stac Chesapeake Bay Program's Scientific and Technical Advisory Committee

Exploring Satellite Image Integration for the Chesapeake Bay SAV Monitoring Program: STAC Workshop report out to STAR

Peter Tango (USGS CBP Monitoring Coordinator)

Brooke Landry (MD DNR Chair SAV Workgroup)

STAR Meeting

May 27, 2021

VIMS | William & Mary
Virginia Institute of Marine Science

Old Dominion University

United States Environmental Protection Agency

USGS science for a changing world

Maryland Department of Natural Resources

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Exploring Satellite Image Integration for the Chesapeake Bay SAV Monitoring Program

A CBP STAC Workshop

October 2019 – February 2020

Co-chairs Brooke Landry (CBP SAV Workgroup) and Peter Tango (CBP Monitoring Coordinator)

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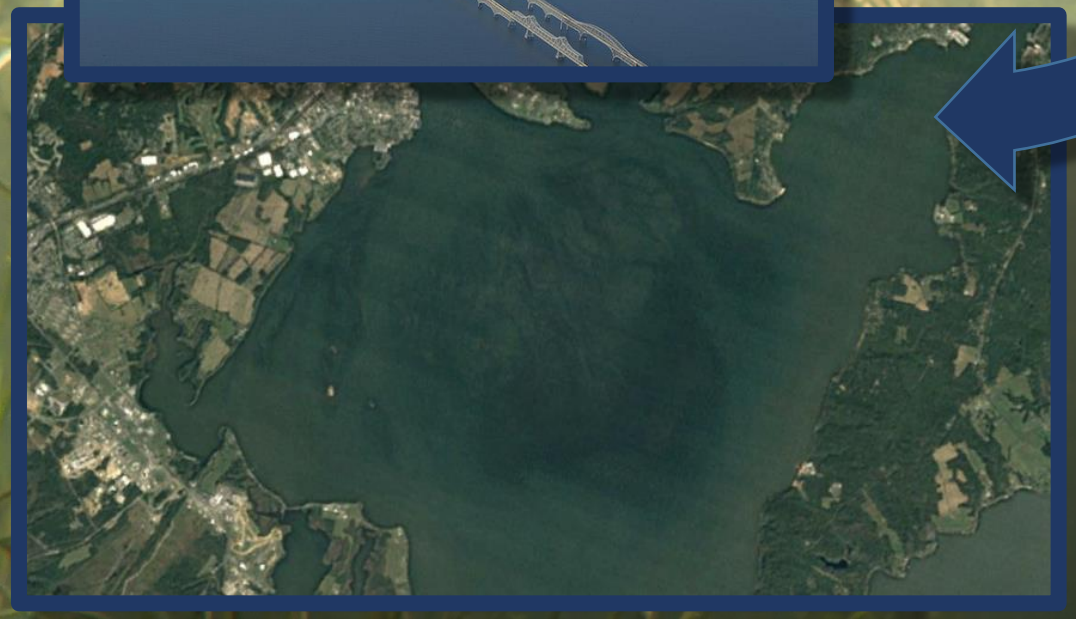
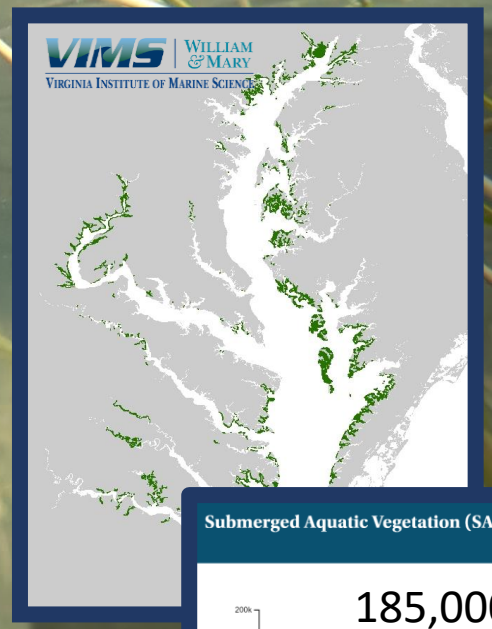
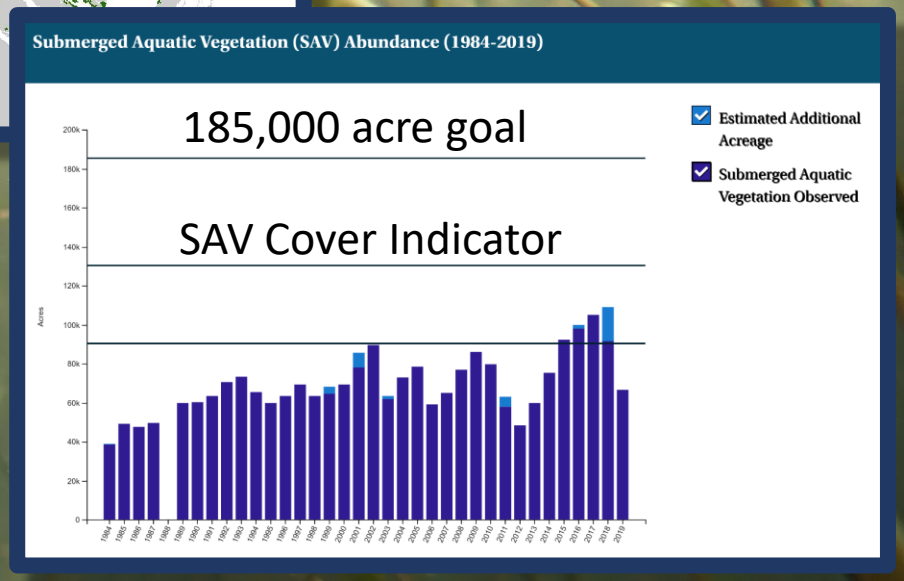
The Chesapeake Bay SAV Monitoring Program is the most successful large-scale, consistent, long-term SAV monitoring program in the world.







Impetus for STAC Workshop: to address vulnerabilities and increase the program's long-term sustainability

The Program is:

1. Increasing in price while partner funding is decreasing (and new flight contractor will raise acquisition costs more)

2. Present methods are logistically cumbersome to coordinate with flight contractors (clouds, wind, tides all need to be perfect)

3. Affected by climate change. The weather itself is becoming more difficult to deal with (more clouds, more rainy days, more flood events that create turbidity issues)

4. Increasing airspace restrictions (DoD doesn't like us taking pictures over installations)

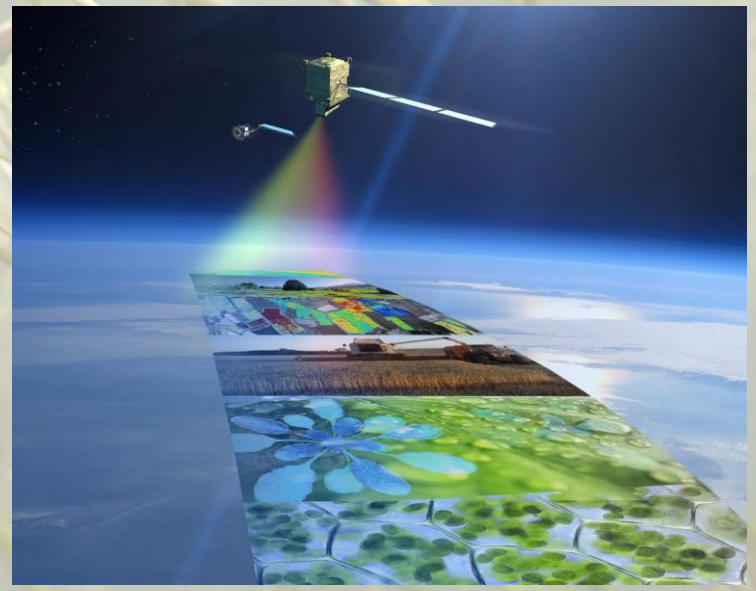
Workshop Objectives

Adoption of monitoring and assessment approaches with significant cost and programmatic efficiencies are needed to ensure the long-term sustainability of the SAV monitoring program.

Workshop Objectives

The overarching purpose of the workshop was to determine if *High-Resolution (i.e., 1m-sq scale)* Commercial Satellite Imagery (CSI) offers us a new era of SAV monitoring?

A few questions needed to be answered…



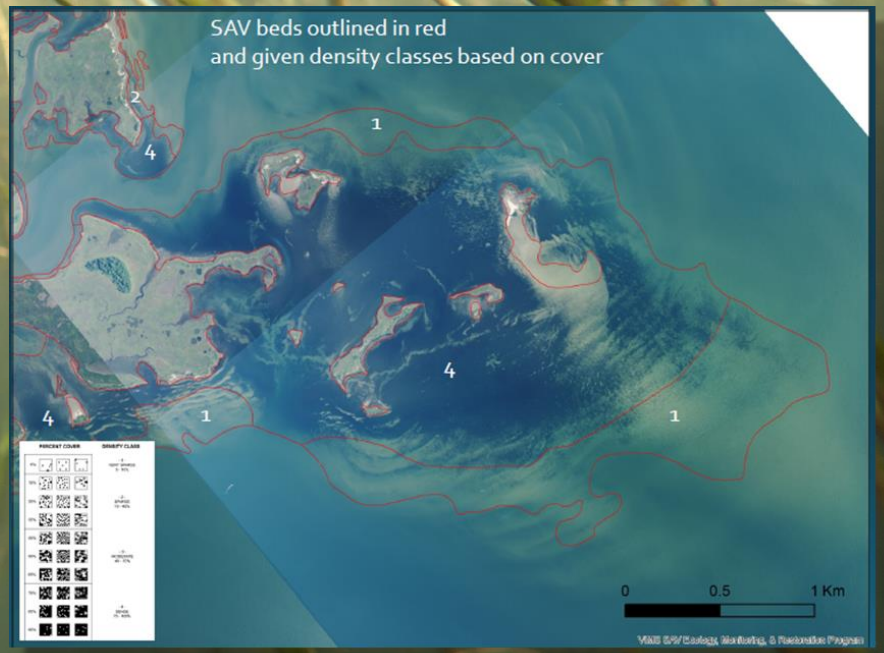
- Could it be obtained? Can we have access to it?
- Is it cost effective to obtain the imagery?
- Can we get what we want when we want it?
- Could high-res satellite imagery be of sufficient quality to monitor bay SAV?
- Could it provide the necessary spatial cover to monitor CB SAV populations?
- Could it be processed more efficiently than aerial imagery for SAV cover tracking? Existing methods.
- Could it be processed in a more efficient, cost-effective manner than aerial imagery? New, AI methods.

Can we acquire it? Yes!

NextView License Agreement and Data Acquisition

Data Acquisition: Acquiring High Resolution CSI is an option for CBP under the NextView License agreement between the National Geospatial Intelligence Agency (NGA) and Maxar (commercial satellite company)

- The NextView License was developed by the NGA to accommodate U.S. Government (USG) agencies, contractors, partners, and other entities that ***require*** CSI to support USG interests.



Is it cost effective to acquire? Yes!
How does FREE sound to you?

Data Acquisition:

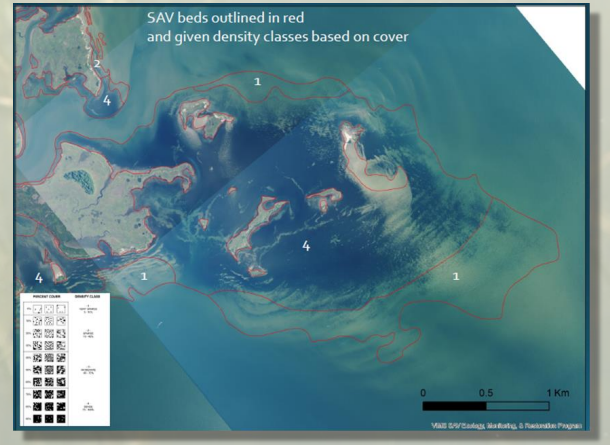
- The NextView License was developed by the NGA to accommodate United States Government (USG) agencies, contractors, partners, and other entities that ***require*** CSI to support USG interests.
    - 2017 updates to the Water Resource Development Act, which amends Section 117 of the Clean Water Act, now ***requires*** EPA to carry out an annual SAV survey in Chesapeake Bay.
    - Therefore, this makes it feasible for the EPA/CBP to request and obtain the high-resolution CSI necessary for the annual SAV assessment ***at no cost***

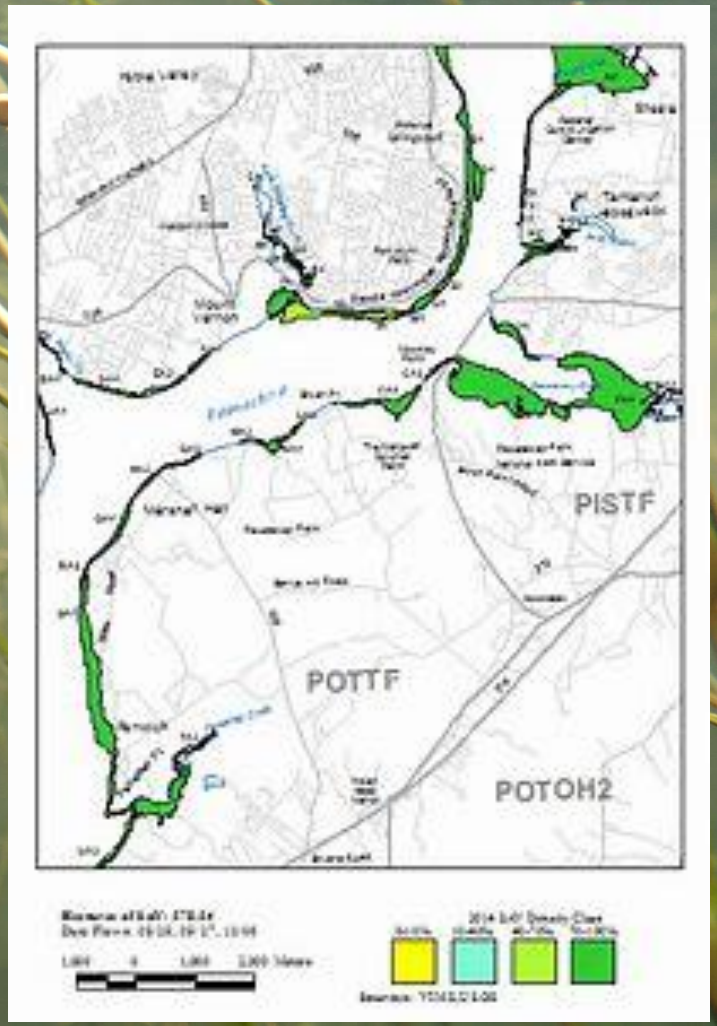
Is the imagery of sufficient quality? It can be.

High Resolution CSI is adequate for SAV mapping

If acquisition of usable data and imagery is achieved, the resolution is adequate for hand-delineation of SAV beds in Chesapeake Bay:

*** VIMS analysts verified that given a good satellite image, they can hand-delineate the SAV just as they do from aerial imagery.





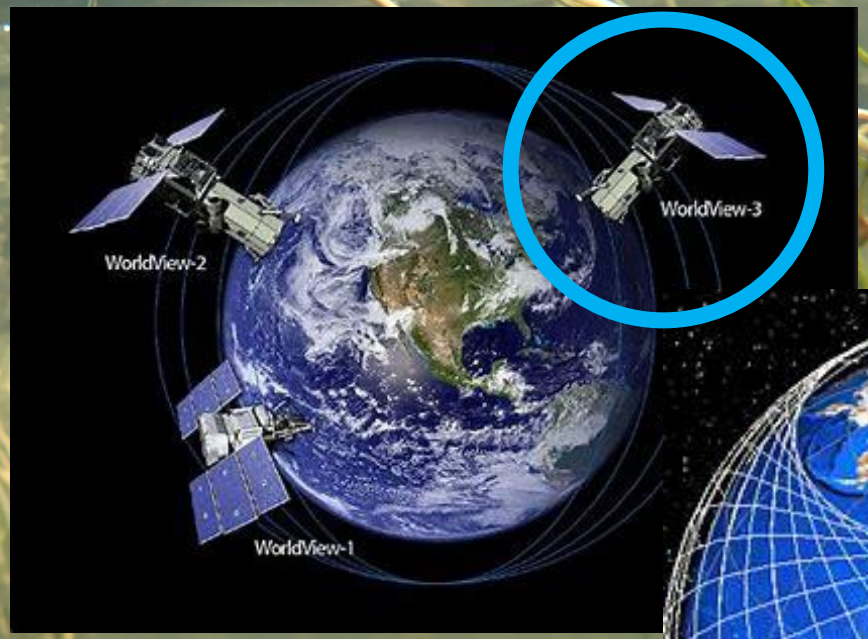
Can available satellites cover the bay?

WorldView 3 Satellite = in theory, mostly yes

WorldView 3 Satellite Constellation:

For the purposes of the CB SAV Monitoring Program, WorldView 3 (owned by Maxar) is the best and most appropriate satellite constellation.

Once launched, WorldView Legion may be even better.

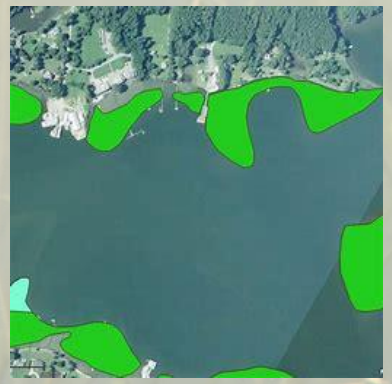


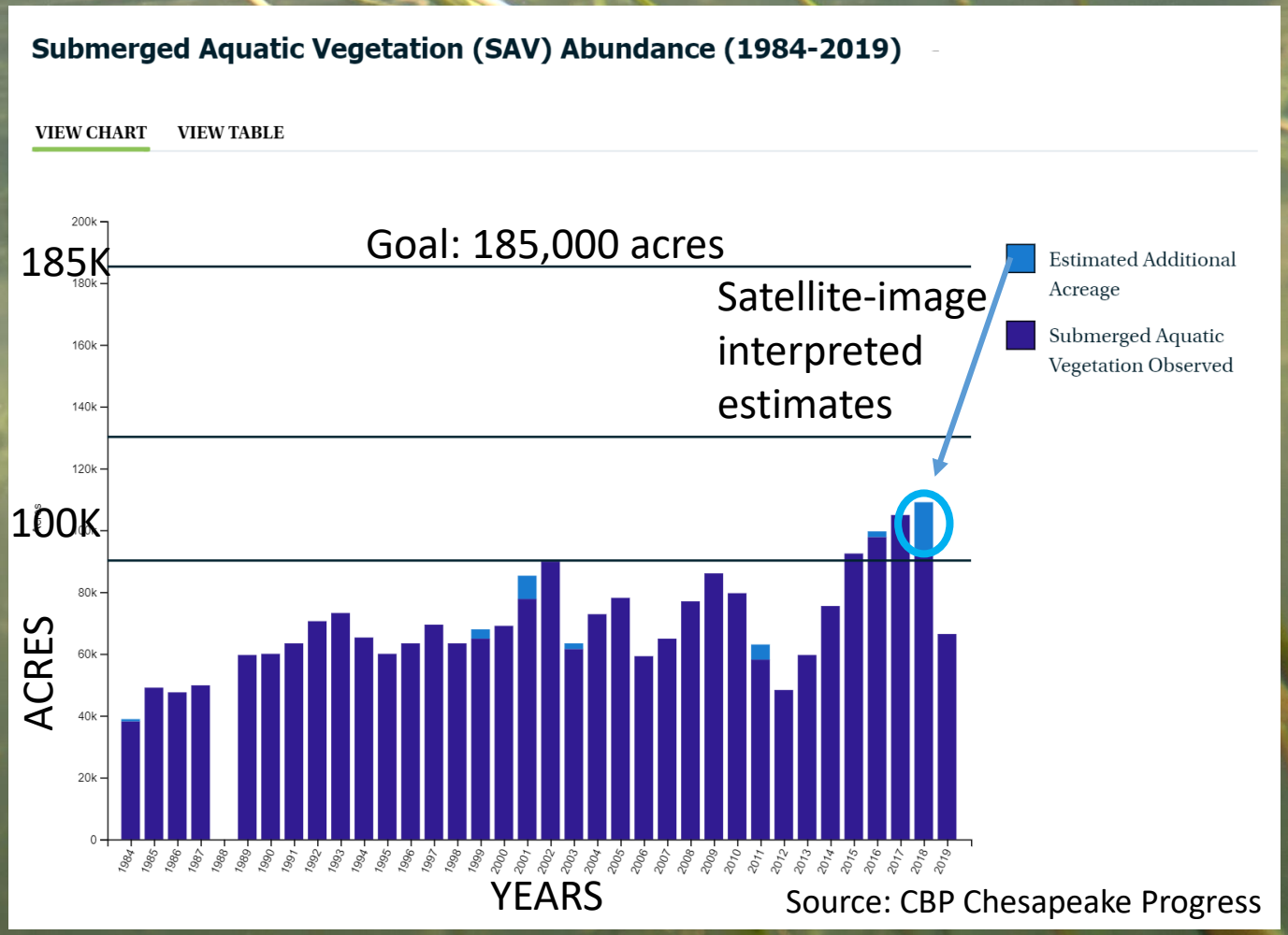
Conceptual image on orbital paths

Can we draw SAV beds efficiently? Yes!

Essentially no different than mapping aerial image

- IN 2018 VIMS used satellite-images to fill in gaps when various issues affected survey completeness
- VIMS mapping technicians found good satellite images as useful as fixed-wing airplane derived images for mapping SAV cover in the bay.





Can we automate image processing with AI:

Yes, in other systems. Not yet for Chesapeake Bay.

Algorithms/AI/machine learning will eventually automate mapping, but there's significantly more work to do before algorithms are ready for CB: With funding, algorithms could be ready in 3-5 years.

Using AI may yield more precise results but we will need to calibrate between old and new methods

E.g. Financing the SAV program: Satellite assessment of SAV in high resolution in estuaries over large areas is already being done, AI/ML interpretation make high thru-put assessment feasible

Can we draw SAV beds with AI? Yes and no

Yes, in other systems. Not yet for Chesapeake Bay.

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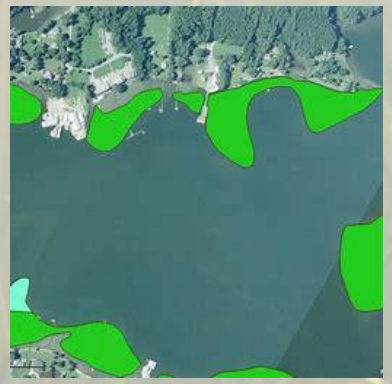
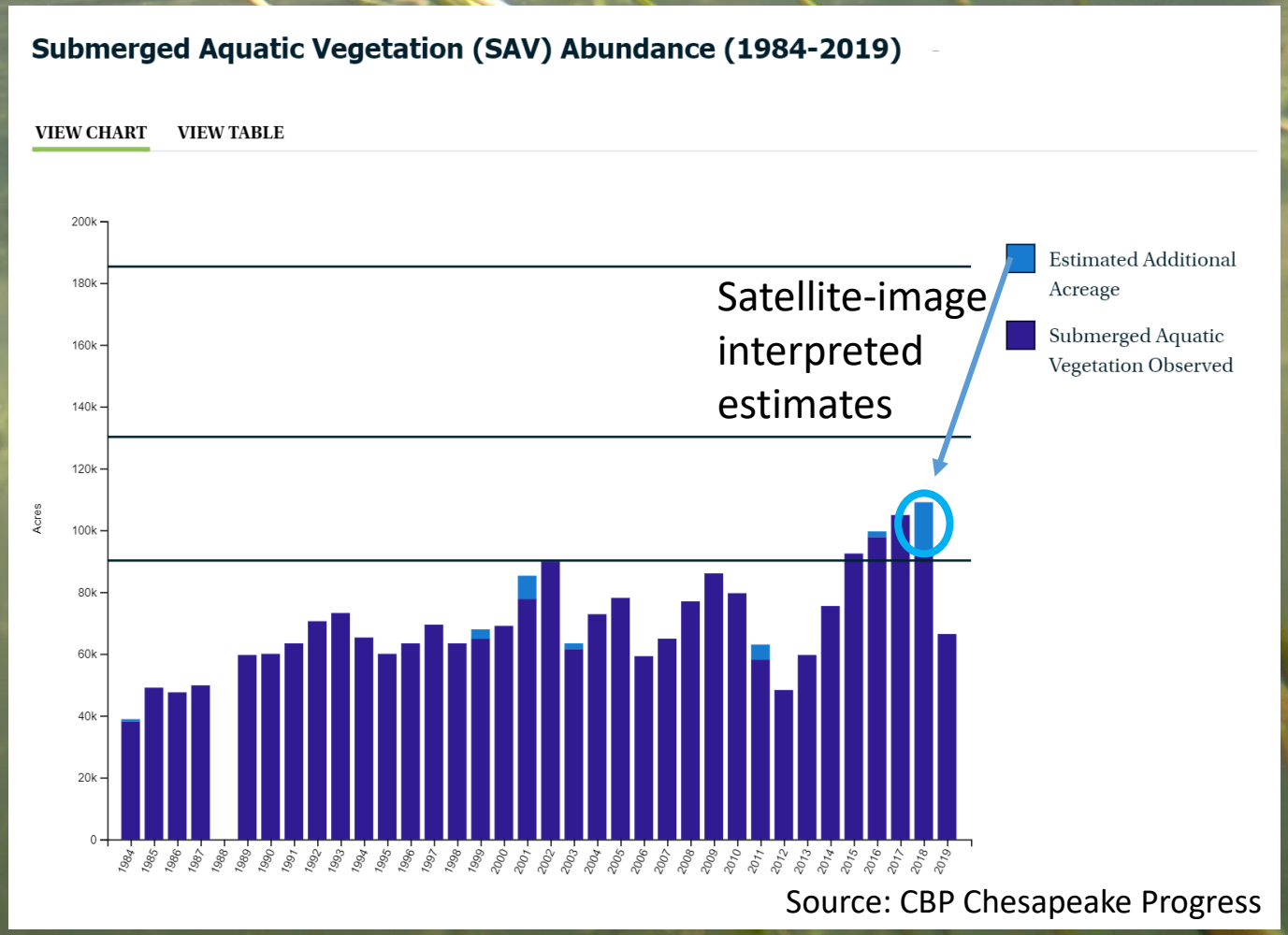




Can we get what we want when we want it?
Workshop Study: Tasking the Satellites

The NextView License Agreement allows TASKING:

Tasking for image acquisition is making a request to the satellite owner and manager for images to be collected on specific days and under specific conditions.

We have permission with the NextView agreement to ask for images to be collected over specific areas and at specific times.

This is necessary for the SAV survey.

Steering Committee Recommendations

2020 and 2021: Conduct contracted aerial acquisition of Bay SAV with complimentary CSI tasking exercise and calibration study (VIMS)

- **TASKING EXERCISE**: Task for FULL BAY as back-up and mimic to determine likelihood of actually acquiring necessary data.
- **CALIBRATION EXERCISE**: Conduct a calibration exercise to determine if imagery produces similar results using 2020 CSI and aerial imagery.*

*This work was funded following this STAC workshop and VIMS has been working through the steps since spring 2020.

2021: Reconvene and make final recommendations based on success of tasking and calibration. Write addendum to report.

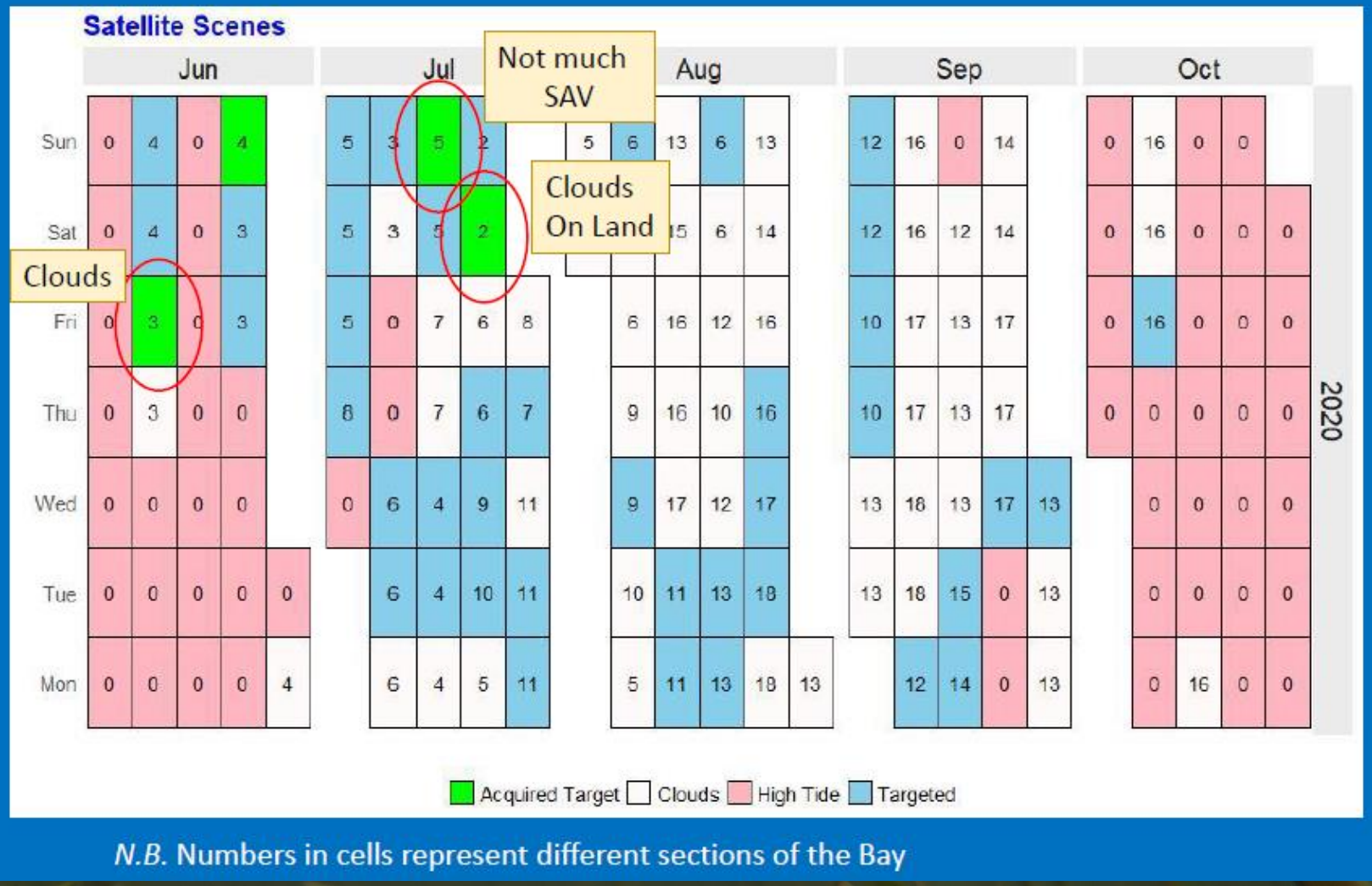
2021 and beyond: Continue algorithm development for automated mapping.

Tasking and Calibration Studies: Preliminary results

Within 20 target areas, made 99 acquisition requests for different areas on different days throughout the growing season based on tide and region.

***Four** out of 99 requests were successful.*

One out of four were usable.

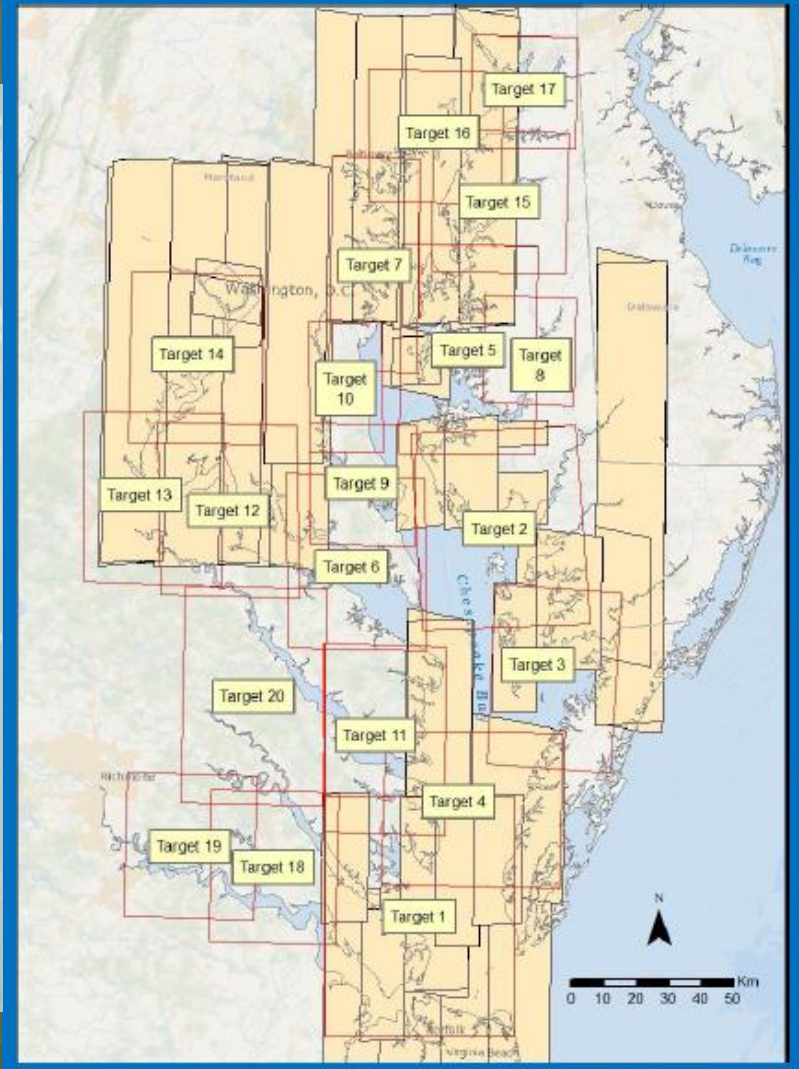


N.B. Numbers in cells represent different sections of the Bay

Tasking and Calibration Studies: Preliminary results

Overall, the tasking exercise was not a success, but a lot about the process itself was figured out.

Ultimately 4 of 99 requests were successful and only 1 was usable…

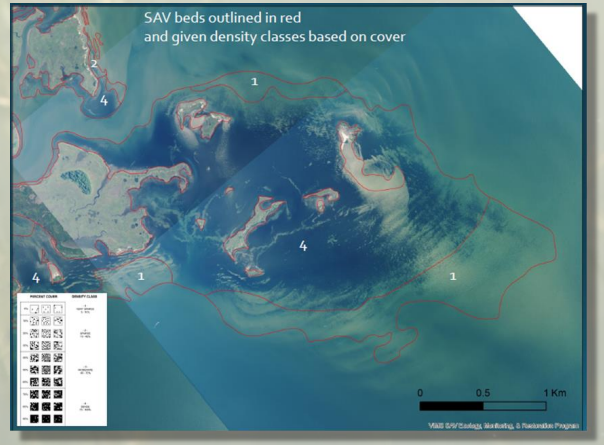


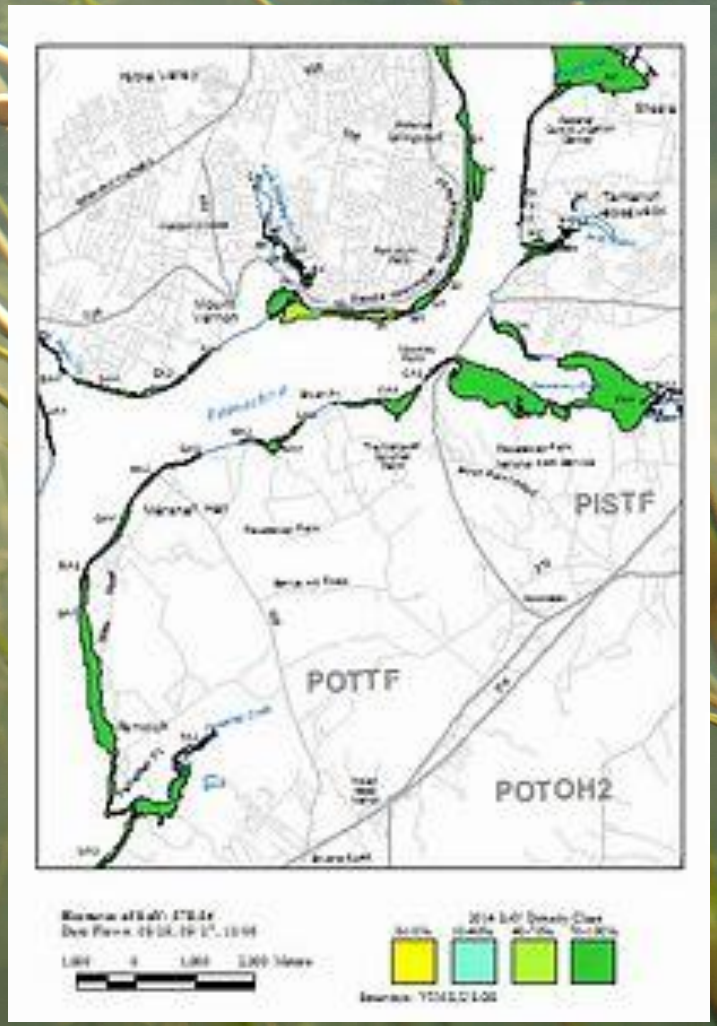
Calibration study – results in 2021

Hopefully for our STAC Workshop on Advanced Monitoring

Calibration of assessments from 2 different images sources looks promising.

*** VIMS analysts verified that given a good satellite image, they can hand-delineate the SAV just as they do from aerial imagery.





Questions: Exciting progress! Targets for work.

The overarching purpose of the workshop was to determine if *High-Resolution (i.e., 1m-sq scale)* Commercial Satellite Imagery (CSI) offers us a new era of SAV monitoring?

A few questions needed to be answered…

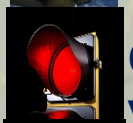
Could it be obtained? **YES**. Can we have access to it? **YES.**

Is it cost effective to obtain the imagery? **YES, like FREE. That's cost effective.**

Could high-res satellite imagery be of sufficient quality to monitor bay SAV? **It can be…**

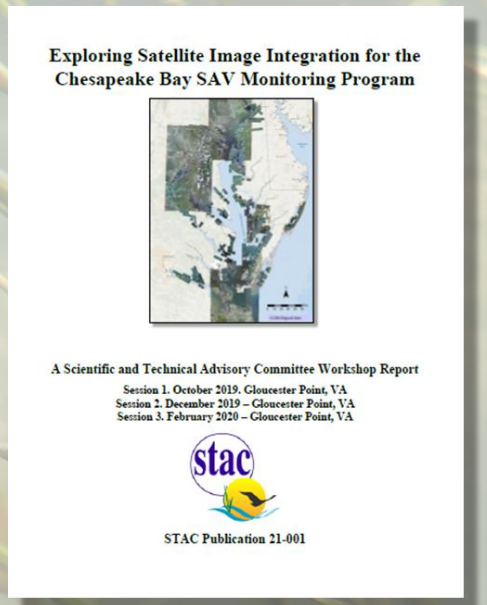
Could it provide the necessary spatial cover to monitor CB SAV populations? **Mostly, yes.**

Could it be processed more efficiently than aerial imagery for SAV cover tracking? Existing methods. **The same.**



Could it be processed in a more efficient, cost-effective manner than aerial imagery? New, AI methods. **CB = Not yet.**

Can we get what we want when we want it to make it work for the monitoring program? **So far…not yet.**



Thank you team! Thank you STAC!

Steering committee and key participants

Brooke Landry: Chair, Chesapeake Bay Program SAV Workgroup; Biologist, Maryland Department of Natural Resources *(Workshop Co-Chair)*

Peter Tango: Chesapeake Bay Monitoring Coordinator, United States Geological Survey *(Workshop Co-Chair)*

Bill Dennison: Vice President for Science Application, University of Maryland Center for Environmental Science *(STAC Member)*

Robert (JJ) Orth: Professor of Marine Science and Director of the Chesapeake Bay SAV Monitoring Program, Virginia Institute of Marine Science

David Wilcox: Manager of the Chesapeake Bay SAV Monitoring Program, Virginia Institute of Marine Science

Richard Zimmerman: Professor of Ocean, Earth, and Atmospheric Science, Remote Sensing expert, Old Dominion University

Blake Schaeffer: Remote Sensing expert, EPA Region 4 headquarters in Raleigh, NC

Carin Bisland: Partnerships and Accountability Branch, EPA Chesapeake Bay Program Office

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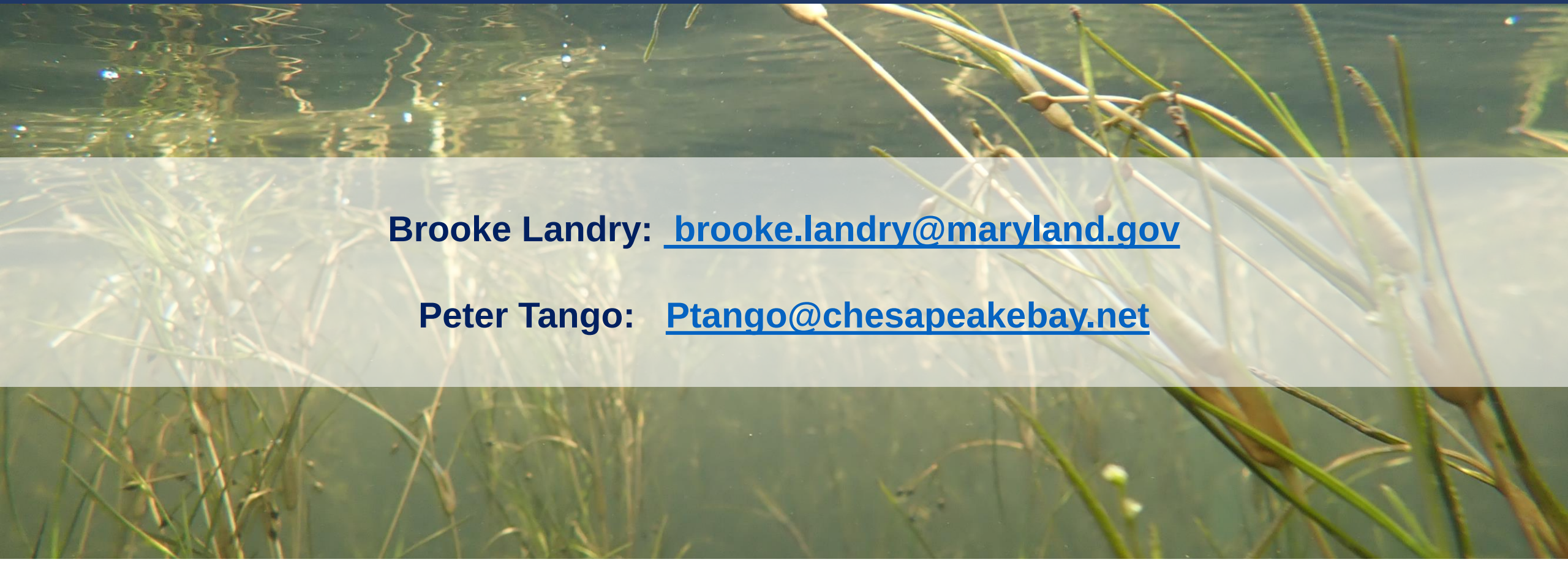
Questions?



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Workshop Results: Publication and Retention Complications

There will be multiple complications regarding CSI publication and retention.

- The imagery belongs to Maxar. Permission and licensing is required to publish each and every image, and permission is not guaranteed.
- Derived products (i.e., SAV maps) are not subject to this licensing requirement.
- EPA primarily needs the derived maps and acreage values, but state agencies need the imagery to provide transparency in the review of aquaculture lease applications and permitting decisions.

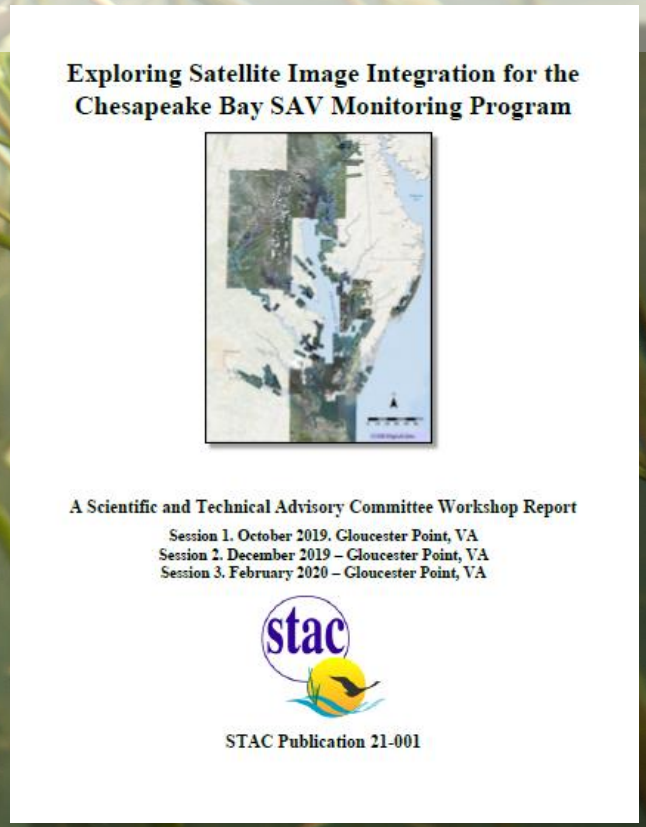
The Final Product

- **Reviews the Chesapeake Bay SAV Monitoring Program**
- **Summarizes each workshop session and the information gleaned**
- **Provides a recommended timeline and next steps**
- **Suggests that the steering committee reconvene after VIMS has completed the tasking and calibration studies*.**

*A report addendum will be added after the tasking and calibration exercises are complete and based on results, the steering committee will recommend – or not – satellite data integration into the SAV monitoring program.

The final report is online now at:

https://www.chesapeake.org/stac/wp-content/uploads/2021/03/FINAL-STAC-Report_Exploring-satellite-data-for-the-CB-SAV-Monitoring-Program.pdf



Tasking and Calibration Studies: Preliminary results

The calibration exercise is not complete yet, but preliminary results suggest that where acquired data is comparable to aerial imagery, hand-delineation will be straightforward (same as 2018).

Satellite vs. Aerial Comparison

Six areas were selected

- Satellite imagery was available
- Aerial and satellite imagery in the same time frame
- No obvious defects in the satellite imagery
- Covering the majority of a USGS quadrangle
- Fairly large amount of SAV in the area

Process

- Each area is mapped by two analysts
  - One using the satellite imagery
  - One using the aerial imagery
- The resulting raw SAV polygons are compared
- Once both are complete, the area is reviewed by both analysts and the PI to evaluate potential sources of difference

Unfortunate Recent Development

In early March, we found out that Congress cut the budget for accessing Maxar imagery

- The approved budget for G-EGD was reduced by 50%, by Congress.
- In order to meet the new budget, access to EV-WHS has been reduced or suspended to civilian agencies until fund's are hopefully restored September 2021.
- The total amount of data that can be used during the months prior to September 2021 is capped at 14 terabytes each month on the open internet site
- Maxar charges NGA by the gigabyte used.

- **If your agency still needs access, NGA is asking that those users be vetted by the agency before their accounts are re-instituted.**