2020 Virginia HABs: Estuarine monitoring summary

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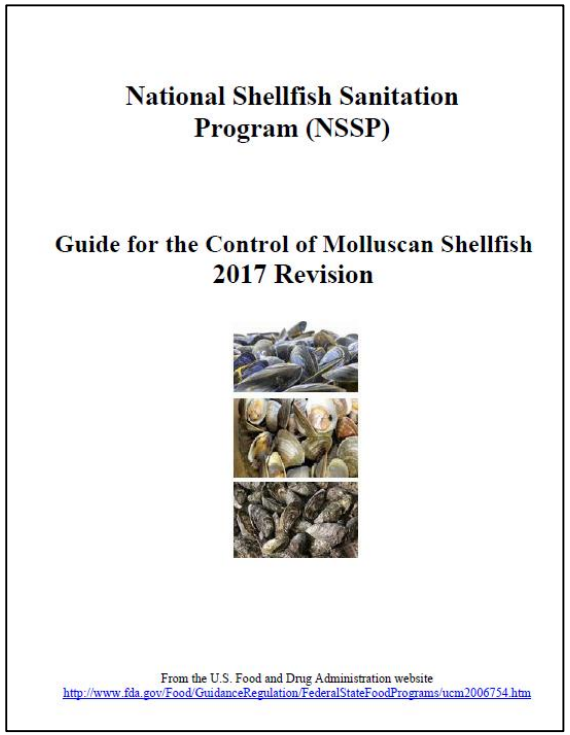
VA HAB Taskforce Meeting
Gloucester Point, Virginia
1/15/2021

Overview

- Bloom response - ODU
- Notable 2020 blooms
- Monitoring results summary
- Related projects –transport, IFCB
- 2021

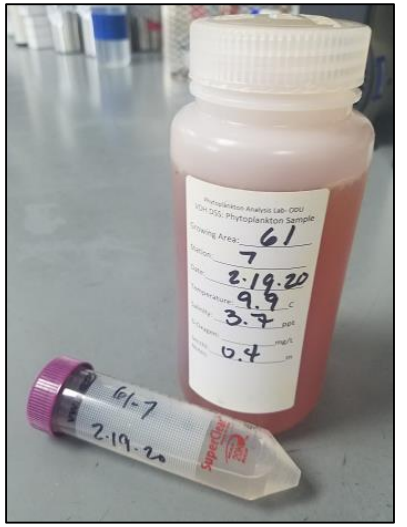
VDH Shellfish monitoring

- Monthly collections- routine fixed sites
  - Lugol's solution (500mL) – phytoplankton analyses (ODU)
  - Unpreserved frozen sample (50mL)- ELISA screening (VDH)
- Bloom samples
  - Response to bloom reports or visual observation by field staff
  - VDH, CBP, HRSD, Time series site

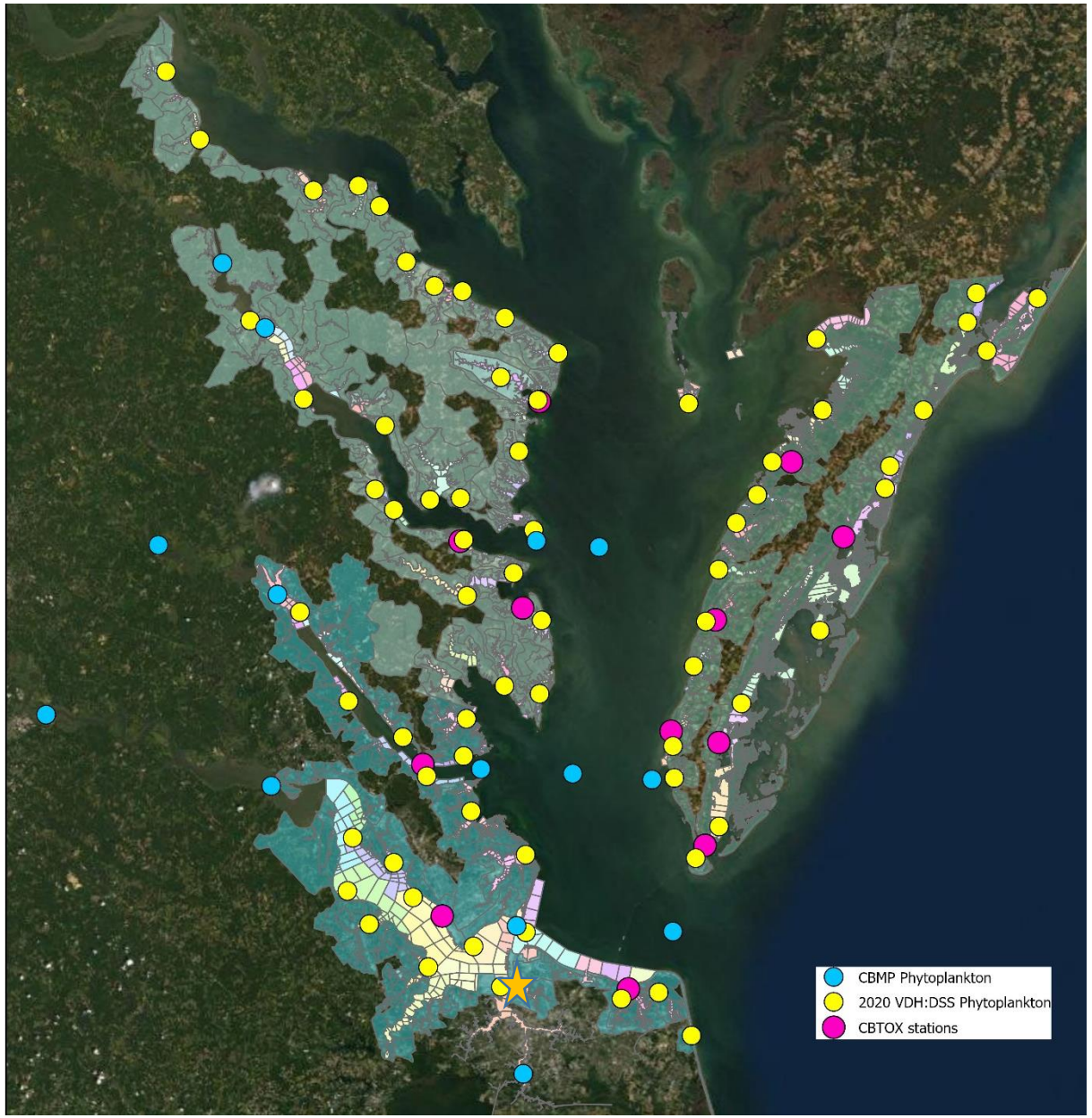

National Shellfish Sanitation Program (NSSP)

Guide for the Control of Molluscan Shellfish 2017 Revision

From the U.S. Food and Drug Administration website
http://www.fda.gov/Food/GuidanceRegulation/FederalStateFoodPrograms/ucm2006754.htm



Phyto Kit: Extra bottles, vials, lugol's, rubber gloves, marker



Virginia Estuarine Phytoplankton monitoring

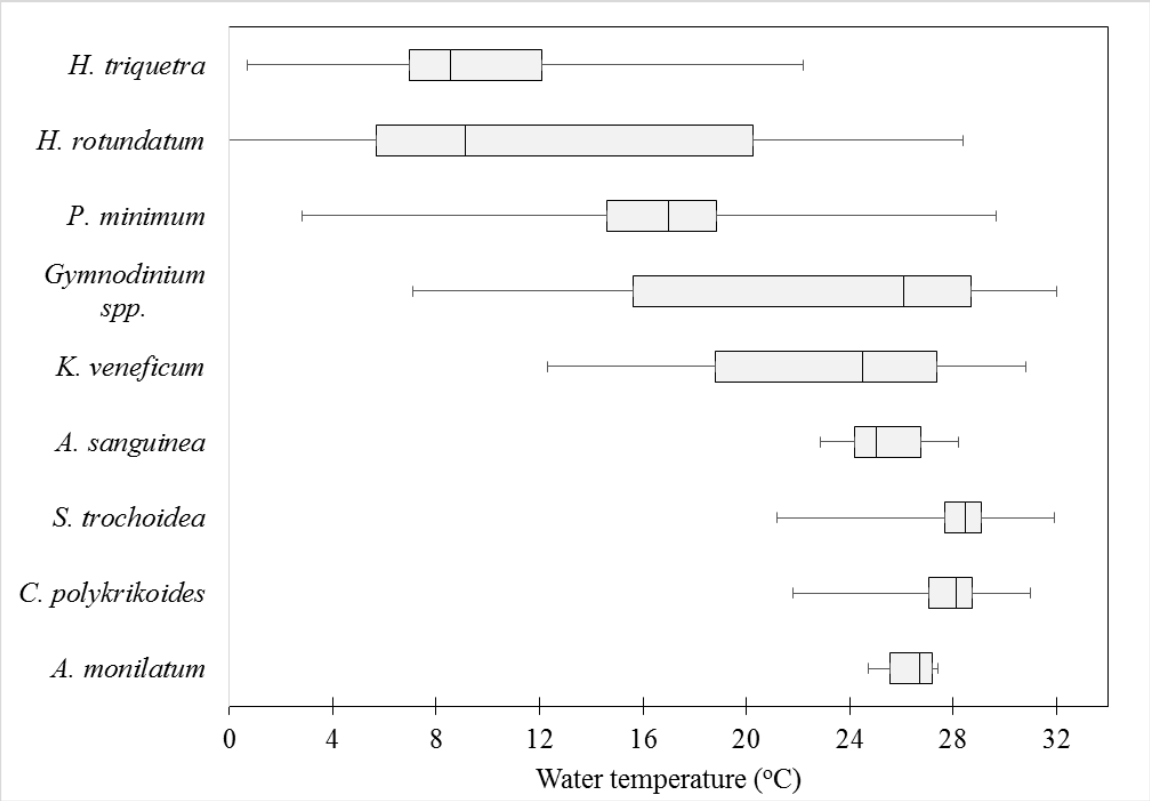
- Chesapeake Bay Monitoring Program (DEQ/ODU)
  - 14 stations
    - 7-Chesapeake Bay monthly year-round
    - 7-Tidal tributaries monthly March-October
  - Full species composition
  - Ad hoc bloom sampling
- VDH: Shellfish (DSS&WHC/ODU)
  - 69 stations
  - Monthly year-round
  - Targeted HAB identification
  - Targeted toxin screening (based on cell counts)
- CBTOX (VDH:DSS/VIMS)
  - 12 stations (2017-2018)
  - 4 stations (2019-2020)
  - Bi-weekly sampling
  - Targeted HAB identification
  - Routine toxin analyses

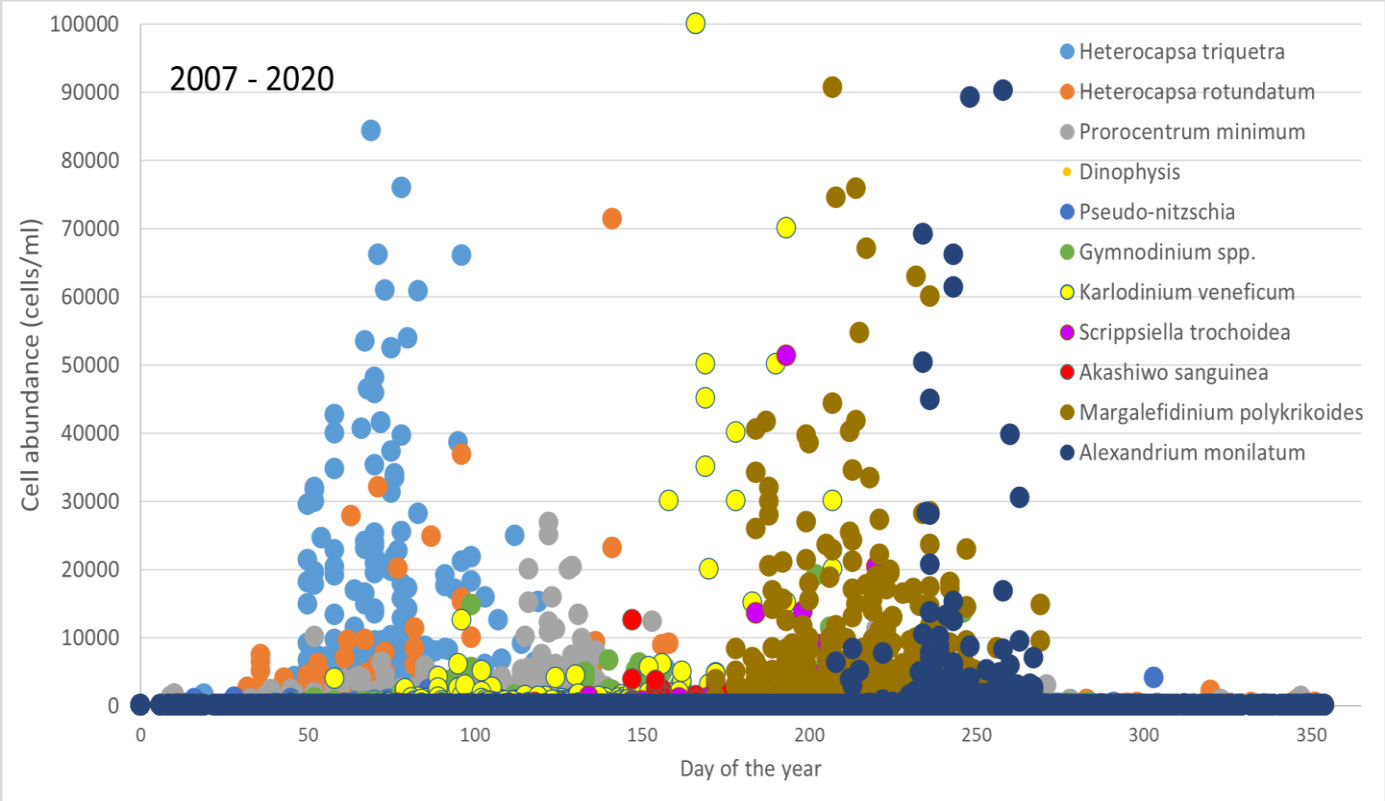
Additional monitoring: ODU, HRSD, ECOHAB Dataflow HRSD (no bloom samples in 2020)

COVID gaps

- No samples from HRSD dataflow from James River so didn’t have the data density of previous years
- No CBP sampling March-April; no trib sampling March-June
- No VDH sampling mid-March – mid-May
- Did do near-daily sampling in the Elizabeth and Lafayette Rivers throughout the year and were able to document *Heterocapsa* bloom there via IFCB
- Still need to count time series data from Lafayette River

“Normal” bloom progression



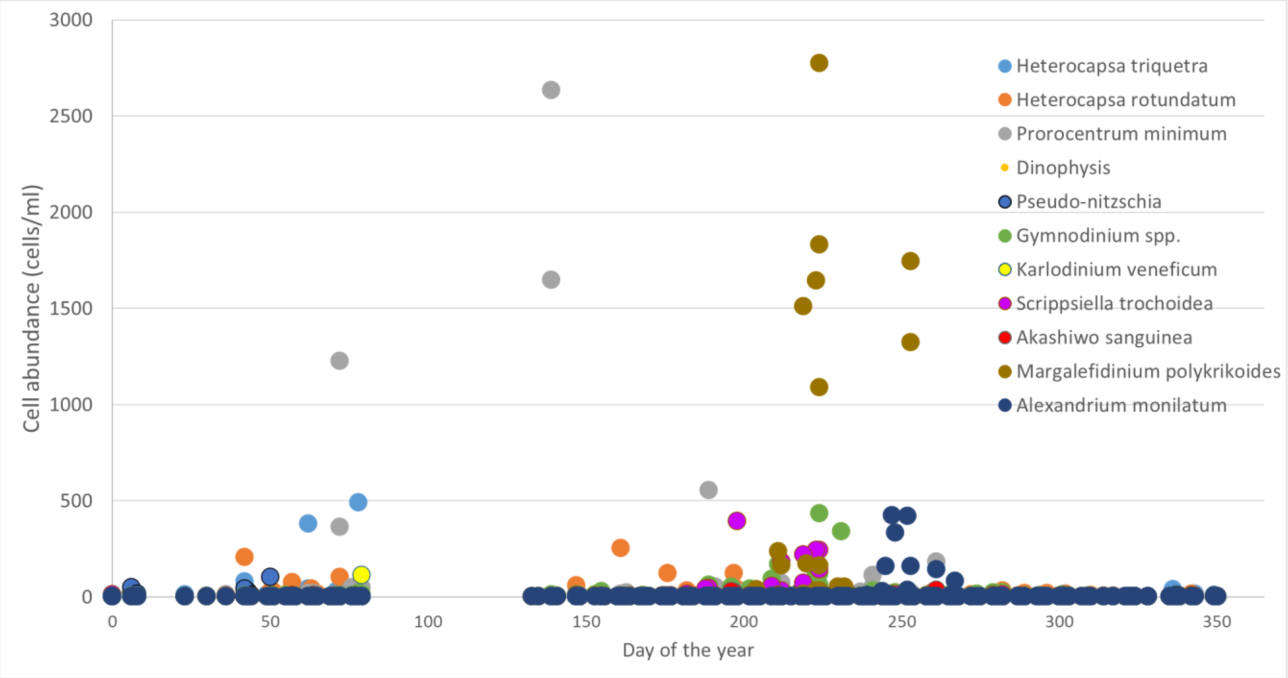


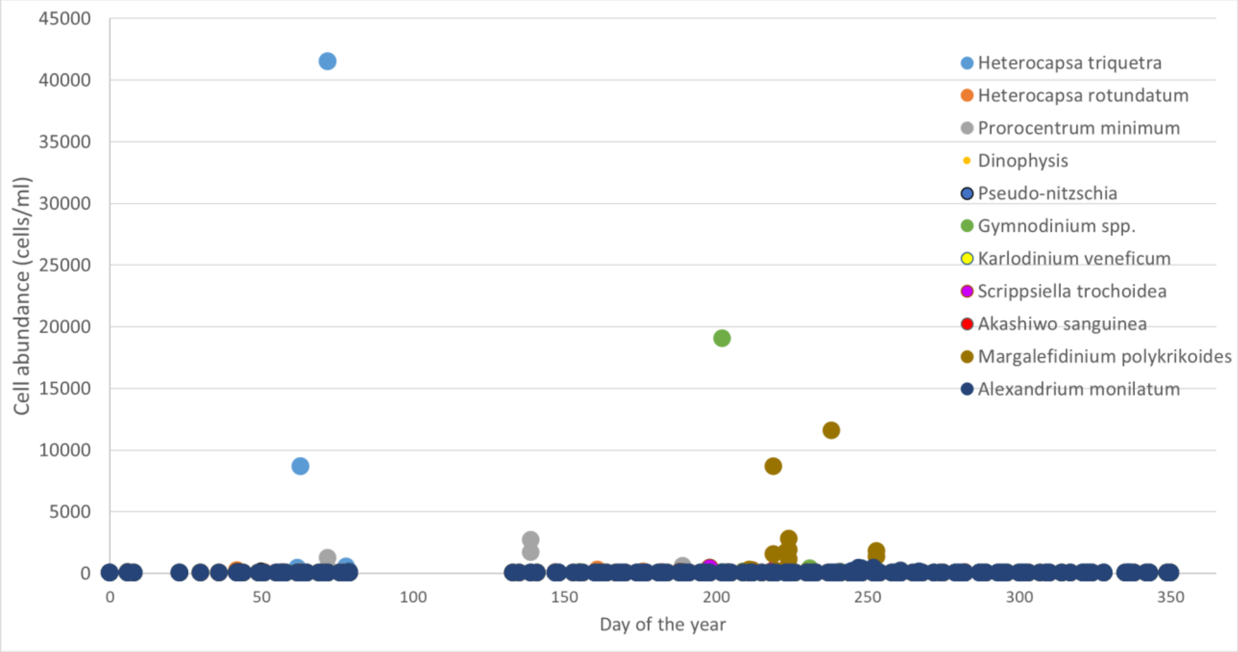
*_Pseudo-nitzschia_* and _Dinophysis_ not abundant enough to make the list

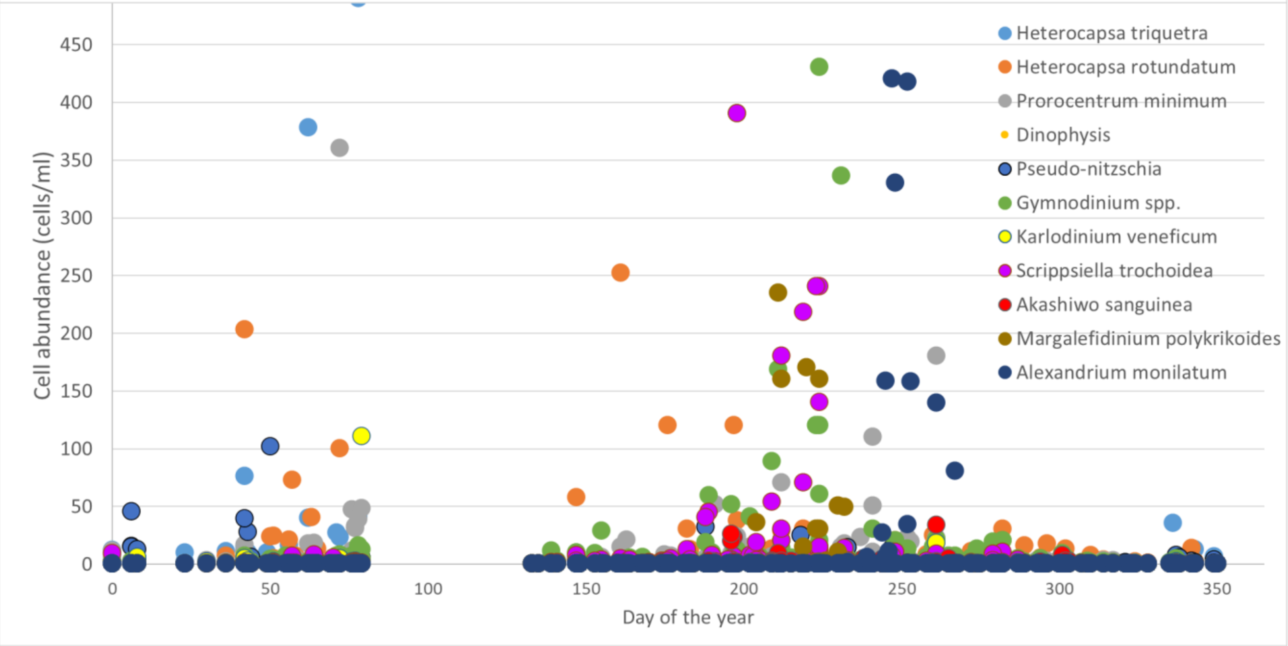
*Removed data where abundances were > 100,000 cells/ml

Notable 2020 Blooms:

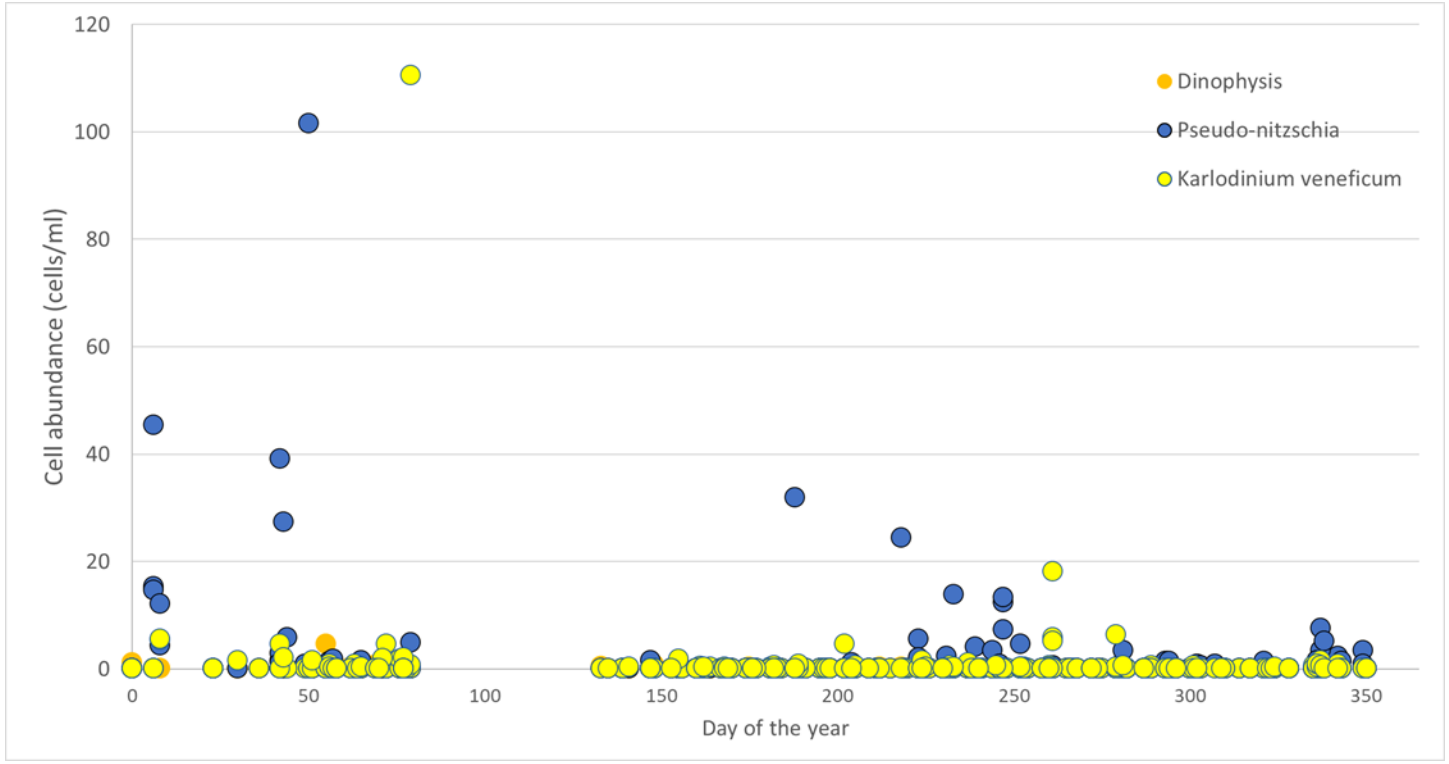
Heterocapsa triquetra (January -March)
Prorocentrum minimum (March – May)
Margalefidinium polykrikoides (July – August)
Alexandrium monilatum (August – September)
But had the full complement of species.



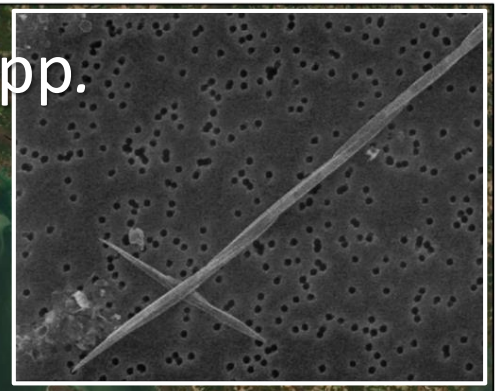




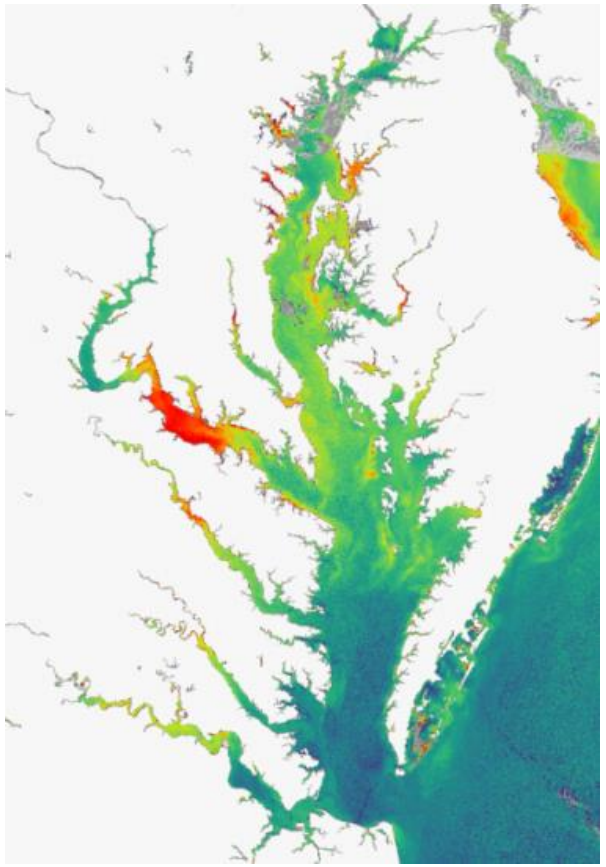
Our less abundant HAB species in 2020



Pseudo-nitzschia spp.



- January 2020 Potomac *Pseudo-nitzschia* event
  - Mixed diatom bloom-*Skeletonema* dominant

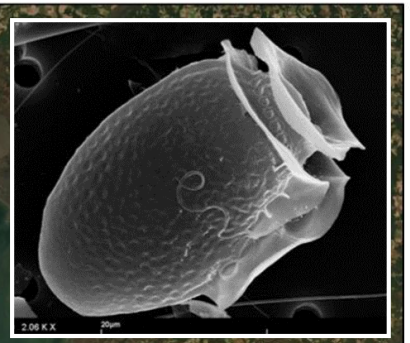


OAA: MODIS-Sentinel imagery-1/1/2020

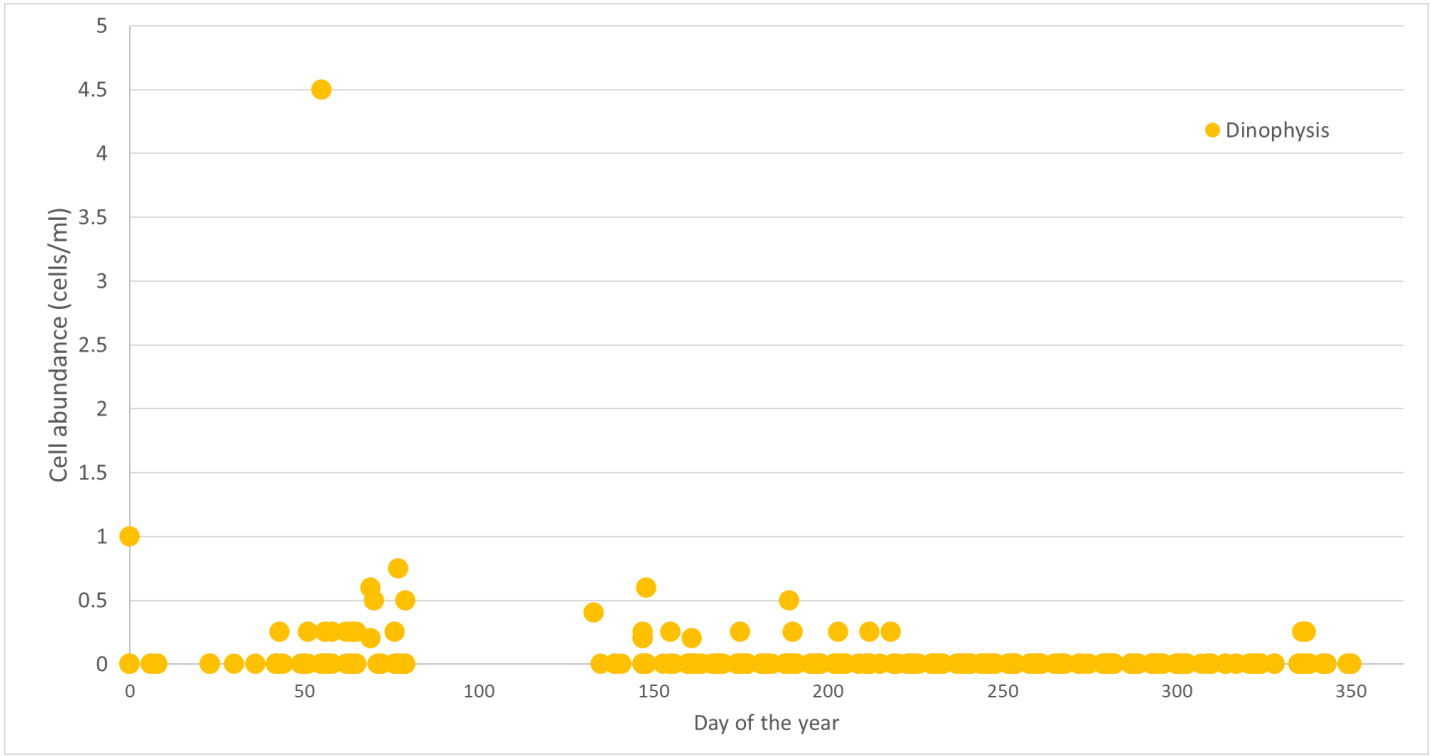
- MD DNR/MDE results ~800- >1000 cells/ml
- Special sample collections DSS: January 6, 2020
- *Pseudo-nitzschia* densities 52-73 cells/ml
- Toxin BDL

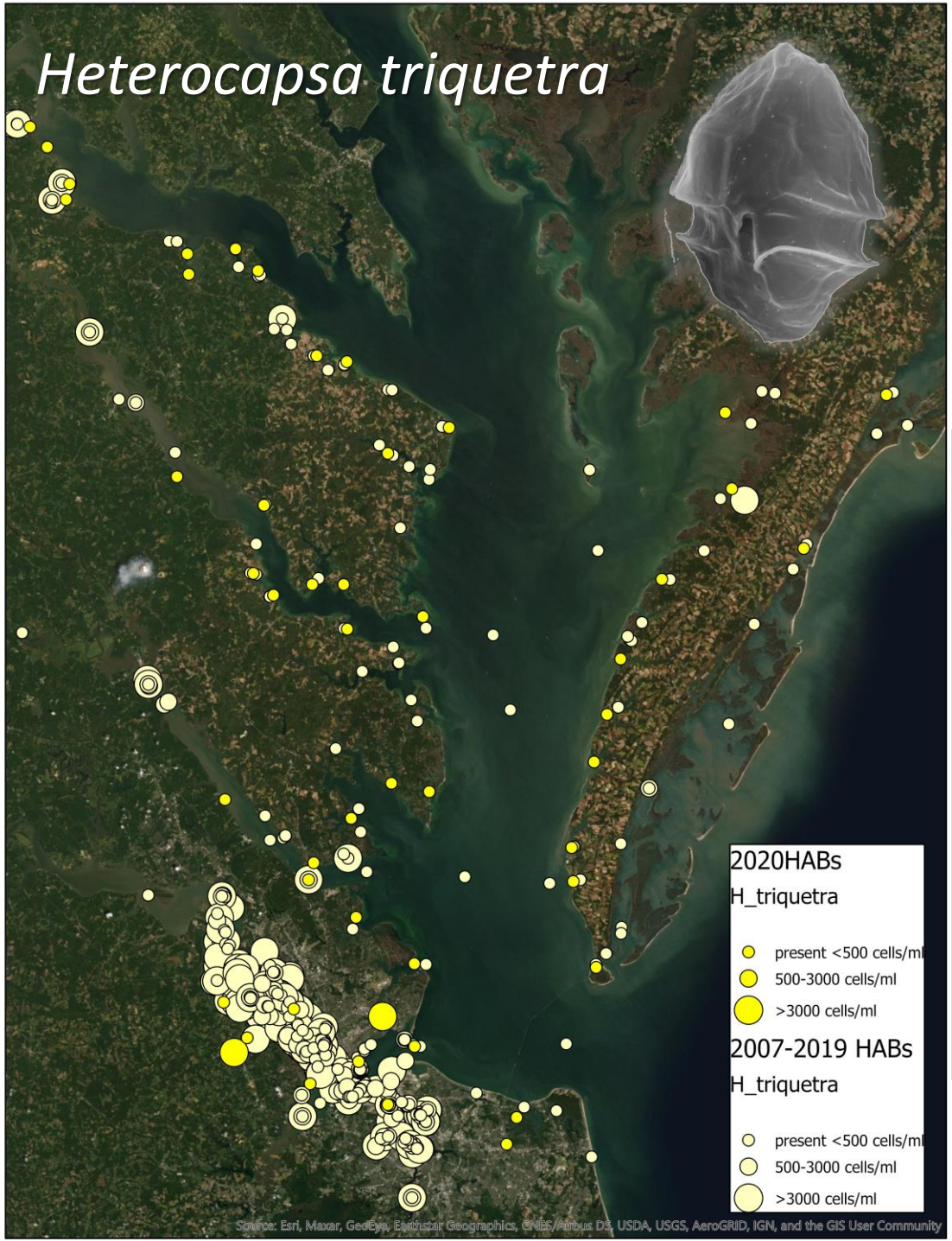
- Generally low cell densities
- Widespread distribution in Chesapeake Bay and seaside Eastern Shore

Dinophysis spp.

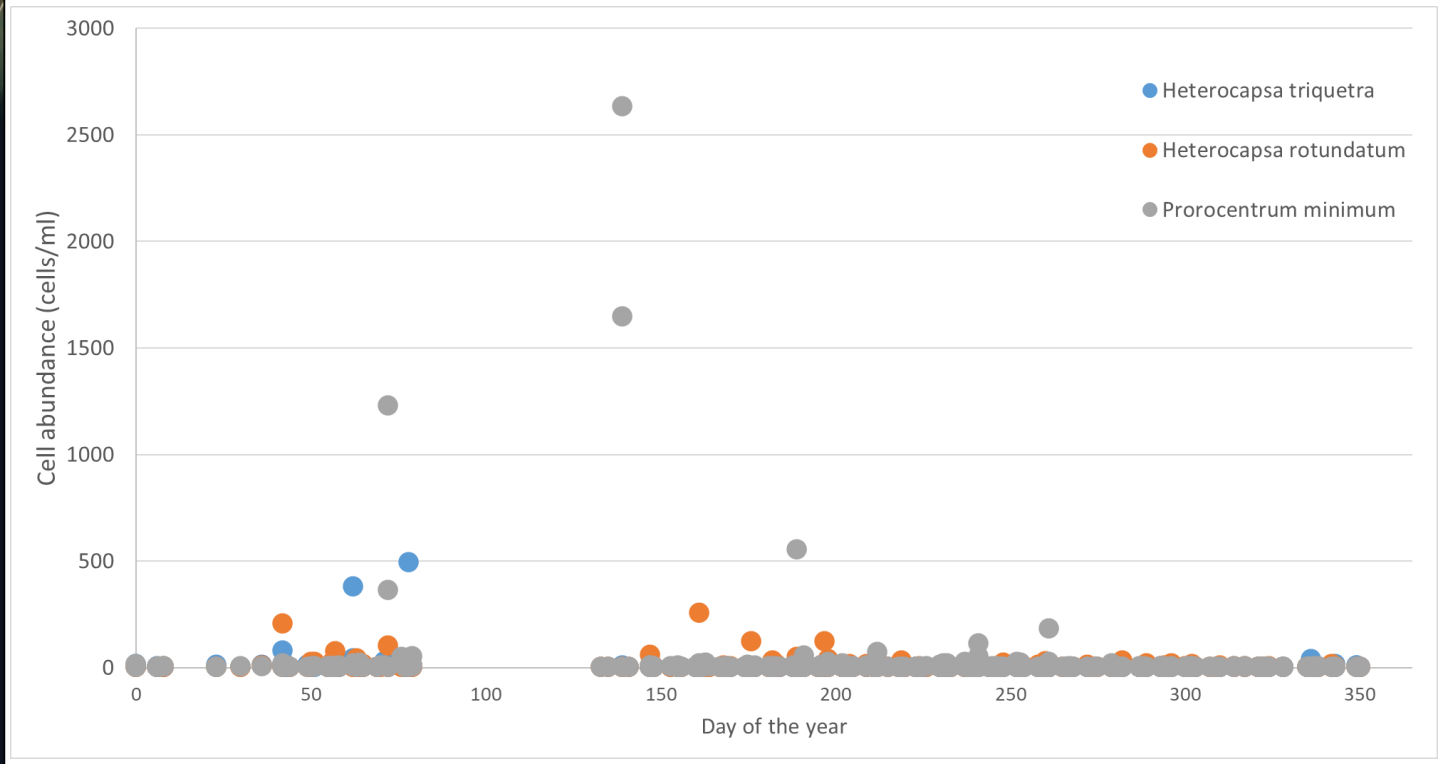


- Generally low cell densities
- Widespread distribution in Chesapeake Bay and seaside Eastern Shore

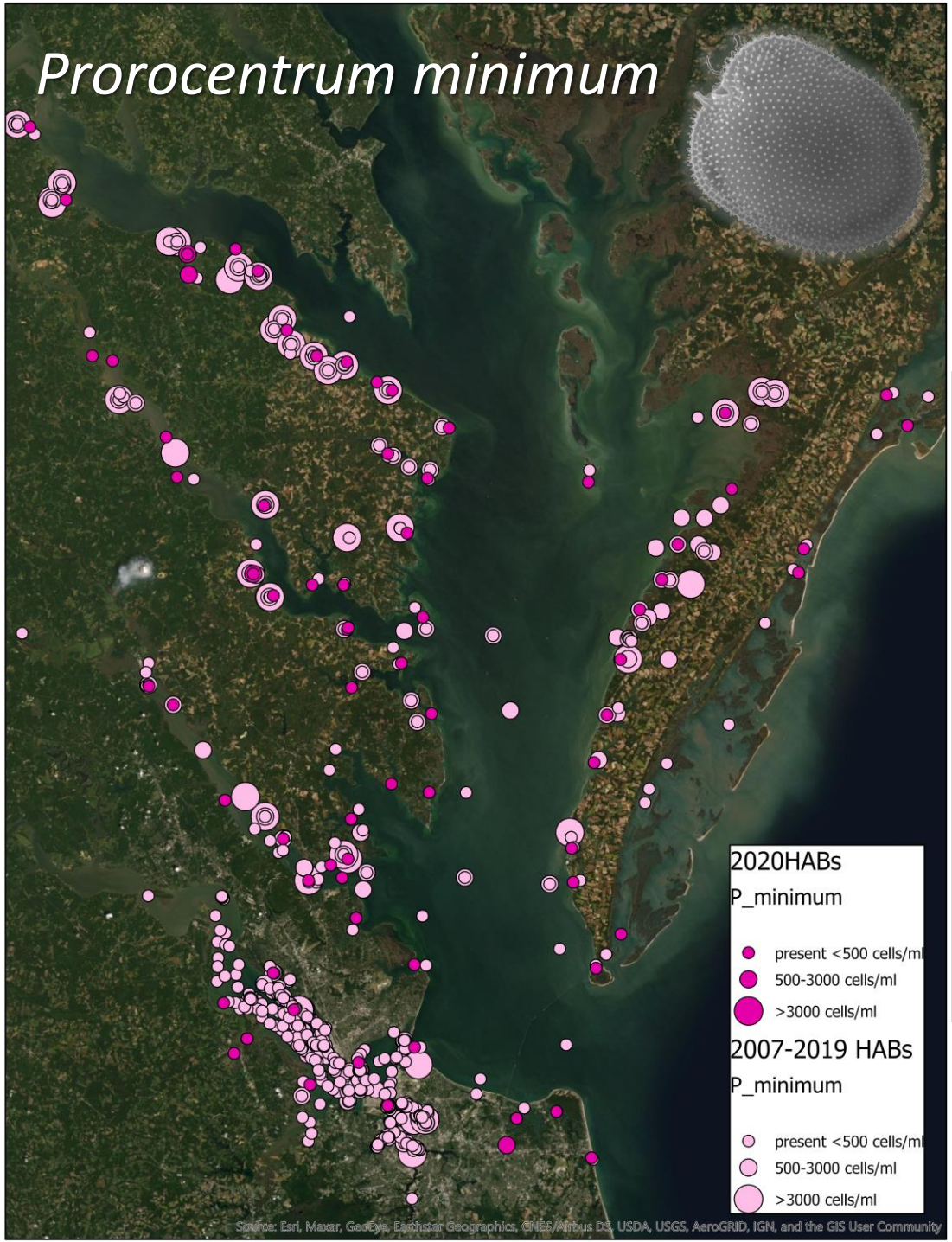




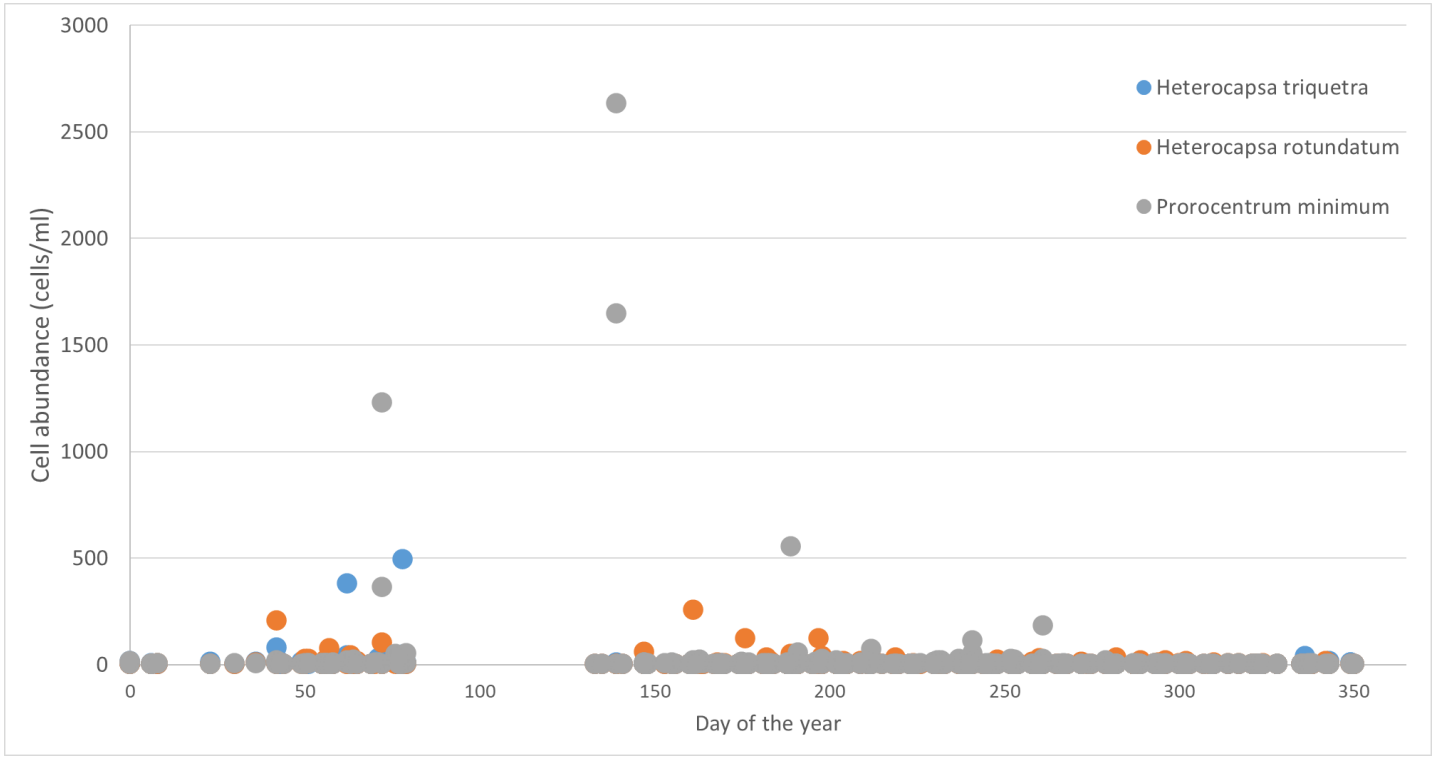
Bloom January - March



*Removed two *H. triquetra* values > 3000 cells/ml



Bloom March – May
(under-sampled due to COVID)



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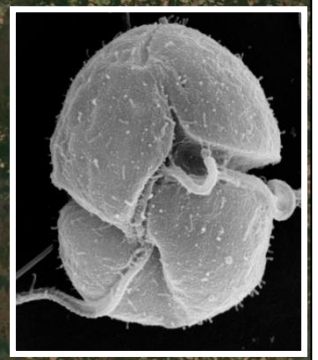
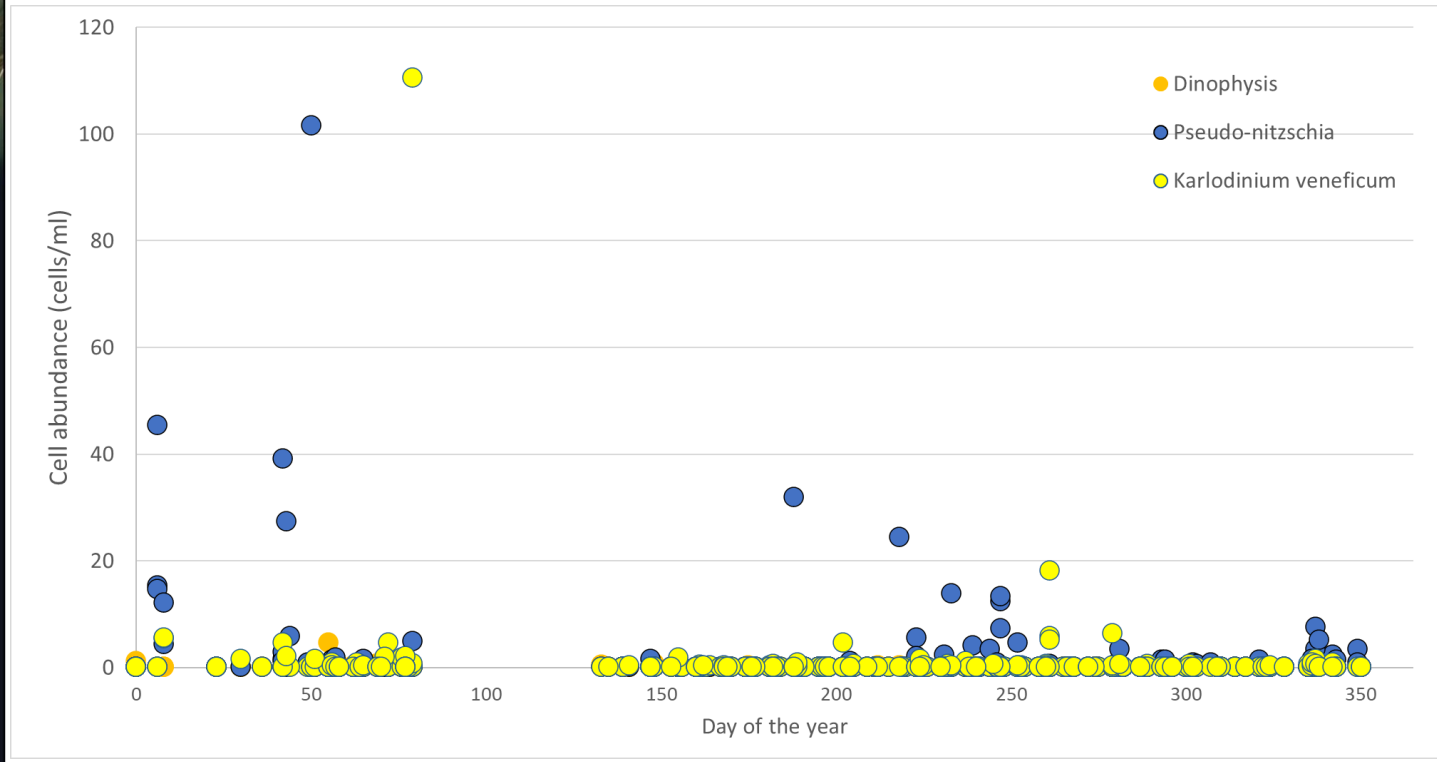
Karlodinium veneficum

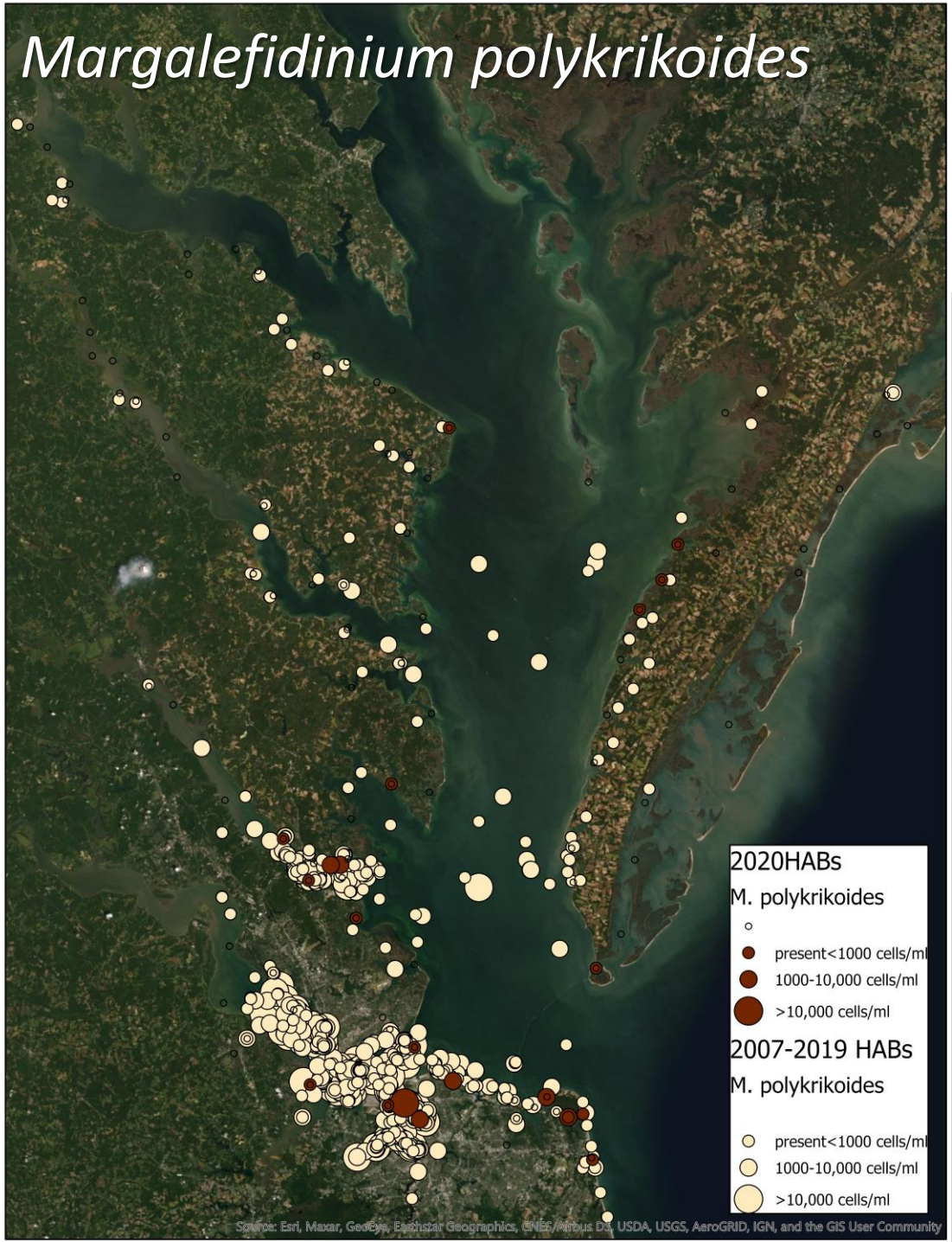


2020HABs
K_veneficum
present <500 cells/ml
500-3000 cells/ml
>3000 cells/ml
2007-2019 HABs
K_veneficum
present <500 cells/ml
500-3000 cells/ml
>3000 cells/ml

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

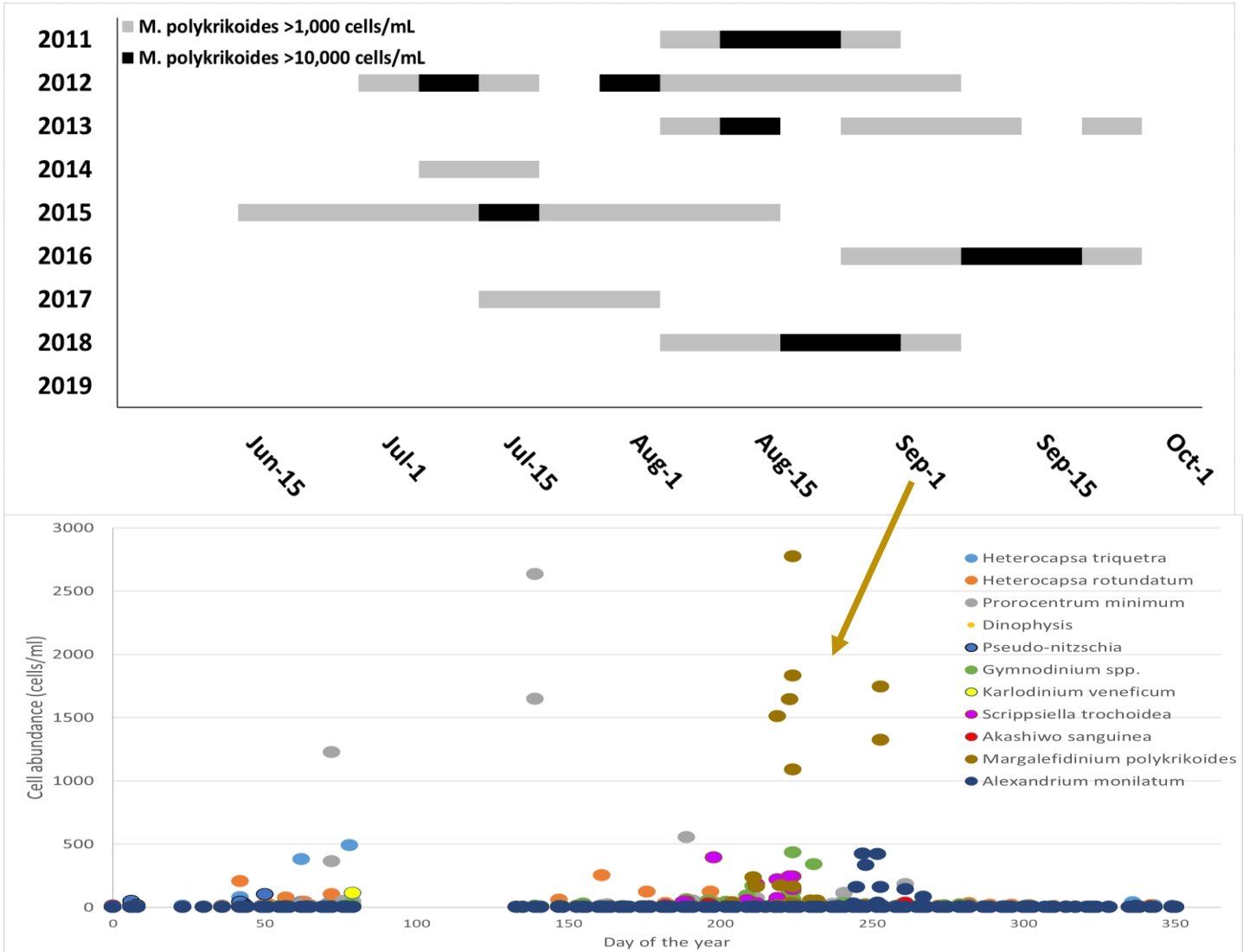
Low abundances but there was a gap in sampling due to COVID



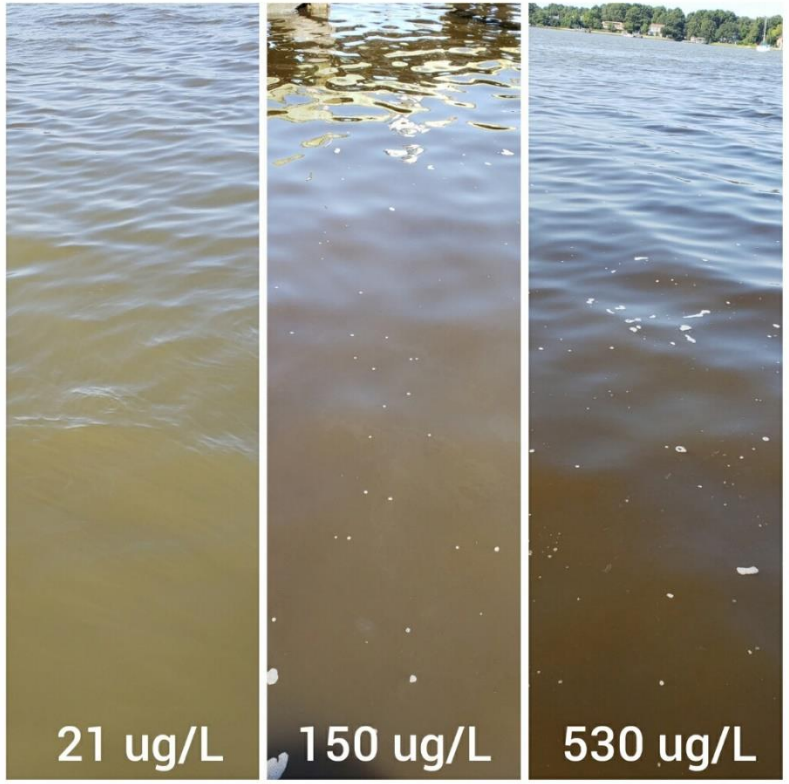


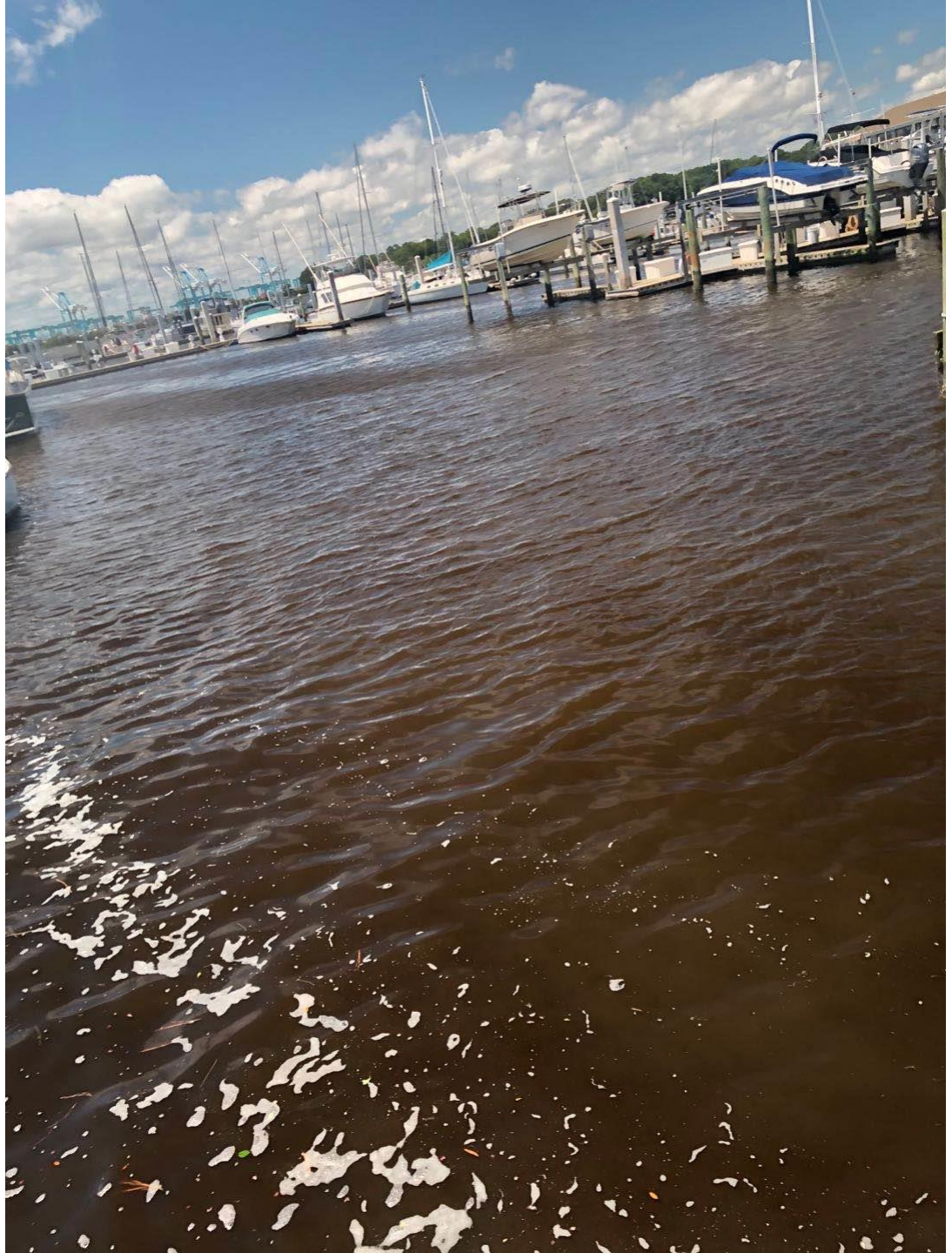
Margalefidinium polykrikoides

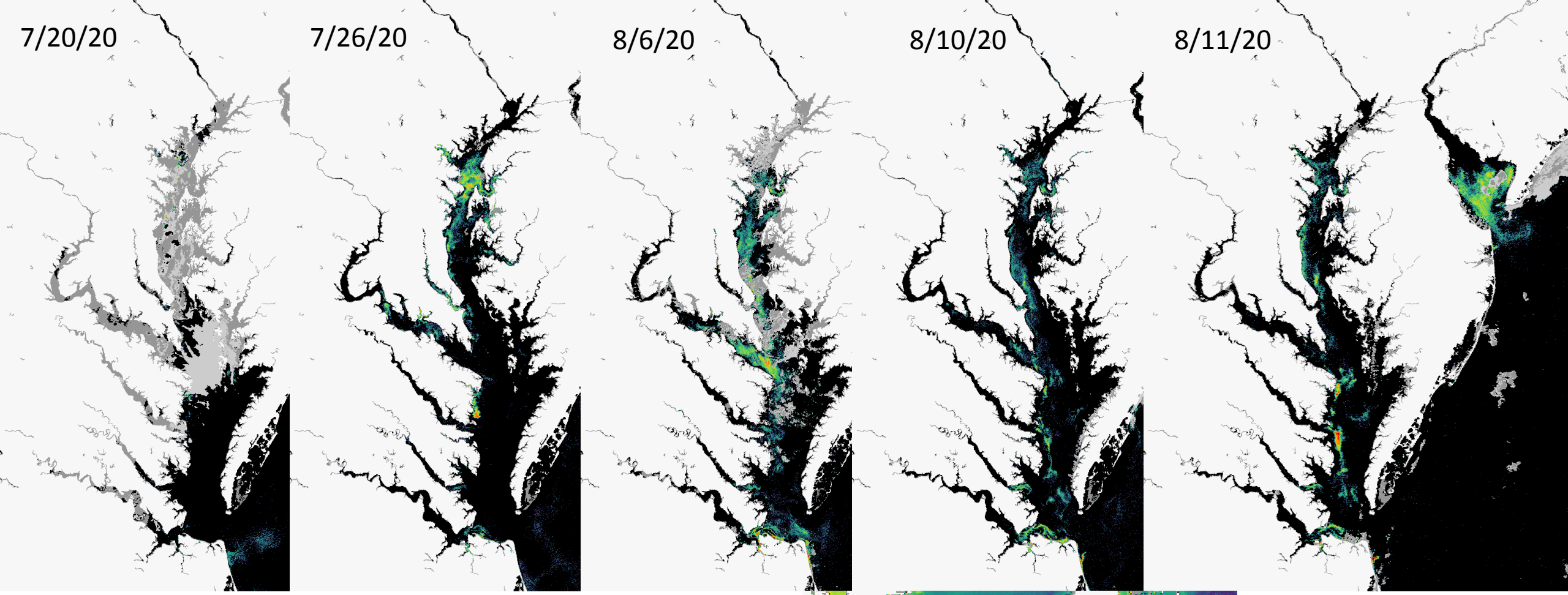
- Massive 2020 bloom – still counting time series samples
- Initiated in Lafayette River July 20, 2020 & reached oceanfront a week later
- Blooms in most of the last 15 – 20 years (not in 2019).



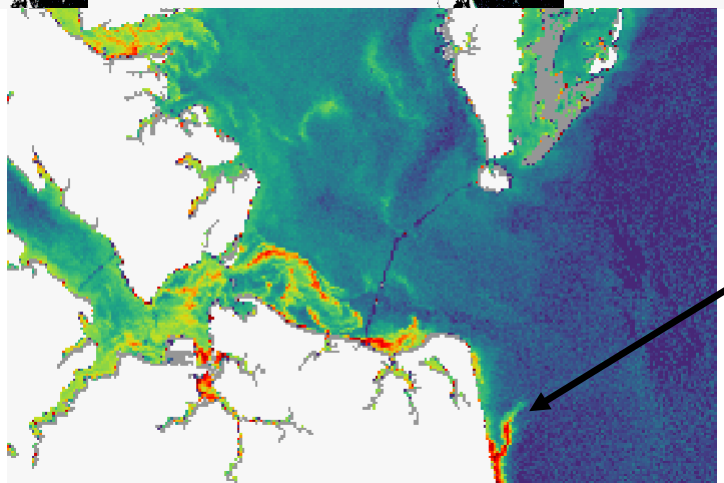
Chlorophyll concentrations in excess of 500 ug/L observed during the day.





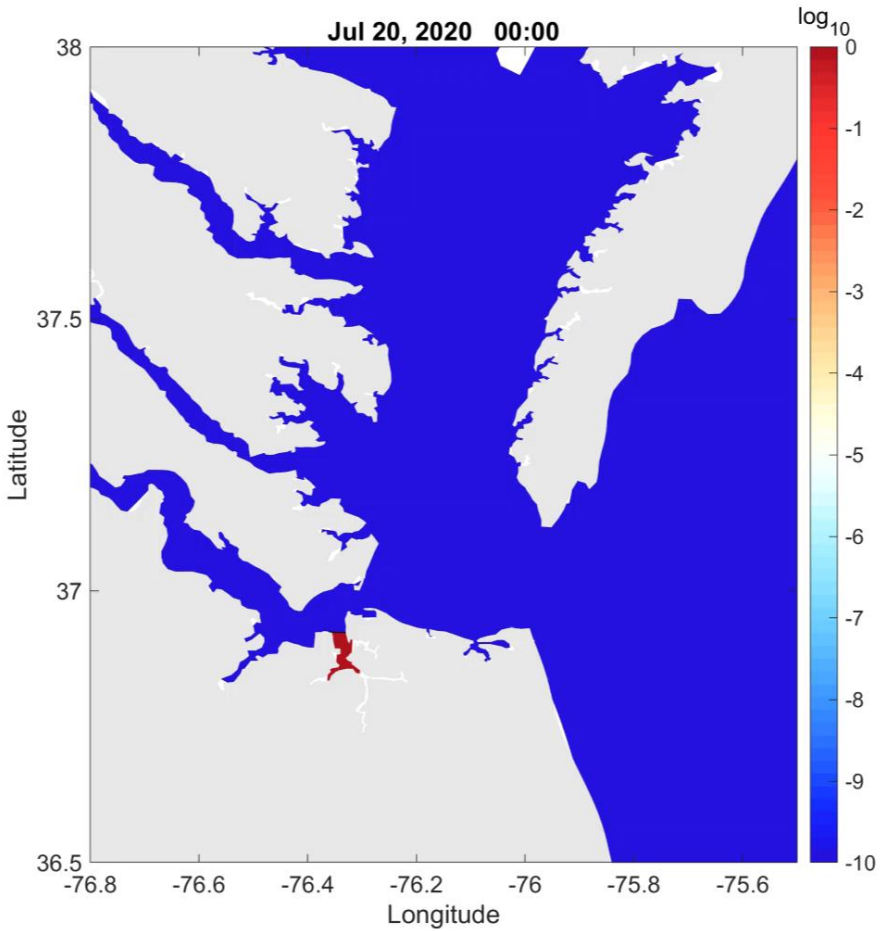


NOAA products (Shelly will tell you more this afternoon)



Observed at ocean front down to NC

2020 Transport – collaboration with Qin & Shen



Dye study

Used calibrated and verified EFDC model for the Ches Bay (Hong & Shen 2012; Du & Shen 2017) and set up model for 2020 using wind data from NOAA, tidal elevation data from 3 station and river discharge data from USGS.

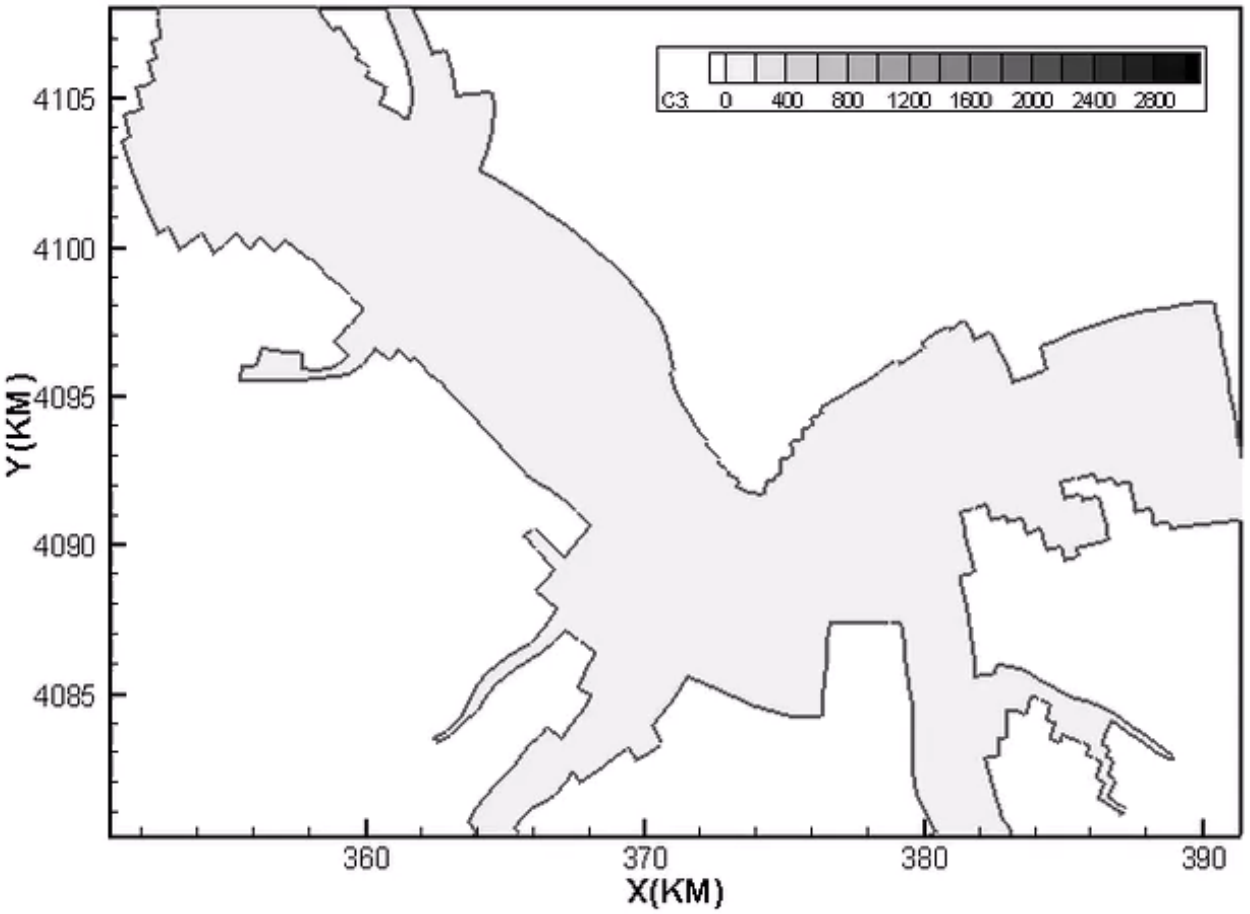
Dye predominantly travelled toward oceanfront, some propagated up Bay.

Big storm on August 4, 2020 which seemed to help transport the bloom.

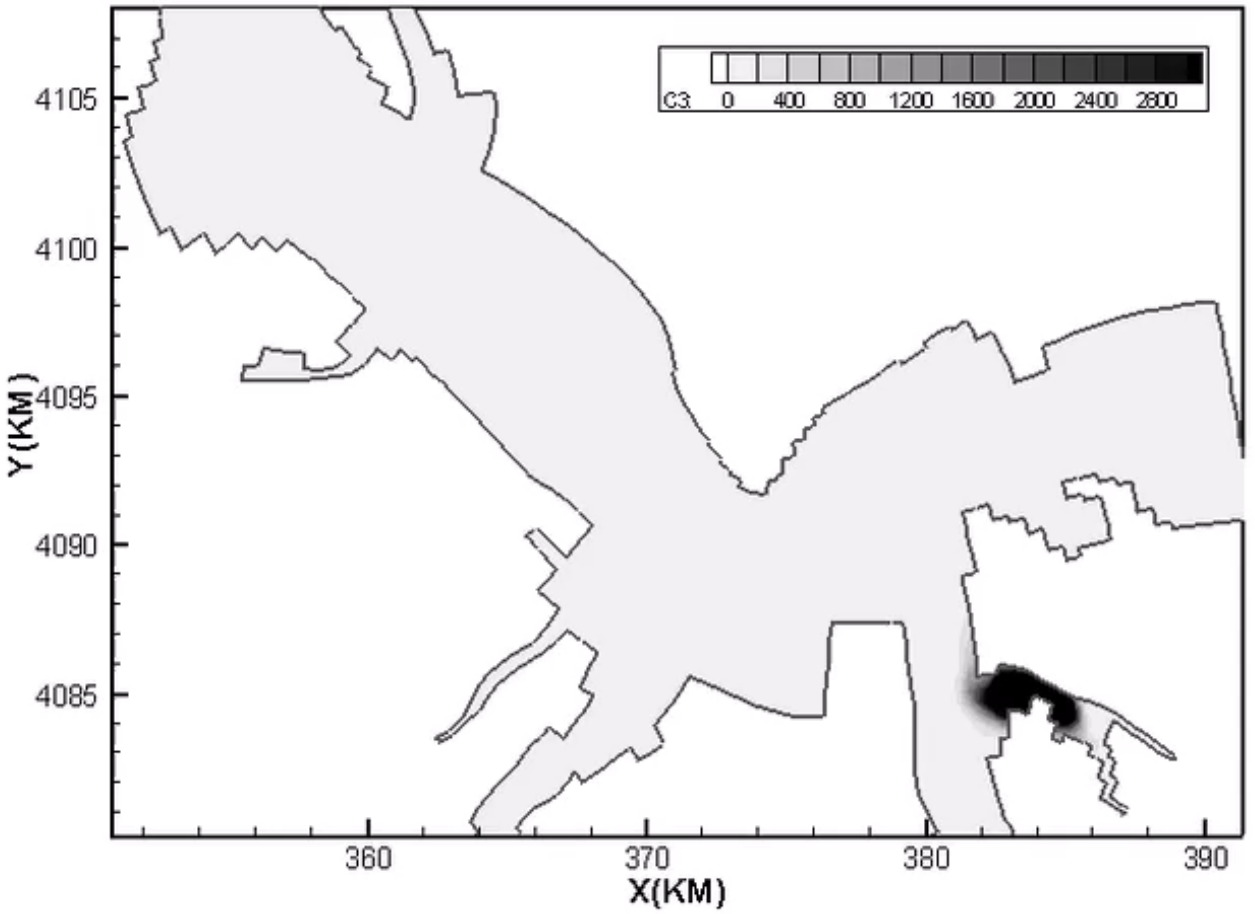
But bloom persisted.

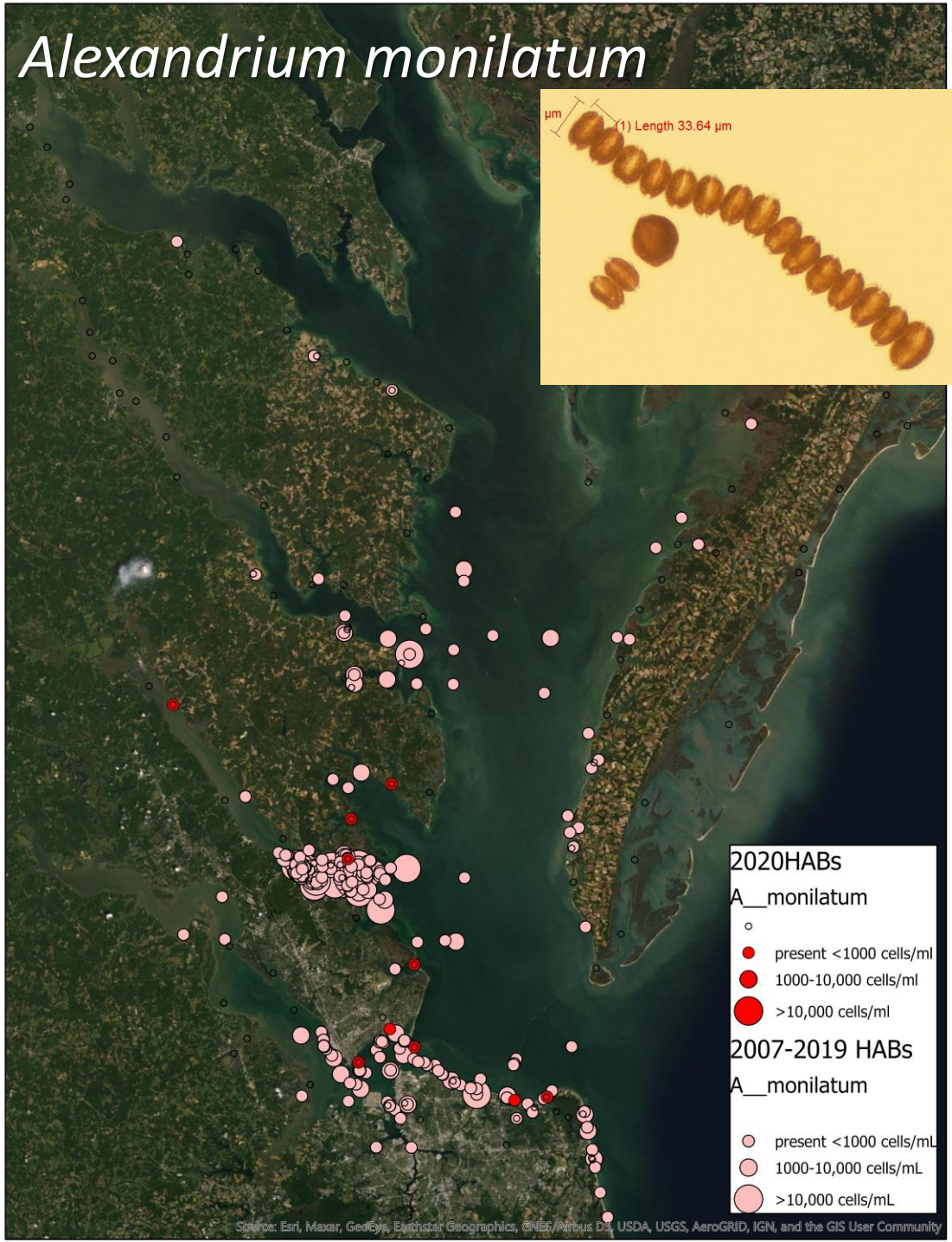
2007 & 2008 Transport

ER Initiation 2007



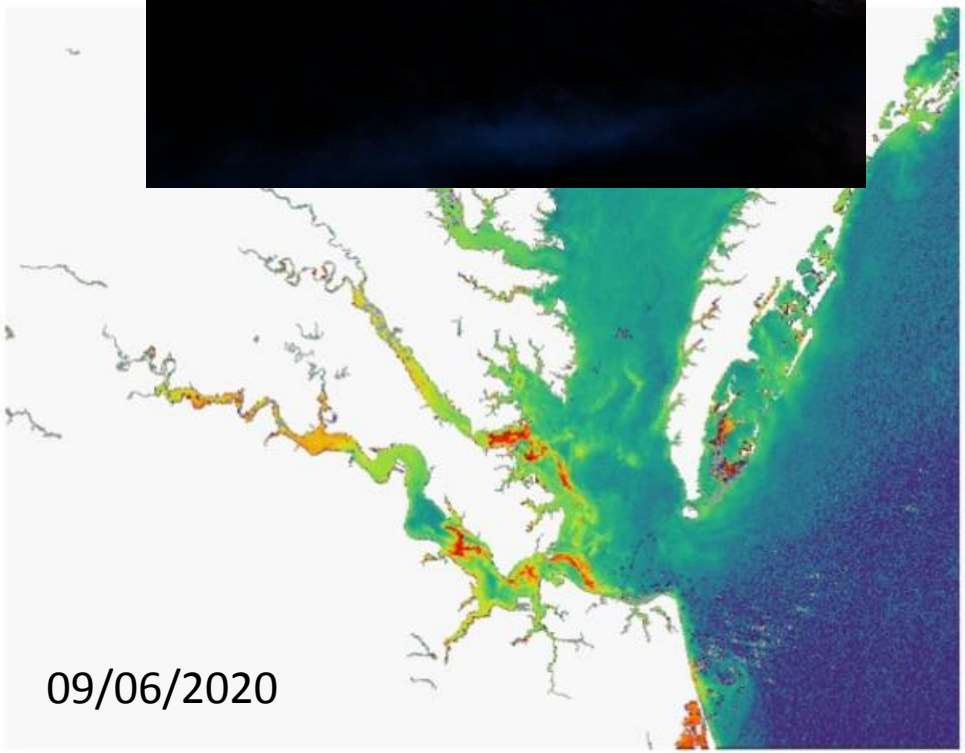
Laf Initiation 2008





Alexandrium monilatum – massive 2020 bloom

- *Alexandrium* – no bloom in 2018 or 2019
- Started in the York River and transported to Ocean View and ocean front

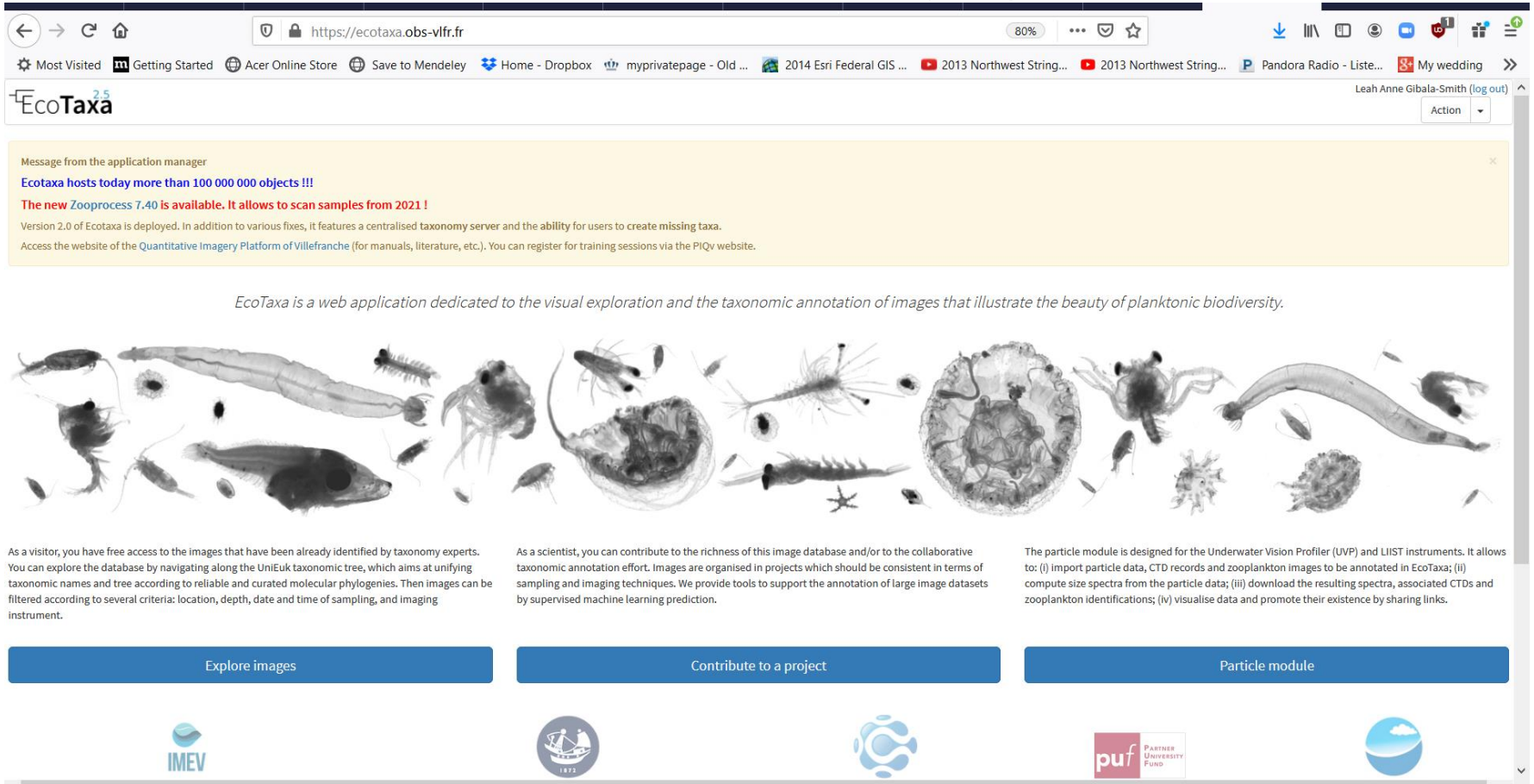


New opportunity in 2020 – what we started during COVID

IFCB & EcoTaxa

- Imaging flow cytobot (IFCB) images everything, even detritus, in a 5 mL sample (this was just what we fed it)
- Sophie Clayton loads images into EcoTaxa
- Leah and Kathryn (plus 2 undergraduate students) identify taxa and “train” software to identify taxa.

EcoTaxa homepage



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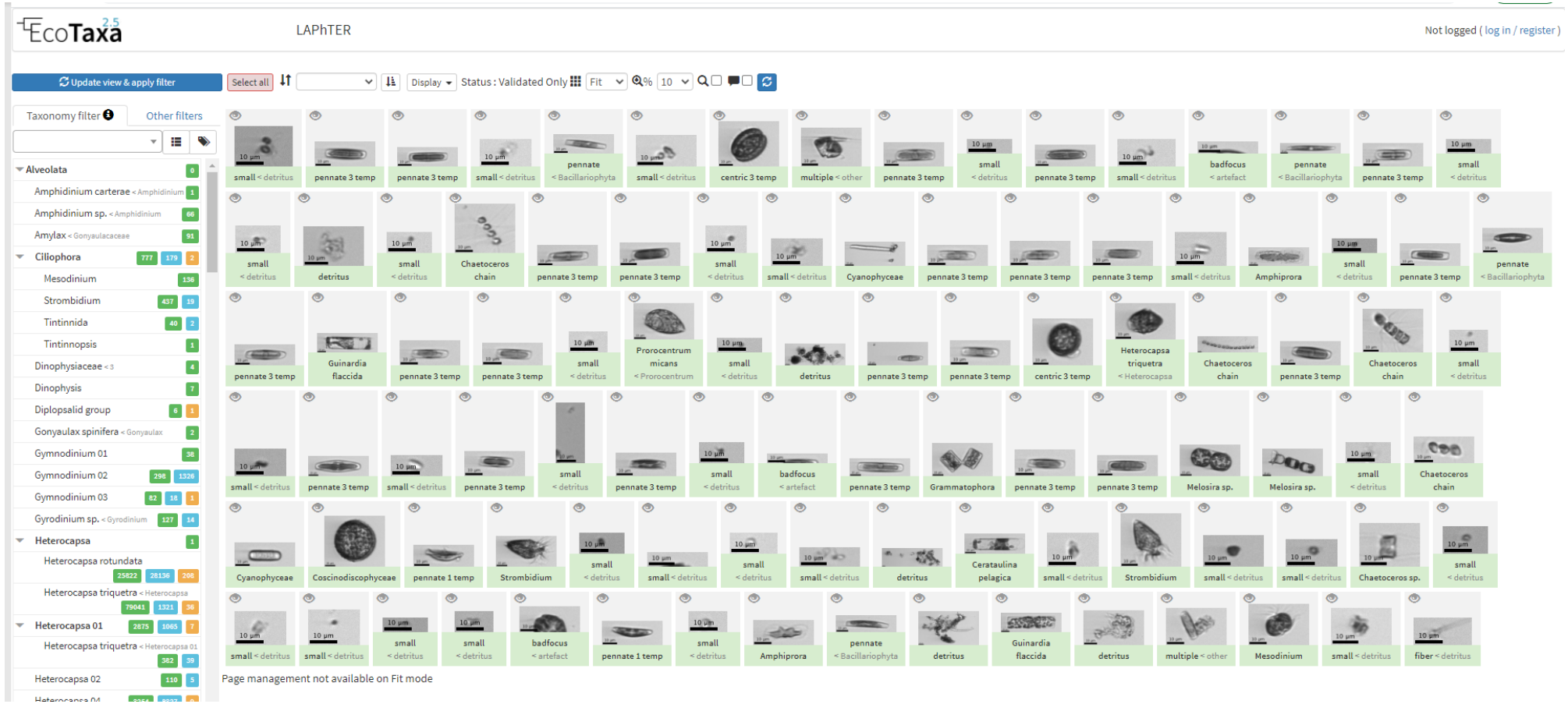
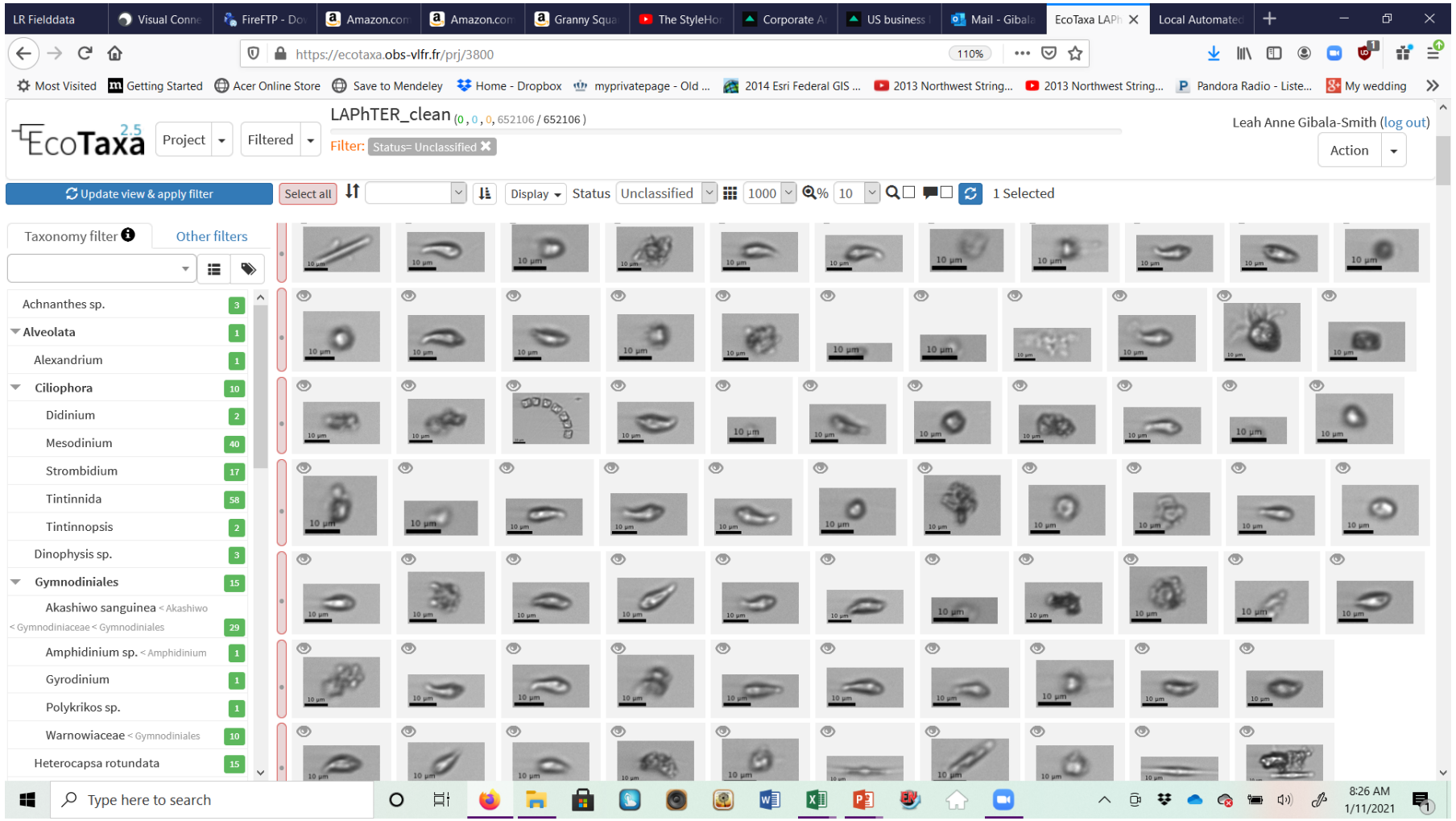
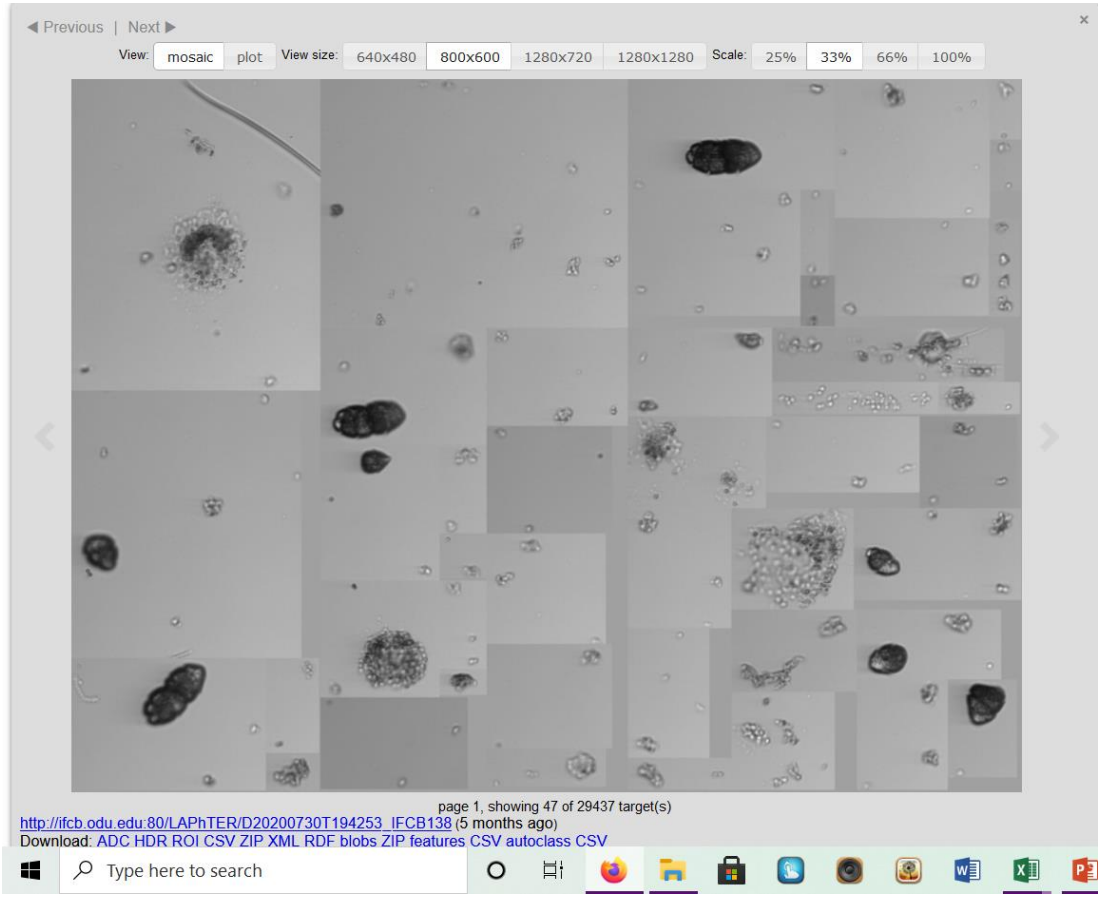


This is an unclassified upload of images from IFCB into ECOTAXA project ready for sorting and validating



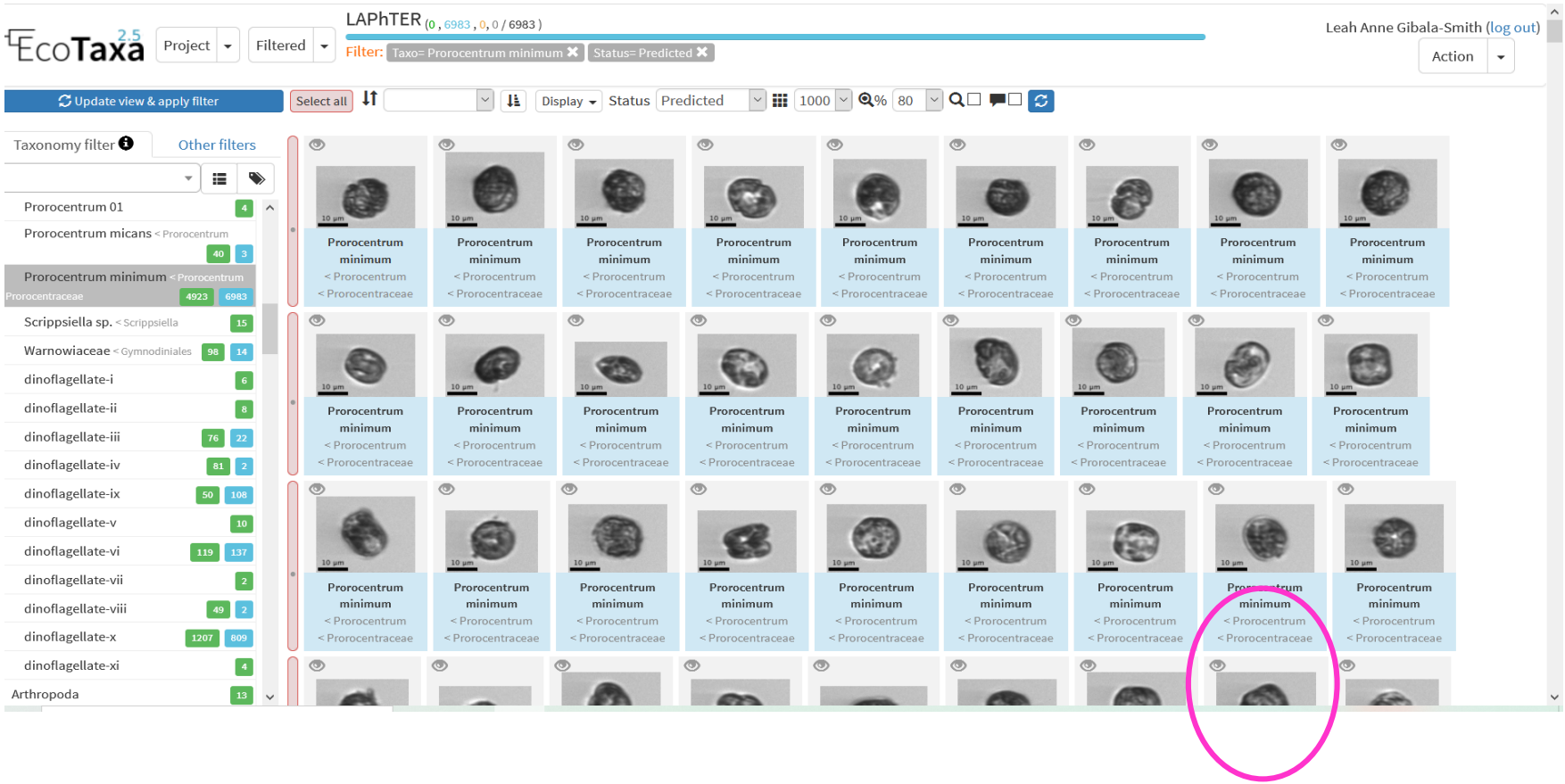
Steps in procedure

1. Upload images and metadata from IFCB into EcoTaxa
2. Manually classify organisms – requires creation of new categories within taxonomic tree
3. Run predictive model on unclassified images to group them into taxa categories
4. Clean predictions by manually validating a portion of the correctly sorted cells and and moving incorrectly sorted cells into their correct taxonomic group
5. Run prediction on unvalidated sorted cells and manually validate/correct a portion of them
6. REPEAT

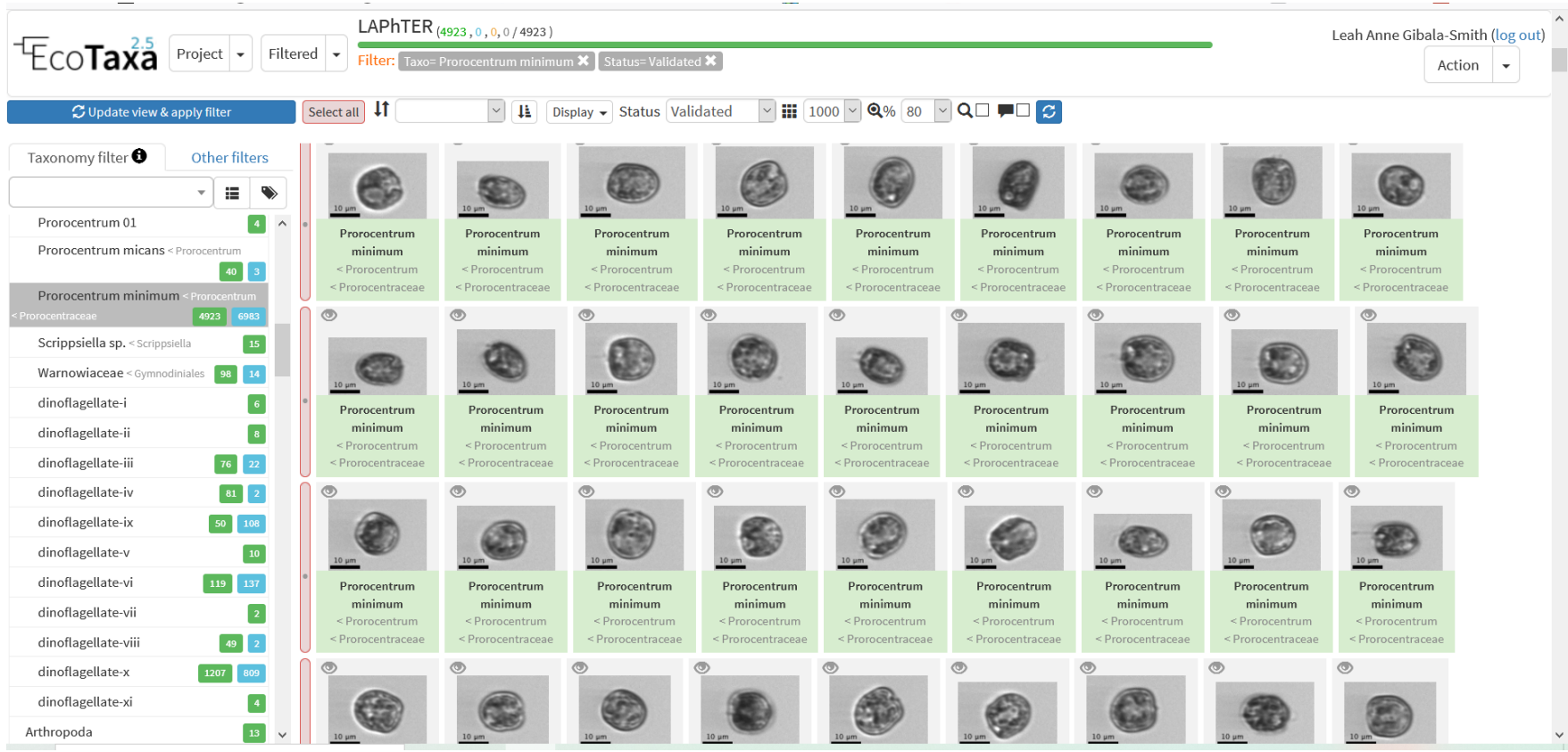


Garbage vs cells!!!

Prediction run – Only 1 cell predicted is a *P. minimum*



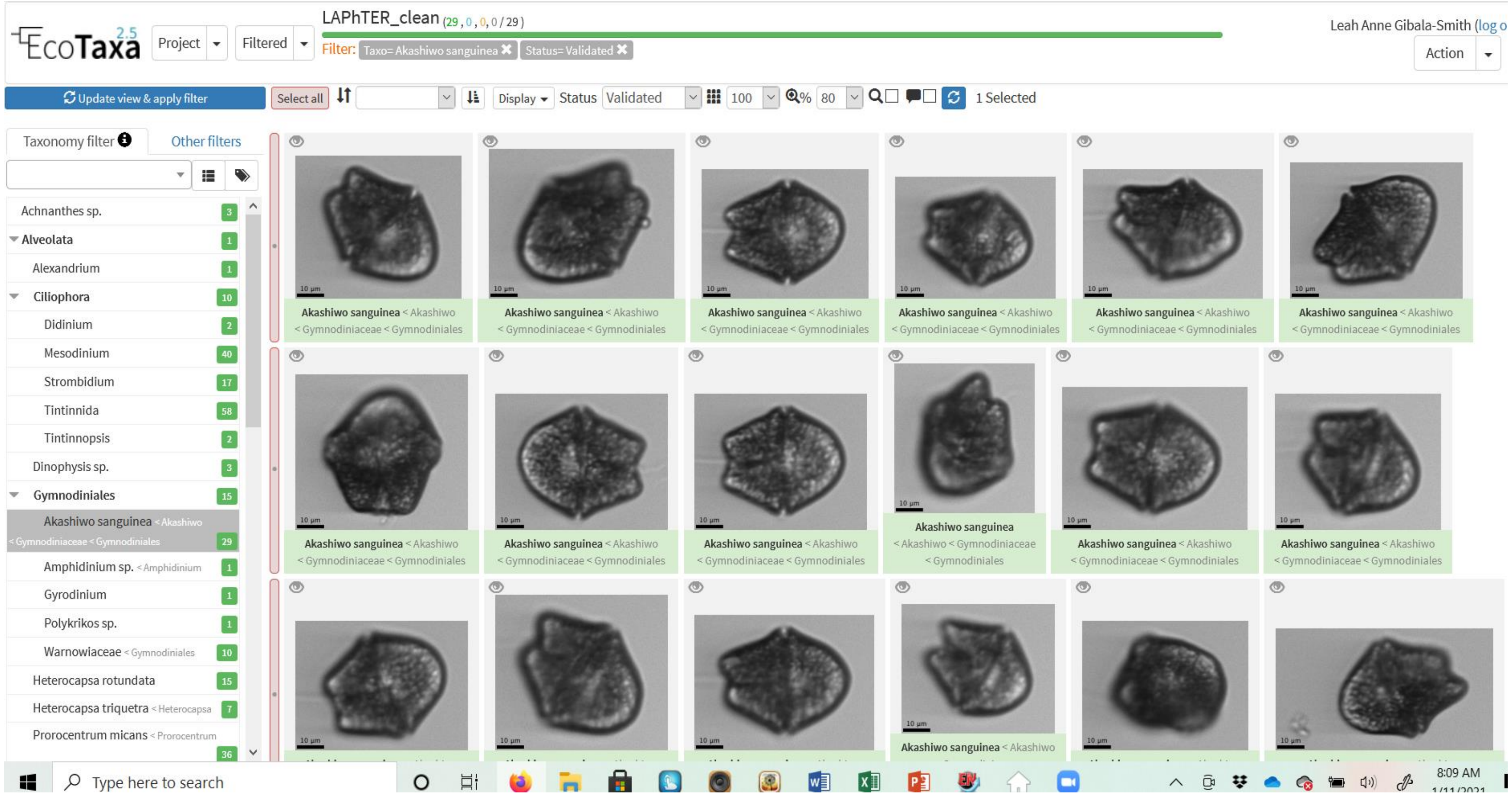
Validated and corrected



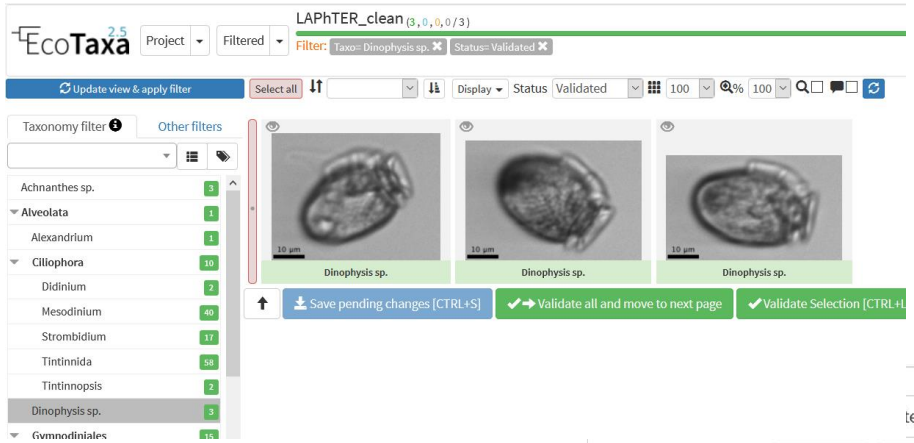
There are inconsistencies in model predictions for some organisms because cell morphology can be highly variable
So, make sub-categories to account for life stages, etc. - more on this later – and rerun the model, it is an iterative process

Eventually, we can group cells and train the instrument to count them in individual samples

Akashiwo

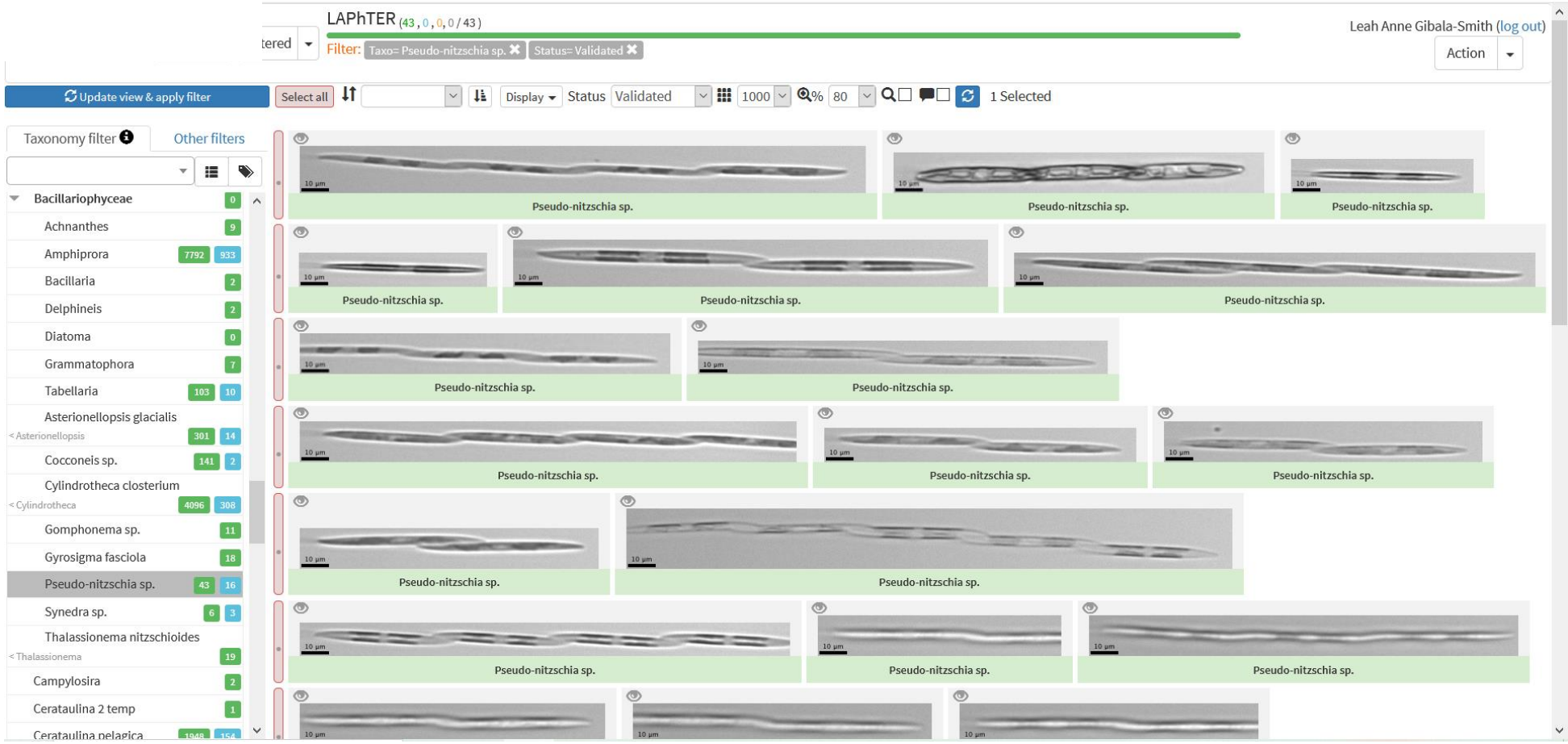


Dinophysis

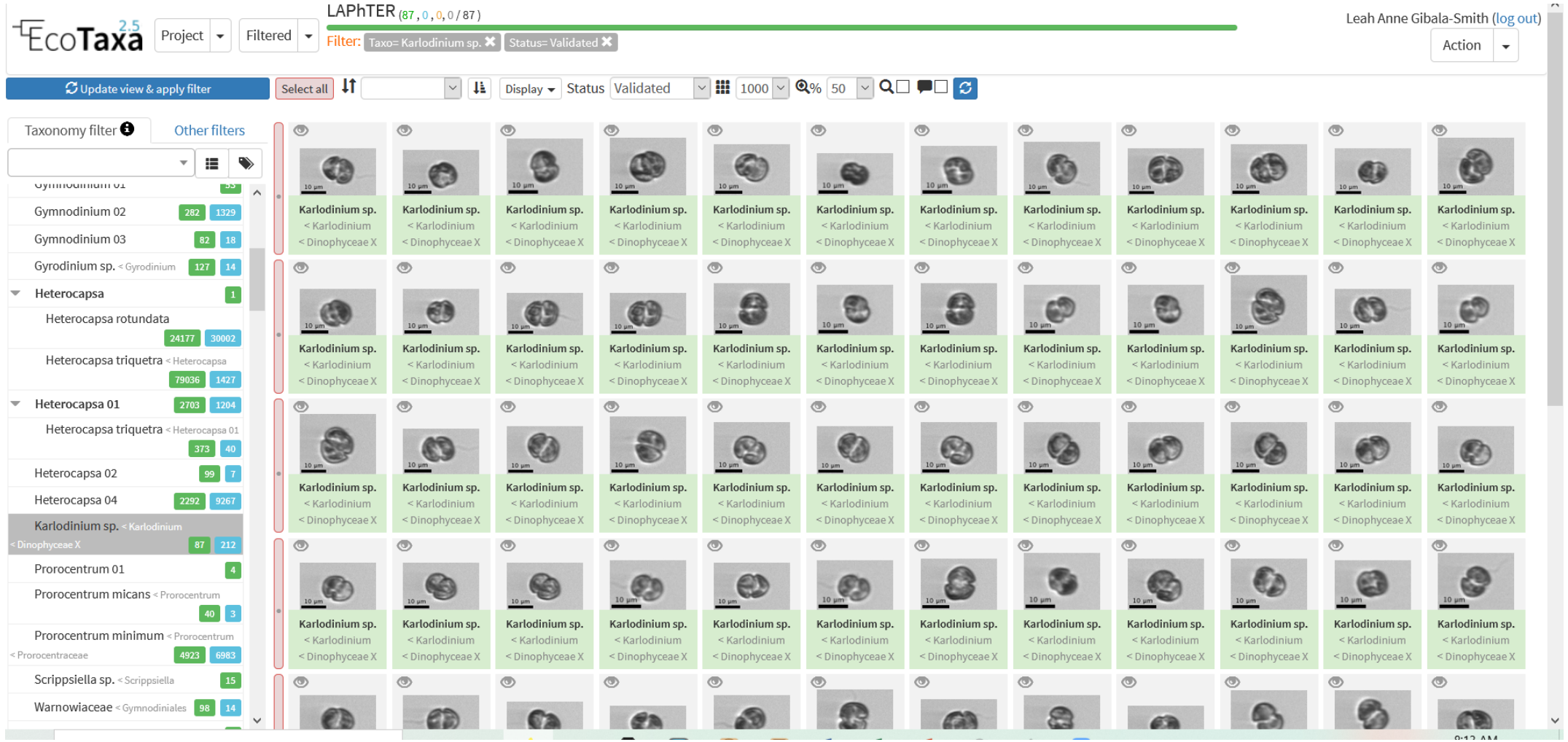


Even the rare ones! We can examine more sample in detail so this may help us!

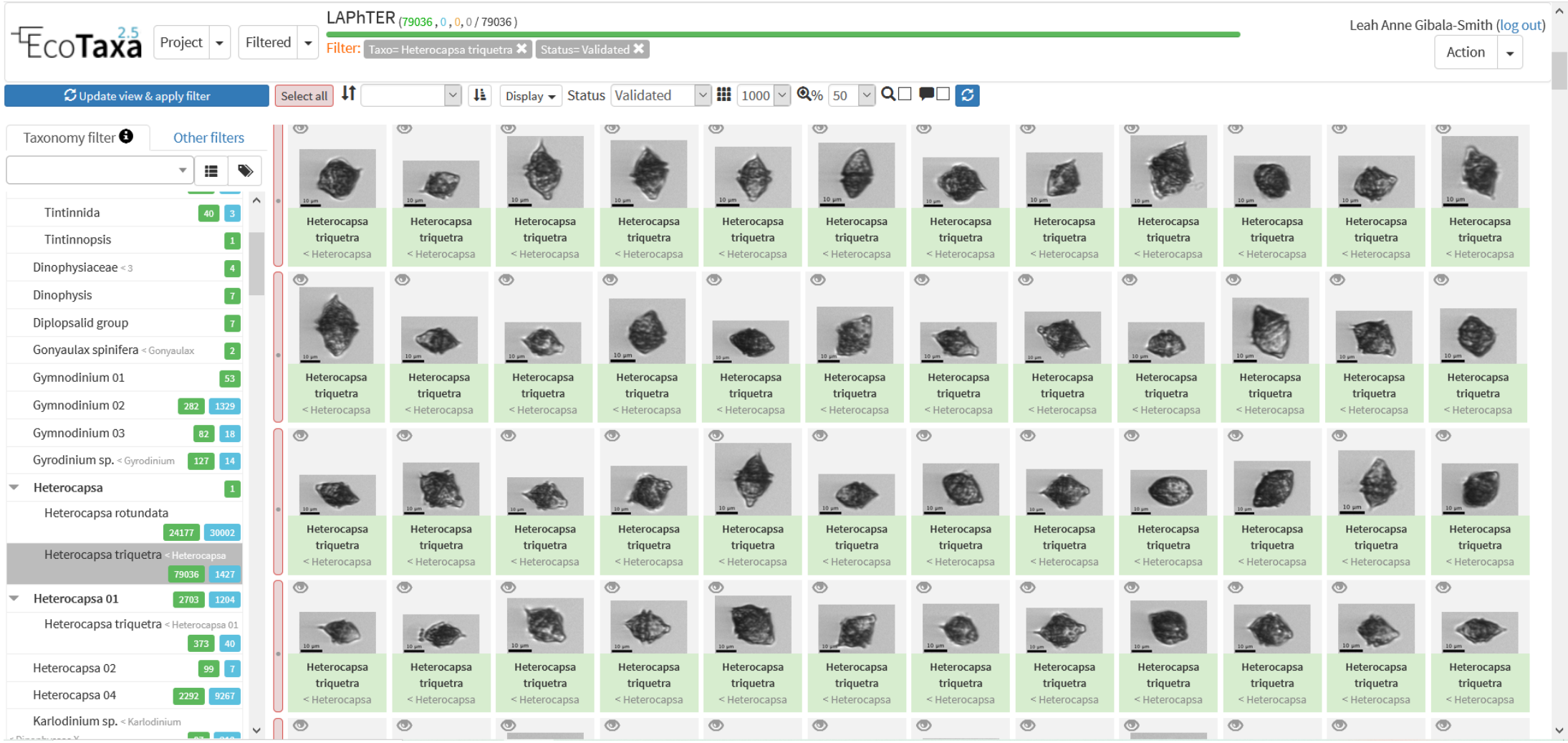
Pseudo-nitzschia



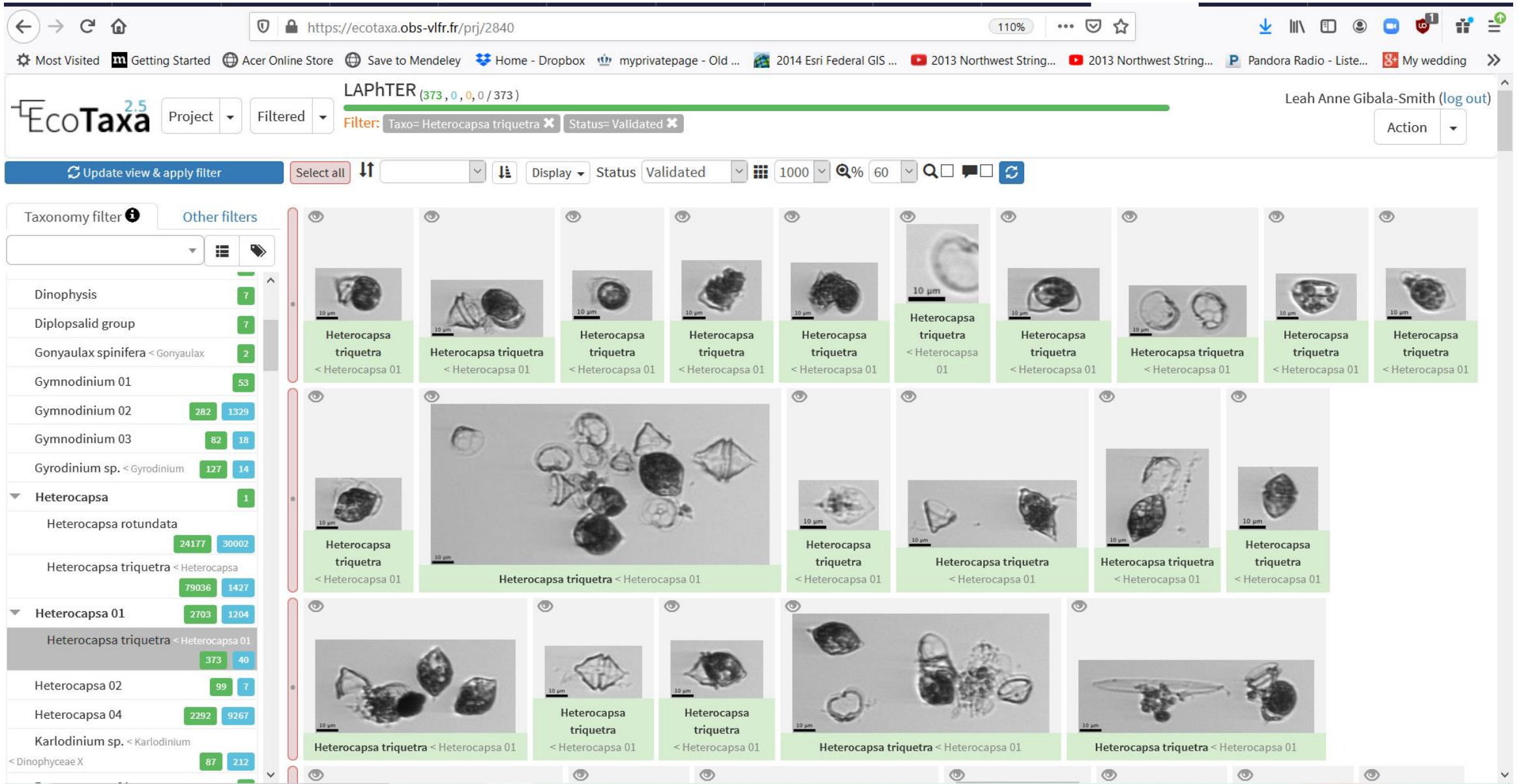
Karlodinium



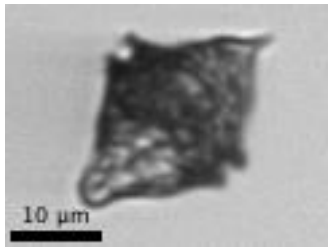
Heterocapsa triquetra – we're also learning about the organisms themselves!



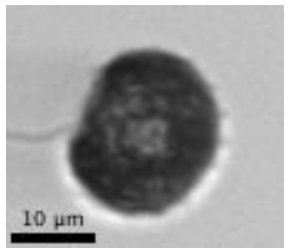
Heterocapsa triquetra – we're seeing different life stages



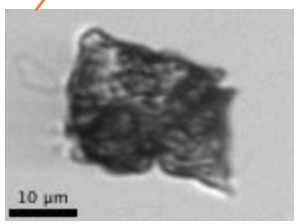
Heterocapsa triquetra Peridinale
Asexual reproduction observed: Eleutheroschisis: theca sheds before or after cell division
Sexual reproduction not observed
Heterocapsa groupings:



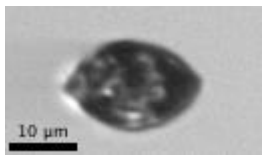
Heterocapsa triquetra
Vegetative cell



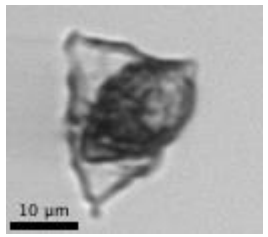
Heterocapa 04
antapical view of the vegetative cell



Heterocapsa 02
Binary fission

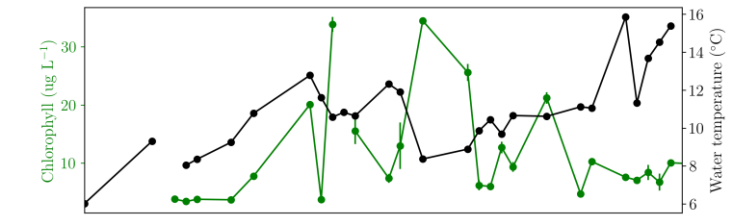


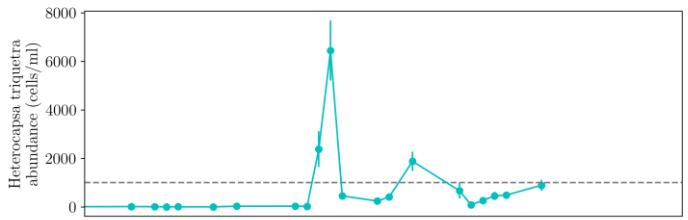
Heterocapsa 01
Ecdysis has occurred -"naked" cells that have shed their theca (part of asexual reproduction) OR can be the result of stress

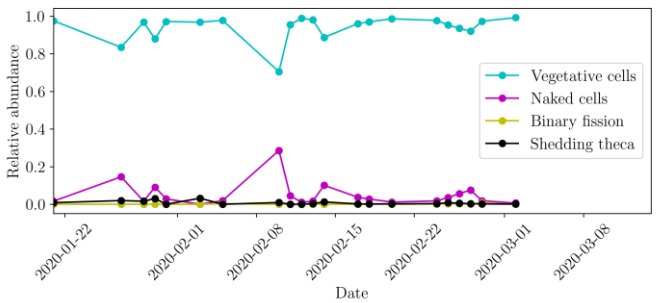


Heterocapsa triquetra < Heterocapsa 01
Cells in the process of shedding their theca but still have an intact pellicle

ECOTAXA CATEGORY TREE & definitions (intermediate working arrangement)







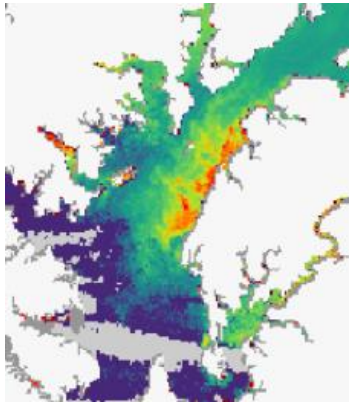
IFCB live dashboard – *Margalefidinium* bloom – images not uploaded to Ecotaxa yet
We know life stages and chain length may play an important role in the initiation and persistence of these blooms and plan to interrogate the database.

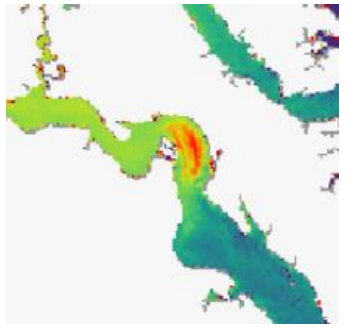
2021 program plans

- Continue VDH & CBP sampling and merging of databases
- Resume HRSD dataflow sampling after COVID hiatus
- Continue sampling at the Lafayette River time series
- Merging of databases
- Continue IFCB training
  - Also getting Flow Cam loaner this winter
- Building off multiple programs – VDH, CBP, HRSD, ECOHAB
- Continued discussions with partners
  - Phytoplankton methods- IFCB, remote sensing
  - Management strategies

New year's resolutions/goals

- Find a way to get a dedicated IFCB
- Year-round sampling and analyses with undergrads and instruments
- Laboratory experiments
  - Isolation of cultures
  - Production of toxins
  - Life cycle events that influence blooms
- More student involvement
- New funding to tie in research with the monitoring to better advise management





Thank you!

Funding:

VDH VIRGINIA DEPARTMENT OF HEALTH
To protect the health and promote the well-being of all people in Virginia

HRSD
Cleaning wastewater every day for a better Bay.

NOAA NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Questions?