National Aeronautics and Space Administration

Connecting Citizen Science with Remote Sensing

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Course Structure and Information

- Three, 1.5-hour sessions on January 24, 26, and 31
  - **English:** at 11:00am - 12:30pm EST (UTC-5:00)
  - **Spanish:** at 2:00 – 3:30pm EST (UTC-5:00)

- Each session will feature lecture and Q&A session where instructors will be online to answer questions

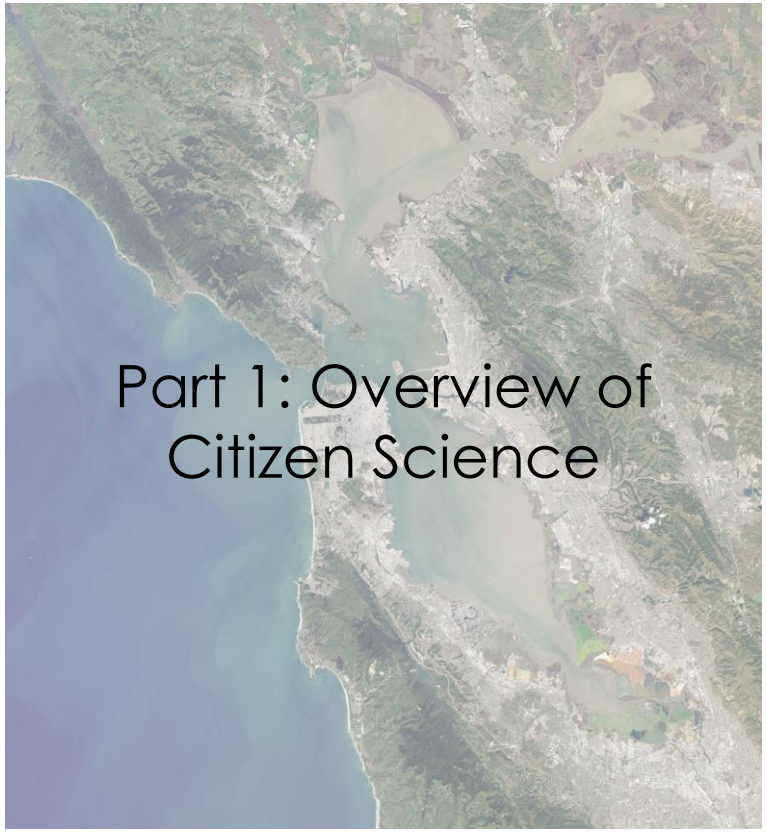
- Webinar recordings and PowerPoint presentations can be found after each session at: https://appliedsciences.nasa.gov/join-mission/training/english/arset-connecting-citizen-science-remote-sensing

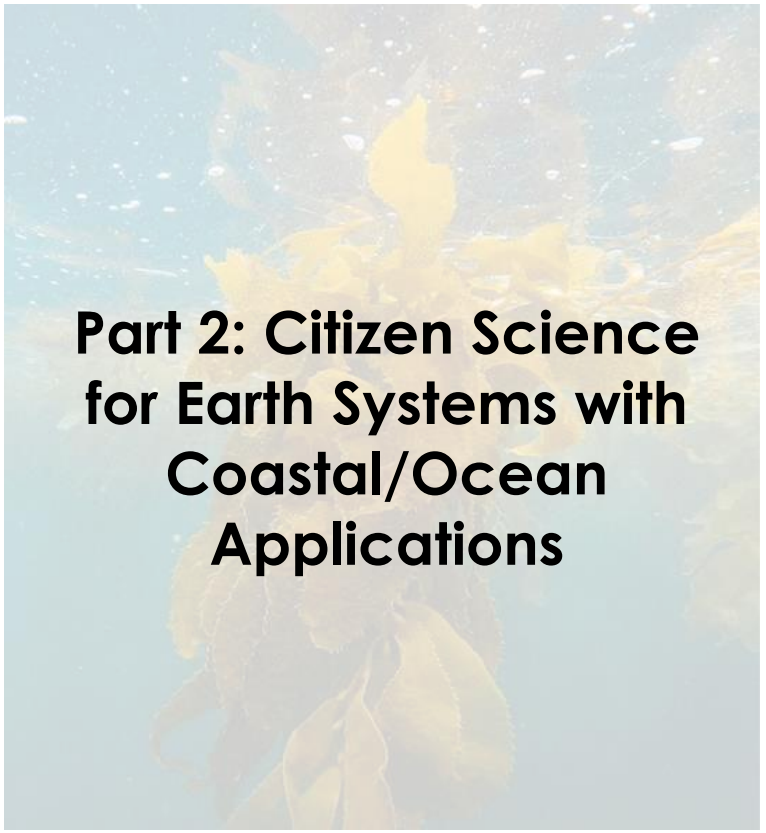
- For additional questions please email:
  - Juan L. Torres-Pérez (juan.l.torresperez@nasa.gov)
  - Amber McCullum (amberjean.mccullum@nasa.gov)
  - Britnay Beaudry (britnay.beaudry@nasa.gov)

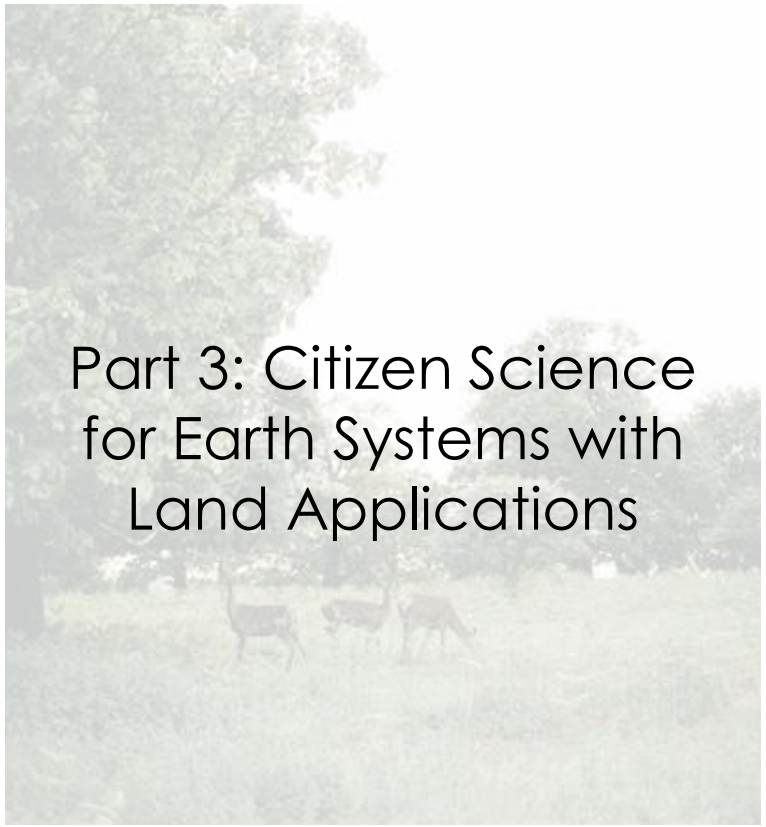
Homework and Certificates

- **Homework:**
  - One homework assignment (available at the end of Session three of this webinar series)
  - Answers must be submitted via Google Forms
  - **HW Deadline: February 14th**
- **Certificate of Completion:**
  - Attend all three live webinars
  - Complete the homework assignment by the deadline (access from ARSET website)
  - You will receive certificates approximately two months after the completion of the course from: marines.martins@ssaihq.com

Course Outline







Learning Objectives

By the end of this training, attendees will be able to:

- Outline key aspects of citizen science projects including:
  - Community engagement and effective communication
  - Motivations, ethics, and policies
  - Data quality assurance and accessibility
- Discover case study examples of the use of Earth Observations for NASA Applied Sciences projects
- Summarize applications of Earth Observations for citizen science

Part 2 Agenda

- Summary of Part 1
- Examples of coastal/ocean-based citizen science projects utilizing Earth observations
  - Floating Forests
  - FjordPhyto
  - Lake Observations by Citizen Scientists and Satellites (LOCSS)
  - NeMO-Net
- Q&A

Summary of Part 1

- General aspects of citizen science and how to get involved
- Benefits and drawbacks of citizen science
- Community engagement and feedback
- Potential for different levels of participation depending on the availability and expertise of citizens
- Getting the word out
- Maintaining interest of participants
- Establishing standardized protocols for data collection and submission
- Data review and curation

Summary of Part 1

- NASA Citizen Science supports projects in diverse areas in Planetary Science, Heliophysics, and Earth Sciences.
  - More than 400 citizen scientists have co-authored peer-reviewed publications.
- **NASA Citizen Science for Earth Systems Program (CSESP)** – Focuses on projects aimed at atmospheric and biospheric sciences.
- Aims to advance the use of citizen science in scientific research about the Earth by supporting citizen science activities and deploying technology to further citizen science research.
- All funded projects must have a clear linkage between citizen science and NASA observation systems.

Examples of Water-Based Citizen Science Projects Utilizing Earth Observations

Floating Forests: A Citizen Science Tool for Monitoring Kelp Extension

Floating Forests: A Citizen Science Tool for Monitoring Kelps

- Kelps are extremely important temperate water ecosystems.
- Some individuals can grow up to 18 inches/day!
- Kelp forests are recognized as one of the most productive and dynamic ecosystems on the planet.
- These are the largest marine biome of the world, covering about 36% of the world's coastlines.
- It is extremely hard to monitor such immense ecosystems with traditional monitoring methods.

Credit: Kyle Cavanaugh (UCLA)

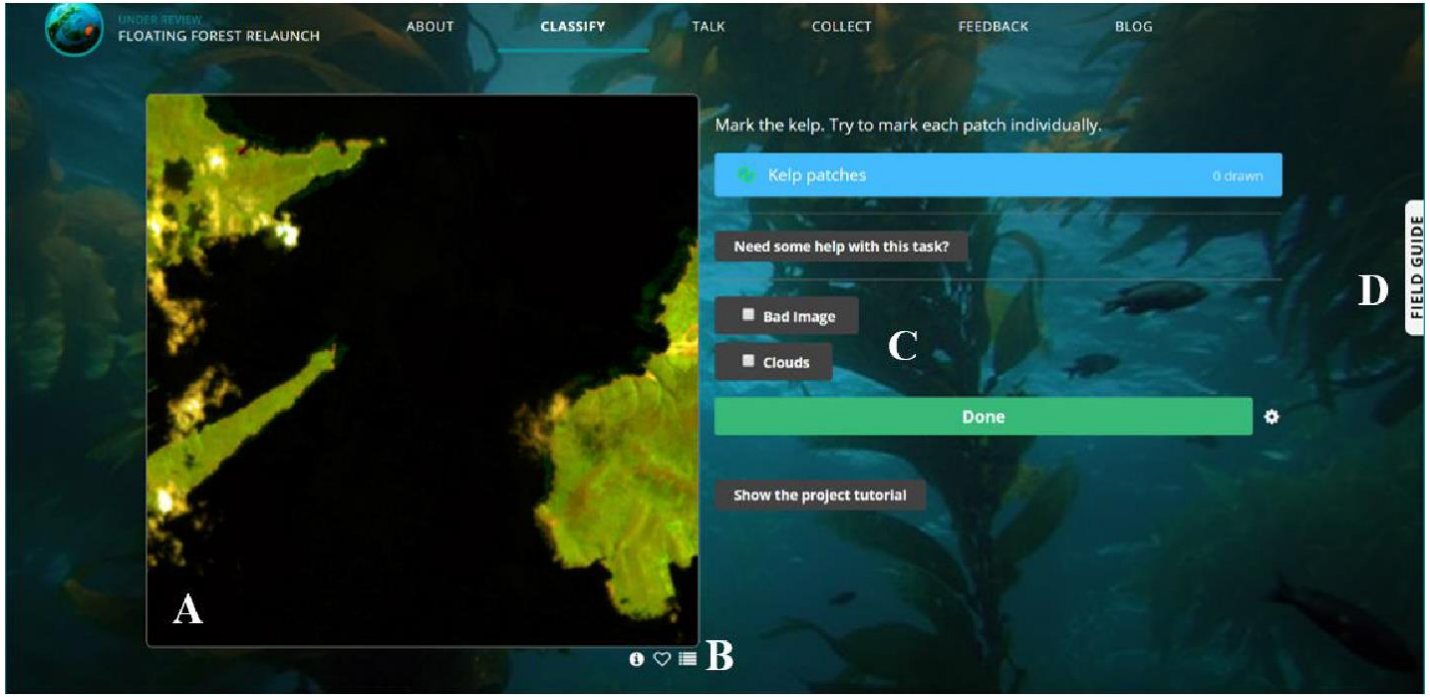
Floating Forests: Methods

- Full-size Landsat scenes are converted into small jpeg subsets.
  - Each scene is split into 400 images each covering ~131 km^2.
- Subsets are presented to citizens via the online interface.
- Images are displayed with a combination of SWIR (red), IR (green), and red band (as blue in the image).
  - This allows kelp canopy to stand out as bright green due to its high near IR reflectance at the water surface.

Credit: https://www.zooniverse.org/projects/zooniverse/floating-forests

Floating Forests: Stats

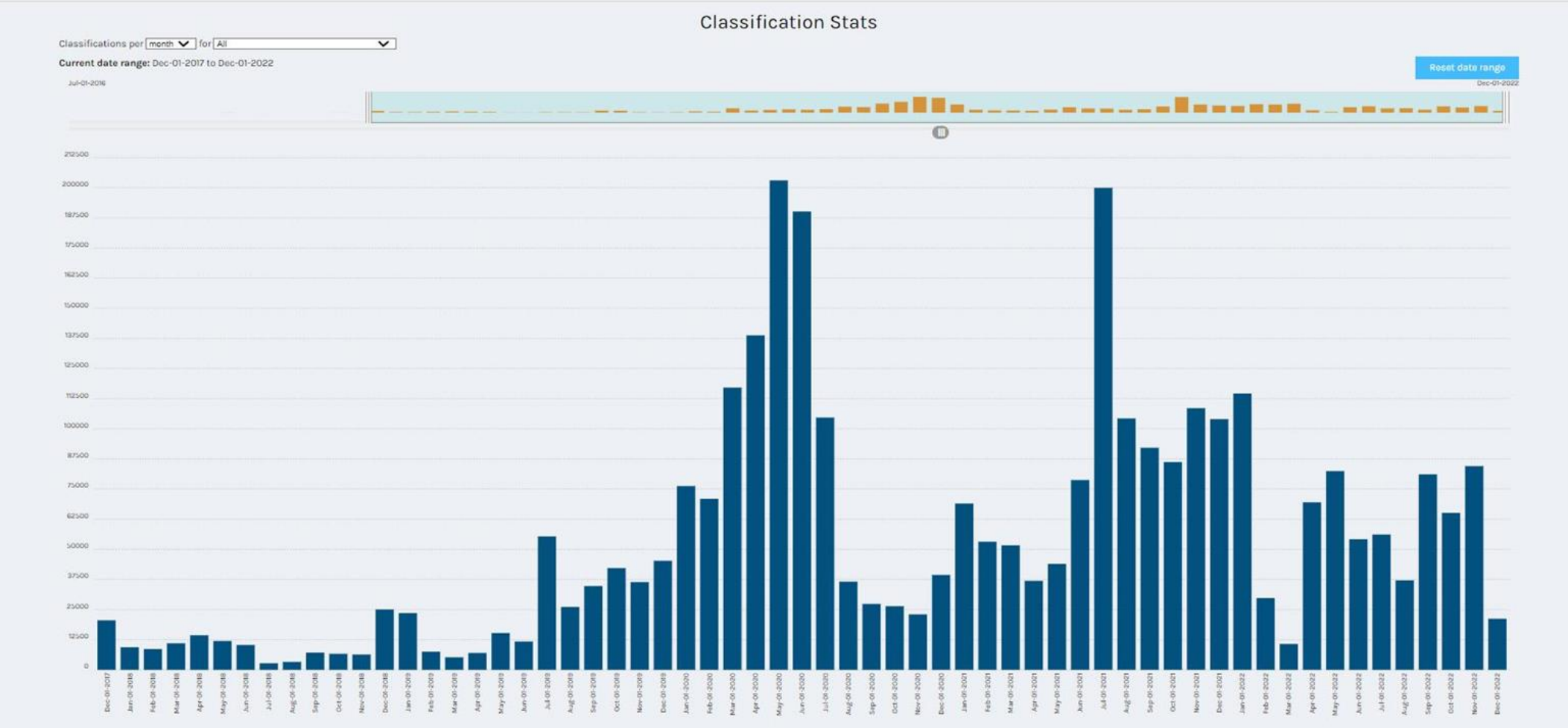
- Citizen science application originally launched in 2014 within the Zooniverse platform
- Allows citizens to classify Landsat images in two different ways:
  - Kelps/No Kelps
  - Delineation of kelp patches along the coastlines
- More than 24,800 registered volunteers
- Each day, more than 1,000 classifications are registered in the application.



Credit: Rosenthal et al. (2018)

Floating Forests: Stats

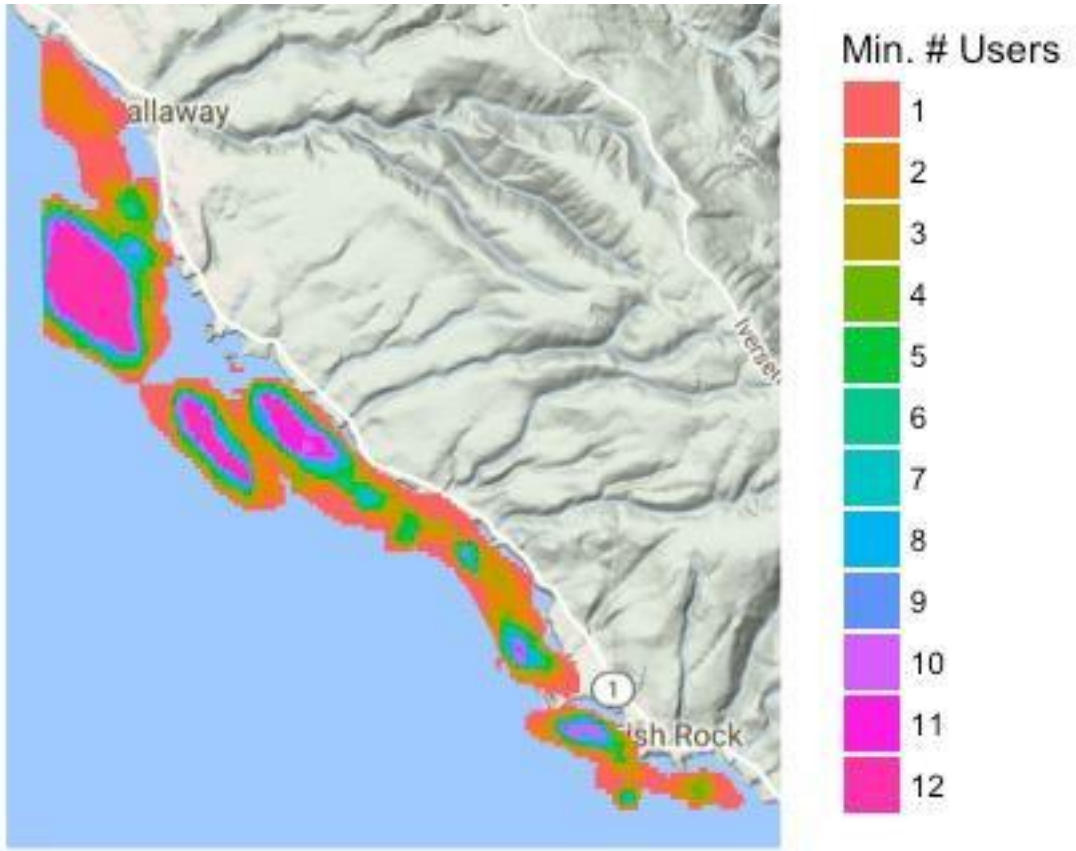
- More than 1,350,000 classifications provided as of Dec 2022!!



Credit: https://www.zooniverse.org/projects/zooniverse/floating-forests

Floating Forests: Stats

- Uses a consensus classification and quantitative comparison to expert generated classifications to analyze data quality.
- How clear or defined the kelp area is affects the consensus among users.



Credit: https://www.zooniverse.org/projects/zooniverse/floating-forests

Demonstration of Floating Forests

FjordPhyto: Polar Citizen Science (Understanding Polar Fjords Through Community Effort)

FjordPhyto: Using Polar Tourism as an Effective Research Tool in the Antarctic Ocean

- Aims at:
  - Determining seasonal and interannual changes in meltwater intrusion at fjords and coastal embayments
  - Characterizing phytoplankton community diversity during the austral growth (Nov-March)
  - Engaging visitors on scientific data collection and creation of a time-series dataset
  - Increasing ocean literacy among visitors through education and participation in citizen science activities
- Leverages vessels used by the Antarctic tourism industry as platforms

Citizens assisting in the collection of phytoplankton samples.
Credit: Cusick et al (2020) Oceanography

FjordPhyto: Using Polar Tourism as an Effective Research Tool in the Antarctic Ocean

- Each year, thousands of tourists visit the Antarctic Peninsula to admire the local fjords and spectacular marine life.
- Gathers phytoplankton community data through biological samples collected by citizen scientists
- These data are used for species identification, cell abundance, carbon biomass, and euphotic depth estimates along diverse sites in the Western Antarctic Peninsula.

Citizens assisting in the collection of phytoplankton samples.
Credit: Cusick et al (2020) Oceanography

FjordPhyto: Methods

- Citizens are first trained and become familiarized with sampling protocols.
- Conductivity, Temperature, Depth (CTD) Measurements
- Secchi Depth (to calculate euphotic depth)
- Surface (or near surface) Phytoplankton Net Tows
- Surface Sea Water Samples
- Basic Phytoplankton Microscopy

Plankton net towing by citizens. Credit: Cusick et al (2020) Oceanography

FjordPhyto

FjordPhyto is a citizen science project developed as a partnership between scientists in the USA and Argentina and the Antarctic travel industry.

NASA Partner

Photo Credit: Allison Cusick

The Antarctic Peninsula

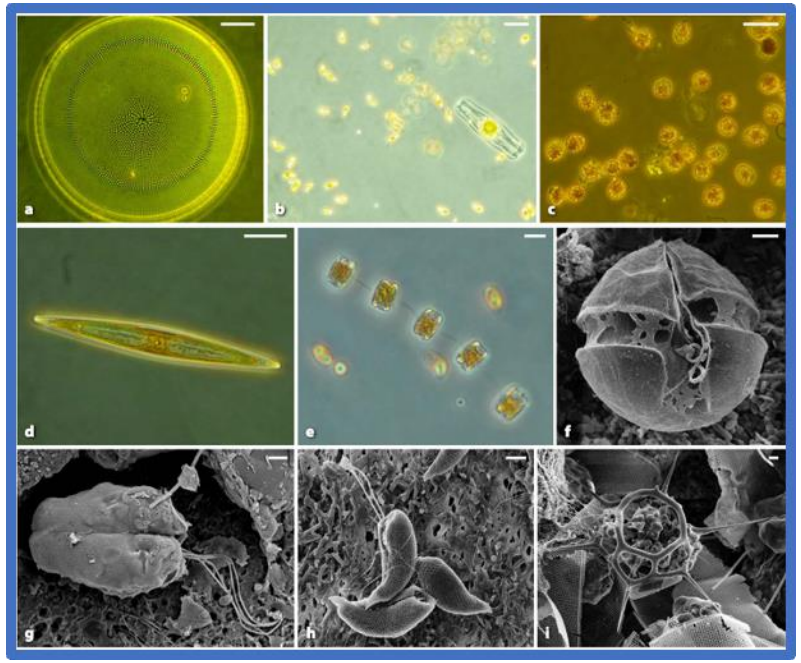
- Fastest rates of warming
- Ocean and air temperatures are increasing
- 87% of glaciers are in retreat
- Wildlife patterns are changing
- Conservation decisions based in research
- Harsh environment and high cloud coverage
- Collaboration here is powerful
- More ‘eyes on the ground’

Graphic by Manuel Canales

Project Questions

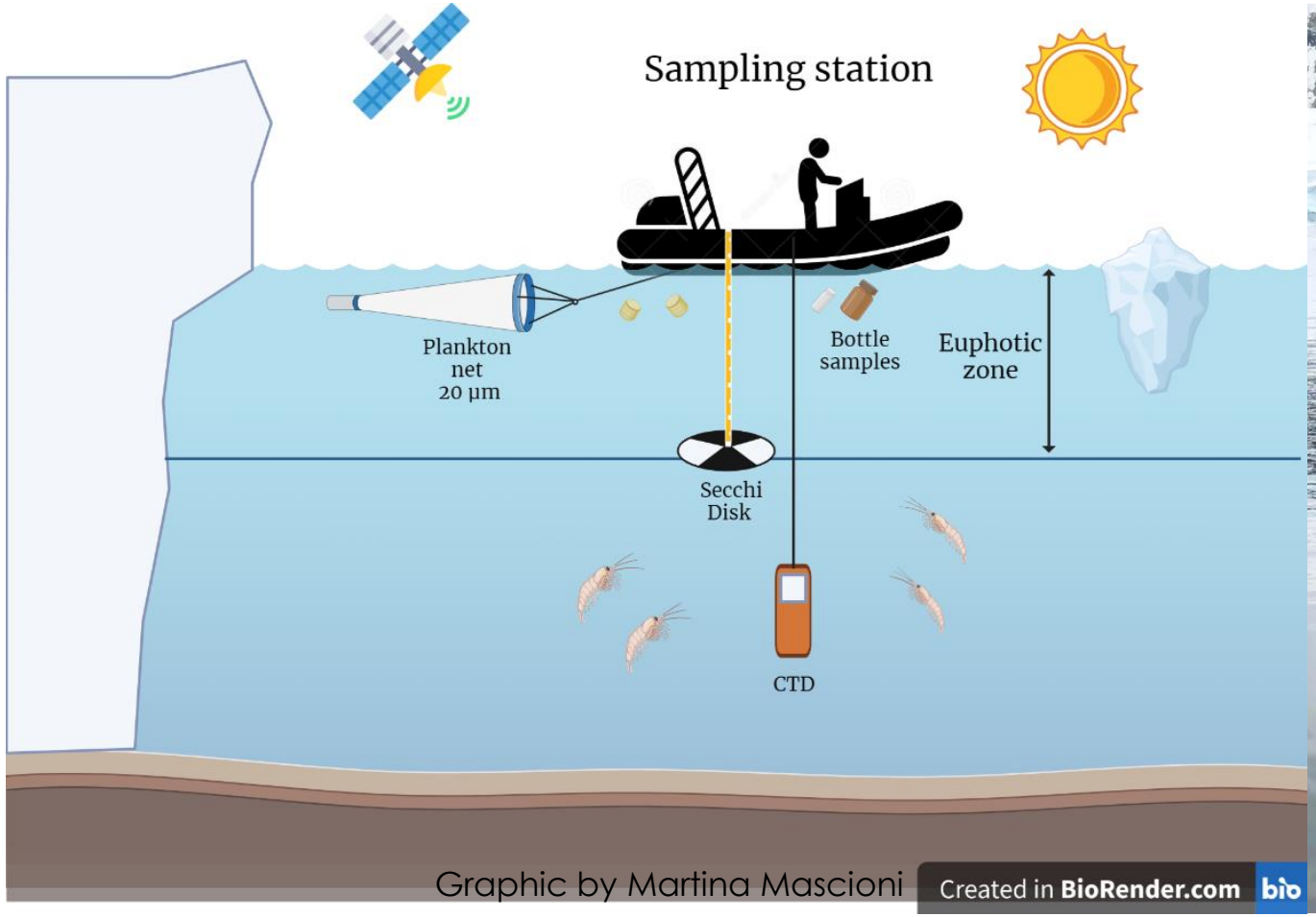
Q1. What is the spatial extent of the glacier meltwater-influenced region over the melting season?

Q2. What is the impact of glacial-meltwater input on phytoplankton abundance and community composition?



Cusick et al 2020

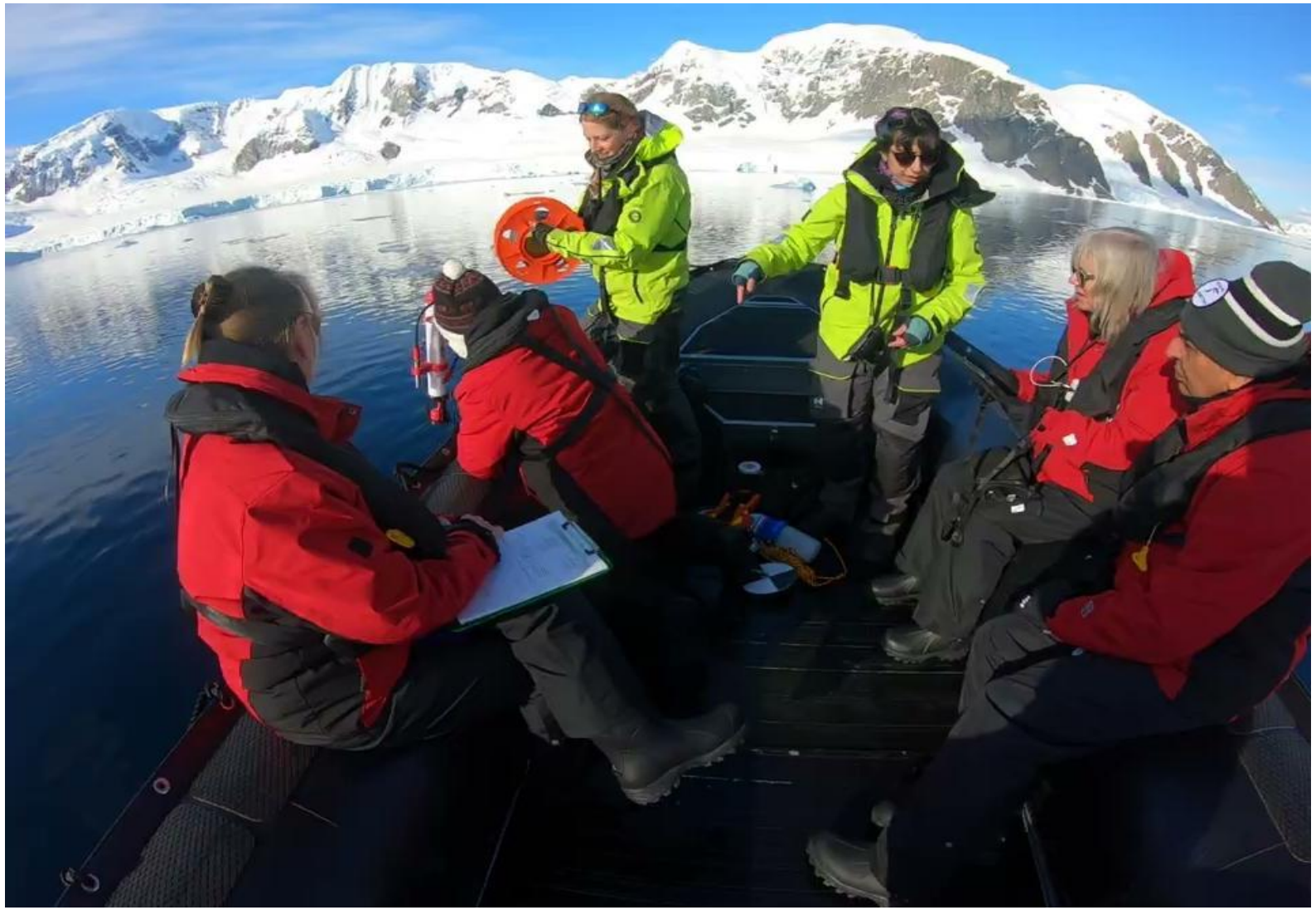
Sampling Protocols



Graphic by Martina Mascioni

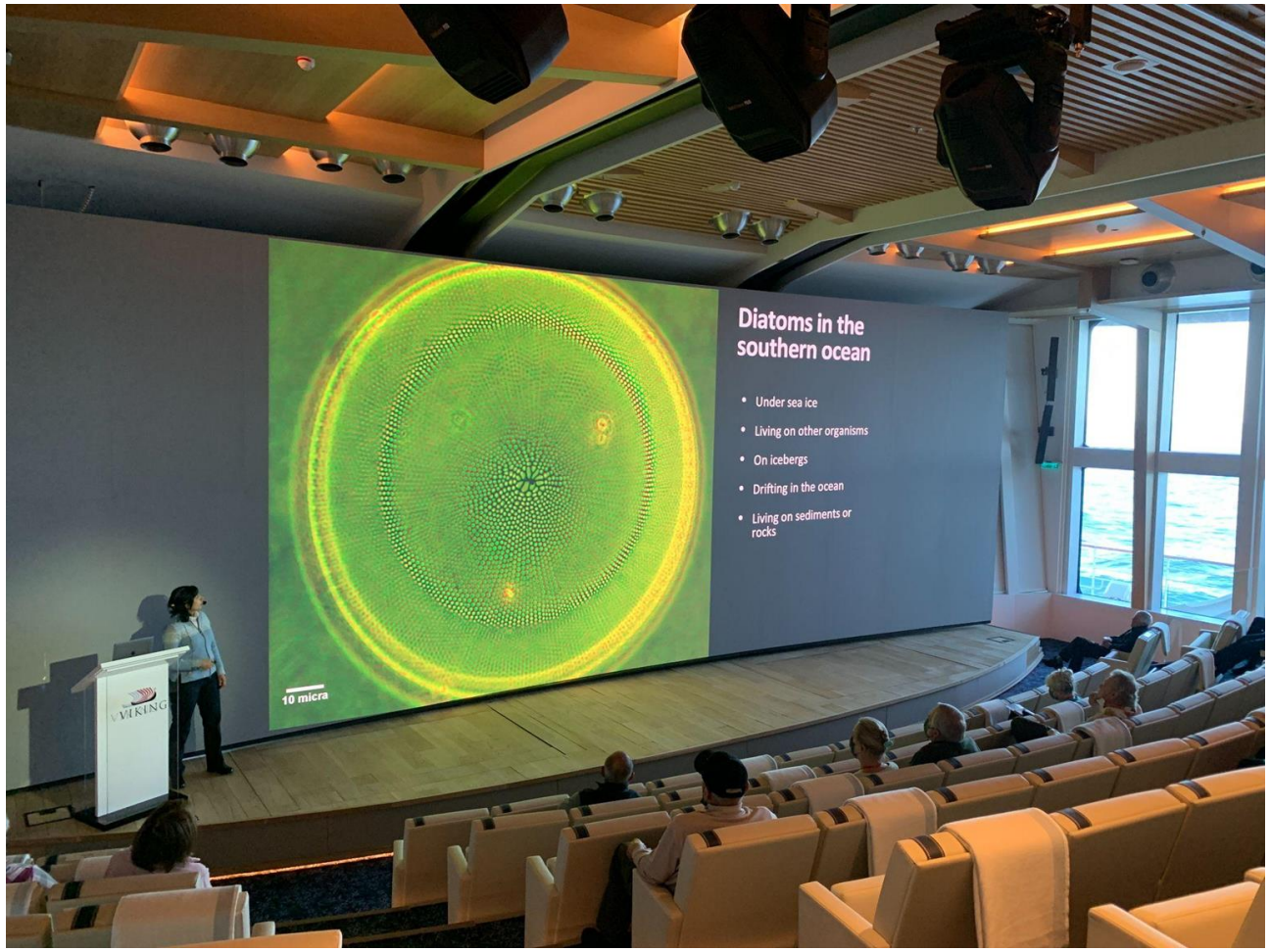
Image by Robert Gilmore

Sampling Protocols



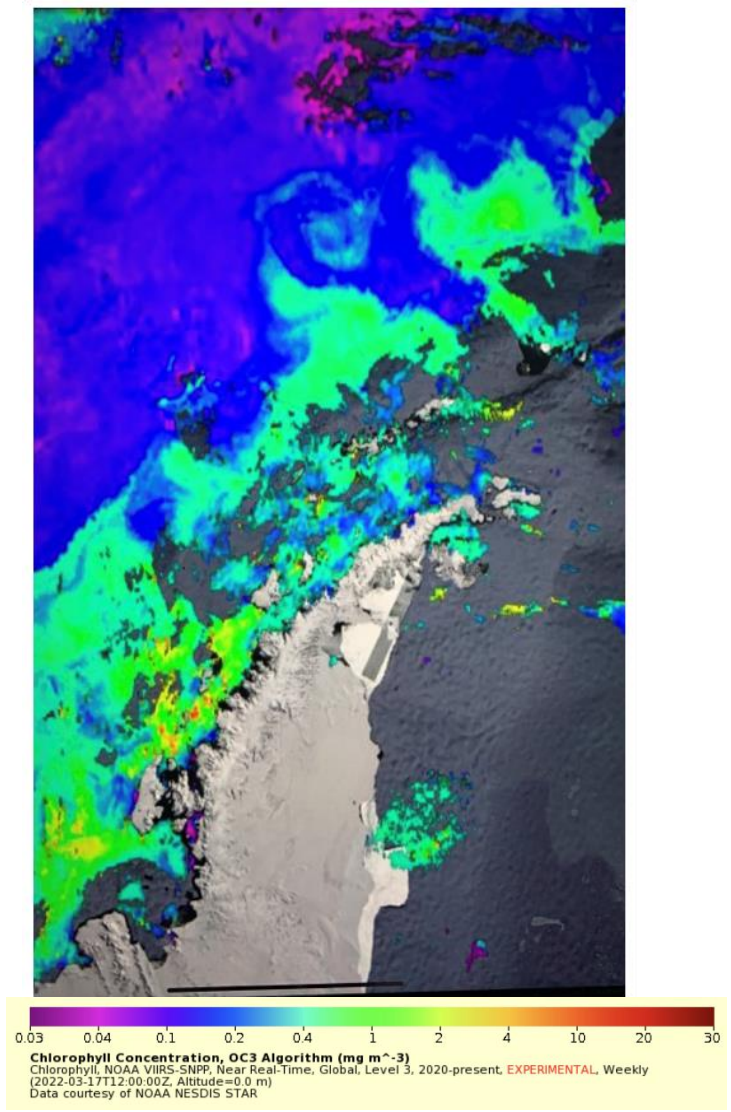
Variety in Science Communication and Outreach

Immersive environment engagement in the field.

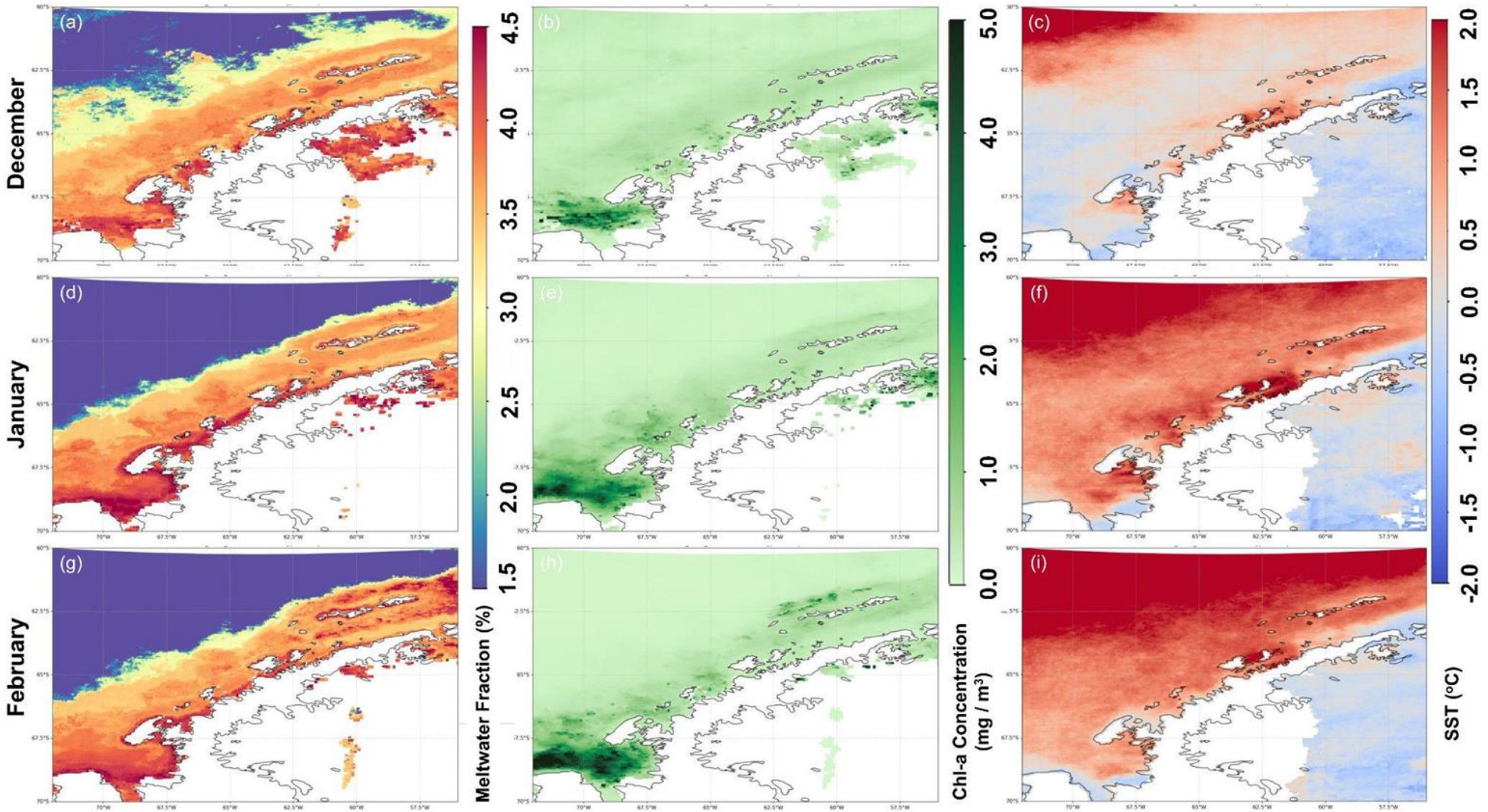


Lectures on ship, off ship, and online.

Connecting In Situ Sampling with Remote Sensing



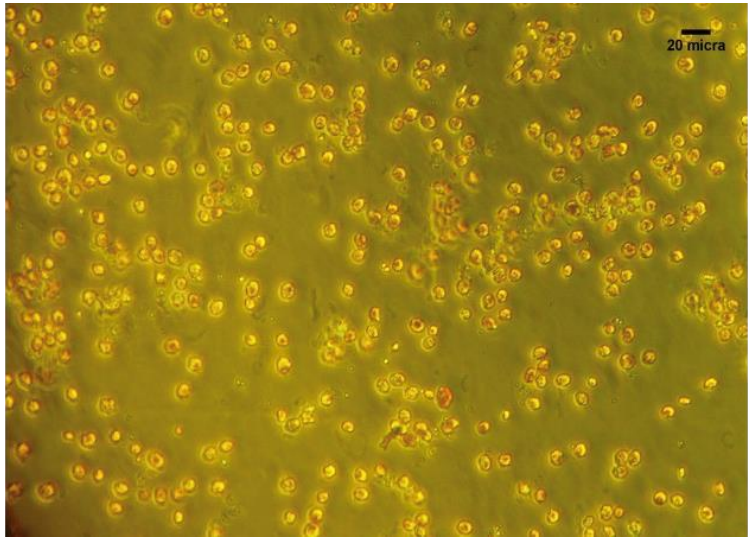
Field data and remotely sensing can help develop predictive algorithms



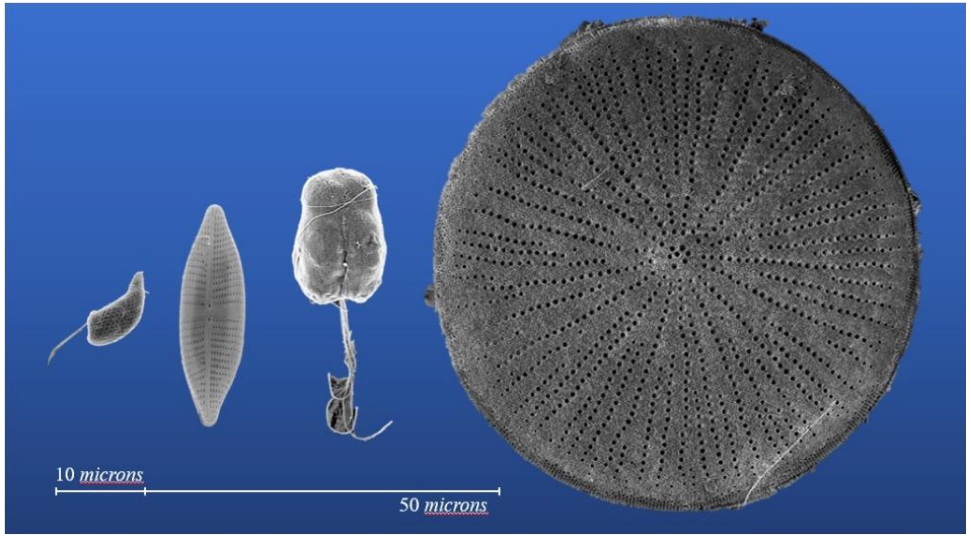
Pan, B.J., Gierach, M.M., Meredith, M.P., Reynolds, R.A., Schofield, O., and Orona, A.J. (2022) “Remote Sensing of Sea Surface Glacial Meltwater Fraction in the Coastal Ocean Waters of the Antarctic Peninsula." Submitted.

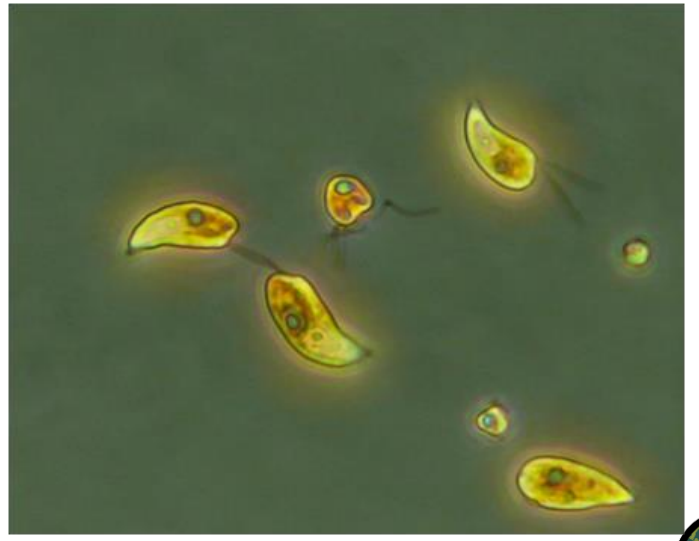
Highlighted Results

- We documented more than 85 genera of phytoplankton.
- We documented the first dinoflagellate bloom with more than 6 million of cells per liter of water!
- We describe possible new species.
- Between years and locations we observed different patterns of seasonal succession.

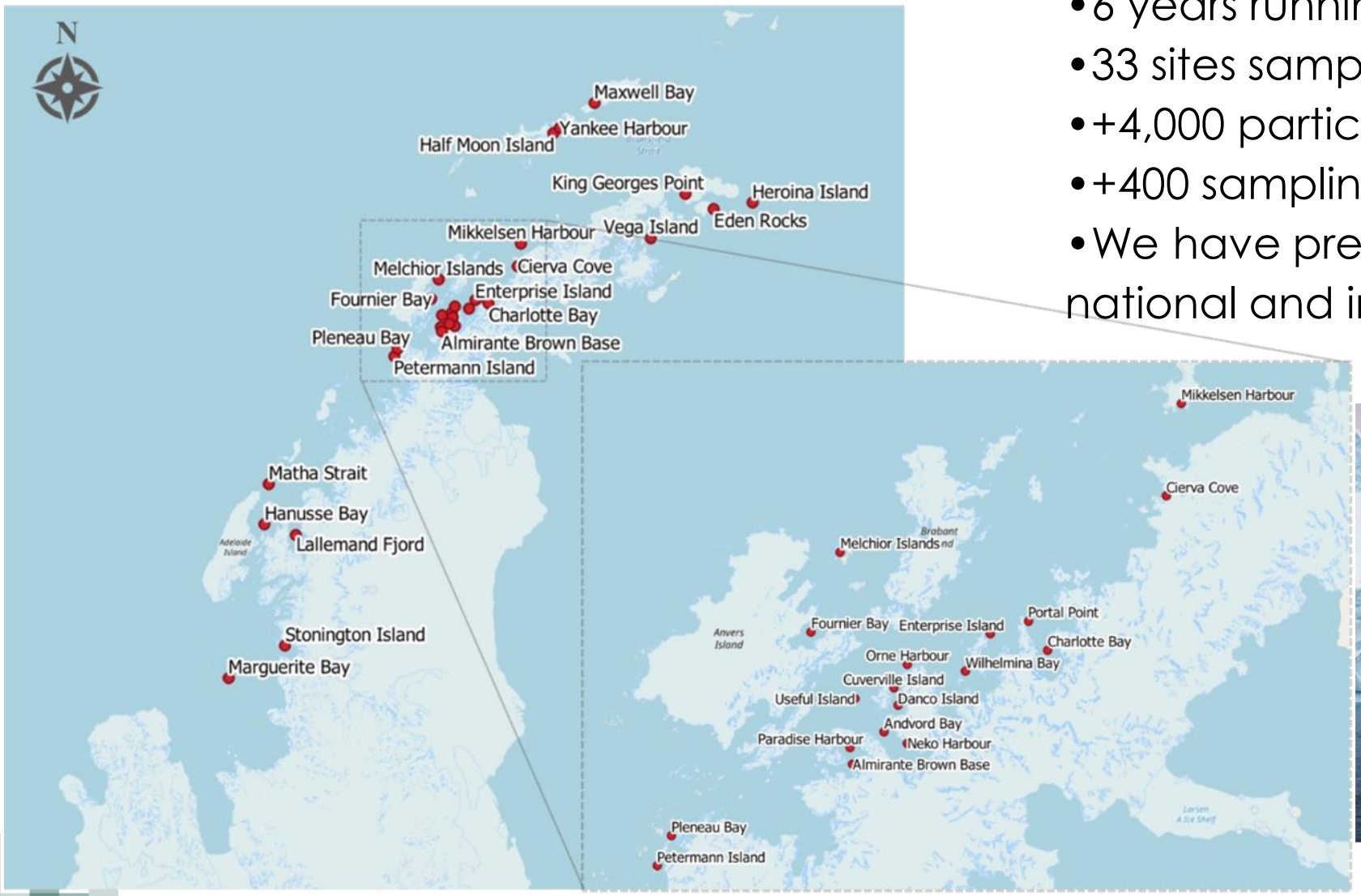


Images by Martina Mascioni





FjordPhyto is building a seasonal time series



- 6 years running
- 33 sites sampled
- +4,000 participants
- +400 sampling events
- We have presented at more than 25 national and international scientific events.

FJORD PHYTO

polar citizen science

@FjordPhyto by the Vernet Lab

www.fjordphyto.org




NASA Partner

NSF

IAATO International Association Antarctica Tour Operators

Antarctic Ambassador

Scripps Institution of Oceanography UC San Diego

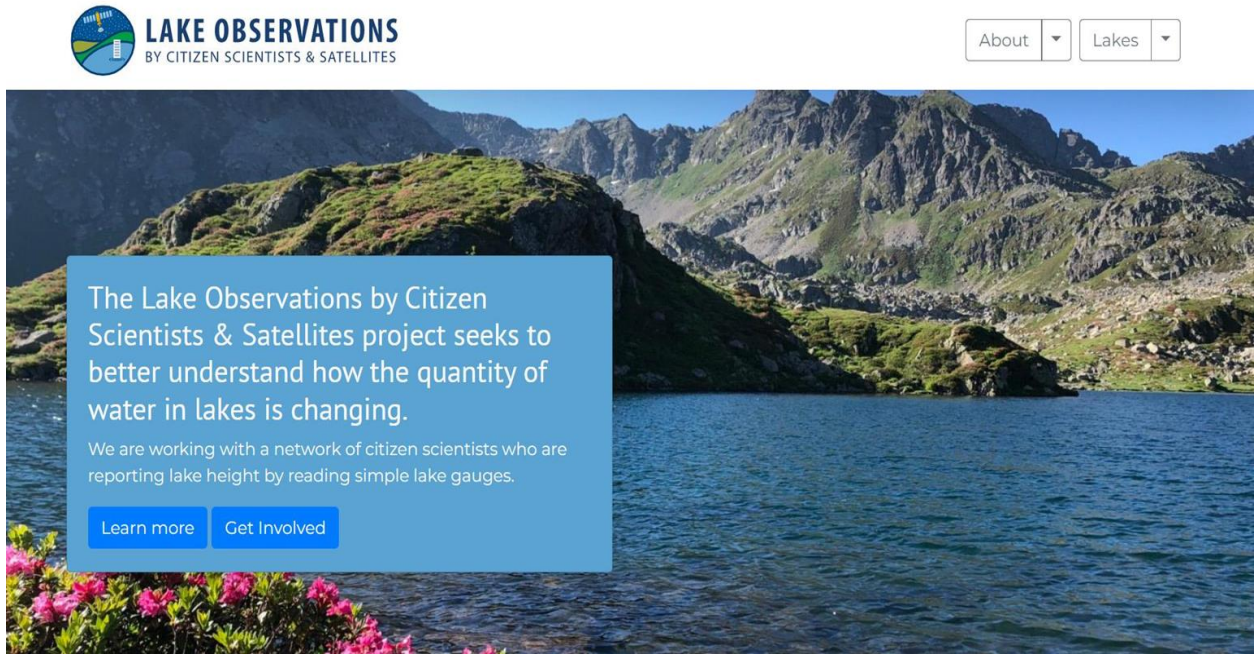
CONICET

Universidad Nacional de La Plata

Lake Observations by Citizen Scientists and Satellites (LOCSS)

Lake Observations by Citizen Scientists and Satellites (LOCSS)

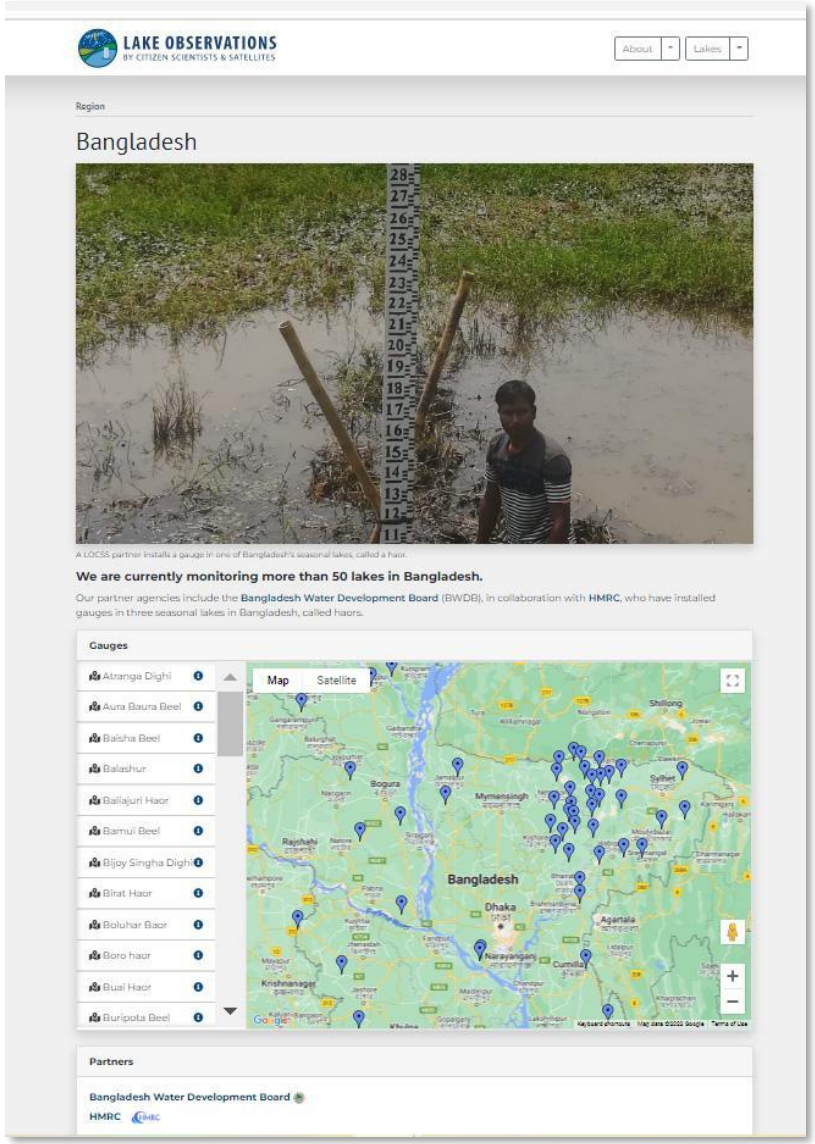
- Citizens monitor variations in lake heights to estimate water volume over time using gauges.
- The project currently monitors lakes in several states (IL, MA, NH, NY, NC, WA) and some international sites (Bangladesh, France, India, Canada, Chile, Nepal, Pakistan).
- Collaborates with local agencies and NGOs to install lake gauges and maintenance.



Credit: https://www.locss.org/

Lake Observations by Citizen Scientists and Satellites (LOCSS)

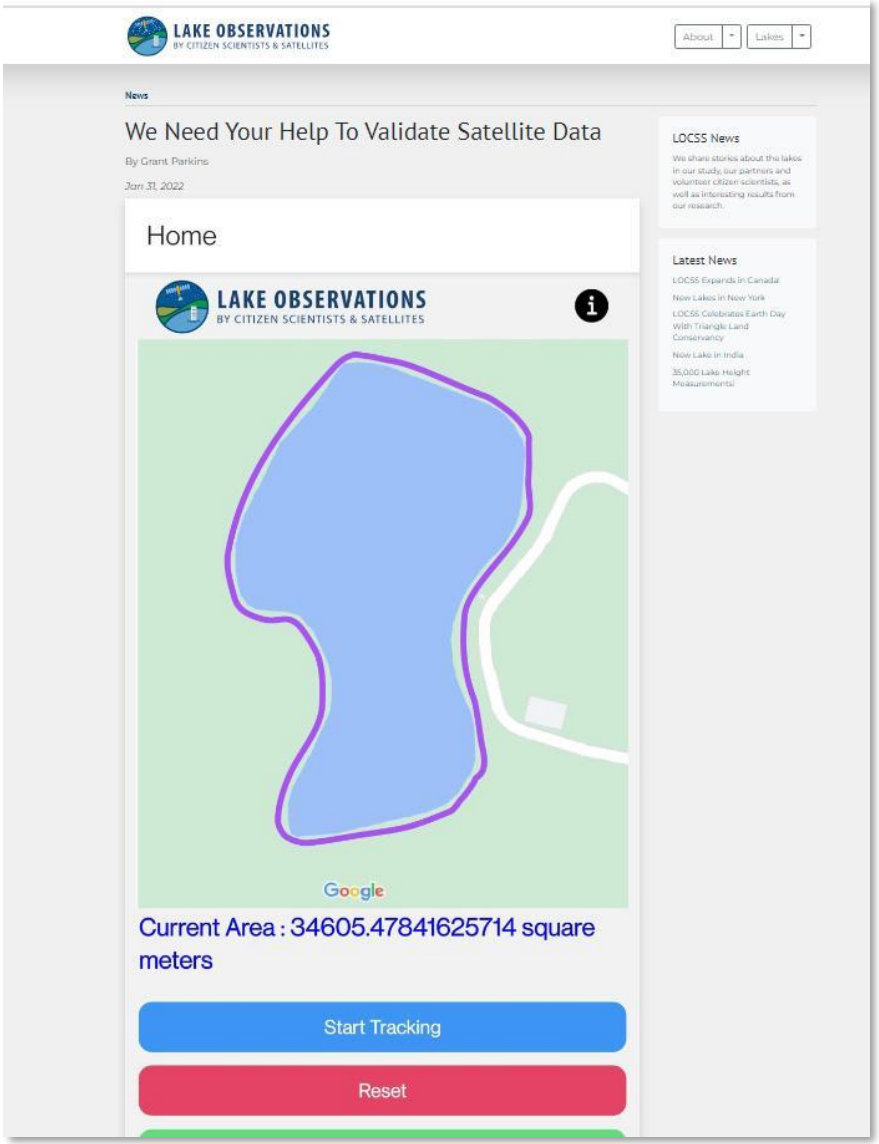
- Combines measurements reported by citizen scientists with surface area estimates derived from satellite data.
- Variations in water volume over time are estimated based on lake height and surface area.
- Project has a monthly newsletter with updates from study sites and potential expansion to others.
- More than 35,000 measurements so far despite being affected by the COVID-19 outbreak.



Credit: https://www.locss.org/

Lake Observations by Citizen Scientists and Satellites (LOCSS)

- Currently testing accuracy of satellite measurements with a citizen-based application
- Citizens download the app and track the lake area with their phone as they walk the lakeshore.
- Citizens can choose to walk the whole lake, a portion, or even select a single point.
- So far, the app is only available for Android phones.



Credit: https://www.locss.org/

NeMO-Net: A Citizen Science Game to Help Map the World's Coral Reefs

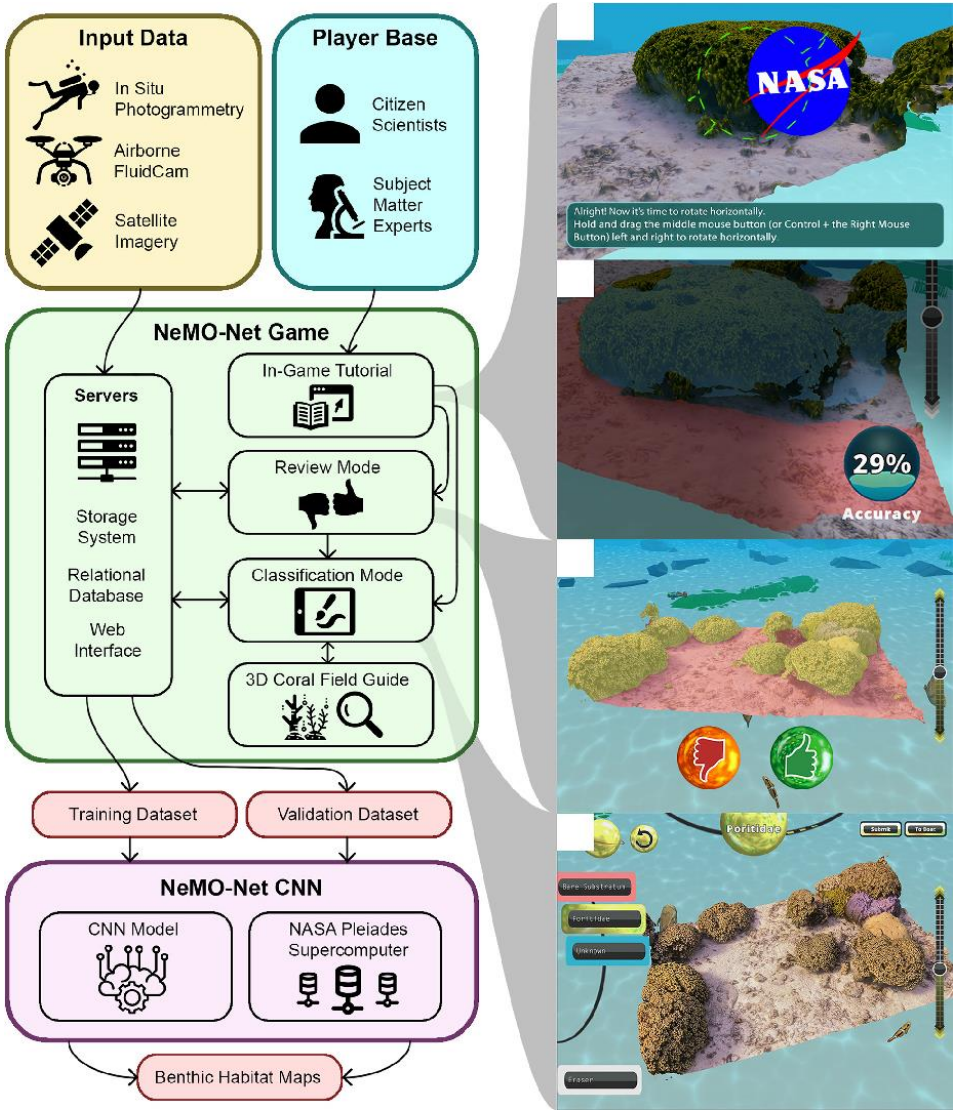
NeMO-Net

- The Neural Multimodal Observation and training Network for global coral reef assessment (NeMO-Net)
- Convolutional Neural Network (CNN) used to generate benthic habitat maps of coral reefs and associated ecosystems
- Requires curated and highly-accurate training datasets
- Citizens can classify 2D (satellite) or 3D images (collected with high resolution cameras) as they advance.
- More than 70,000 classifications submitted by citizen scientists so far!

Credit: Ved Chirayath (Univ. Miami)

NeMO-Net: A Fun Game/App for Coral Reef Classification

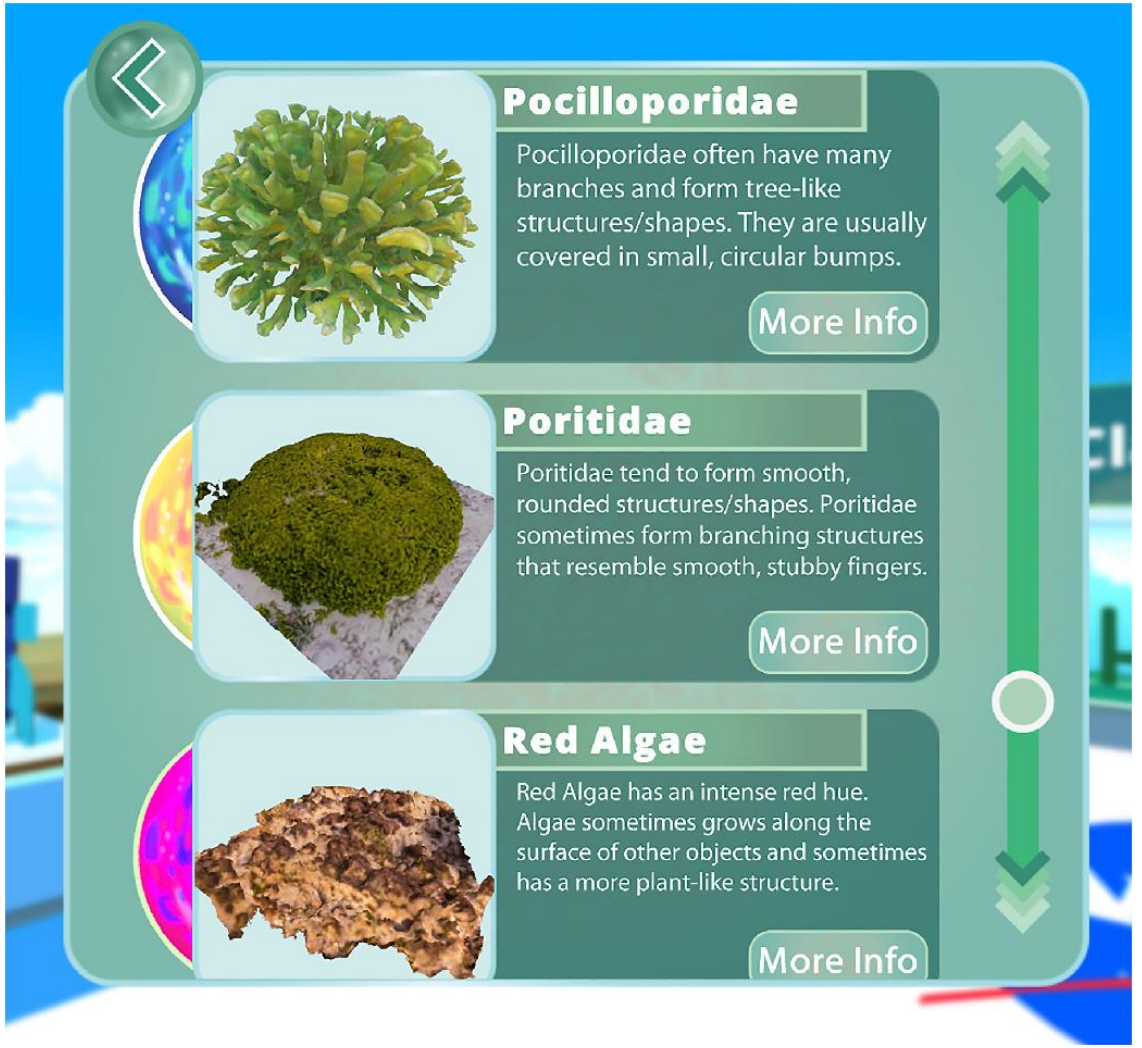
- Trains users to accurately identify benthic categories at diverse levels
  - From broad geomorphologic to biodiversity
- Generates high resolution habitat labels (sub-cm to meter)
- Allows users to edit or rate other users' classifications to improve segmentation accuracy
- So far, includes data from Guam, Hawaii, American Samoa, Puerto Rico, and the Indian Ocean



Credit: van den Bergh et al (2021) FMARS. https://doi.org/10.3389/fmars.2021.645408

NeMO-Net: A Fun Game/App for Coral Reef Classification

- Available for iPhones, iPads, and Android systems
- Contains a field guide to help users identify benthic features or components, some of these to the taxonomic family level
- For 3D data, users are able to rotate the images 360° to help them fill in the blanks for hard-to-reach areas within the image.
- Uses several metrics to evaluate and filter users' classifications and measure users' agreeance



Credit: http://nemonet.info/

Summary

- Citizen science has become an important component of ocean/coastal/inland water body research.
- Projects like Floating Forests help researchers study the largest marine biome on Earth, the kelp forest, at unprecedented levels with the help of citizens.
- FjordPhyto engages tourists in oceanographic sampling of the southern seas and aids in the understanding of critical phytoplankton populations.
- Projects like LOCSS prove these citizen science activities can be done at national and international levels.
- Games like NeMO-Net are not only an educational tool capable of engaging citizens of all ages but also help collect data from remote areas where coral reefs provide critical ecosystem services.

Contacts

- Trainers:
  - Juan L. Torres-Pérez: juan.l.torresperez@nasa.gov
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  - Britnay Beaudry: britnay.beaudry@nasa.gov

- Training Webpage: https://appliedsciences.nasa.gov/join-mission/training/english/arset-connecting-citizen-science-remote-sensing

- ARSET Webpage: https://appliedsciences.nasa.gov/what-we-do/capacity-building/arset

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