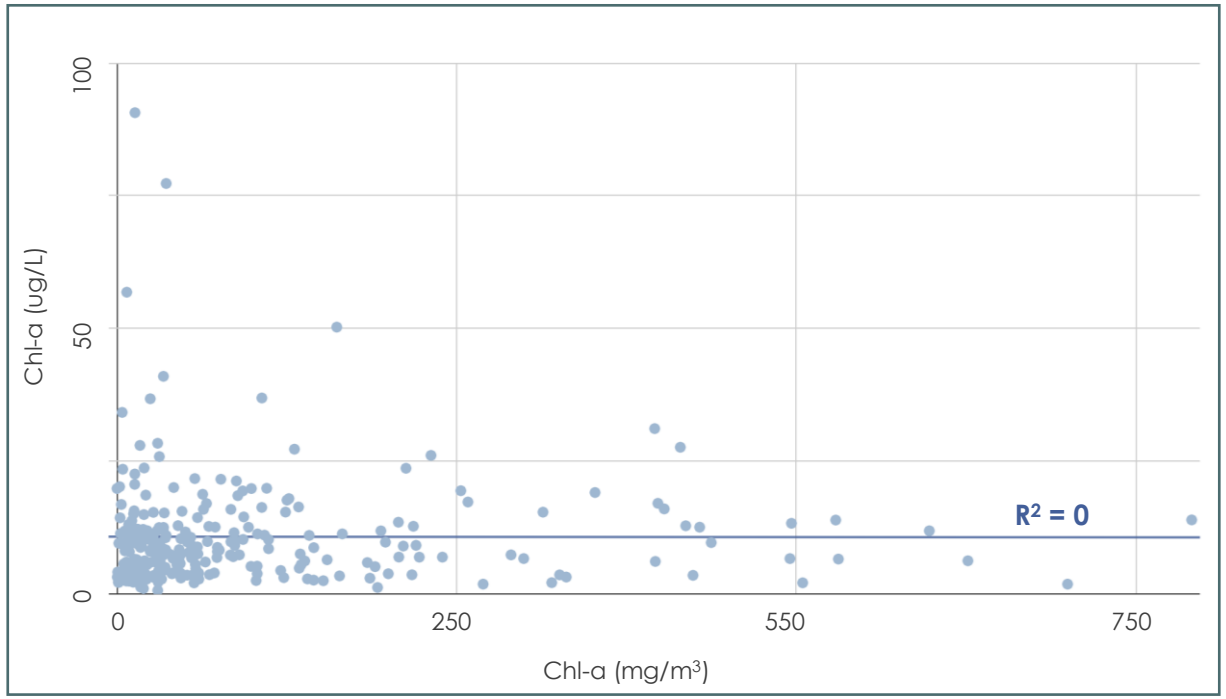
Station B6 - Mountain View (Mid-Bay)

In situ Chl-a (ug/L)

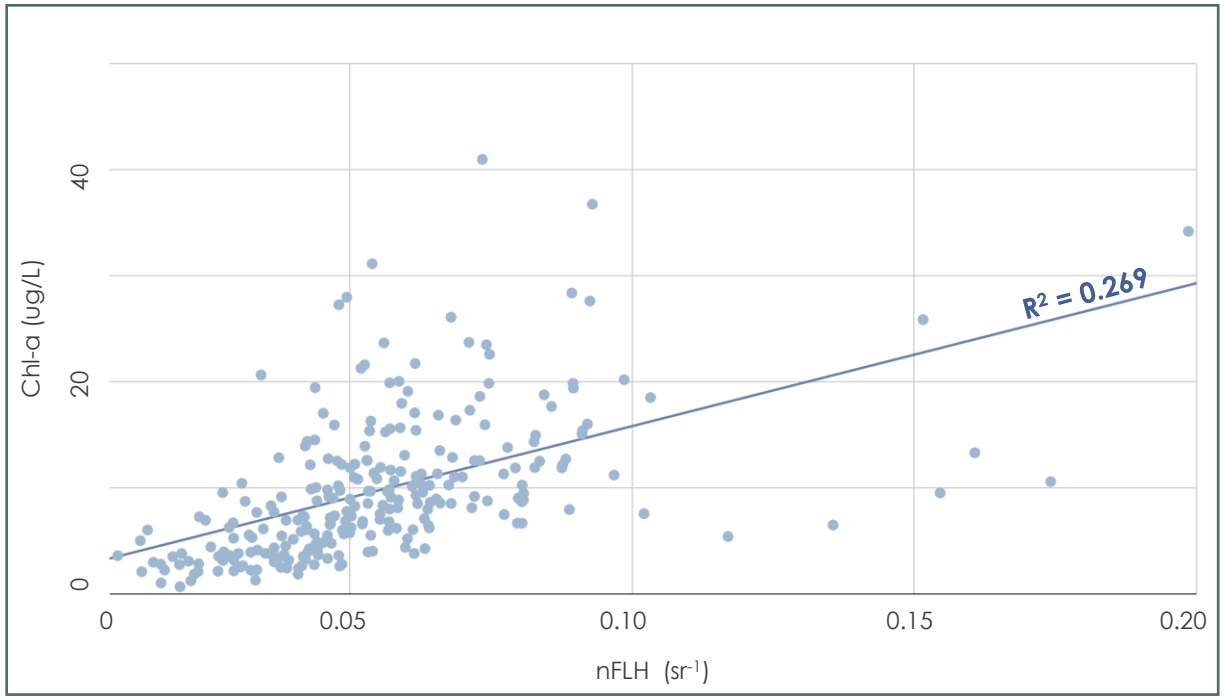
Sentinel-3 OLCI Chl-a (mg/m^3)

Chla VS nFLH Correlation

Sentinel-3 OLCI Chl-a VS In situ Chl-a

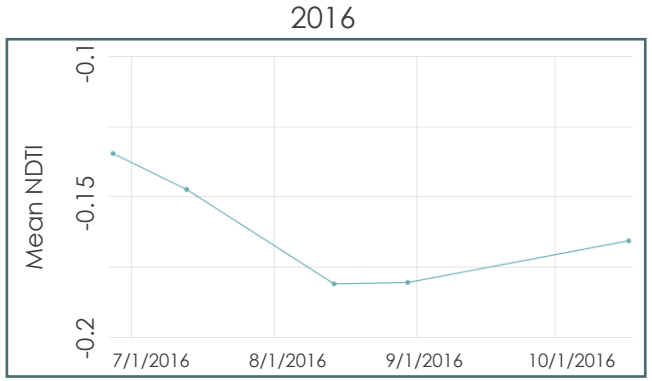


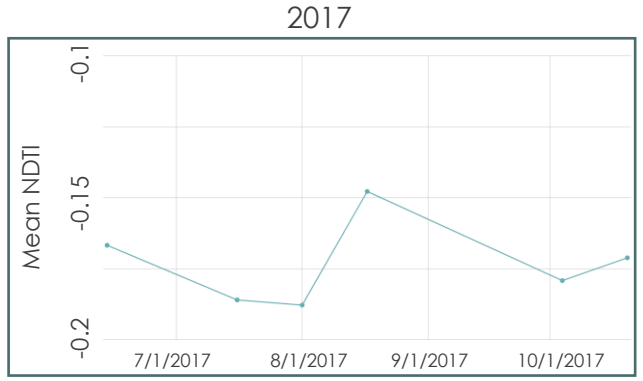
nFLH VS In situ Chl-a

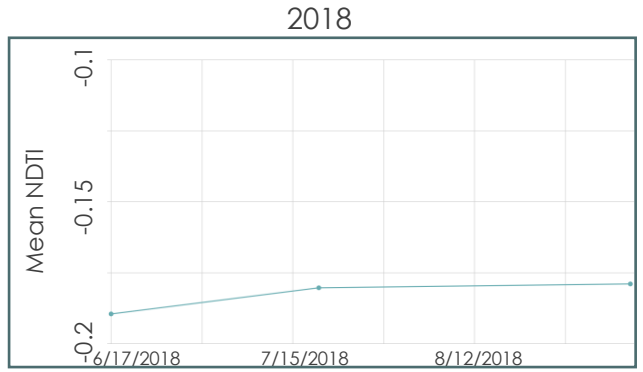


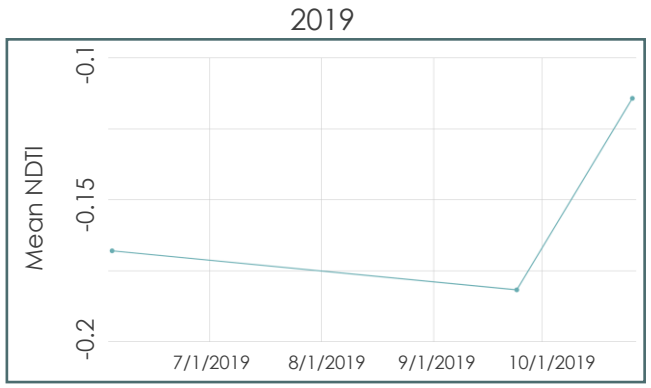
Station B3 – Conimicut Point (Upper-Bay)

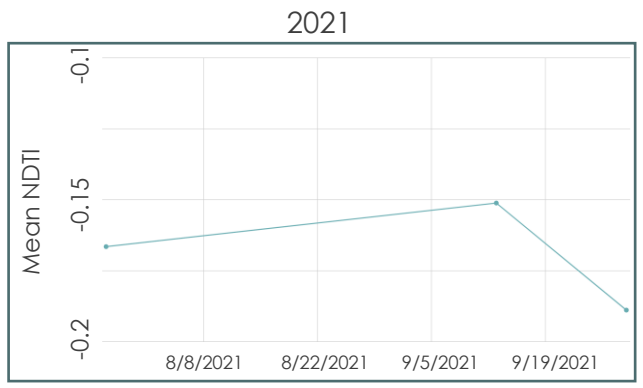
Normalized Difference Turbidity Index

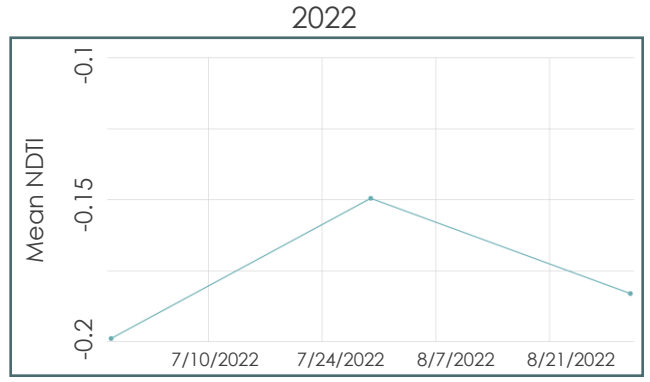


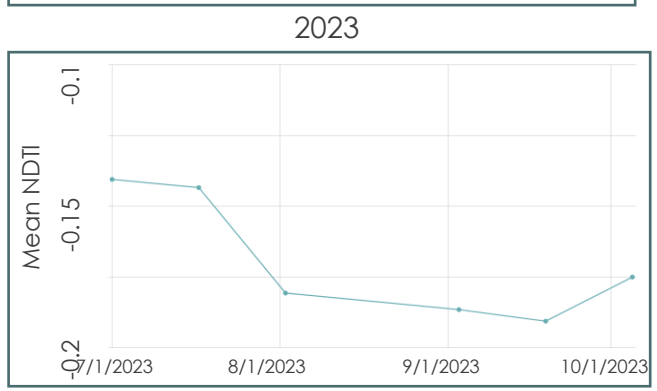












Normalized Difference Turbidity Index (NDTI) = (Red-Green)/(Red+Green)

Landsat 8 OLI & Landsat 9 OLI-2
Red: Band 4
Green: Band 3

Errors, Uncertainties, and Limitations

Sentinel-3

- Spatial resolution (300m)
- Cloud coverage

Landsat

- Lack of imagery
- Cloud coverage

***In-Situ* Data**

- Missing turbidity
- Gaps in data
- Restricted to sonde locations

Feasibility & Partner Implementation

- It is **feasible** to use Earth observations to track HABs.
- EOs **compliment *in-situ* data** and partners can use the two together.
- Partners should compare **nFLH to chlorophyll** and **TSS to the Nechad algorithm output** to accurately combine the two datasets.

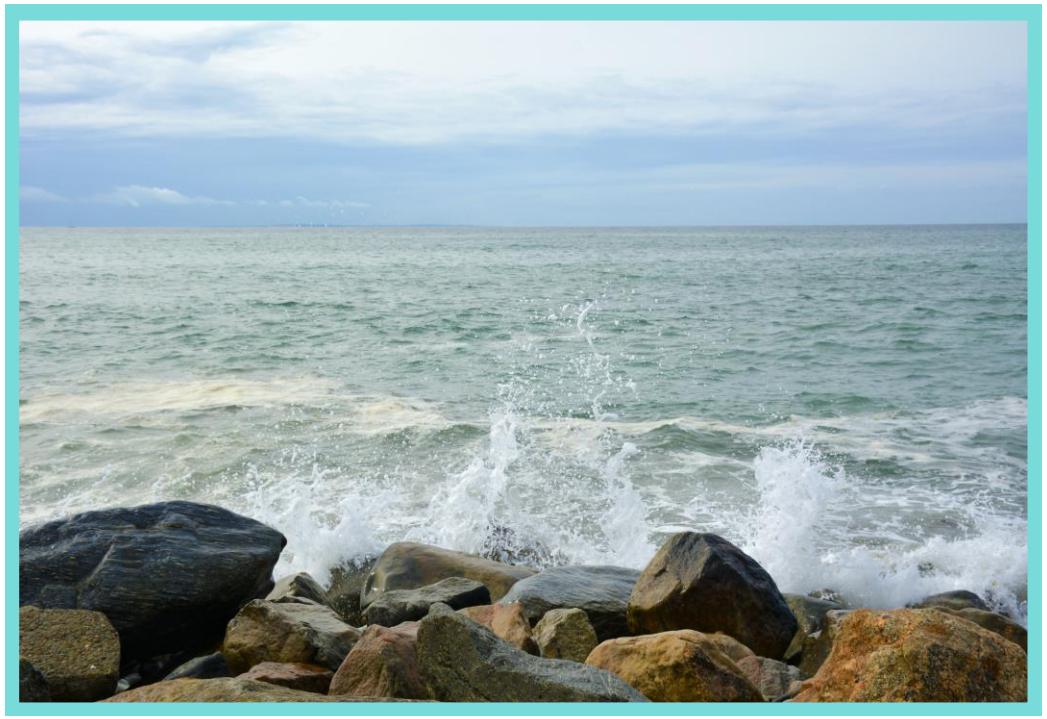


Image Credit: Ayla Fox for NBEP

Conclusions

- **Chlorophyll-a** and **TSS** are both **effective proxies** for tracking HABs.
- **nFLH** was the **best** remote sensing product for tracking **chlorophyll**.
- The **Nechad algorithm** was the **best** remote sensing product for tracking **TSS**.
- **Landsat-8 and 9 products** were **not effective** in tracking **turbidity.**

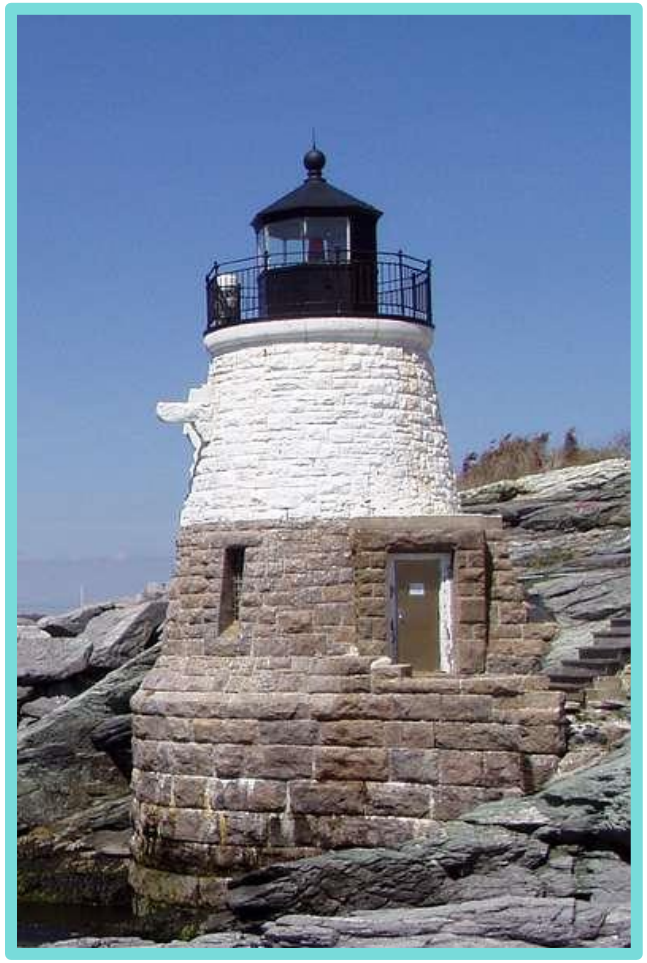


Image Credit: GetArchive

Acknowledgments

- **Advisor**: Dr. Cedric Fichot (Boston University)
- **Partners**:
  Dr. Autumn Oczkowski (United States Environmental Protection Agency)
  Dr. David Borkman (Rhode Island Department of Environmental Management)
- **Lead**: Madison Arndt (DEVELOP MA – Boston)

This material contains modified Copernicus Sentinel data 2016-2023, processed by ESA.

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