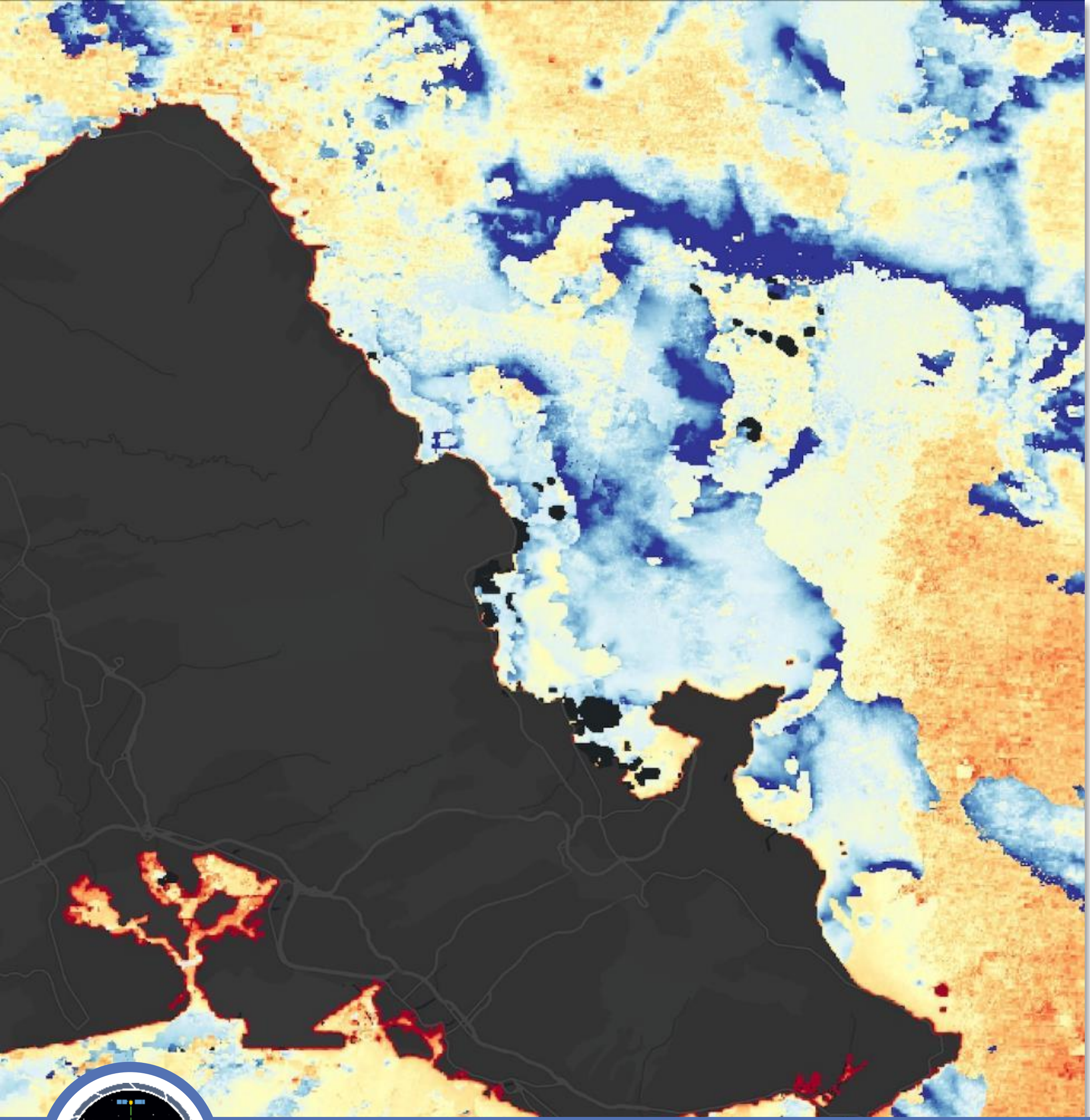


National Aeronautics and Space Administration

HAWAII CLIMATE

Utilizing Earth Observations to Assess Thermal Stress Impacts on Coastal Hawaiian Fishponds

Raz Wachtel (Project Lead)

Mina Nada

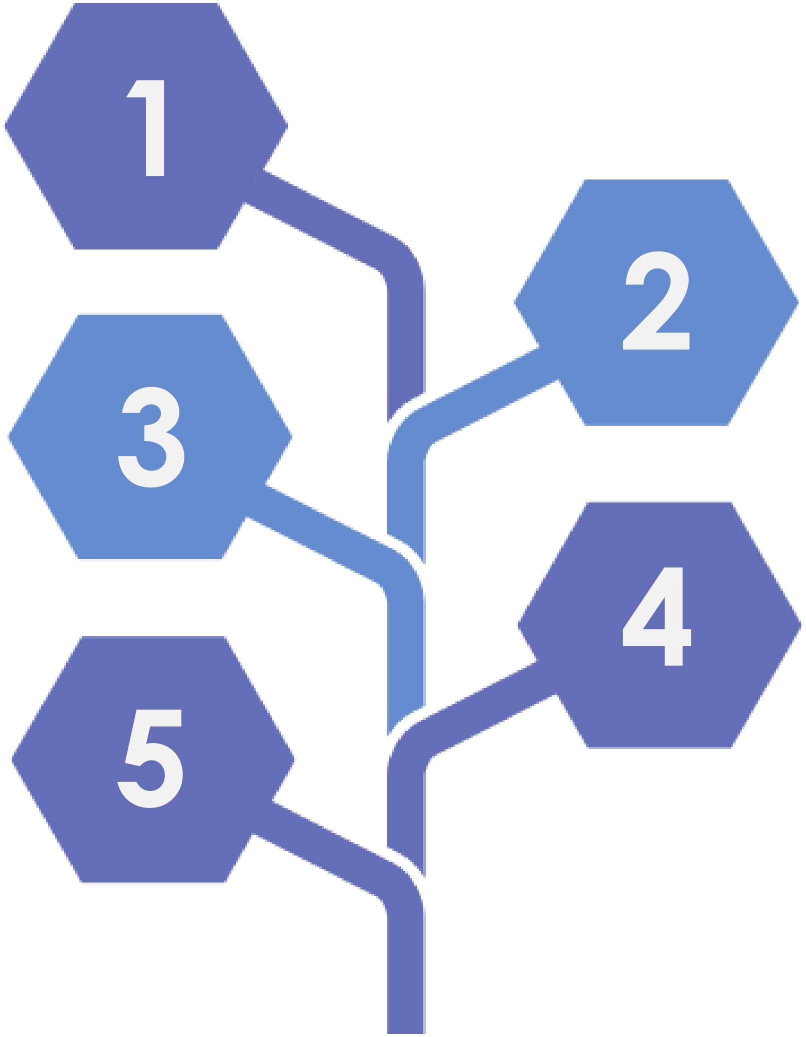
Danielle Sonobe

Tyler Morgan

California – JPL | Spring 2024

Outline

1. **Introduction**
   Study area, partner, & background information
2. **Objectives**
   Community concerns & project objectives
3. **Methodology**
   Using Earth observations and other data to explore analysis
4. **Results**
   End products
5. **Conclusion**
   Future work, feasibility assessment & acknowledgements



Introduction to Loko i'a

Loko i'a are aquacultural systems that ancient Hawaiians used to harvest prized native fish over 1500 years ago.

Colonization-driven changes in land management reduced the number of active loko iʻa from over 500 to ~20, **destabilizing inshore ecosystems and diminishing native Hawaiian cultural traditions.**

awa

Image Credit: Randall John

Milkfish
(Chanos chanos)

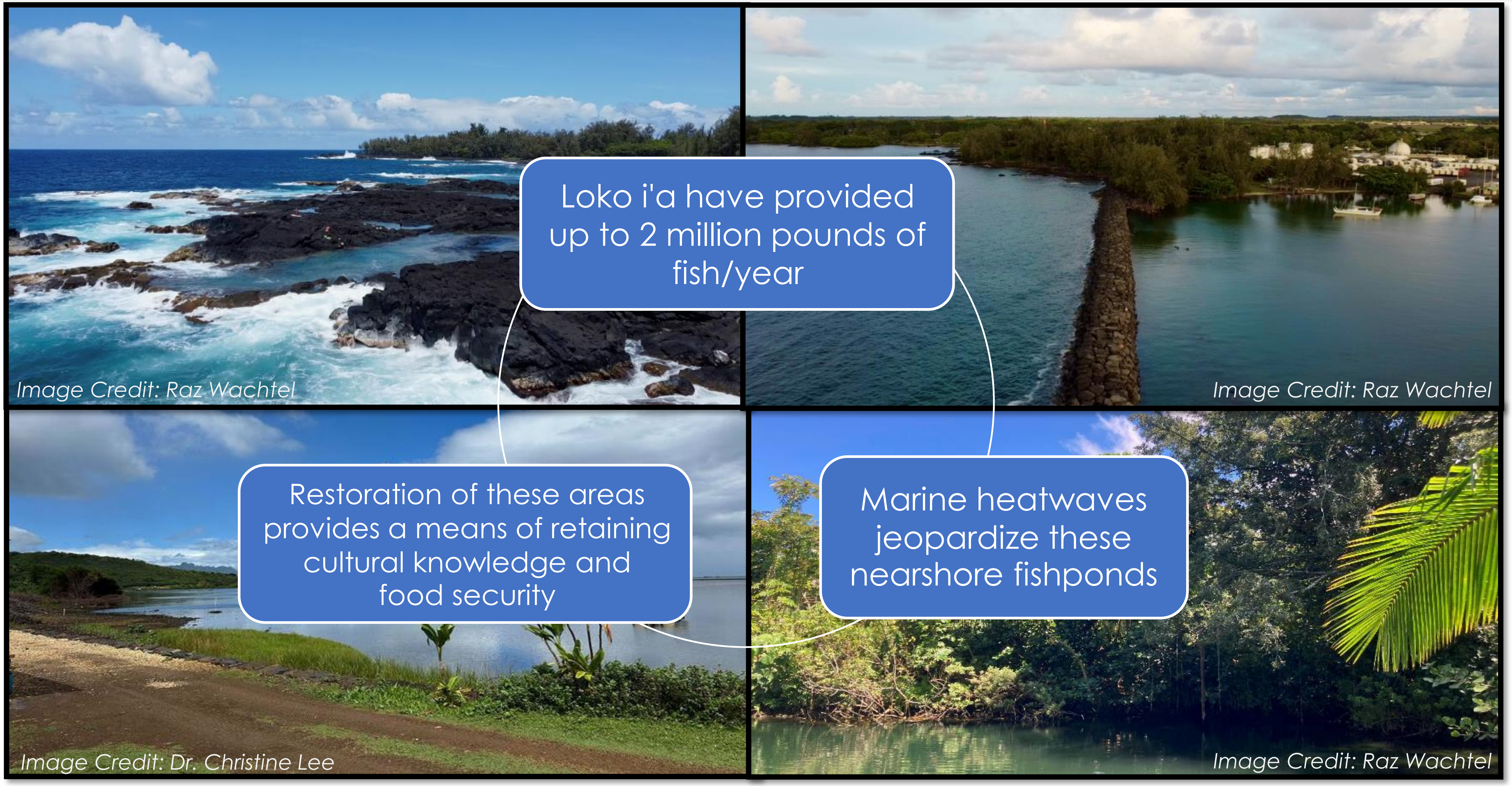
ʻamaʼama

Image Credit: Randall John

Striped Mullet
(Mugil cephalus)

Image Credit: Eric Tessmer

Introduction to Loko i'a



Partner Organizations

NOAA Pacific Islands Regional Office
Federal Government

Kau'aina Ulu 'Auamo (KUA)
Non-profit

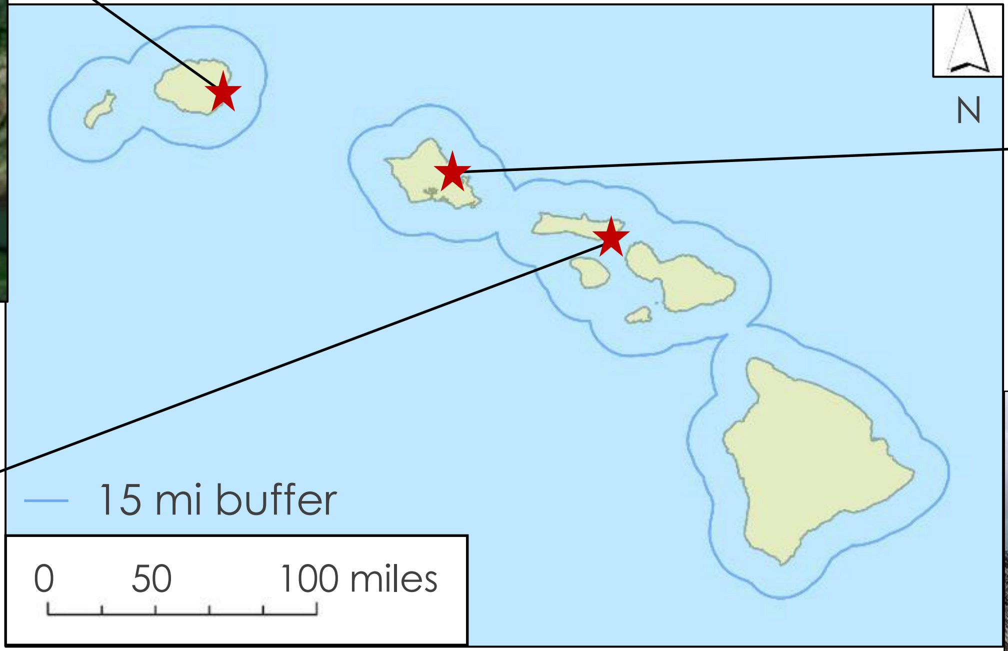
University of Hawai'i at Manoa
Academic

Image Credits: NOAA, NASA DEVELOP Team

Study Area


Menehune
Area: 30 km²
Image Credits:
Esri, Maxar, Earthstar Geographics, and the GIS User Community


Keawanui
Area: 70 km²
Image Credits:
Esri, Maxar, Earthstar Geographics, and the GIS User Community


N
15 mi buffer
0
50
100 miles


He'eia
Area: 180 km²
Image Credits:
Esri, Maxar, Earthstar Geographics, and the GIS User Community


He'eia
Image Credit: Dr. Christine Lee

Objectives

Assess

Regional SST changes from 2002 – 2021 with a focus on specific fishponds

Investigate

Changes in water quality for loko i'a health and sustainability from 2013 – 2023

Quantify

Thermal habitat suitability for the native fish

Inform

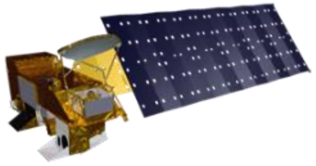
Partner orgs of ponds with the highest susceptibility to thermal stress

Island (Regional) Scale → **Fishpond Scale**

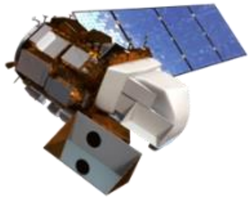
Earth Observations

Sea Surface Temperature (SST)

Landsat 8 TIRS

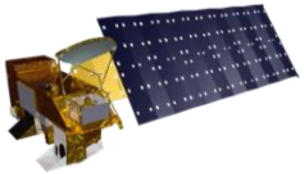


Aqua MODIS



Chlorophyll a (Chl a) & Turbidity

Landsat 8 OLI



Sentinel-2 MSI

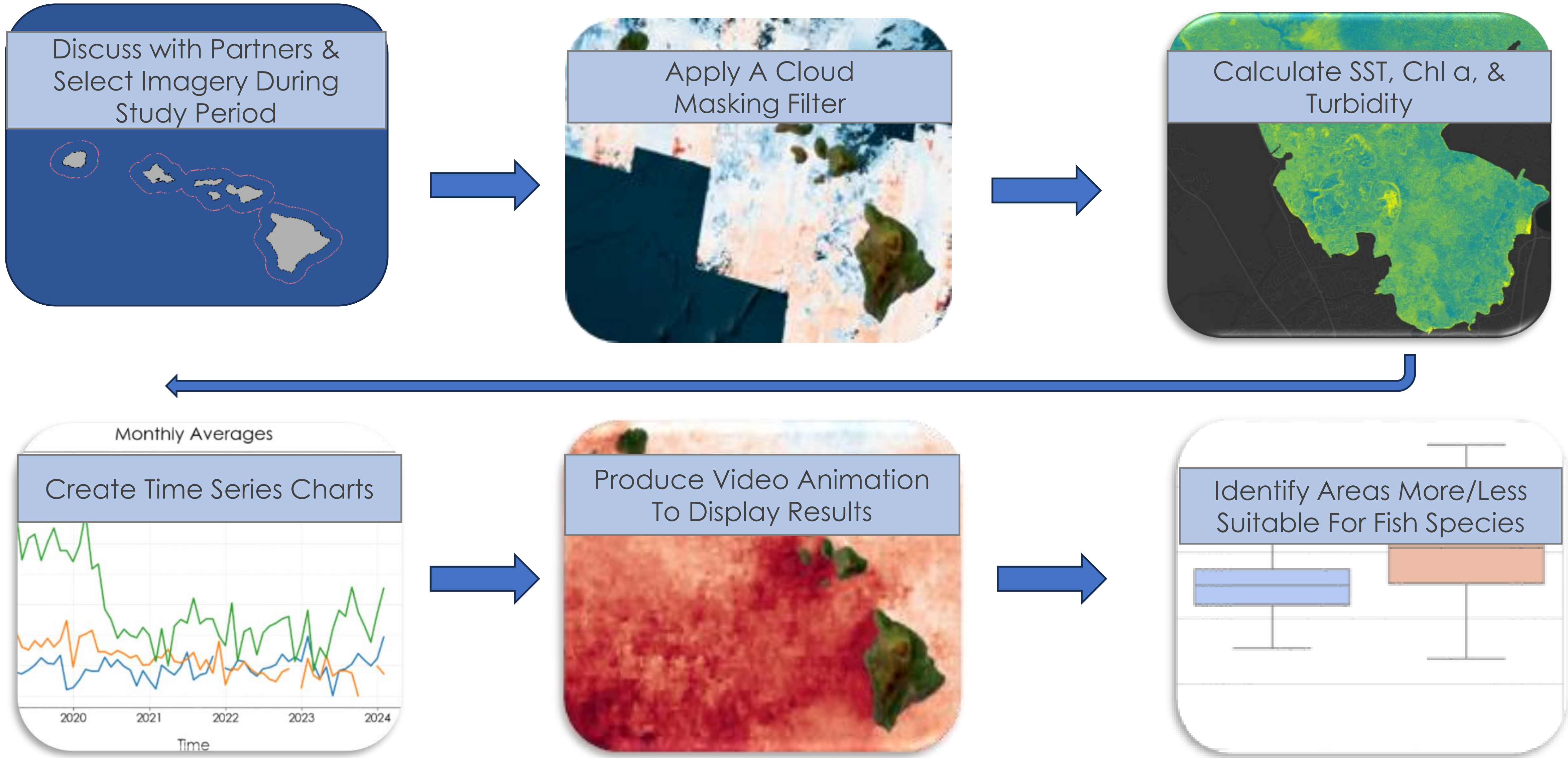
2002

2023

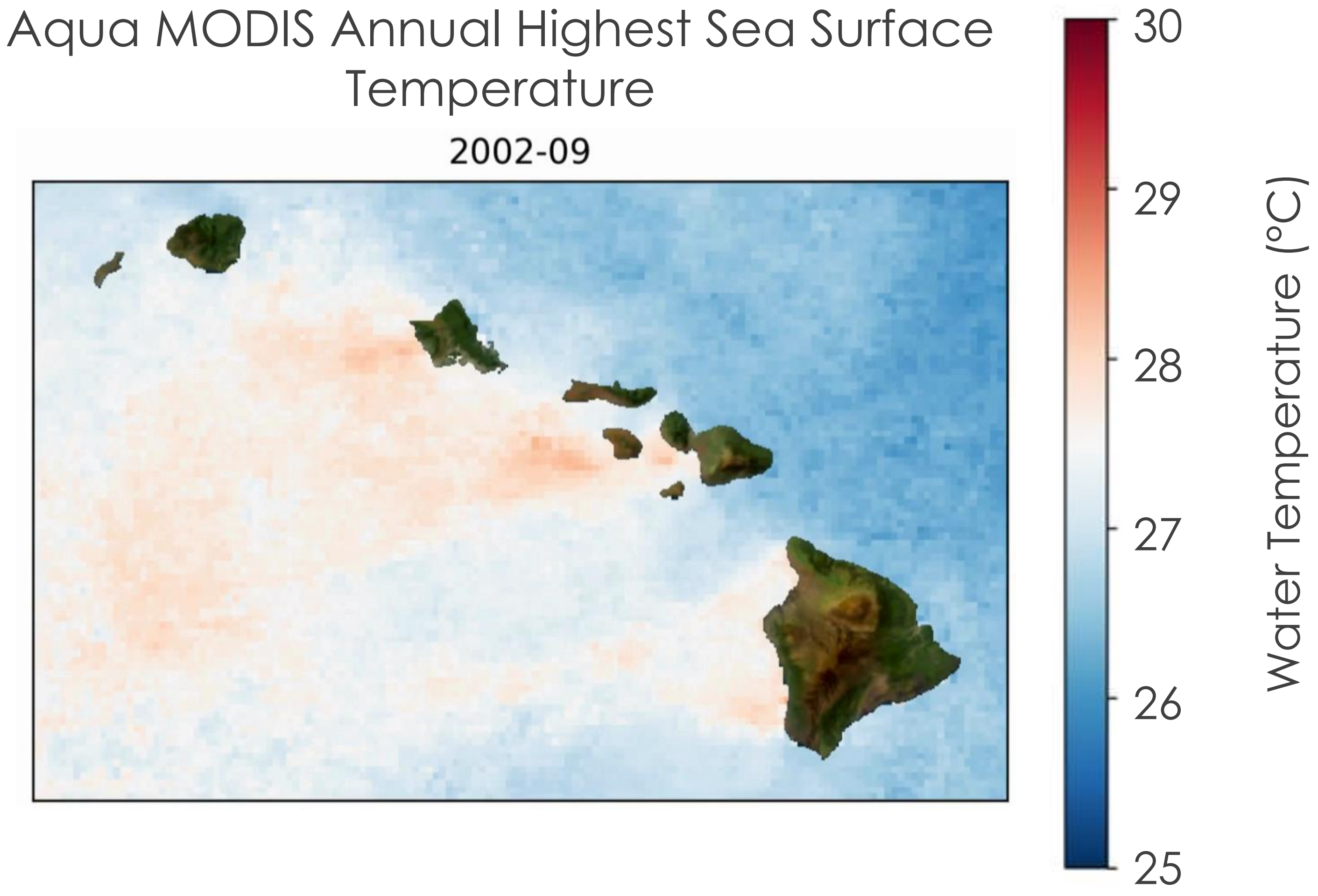
Satellite Product	Resolution	Time Range	Purpose
Landsat 8 TIRS	100m	2013–2023	SST
*Landsat 8 OLI	30m	2013–2019	*Turbidity
Sentinel-2 MSI	10m	2019–2023	Chl a
Aqua MODIS	4.6 km	2002–2021	SST & Chl a

Image Credits: NASA, ESA

Methodology

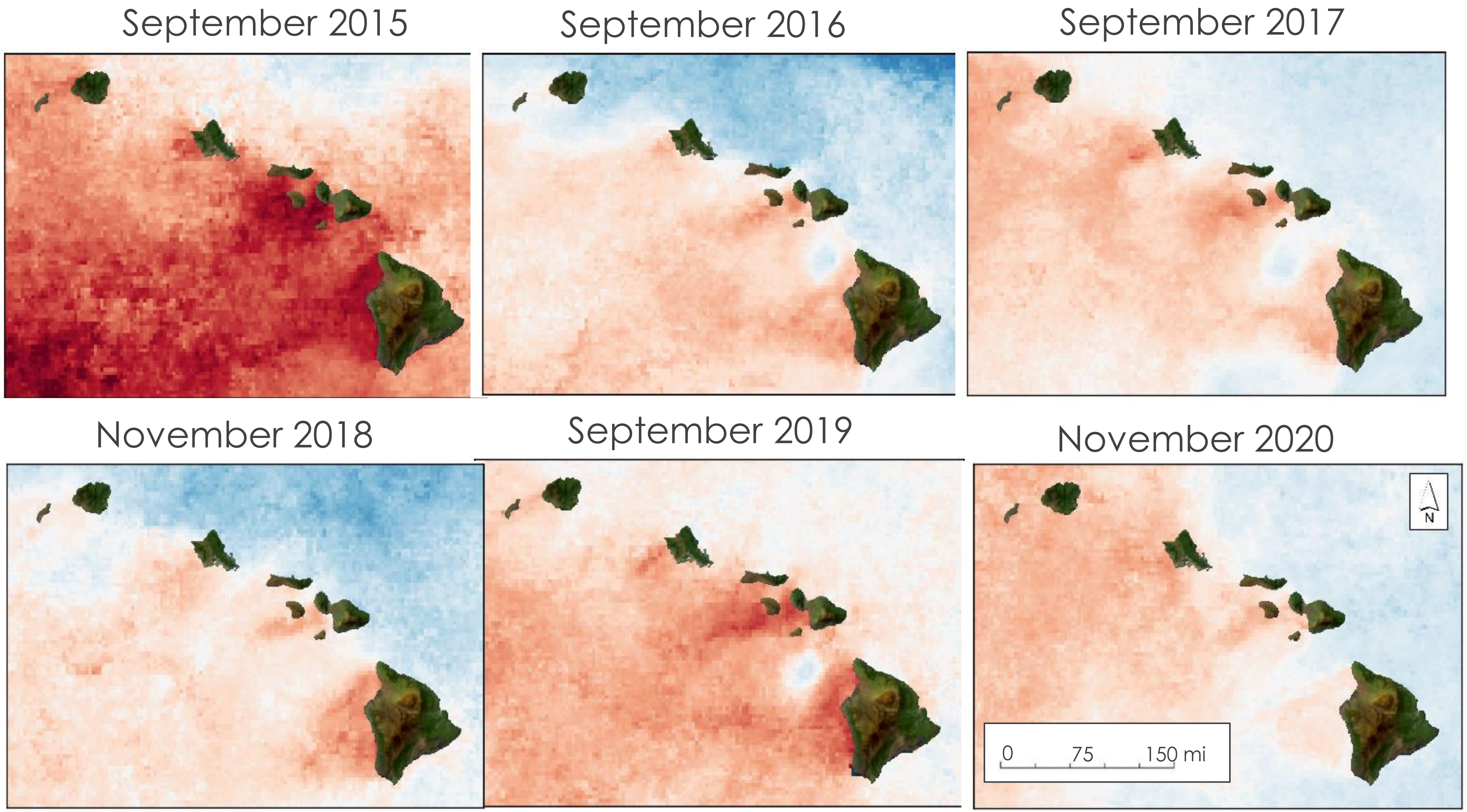


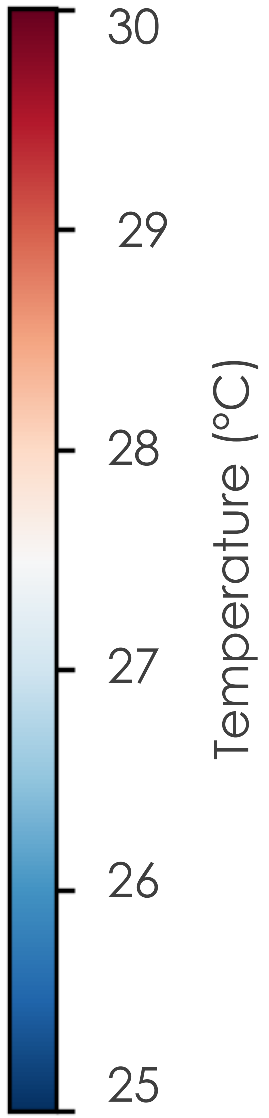
Results: SST Video Animation



Base Map Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

Results: SST Aqua MODIS





Base Map Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

Ocean Circulation "Island Shadow" Denotes Possible Pond Sheltering

"Unsheltered"

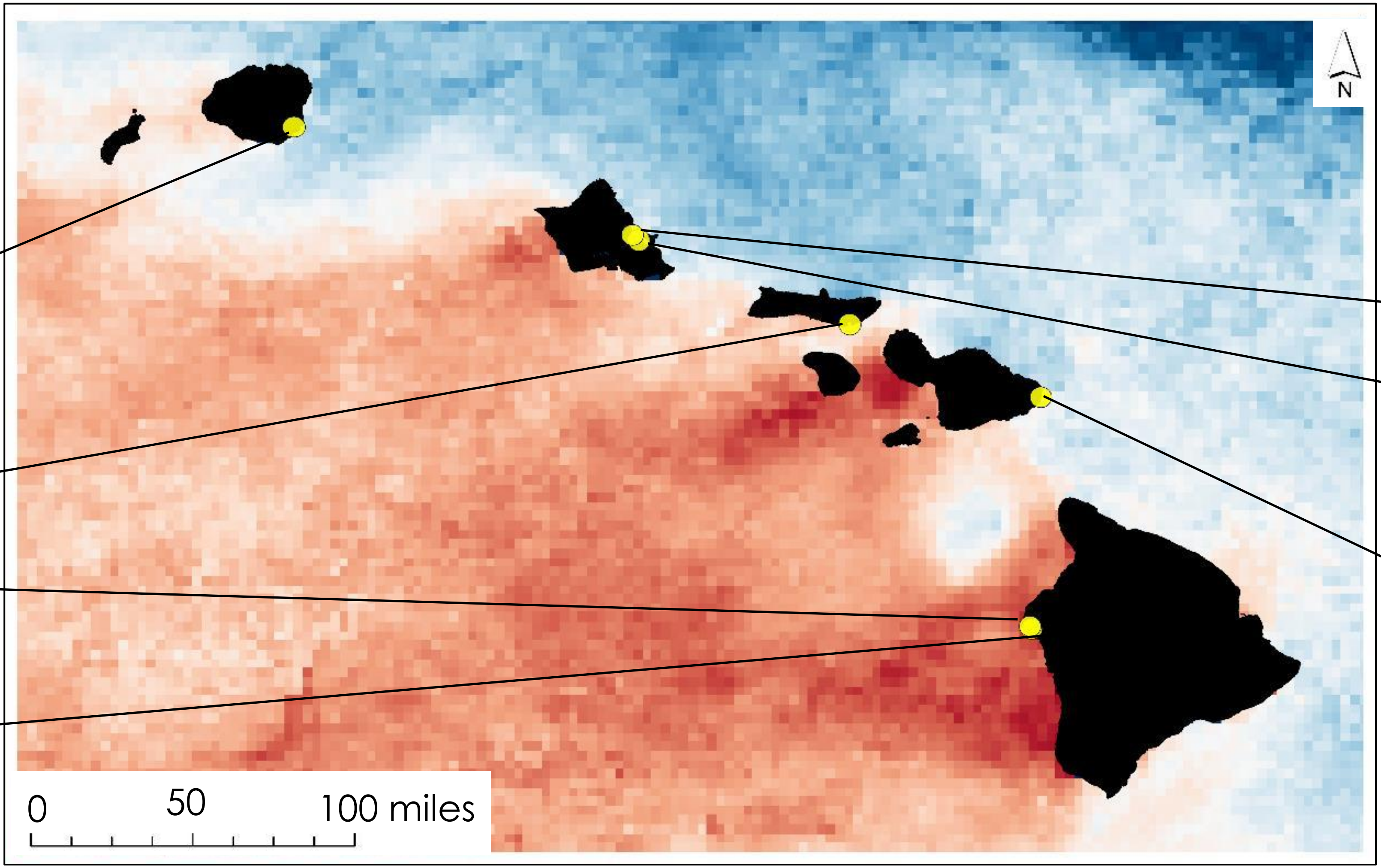
West coast ponds in "island shadow" consistently exposed to higher heat

Menehune

Keawanui

Kaloko

'Aimakapa'a



"Sheltered"

East coast ponds located outside of the "island shadow" of high heat

Kahouna

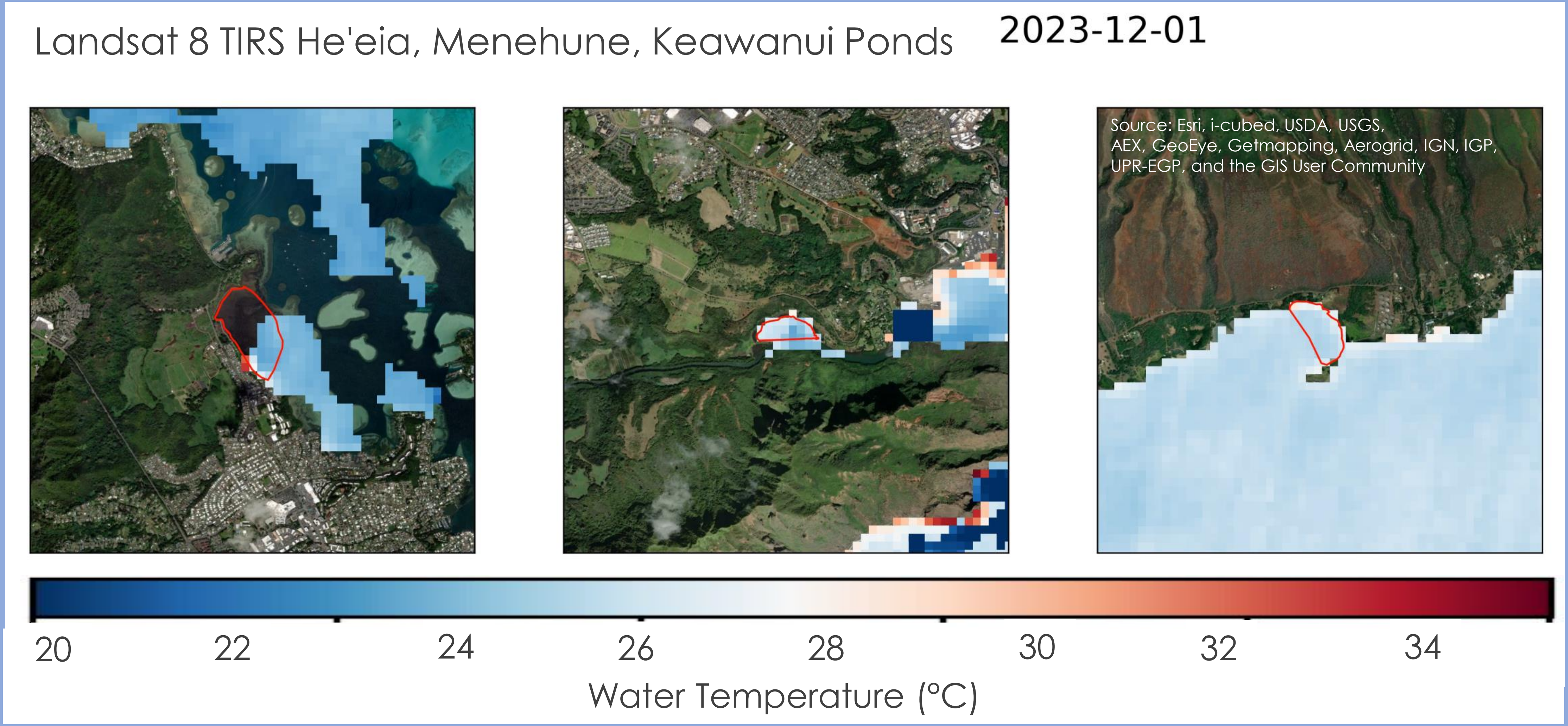
He'eia

Haneo'o

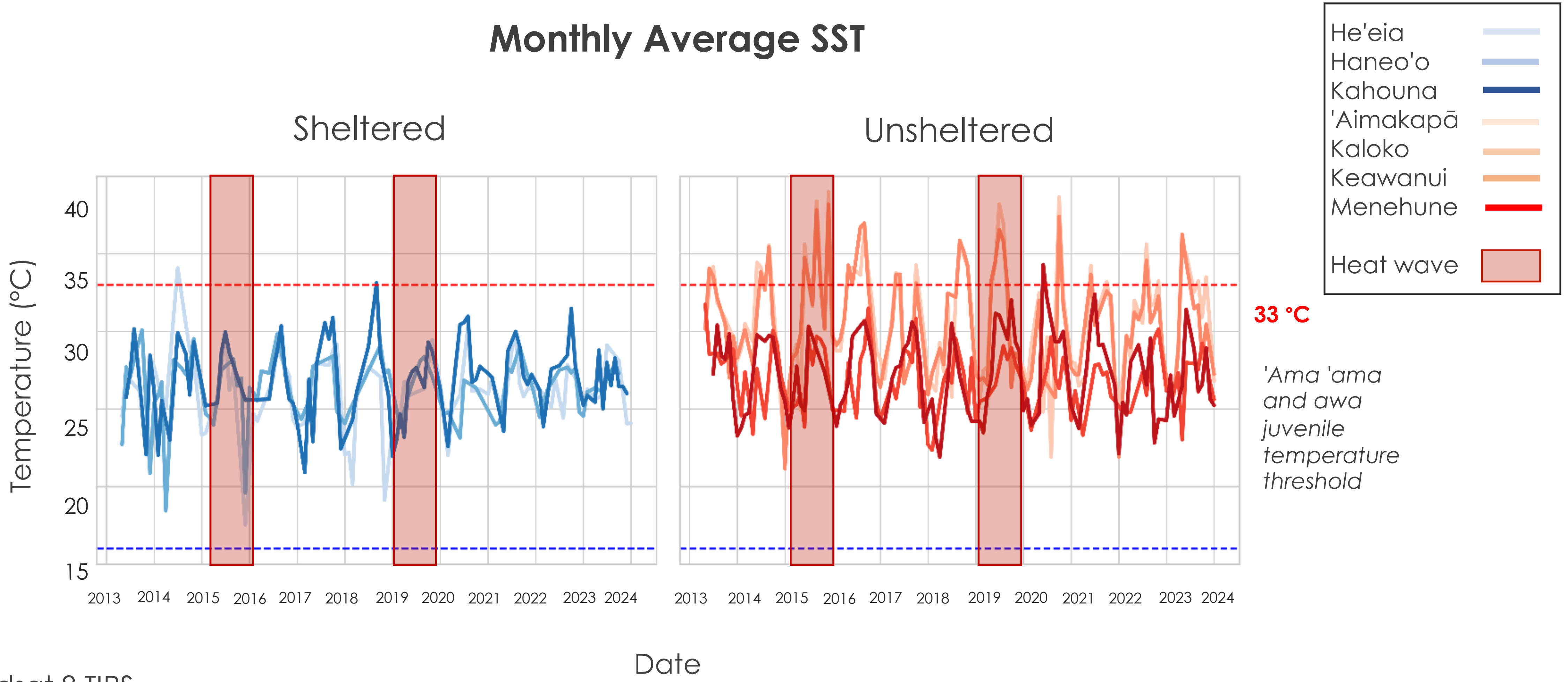
Aqua MODIS 2016 Sea Surface Temperature

25°C 30°C

Results: SST Video Animation for Ponds

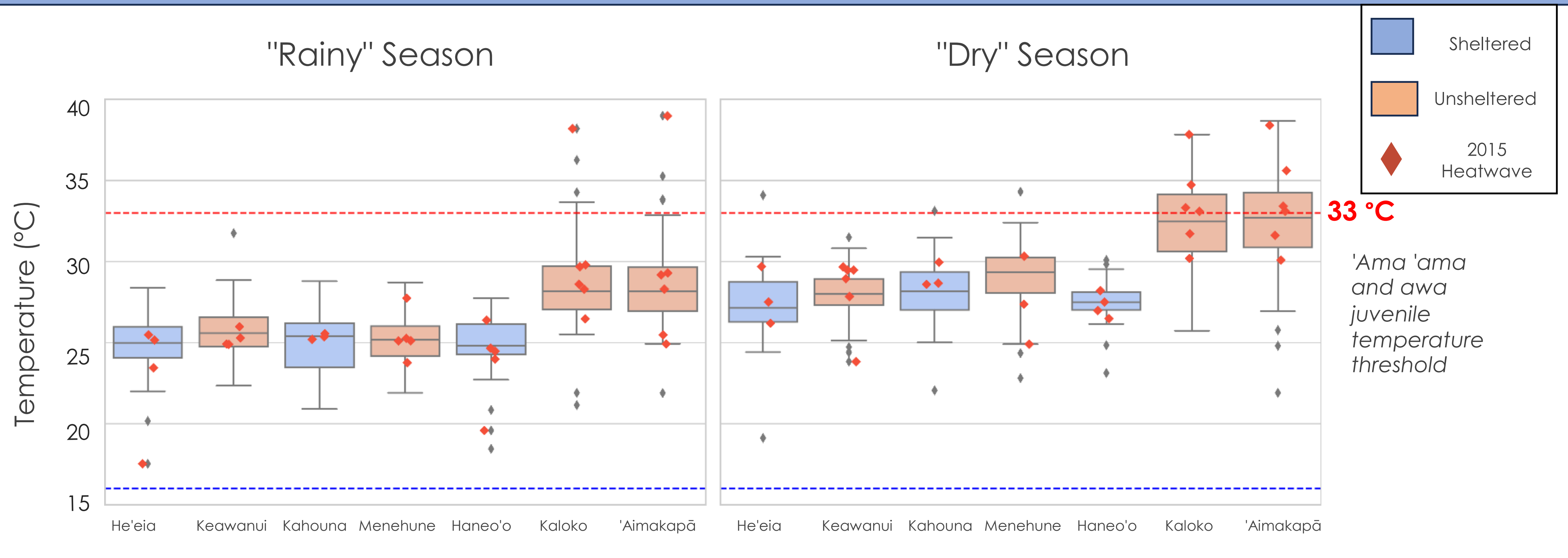


Unsheltered Ponds are Exposed to Higher Temperatures



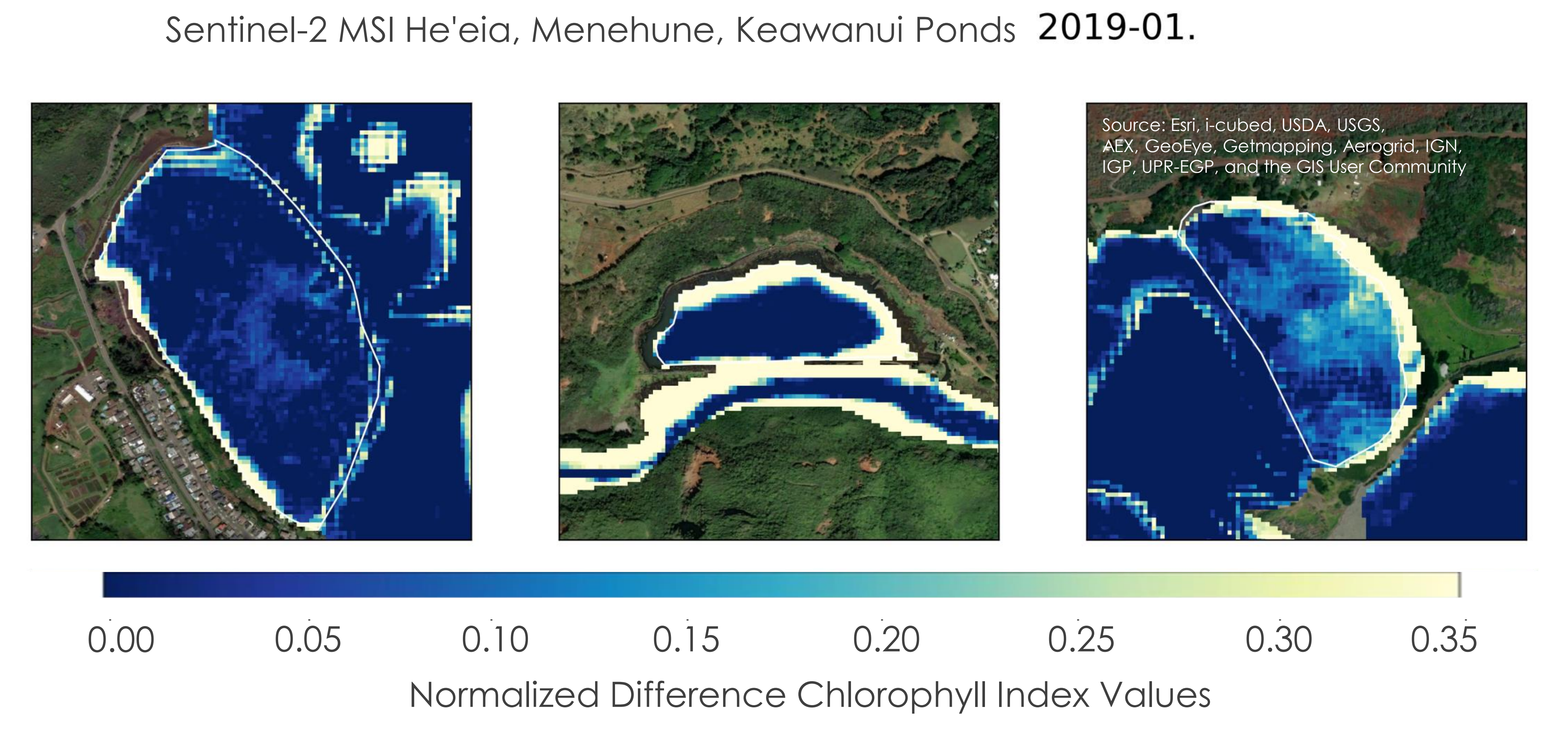
Landsat 8 TIRS

Smaller Ponds Near Thresholds in Dry Seasons

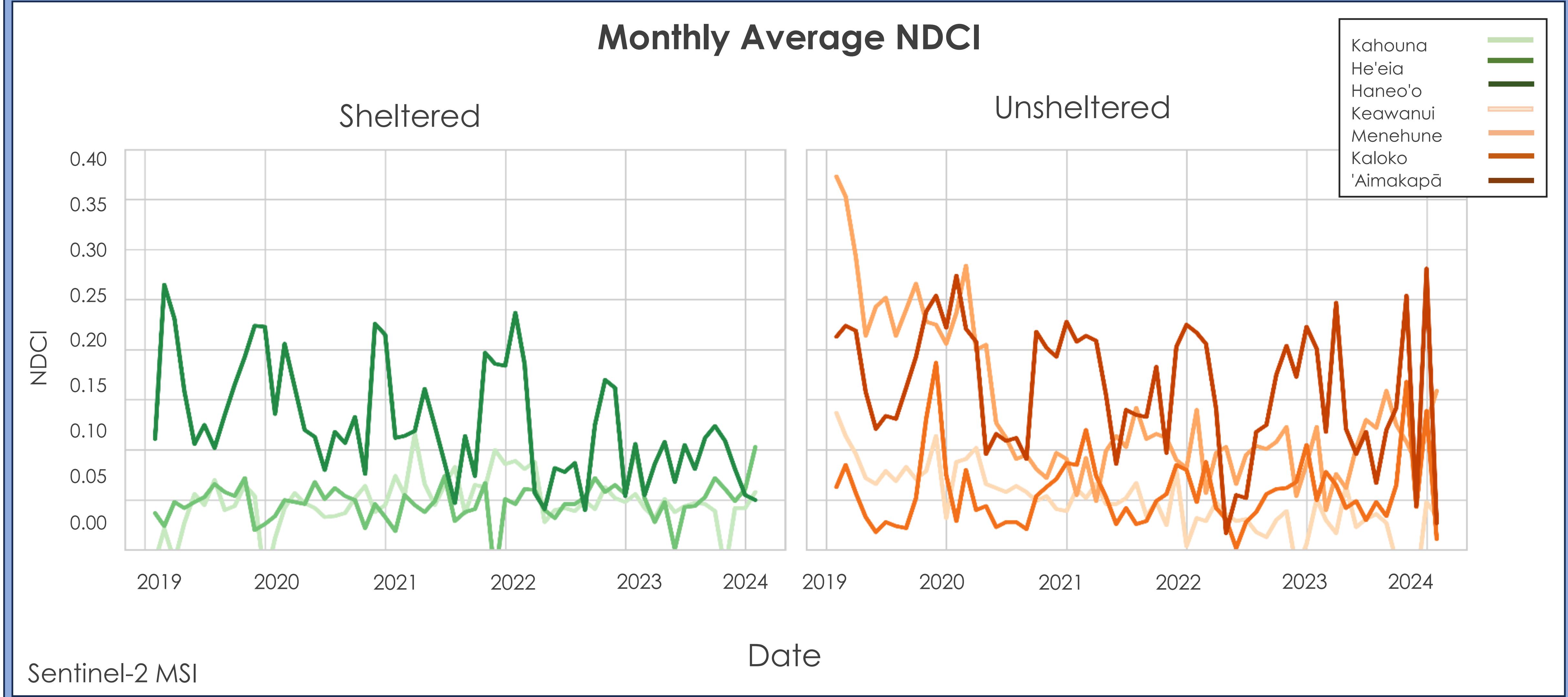


Landsat 8 TIRS

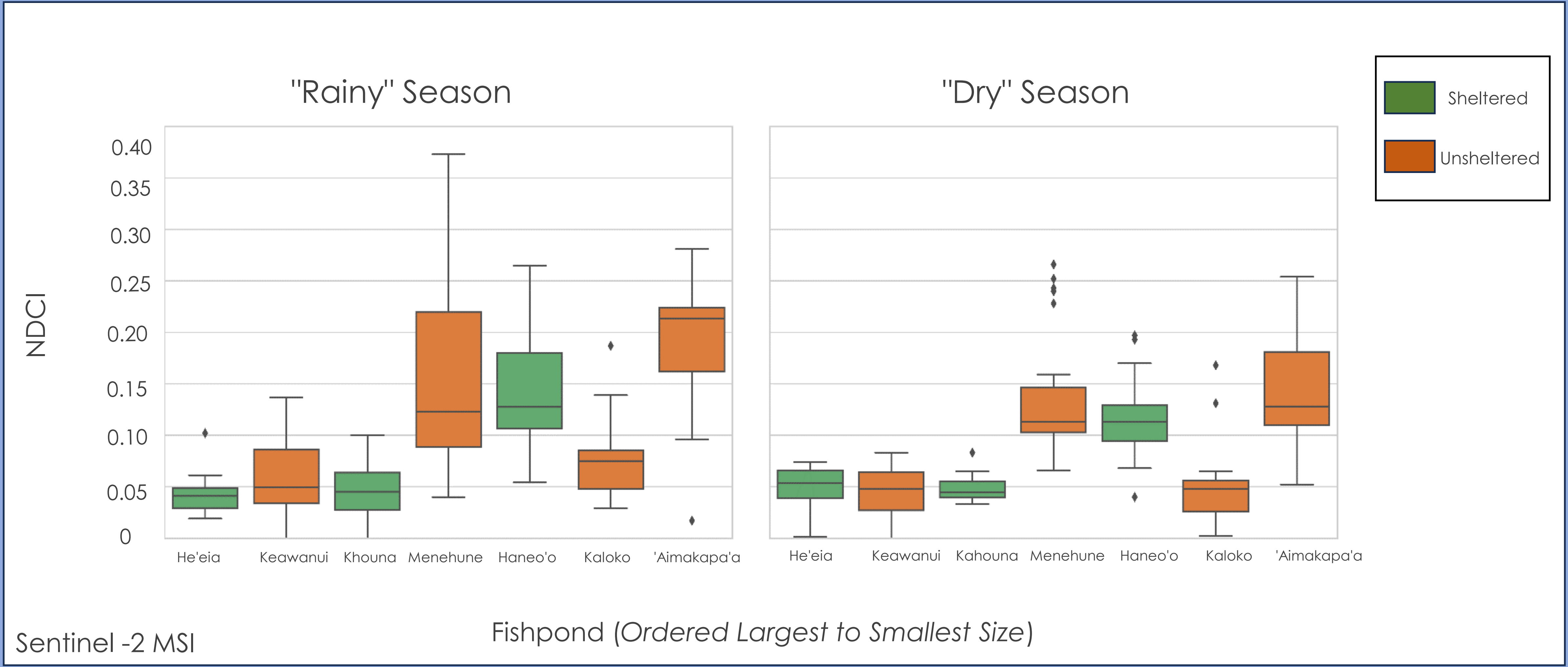
Results: Chl a Video Animation for Ponds



Chlorophyll Varies from Pond to Pond



More NDCI Variability in the Rainy Seasons



Data Availability & Challenges

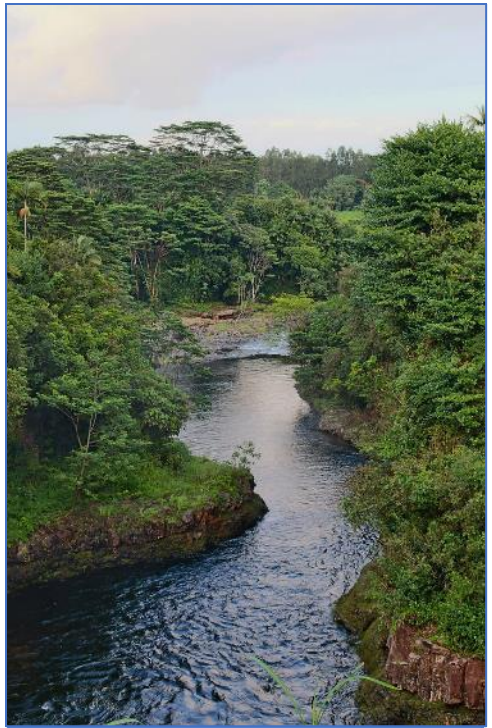
Lack of In Situ Data

- Georeferencing ECOSTRESS
- Chlorophyll a accuracy in shallow waters
- Lack of fish catch data

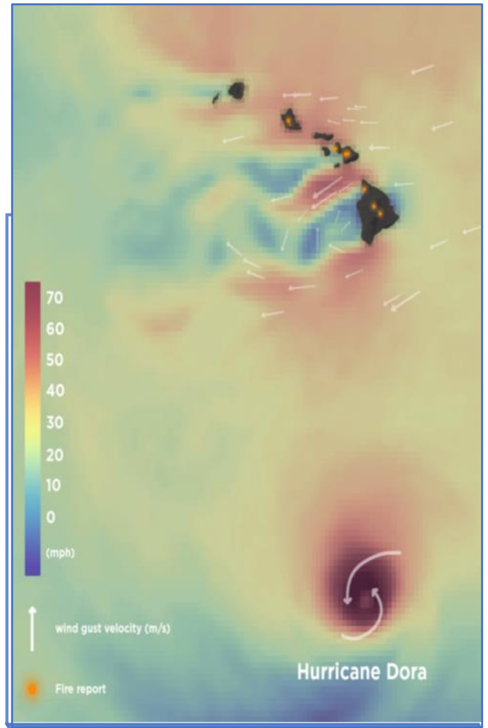
Feasibility Assessment

- Resolution of satellites limited study to only larger pond
- Turbidity analysis not feasible within timeframe

Future Work



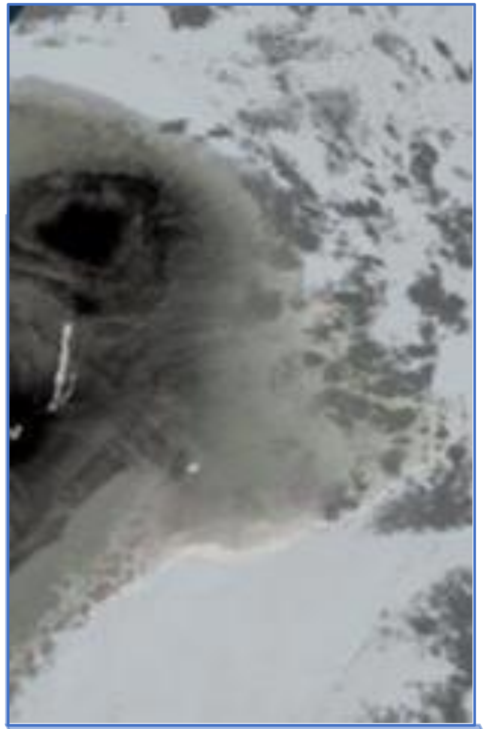
Groundwater



Ocean Currents/Wind

Invasive Species

Land Use/Land Cover



ECOSTRESS

Image Credits (left to right): Robert Linsdell, Wikiwillz, Famartin, Cyrill Bambilla

Takeaways

Small, unsheltered fishponds are more likely to exceed thermal thresholds for juvenile fish (awa and 'ama'ama)

Chlorophyll (proxy for primary prod uctivity) had no clear trends with temperature increases

NASA Earth observations are viable for large-scale regional monitoring

In situ data are needed for pond-specific restoration practice

Acknowledgements

Team Members

Raz Wachtel
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Mina Nada

Tyler Morgan

Advisors

Dr. Christine Lee (NASA Jet Propulsion Laboratory, Caltech)
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Dr. Angelica Rodriguez (NASA Jet Propulsion Laboratory, Caltech)
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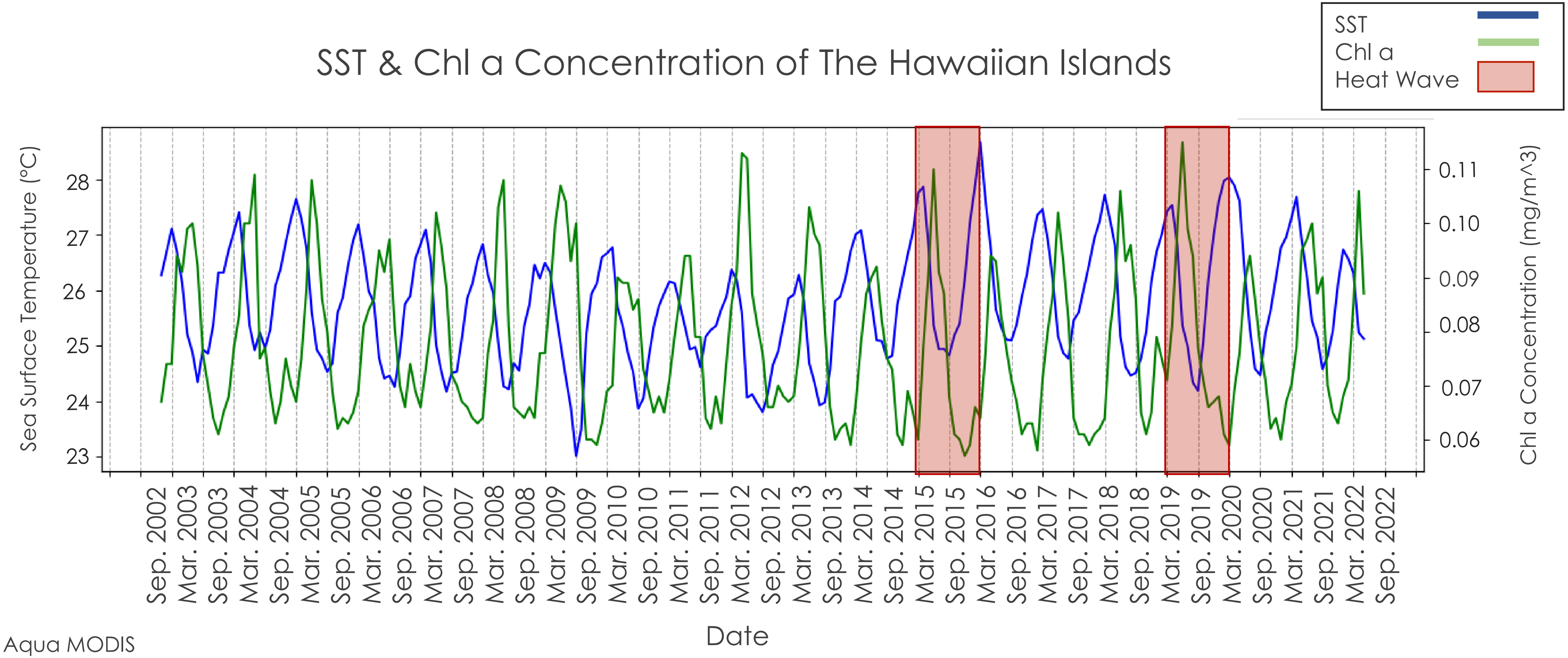
Jane Zugarek (NASA DEVELOP – JPL)

Backup Slide

Chlorophyll Signal Lagged with Temperature



Aqua MODIS