

National Aeronautics and  
Space Administration



# Utilizing Earth Observations and Community Science to Detect and Map the Displacement of *Cladophora* along the Milwaukee County Shoreline

**Steven Chao**

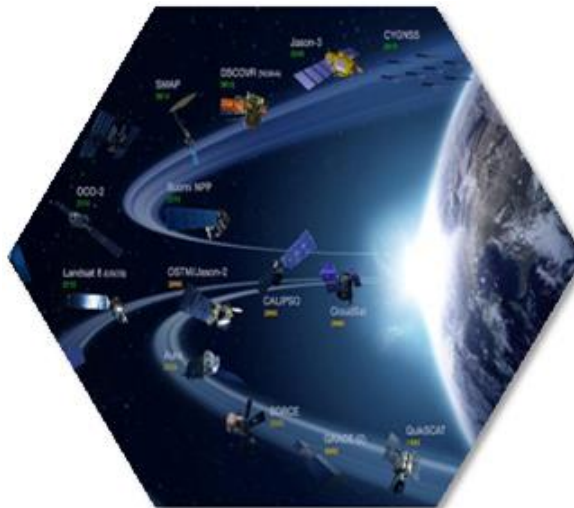
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Breen, Genevieve Clow, & Elizabeth  
Looby



**AGU Fall Meeting**  
December 14<sup>th</sup>, 2018  
ED52A-07

# NASA DEVELOP National Program

DEVELOP addresses environmental and public policy issues through **interdisciplinary feasibility studies** that apply the lens of **NASA Earth observations** to community concerns around the globe. Bridging the gap between NASA Earth Science and society, DEVELOP projects **build capacity** in both participants and partner organizations to better prepare them to address the challenges that face our society and future generations.



NASA Earth Science



DEVELOP



Decision Makers





## Project Partner: Groundwork Milwaukee

- ▶ Non-profit organization dedicated to environmental restoration through community-based campaigns
- ▶ Seeks to earn Milwaukee County's yearly contract to clean *Cladophora* washup from beaches



Image Credit: NOAA GLERL on flickr

Image Credit: Groundwork Milwaukee



## Community Concern: Decaying *Cladophora* Washup

- ▶ Releases an unpleasant, pungent smell
- ▶ Deters people from visiting beaches
- ▶ Breeding ground for harmful bacteria
- ▶ Impact local water quality
- ▶ Closure of a Lake Michigan beach can result in economic losses of \$37,000 per day



# Project Objectives

## Summer

## Fall

Habitat Suitability  
Submerged Aquatic Vegetation

Investigate methods of *Cladophora*  
detection in satellite imagery

Chlorophyll-a Algorithms

Washup Predictive Map

Identify factors influencing the  
deposition of *Cladophora* mats onto  
Milwaukee County Beaches

Predictive Washup Tool

Collector for ArcGIS  
Project Video  
Esri Story Map

Increase the Milwaukee community's  
awareness of issues regarding  
*Cladophora* nuisance

Project Video

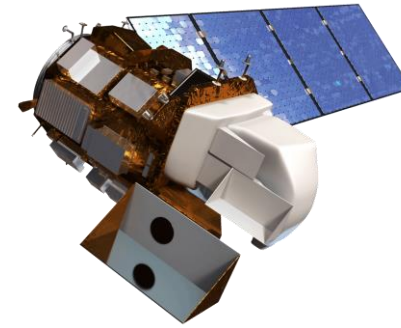


# Study Area & Period

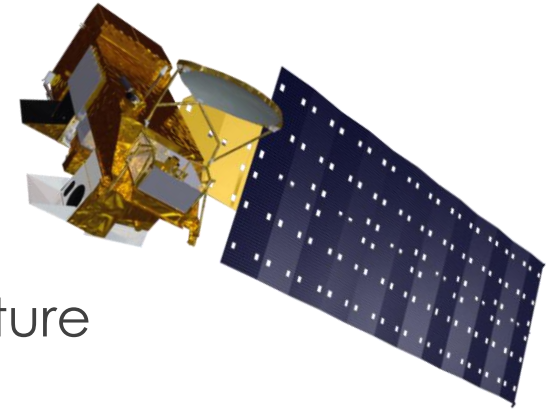


- ▶ Western shoreline of Lake Michigan in Milwaukee County, WI
- ▶ June to September of the years 2016, 2017, & 2018

# Earth Observations



Landsat 8 OLI  
SAV, Turbidity,  
Chlorophyll-a



Aqua MODIS  
Water Temperature

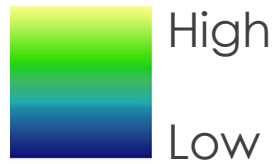


Sentinel-2 MSI  
Chlorophyll-a

# Term 1 Results: Habitat Suitability & SAV Comparison

September 2016

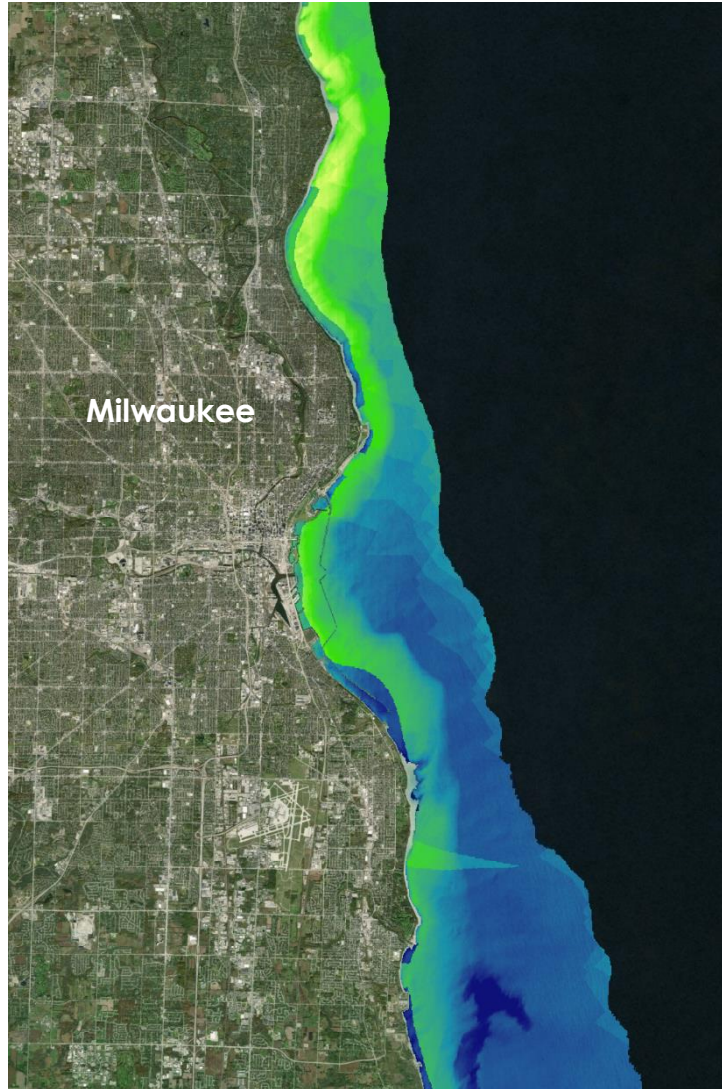
Habitat Suitability



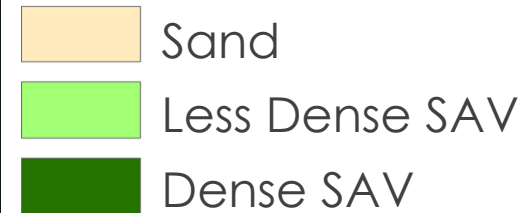
0 10 km



A horizontal black line representing a scale from 0 to 10 km.



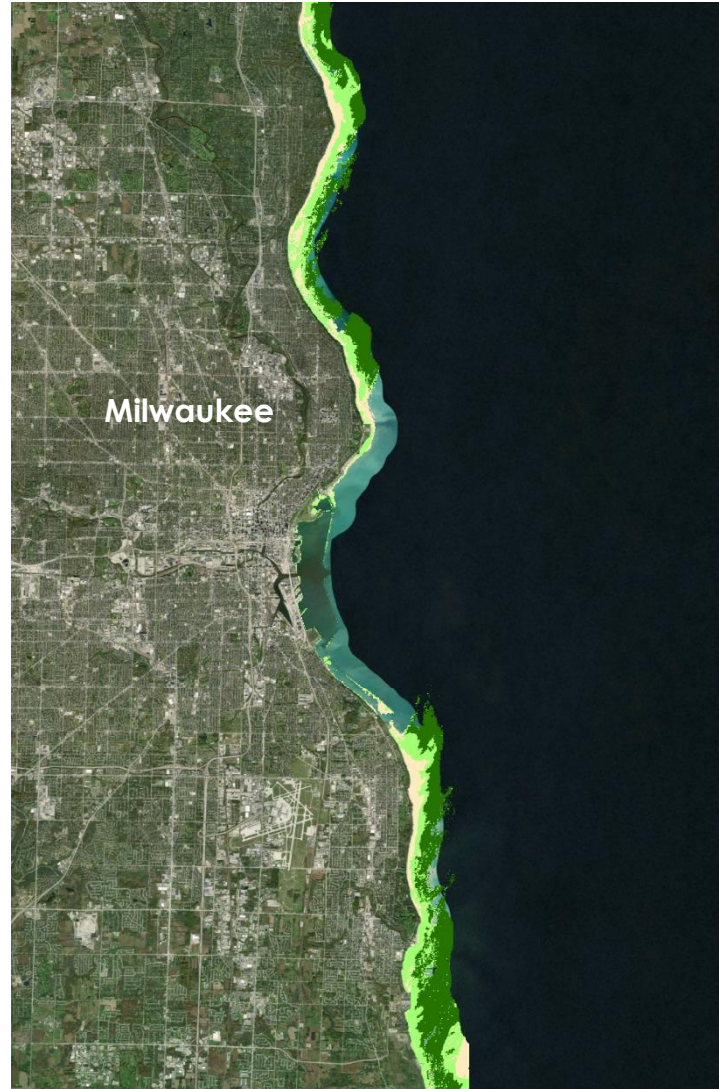
SAVMA Classification



0 10 km



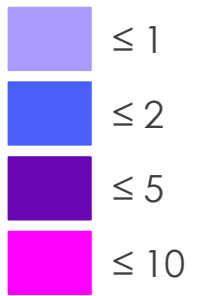
A horizontal black line representing a scale from 0 to 10 km.



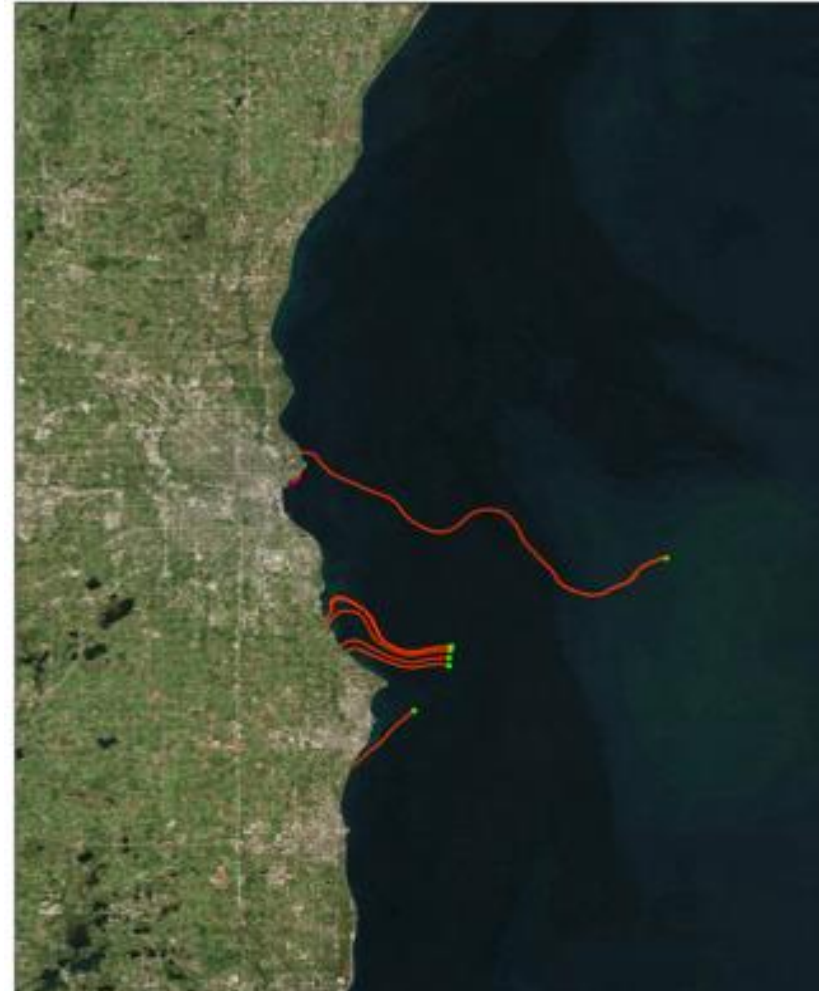
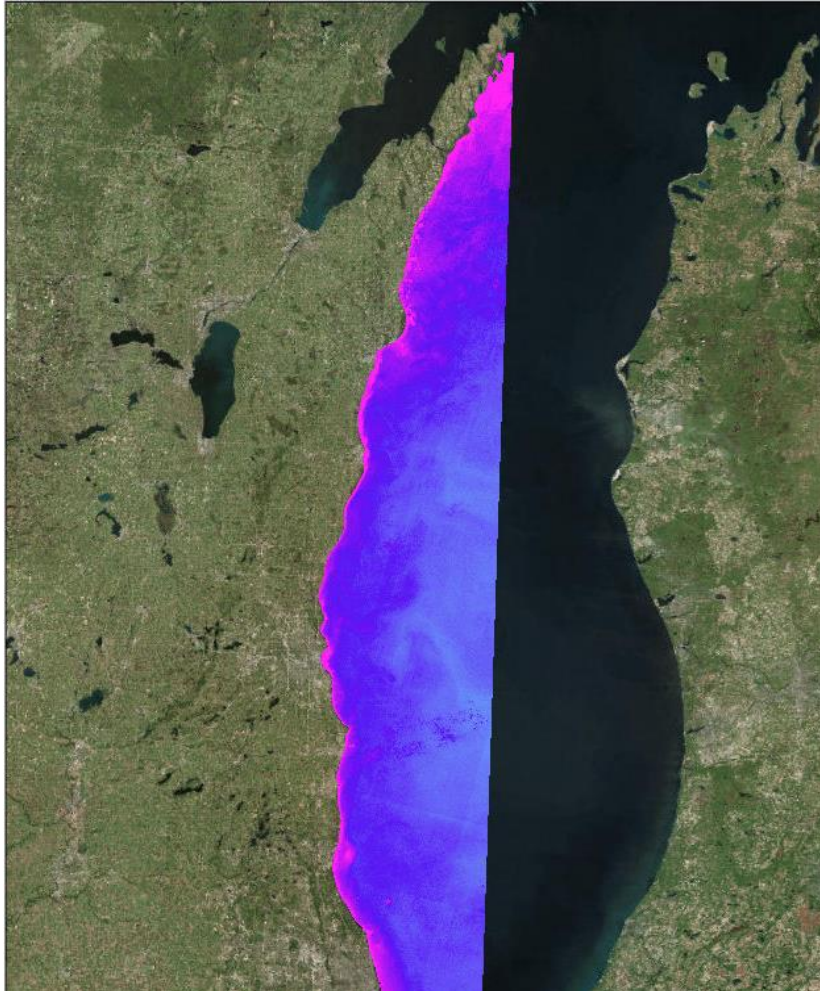


# Term 2 Results: Chlorophyll-a Detection & Predictive Washup Tool

Chlorophyll-a  
Concentration  
( $\mu\text{g/L}$ )



0 60 mi



Predictive  
Washup Tool

-  Initial *Cladophora* Location
-  *Cladophora* Trajectory



0 24 mi

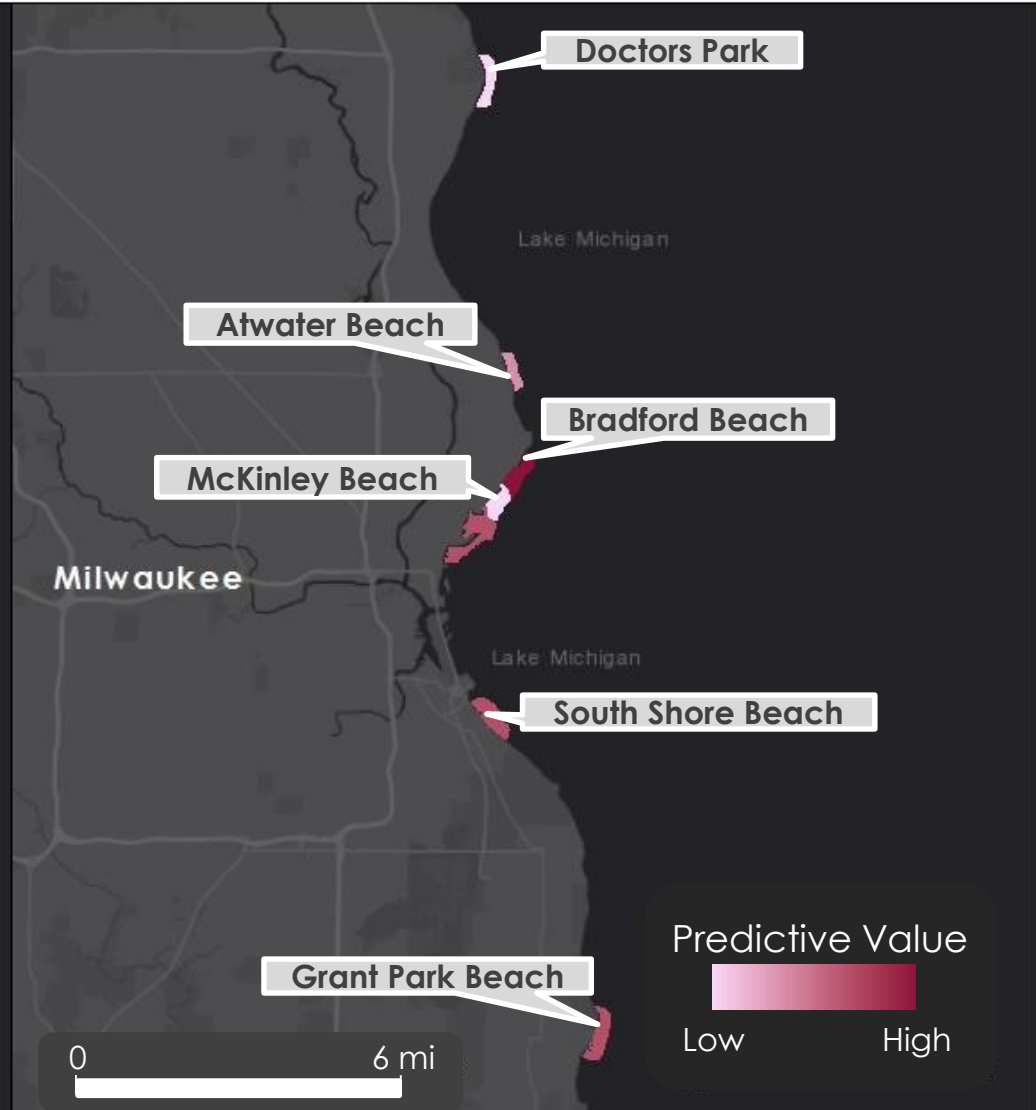


# Results Comparison

*Term 1: Predictive Washup Map*



*Term 2: Modeled Cladophora Washup*





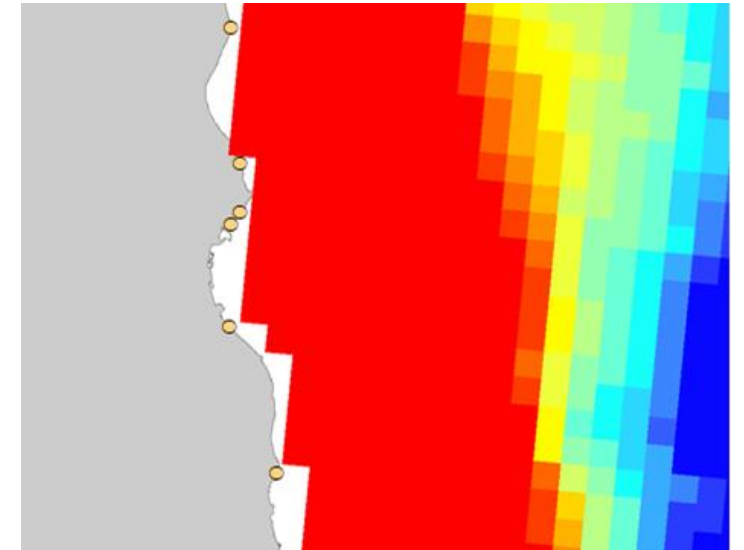
# Errors and Uncertainties

## Lack of High Resolution Data

- ▶ Pixel size too large to directly detect algae washup on beaches
- ▶ Some datasets do not span the entire study area

## Lack of *in situ* Data

- ▶ Needed for coefficient calibration and validation of habitat suitability and washup predictive models



$$\text{Habitat Suitability} = (\text{?} \times \text{Bathymetry}) + (\text{?} \times \text{Water Temperature}) + (\text{?} \times \text{Substrate}) + (\text{?} \times \text{Phosphorus Levels}) + (\text{?} \times \text{Turbidity})$$

# Collector for ArcGIS



| Location:  | 429,272.406 4,768,334.026 Meters     |
|------------|--------------------------------------|
| Field      | Value                                |
| FID        | 7                                    |
| Shape      | Point                                |
| Date_Time  | 7/5/2018                             |
| Author     | AL, AH                               |
| Beach_loc  | Bradford Beach                       |
| Other      |                                      |
| Algae_amou | Little amount                        |
| Algae_smel | No smell                             |
| WinDir_yst | S                                    |
| WinSpd_yst | 19.7 mph                             |
| AirTemp_ys | 75                                   |
| Precep_yst | 0                                    |
| WaterTemp_ | 67                                   |
| WinDir_tod | WNW                                  |
| WinSpd_tod | 9.7 mph                              |
| AirTemp_to | 77                                   |
| Precept_to | 0                                    |
| WaterTemp1 | 63                                   |
| GlobalID   | b1300b8e-4d4c-4a33-bfb1-099802995004 |
| Algae_fres | Not fresh                            |

Identified 1 feature

 *Cladophora* wash up locations

# Predictive Washup Tool vs Collector Points

## *In Situ* Observations

-  *Cladophora* observed
-  No *Cladophora* observed
-  No data

## Tool Outputs

-  Highest chlorophyll-a values
-  Clustered points

0 1.5 mi

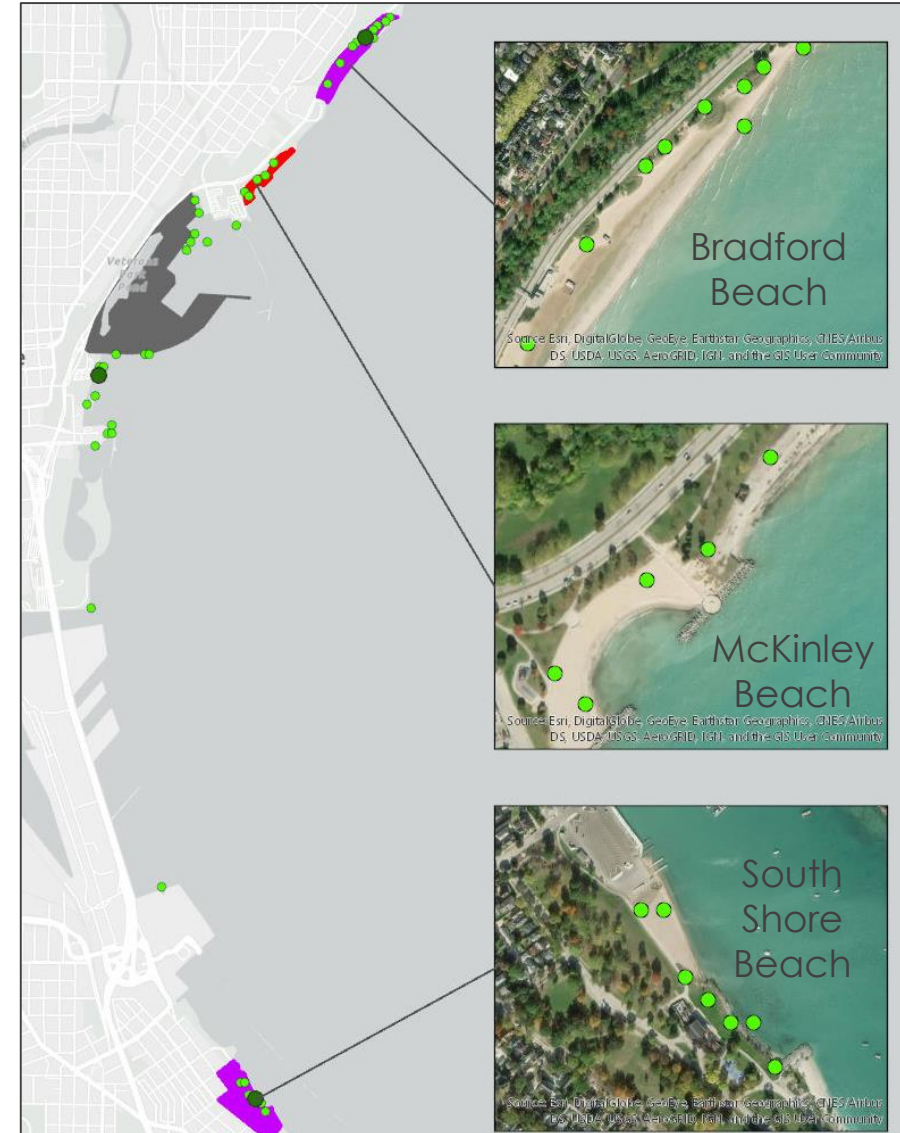




Image Credit: Scott Higgins, University of Waterloo



# Community Engagement

- ▶ Storytelling products with the goal of encouraging community involvement with GWMKE

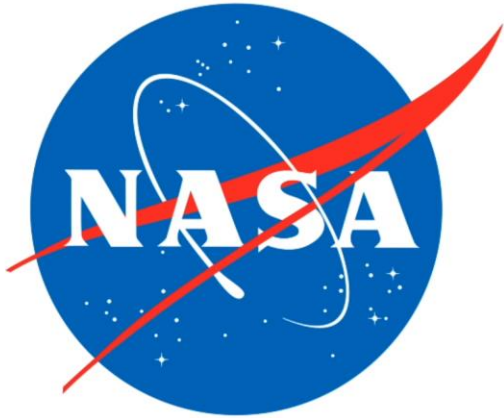
*#FunkyShoresMKE*



# Project Videos

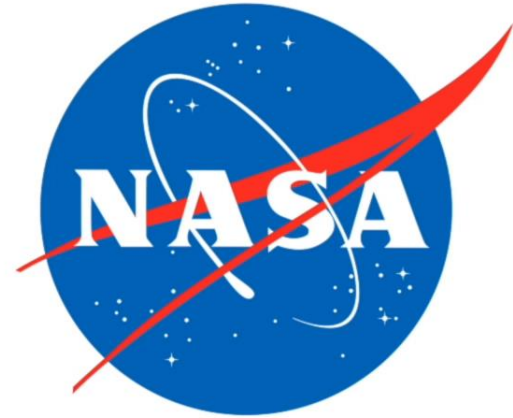
## **Summer**

*“From Lake Floor to Beach Shore”*



## **Fall**

*“Stinky Business”*





# Esri Story Map





## Twitter Post from GWMKE

**Groundwork Milwaukee** @GroundworkMKE · Sep 5

Over the summer of 2018, Groundwork Milwaukee has been collaborating with NASA Develop to build a model to predict where cladophora, a green algae, will wash-up on the shores of Lake Michigan. The goal is to speed up the removal of the washed-up...



**Lake Michigan Water Resources - NASA DEVELOP ...**

DEVELOP addresses environmental and public policy issues through interdisciplinary research projects that apply the lens of NASA Earth observations to commun...  
[youtube.com](https://www.youtube.com)



## Possible Community Engagement Tweets

“It’s that time of year. Cladophora is washing up on our beaches and costing Milwaukee economic losses due to beach closures. Read up on this [Stinky Situation](#) #FunkyShoresMKE”

“Cladophora. The nuisance algae you should know about. Smells bad and costs Milwaukee tens of billions of dollars. Read up on this [Stinky Situation](#) #FunkyShoresMKE”



# Conclusions

- ▶ The scientific analyses and tools produced by this project have the potential to help Groundwork Milwaukee more efficiently clean *Cladophora* washup from their community beaches.
- ▶ *In situ* data are needed to help refine these tools and analyses.
- ▶ Collector for ArcGIS is being utilized by Groundwork Milwaukee to build a database of *in situ* data.
- ▶ Community involvement and engagement can simultaneously help collect *in situ* data and make residents more aware of local environment problems and how they can help to solve them.
- ▶ Storytelling is often essential to encouraging involvement from the community. Our videos, Esri Story Map, and sample Twitter posts are resources that Groundwork Milwaukee can use to encourage the public to participate in their environmental restoration initiatives.



# Acknowledgments

## Groundwork Milwaukee

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- ▶ Lawrence Hoffman, GIS Program Manager
- ▶ Alex Halloway & Alex Litscher, GIS Interns

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- ▶ Joe Spruce, Science Systems and Applications, Inc.

## DEVELOP National Program Staff at NASA Ames Research Center

- ▶ Jenna Williams, former Center Lead
- ▶ John Dilger, former Geoinformatics Fellow
- ▶ Farnaz Bayat, current Center Lead

