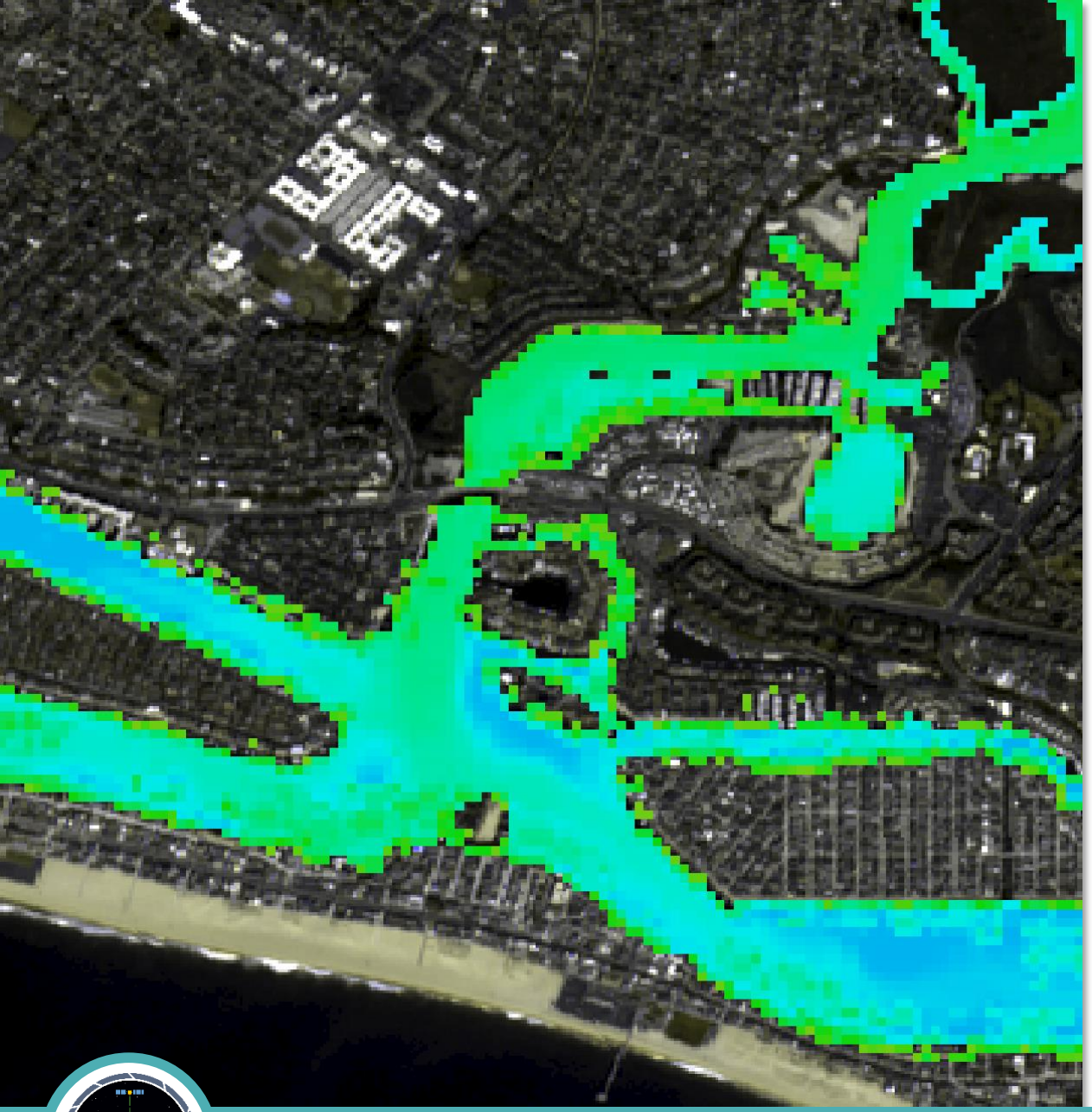


National Aeronautics and Space Administration

SOUTHERN CALIFORNIA WATER RESOURCES

Using NASA Earth Observations to Monitor Seagrass Extent and Water Quality Parameters in Southern California

Katya Beener

Caroline Baumann

Nelly Perez

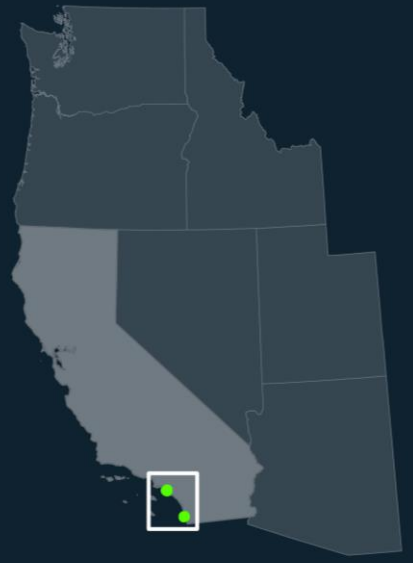
Gwenyth Greco

DEVELOP California – JPL | Spring 2024

Study Area and Period

- **Areas of Interest**
  - Newport Bay (Orange County, CA)
  - Mission Bay (San Diego County, CA)

- **Study Period**
  - January 2019 – December 2023



Study Area: Newport Bay





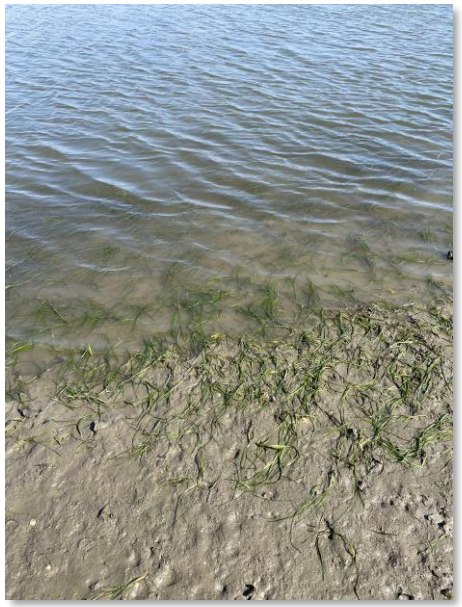



Image Credits: NASA DEVELOP SCWR team

Objectives

Map regional water quality parameters to provide partners with the resources to predict expected eelgrass health in the region

Identify the requirements of mapping eelgrass extent using Earth observations to determine if this technique can replace ground measurements

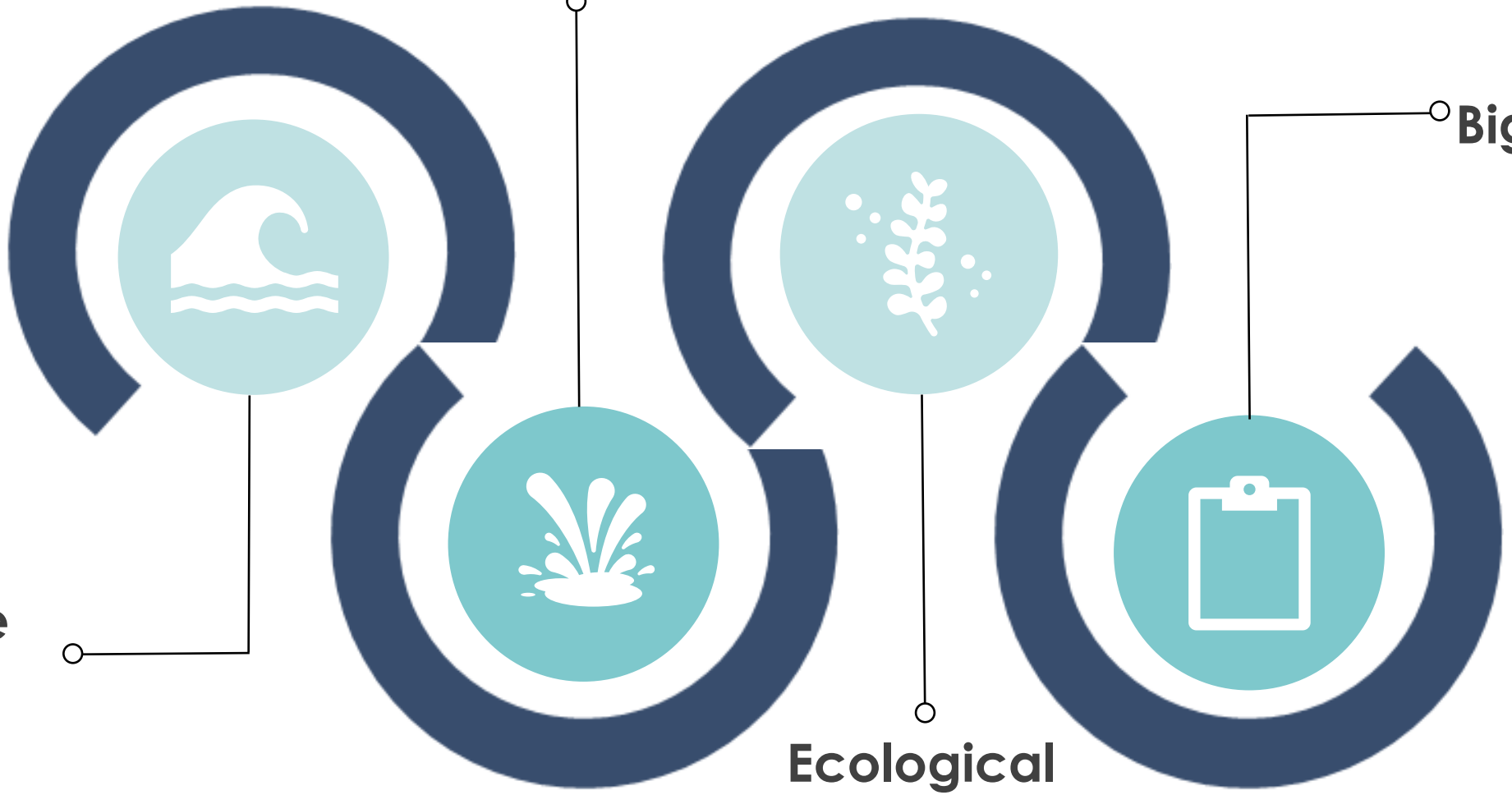
Partners

Southern California Coastal Water Research Project (SCCWRP)

NOAA National Marine Fisheries Service (NMFS)
West Coast Region

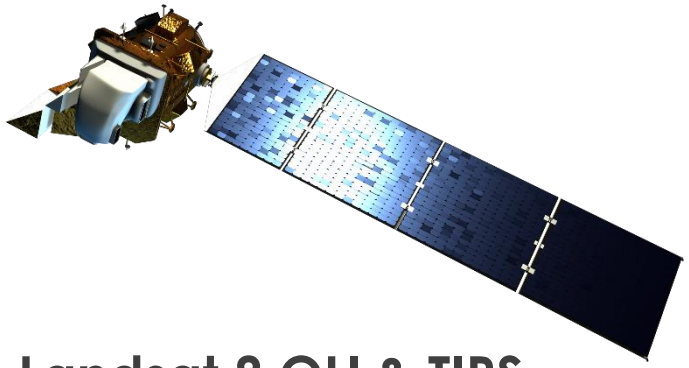
State of California San Diego Regional Water Quality Control Board

Community Concerns

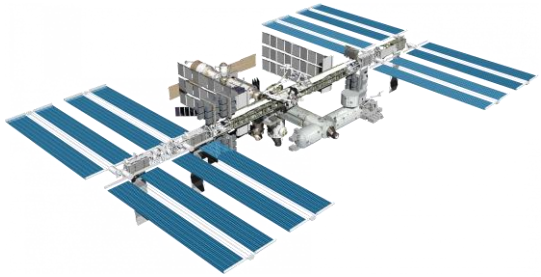


Earth Observations

NASA



Landsat 8 OLI & TIRS
2013



ISS ECOSTRESS
2018

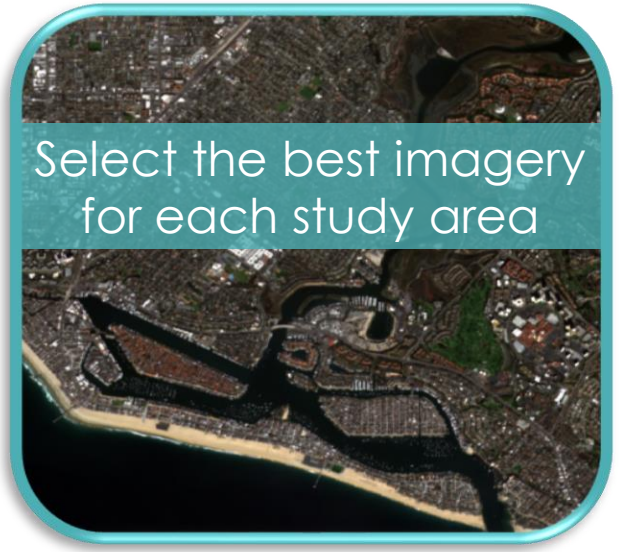
Landsat 9 OLI-2 & TIRS-2
2021

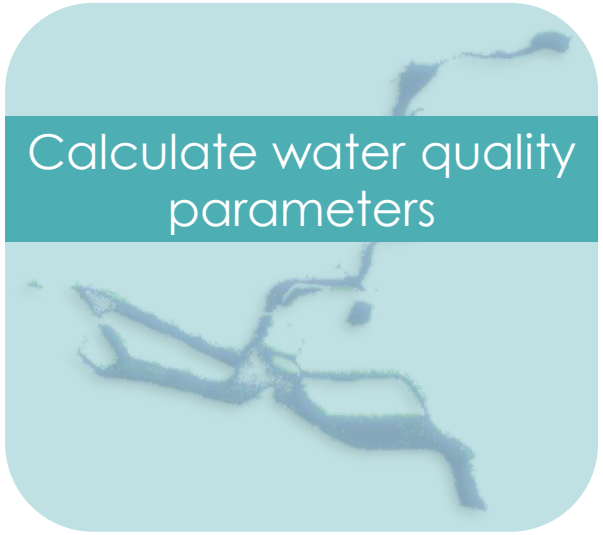
ESA

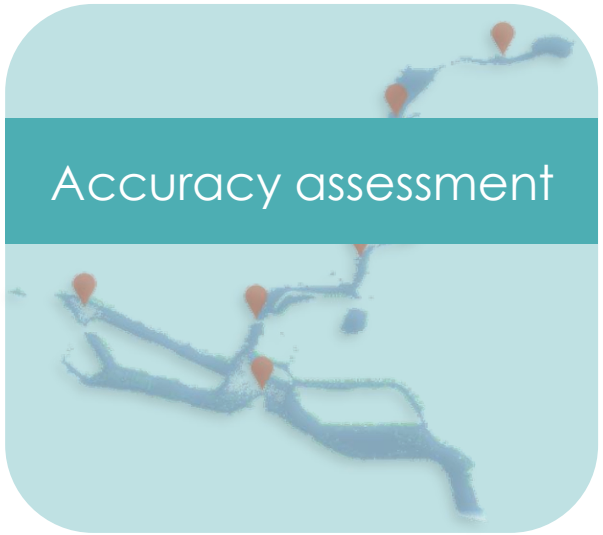
Sentinel-2 MSI
2015

Image credits: NASA, ESA

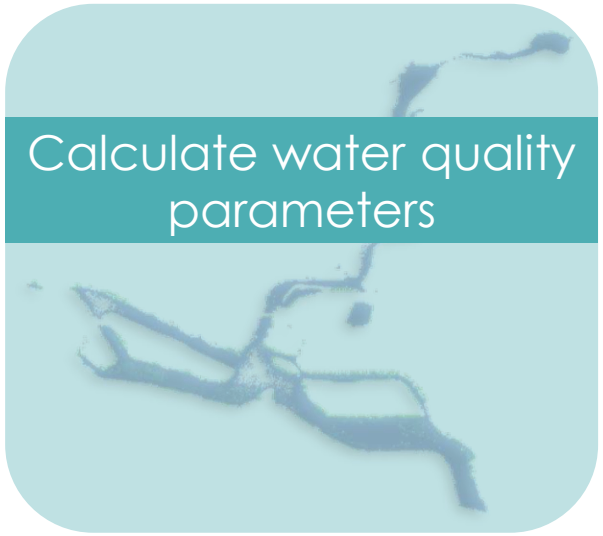
Methodology: Water Quality Parameters

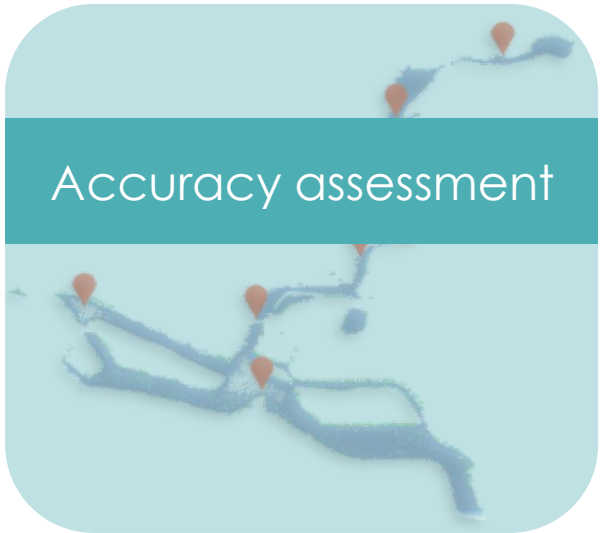




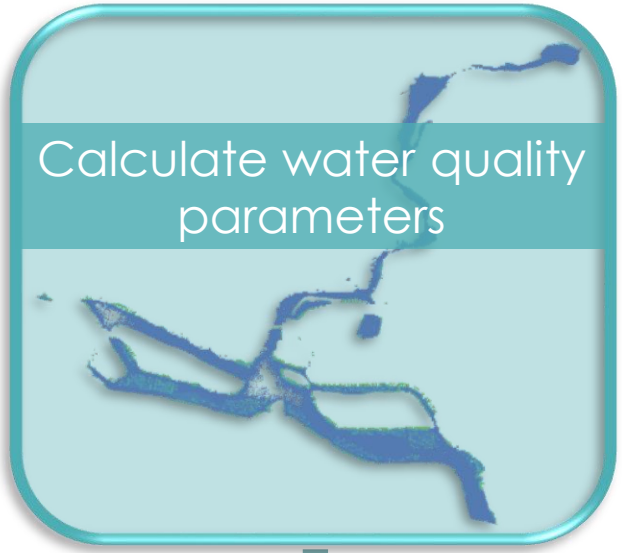


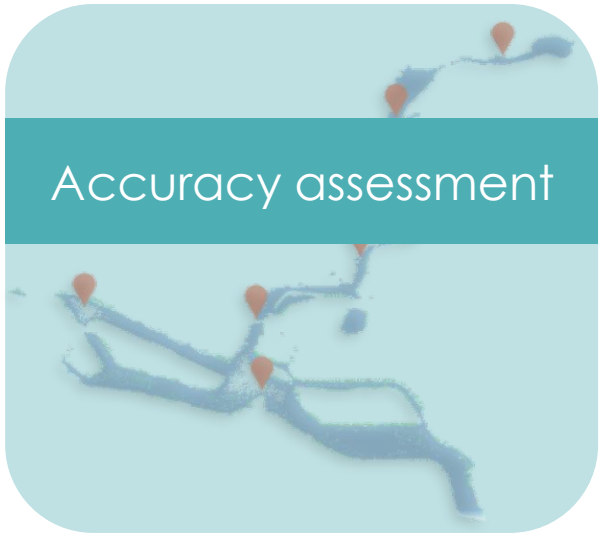
Methodology: Water Quality Parameters



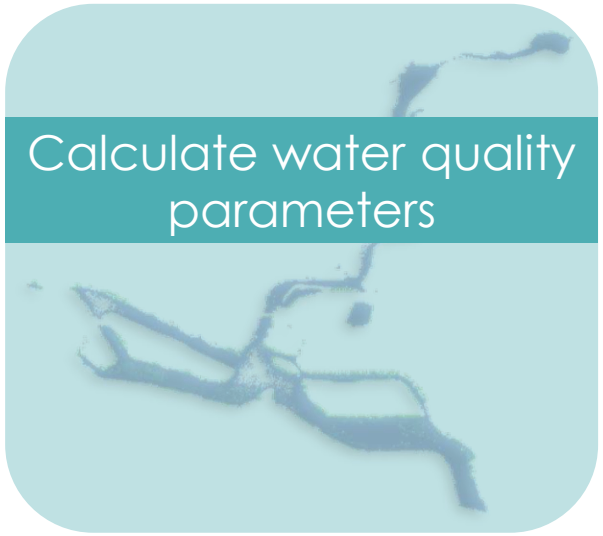


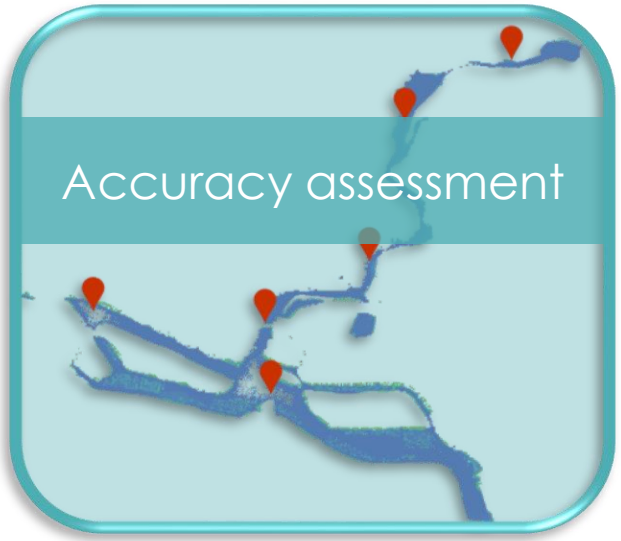
Methodology: Water Quality Parameters



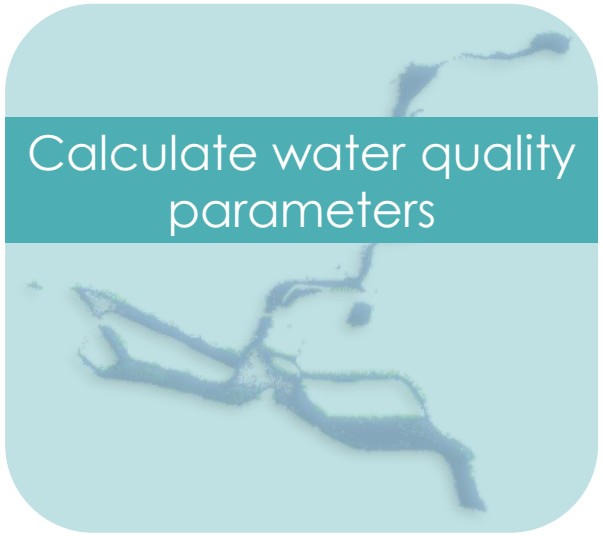


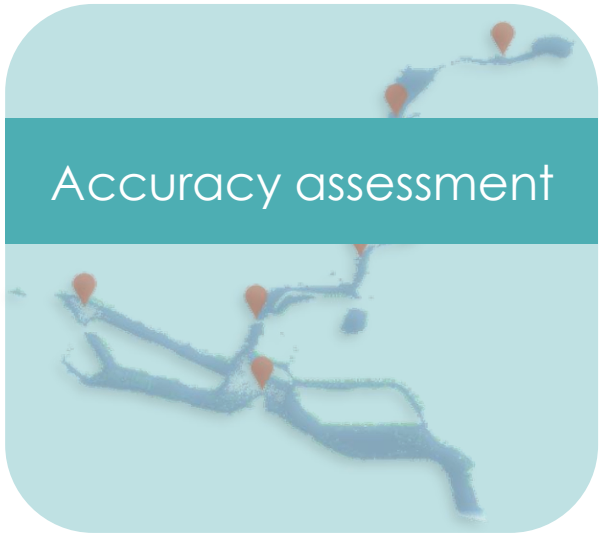
Methodology: Water Quality Parameters



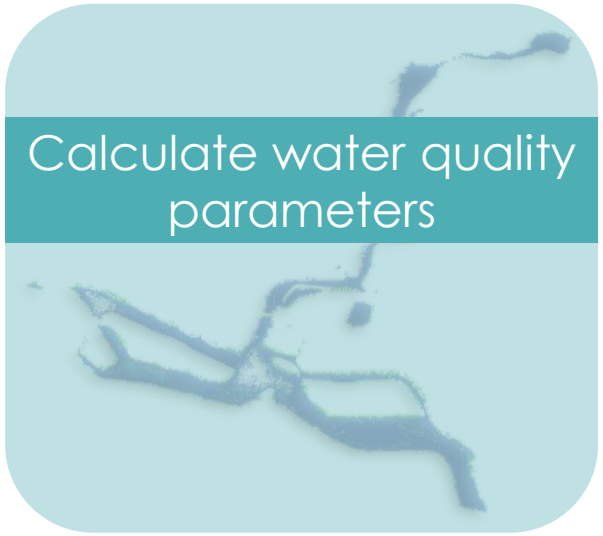


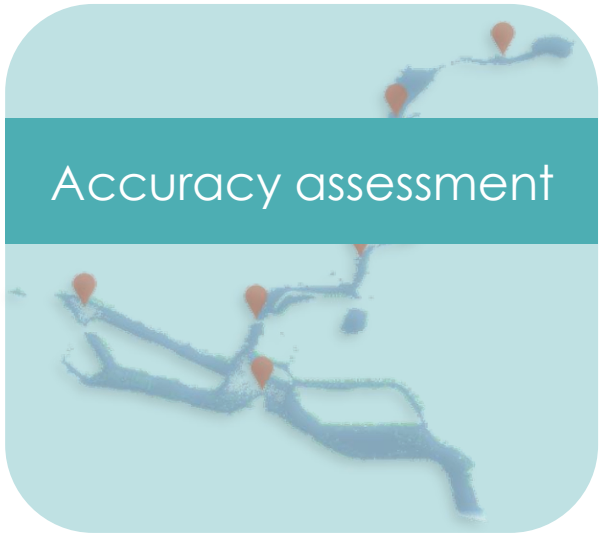
Methodology: Water Quality Parameters





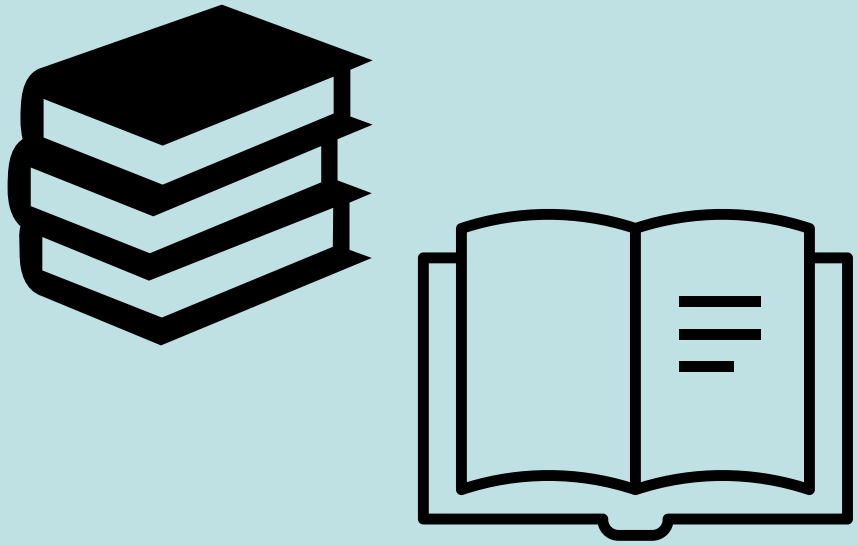
Methodology: Water Quality Parameters





Methodology: Eelgrass Extent

Review literature to determine feasibility of creating eelgrass extent maps from Earth observations

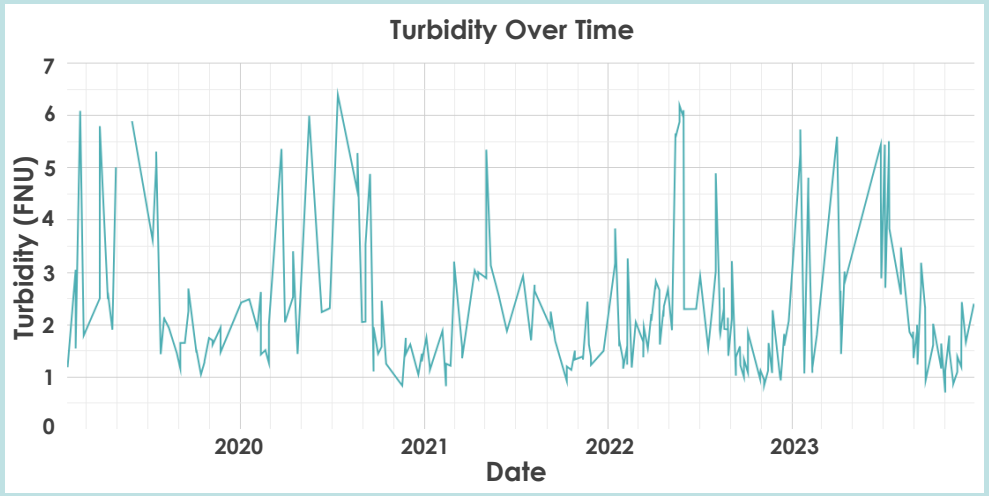


Identify trends in parameter requirements for successful remotely sensed eelgrass mapping

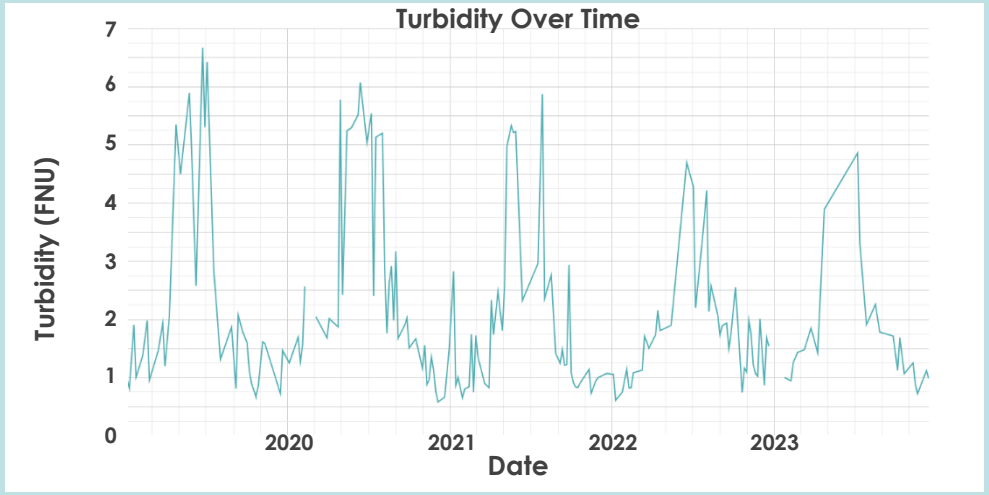
Results: Turbidity Graphs

Newport Bay

Landsat 8 & 9

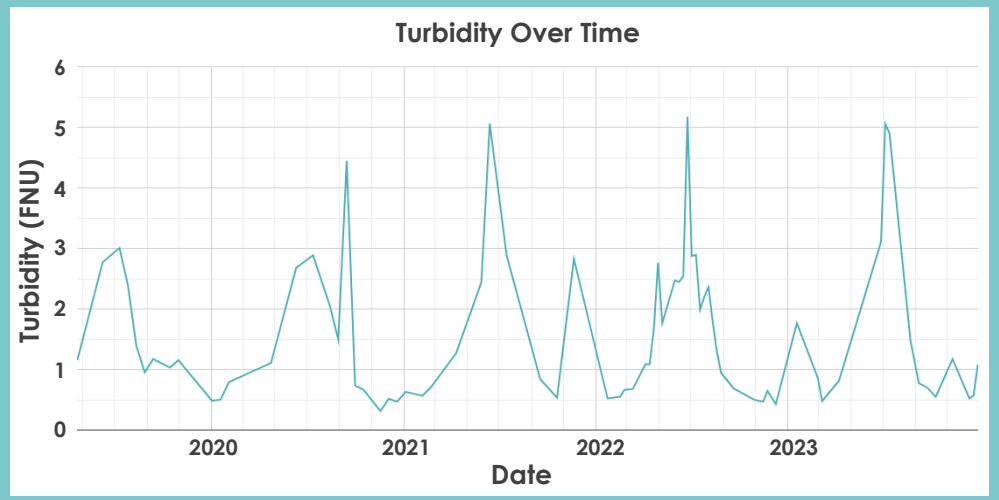


Sentinel-2

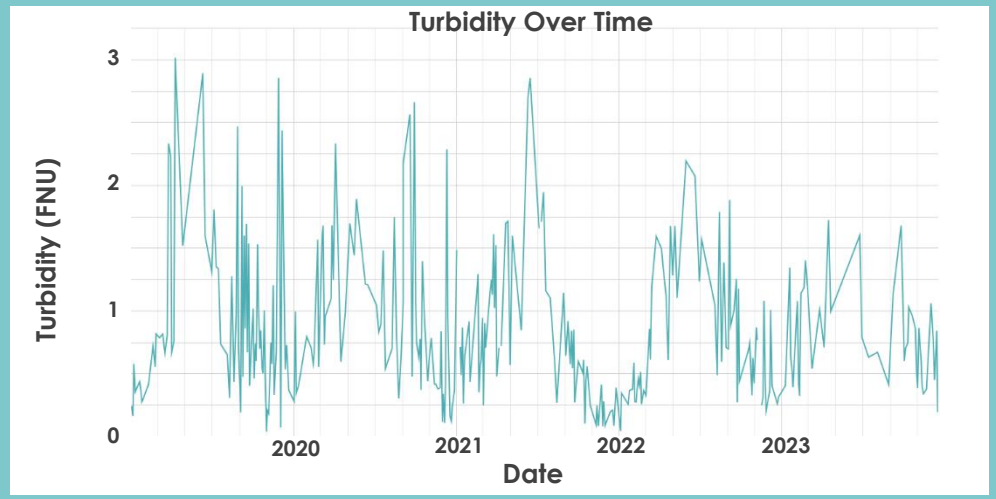


Mission Bay

Landsat 8 & 9



Sentinel-2



Results: Turbidity Animation

Mission Bay

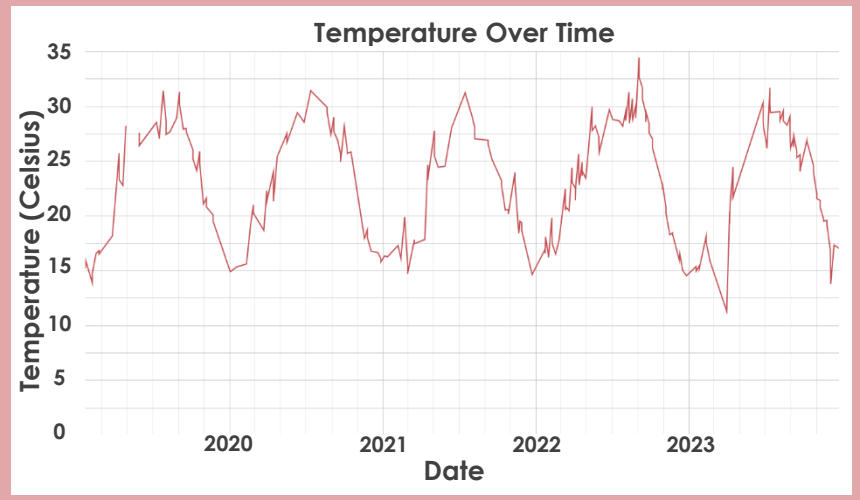
March 2021 – September 2021

Basemap Credit: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

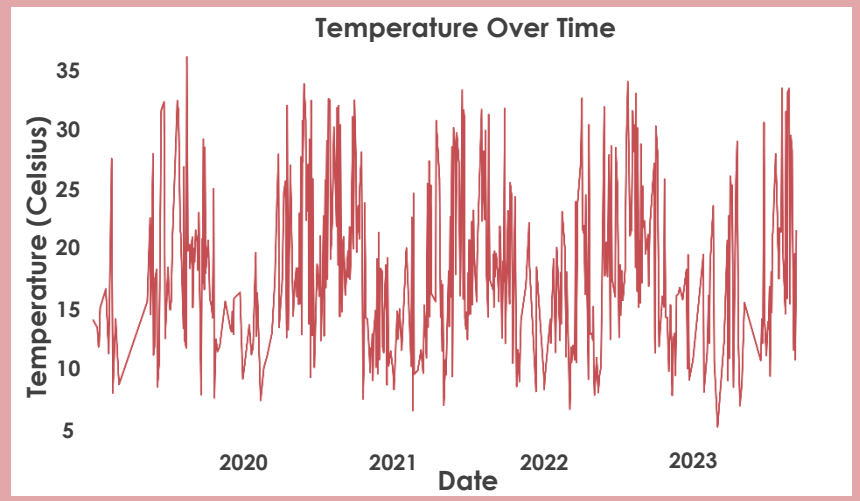
Results: Temperature Graphs

Newport Bay

Landsat 8 & 9

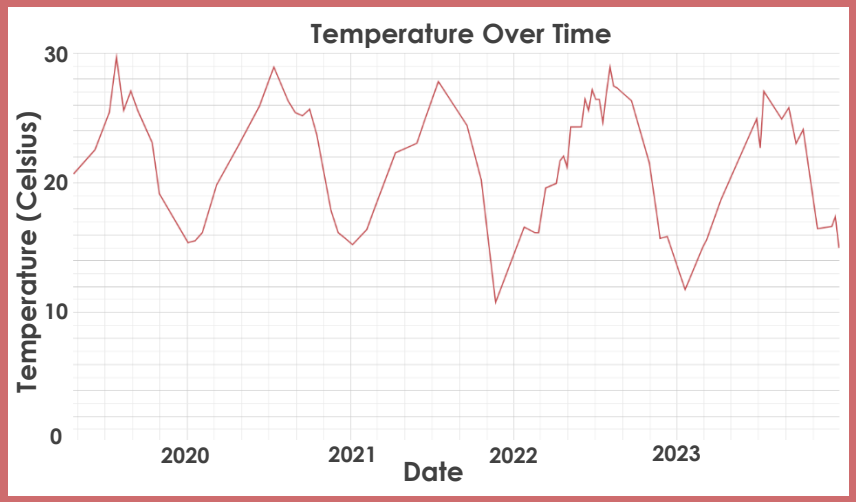


ECOSTRESS



Mission Bay

Landsat 8 & 9



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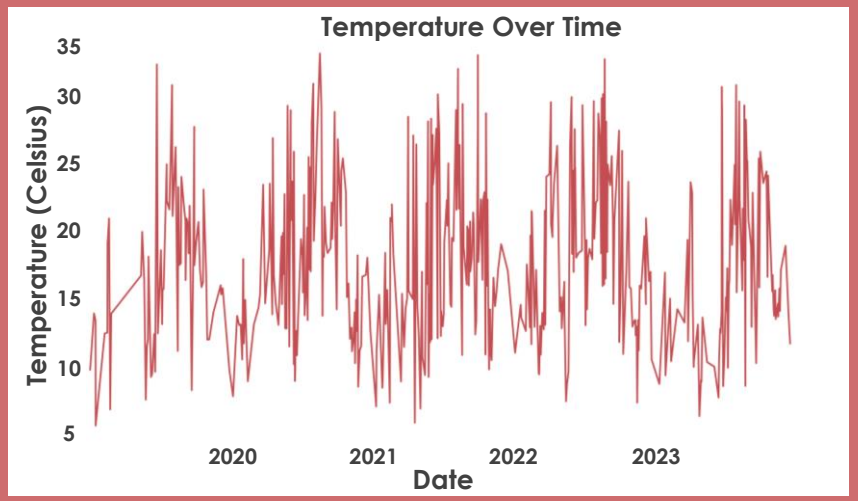


Results: Temperature Animations

Newport Bay

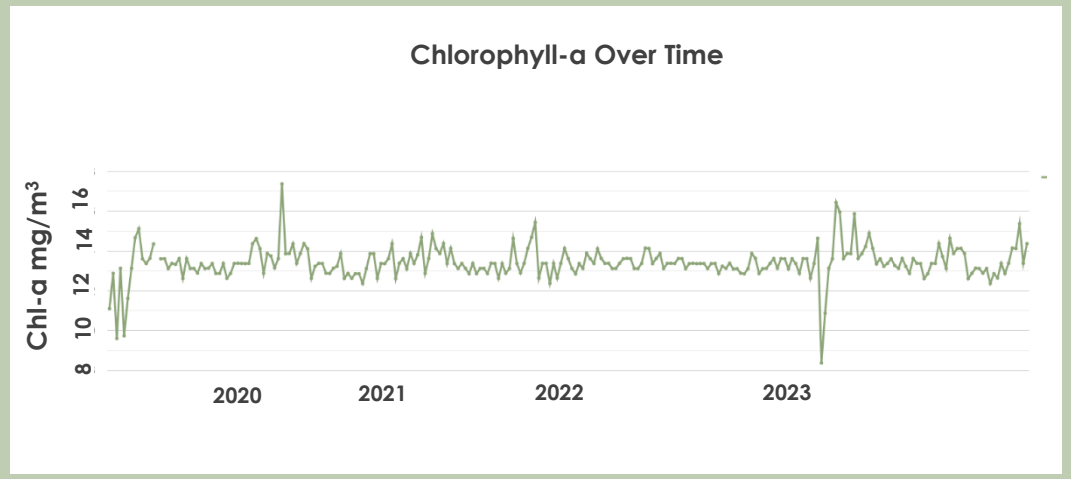
April 2023 – August 2023

Basemap Credit: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

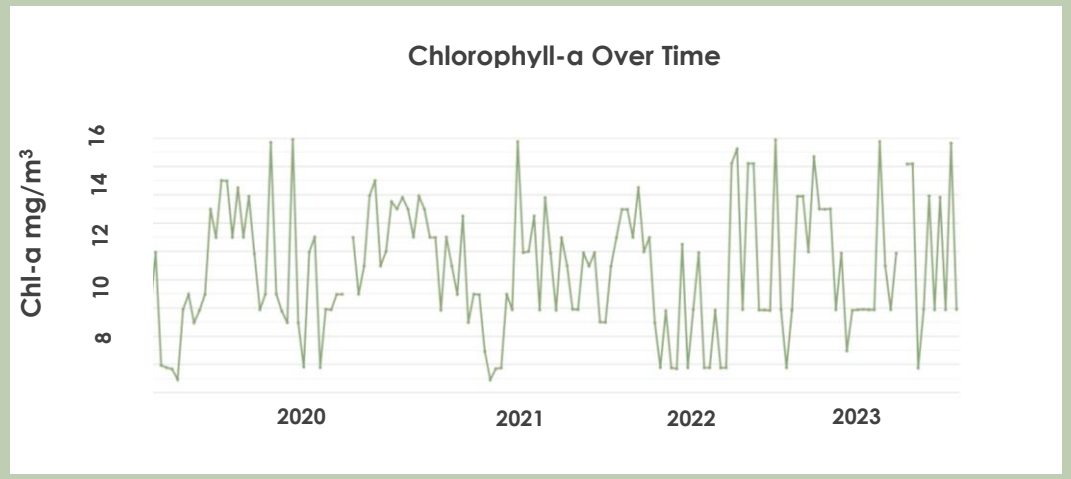
Results: Chlorophyll-a Graphs

Newport Bay

Landsat 8 & 9

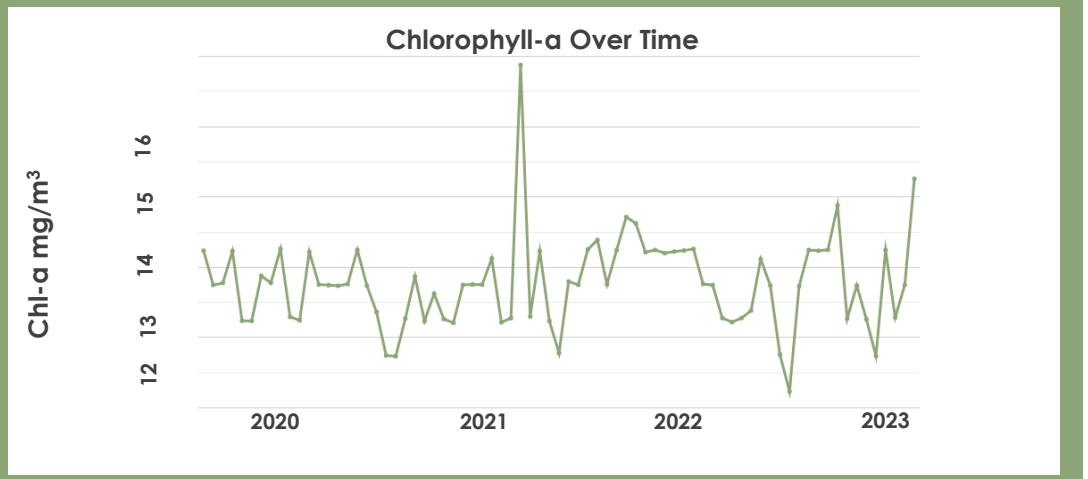


Sentinel-2



Mission Bay

Landsat 8 & 9



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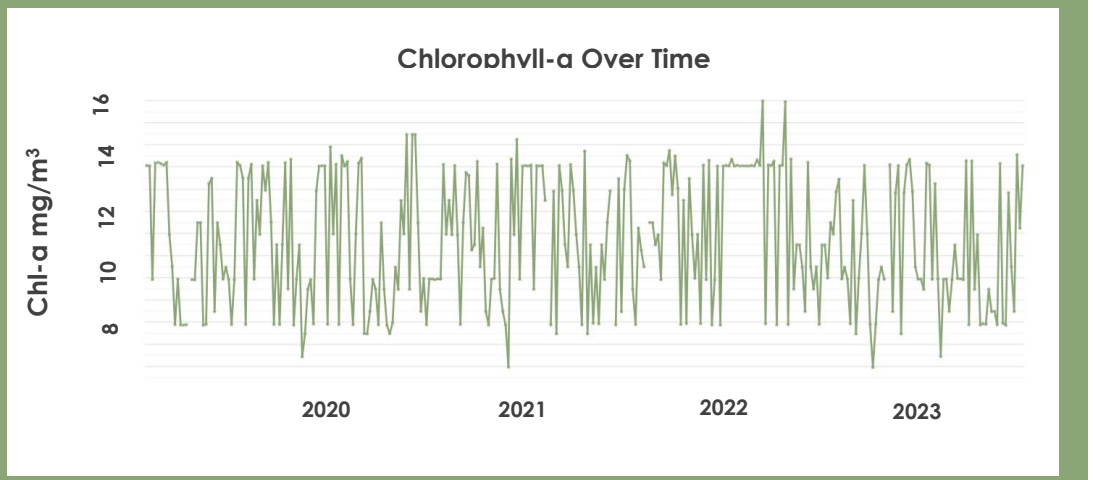


Results: Chlorophyll-a Animations

Newport Bay

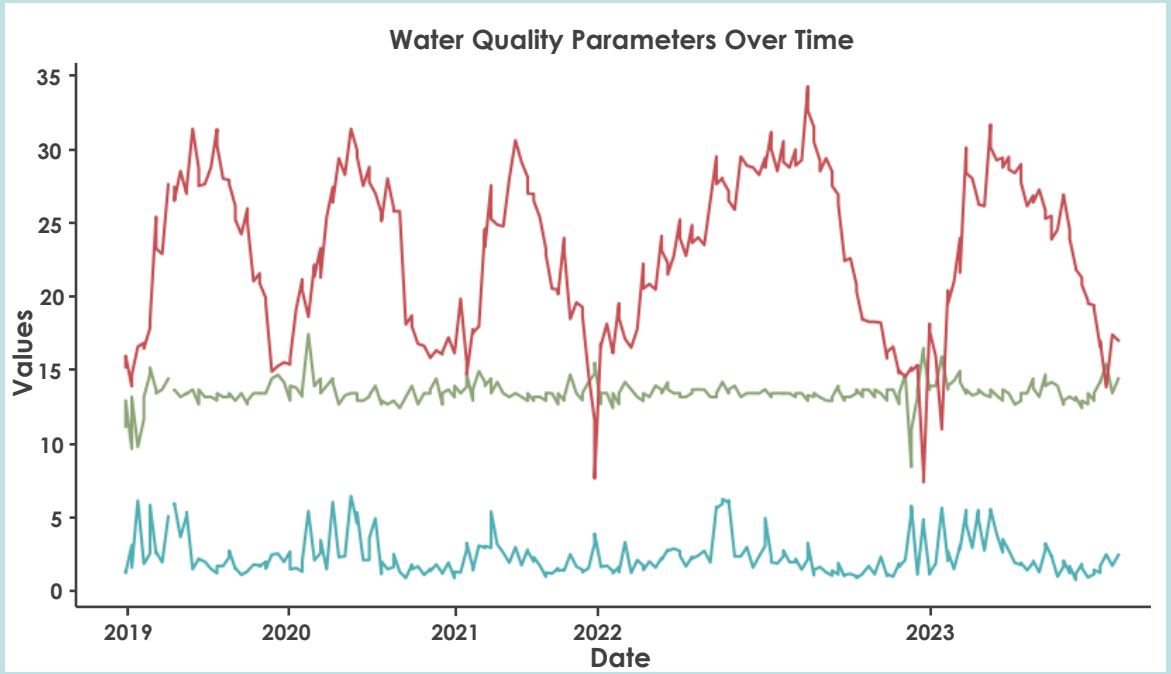
January 2022 – December 2023

Mission Bay

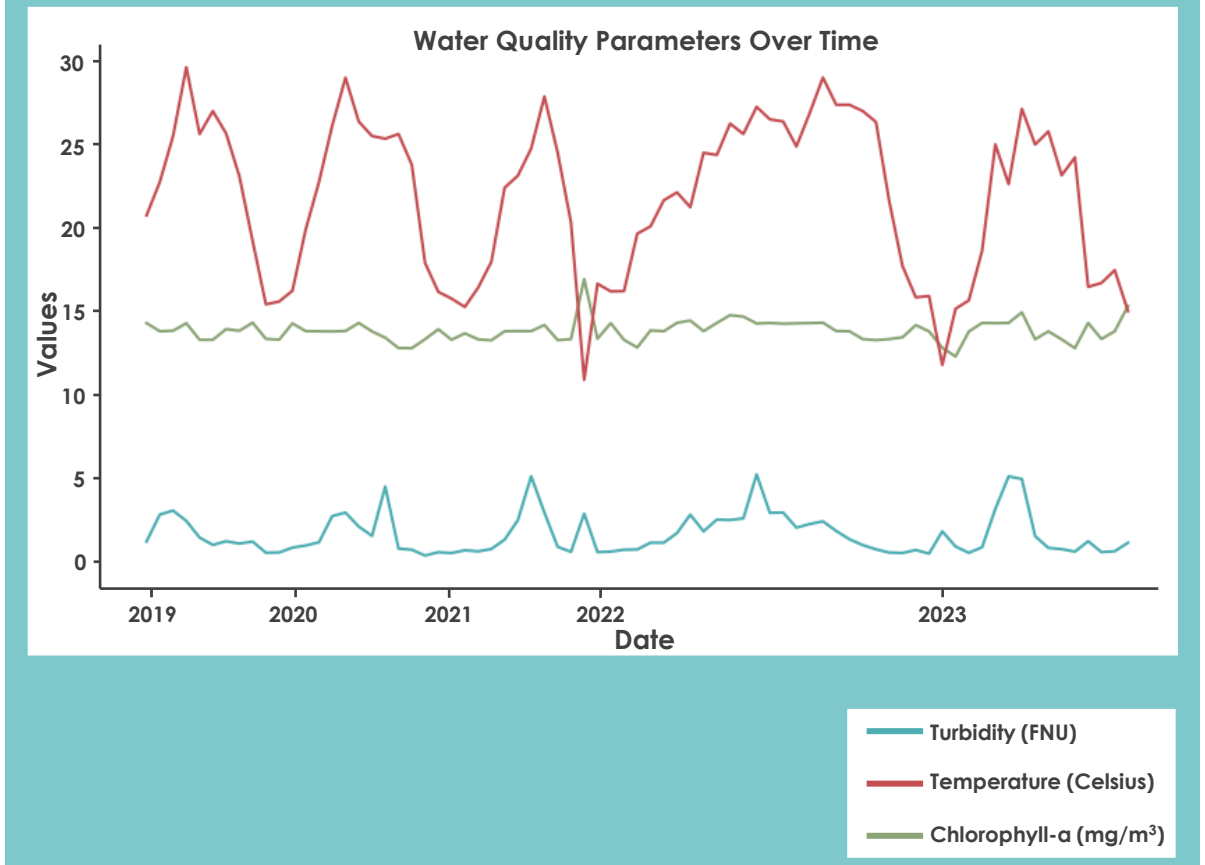
January 2022 – December 2023

Results: Overlayed Graphs

Newport Bay – Landsat 8 & 9

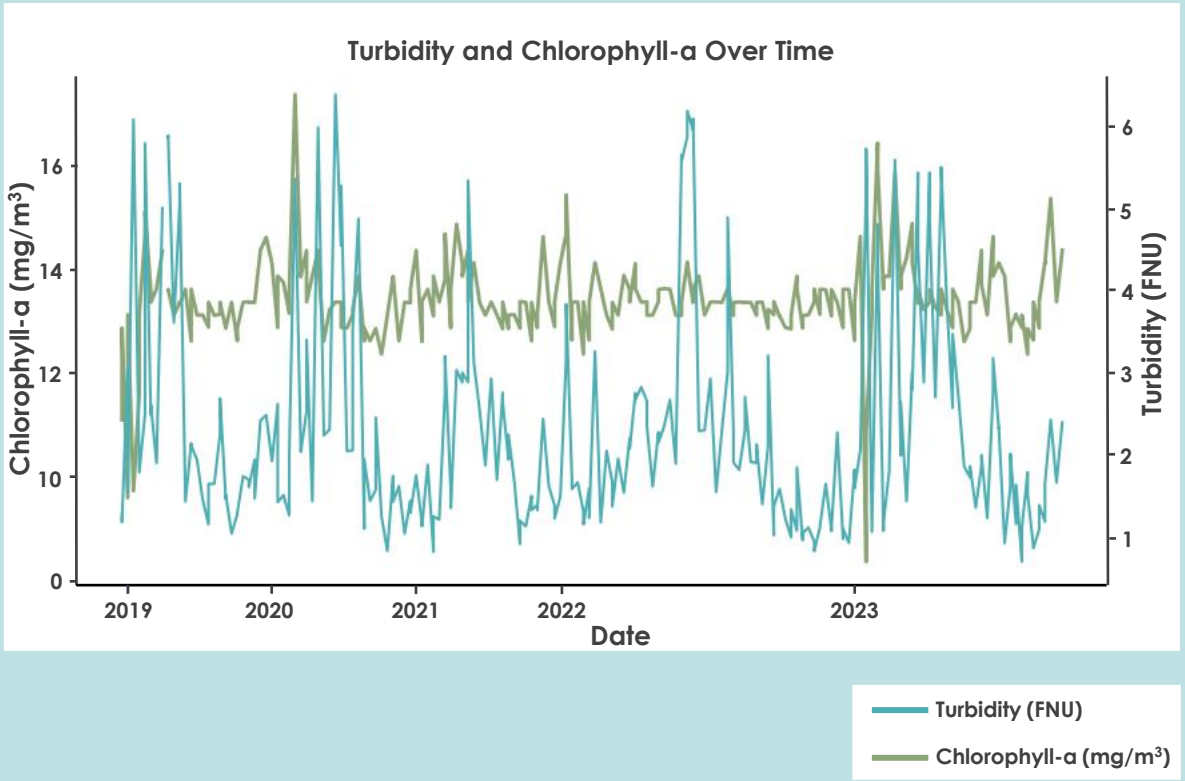


Mission Bay – Landsat 8 & 9

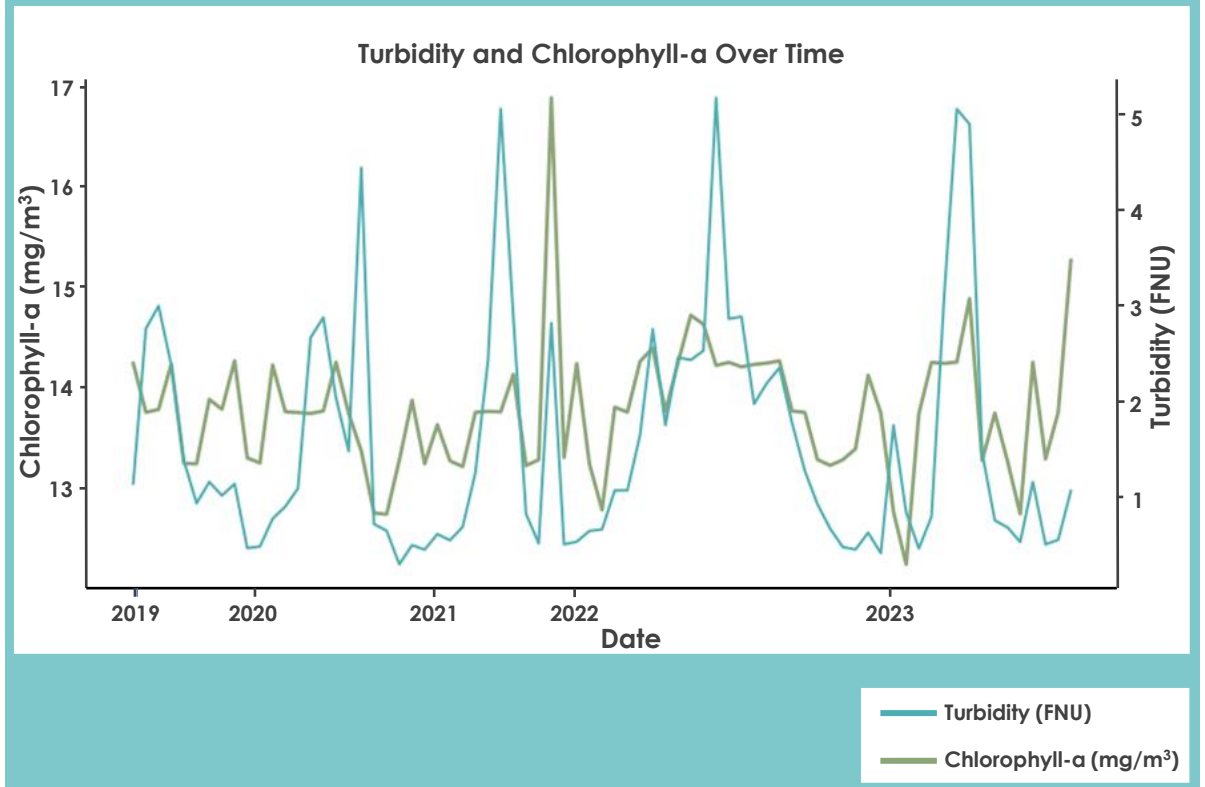


Results: Overlayed Graphs : Turbidity & Chl-a

Newport Bay – Landsat 8 & 9

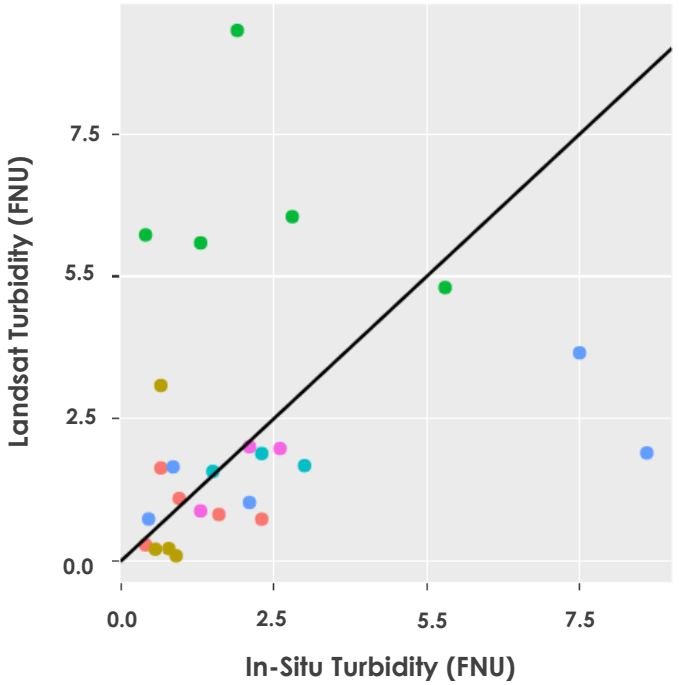


Mission Bay – Landsat 8 & 9



Accuracy Assessment

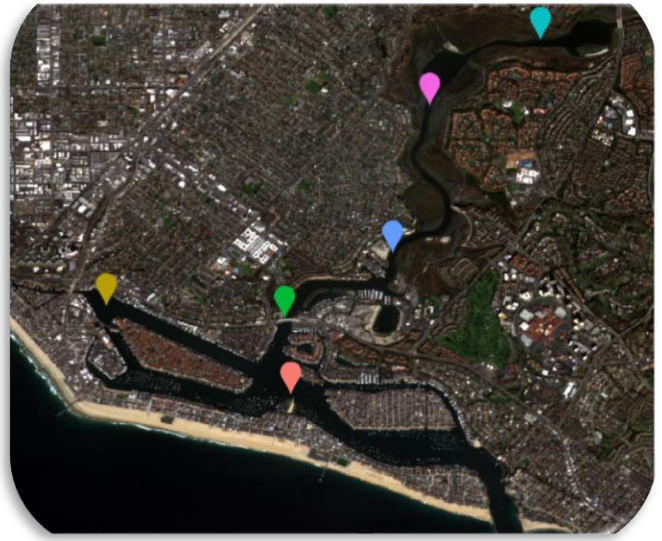
Accuracy of In-Situ and Landsat Turbidity



Landsat 8 & 9
RMSE: 2.25 FNU
MAE: 1.77 FNU

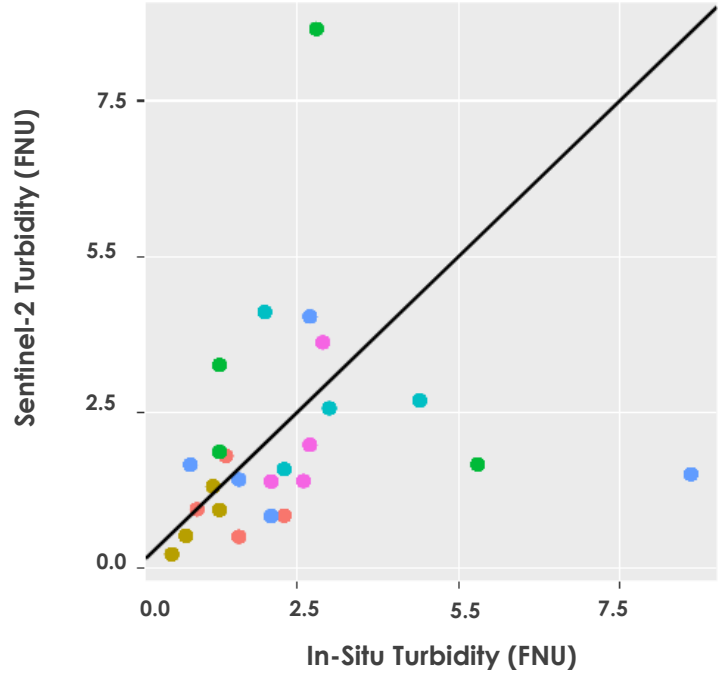
Station

- LNBHIR
- LNBTUB
- UNBCHB
- UNBJAM
- UNBSNB
- UNBSDC



*in-situ data was matched with satellite acquisition dates within a 0–4-day range

Accuracy of In-Situ and Sentinel-2 Turbidity



Sentinel-2
RMSE: 2.25 FNU
MAE: 1.42 FNU

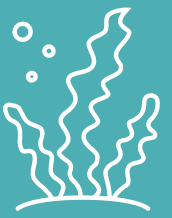
Errors and Uncertainties

Incomplete in-situ data for ground truthing

Imperfect atmospheric correction for water applications

Possible influence of edge effect

The possibility of eelgrass extent mapping using remotely sensed imagery



Conclusions: Water Quality Parameters

Turbidity

- Seasonal change
- Peaked in summer months
- No overall change across years

Temperature

- Seasonal change
- Peaked in summer months
- No overall change across years

Chlorophyll-a

- No seasonal change
- No overall change across years

Conclusions: Eelgrass Extent Mapping Feasibility

We made recommendations based on literature for necessary conditions and possible methods for accurate eelgrass mapping

< 2 m water depth

Low turbidity

Highest spatial resolution imagery

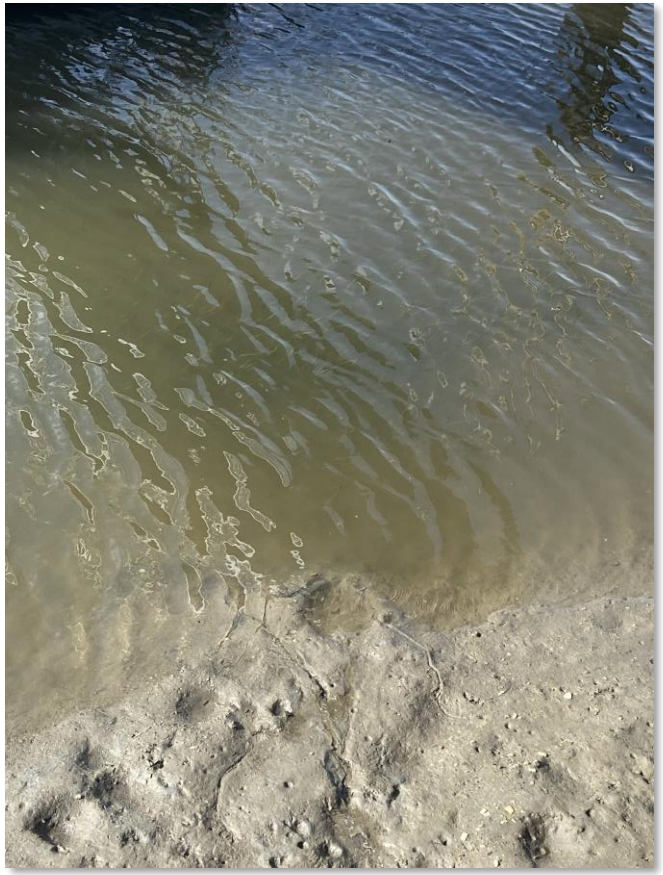


Image Credit: NASA DEVELOP SCWR team

Future Work

More extensive ground truthing of water quality parameters

Eelgrass extent mapping with Earth observations

Investigating different bays and estuaries of various sizes and characteristics

Acknowledgments

- Christiana Ade, PhD, NASA Jet Propulsion Laboratory, CalTech
- Adriana Parra Ruiz, PhD, NASA Jet Propulsion Laboratory, CalTech
- Benjamin Holt, NASA Jet Propulsion Laboratory
- Michael Pazmino, California - JPL
- Jane Zugarek, California - JPL

Partners

- Southern California Coastal Water Research Project (SCCWRP)
- NOAA National Marine Fisheries Service (NMFS) West Coast Region
- State of California San Diego Regional Water Quality Control Board

This material contains modified Copernicus Sentinel data (2019-2023) processed by ESA.

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