

# Improved Forecasts of Respiratory Illness Hazard from Gulf of Mexico *Karenia brevis* Red Tide: 2018 NASA Public Health update

<sup>1</sup>Rick Stumpf, <sup>2</sup>Barbara Kirkpatrick,  
<sup>1</sup>Wayne Litaker, <sup>2</sup>Robert Courier,  
<sup>1</sup>Shelly Tomlinson, <sup>1</sup>Andrew Meredith,  
<sup>4</sup>Tracy Fanara, <sup>3</sup>Andy Reich

<sup>1</sup>NOAA, <sup>2</sup>Gulf of Mexico Coastal Ocean Observing System,  
<sup>3</sup>Florida Department of Health, <sup>4</sup>Mote Marine Laboratory



# *Karenia brevis* red tide, 2018

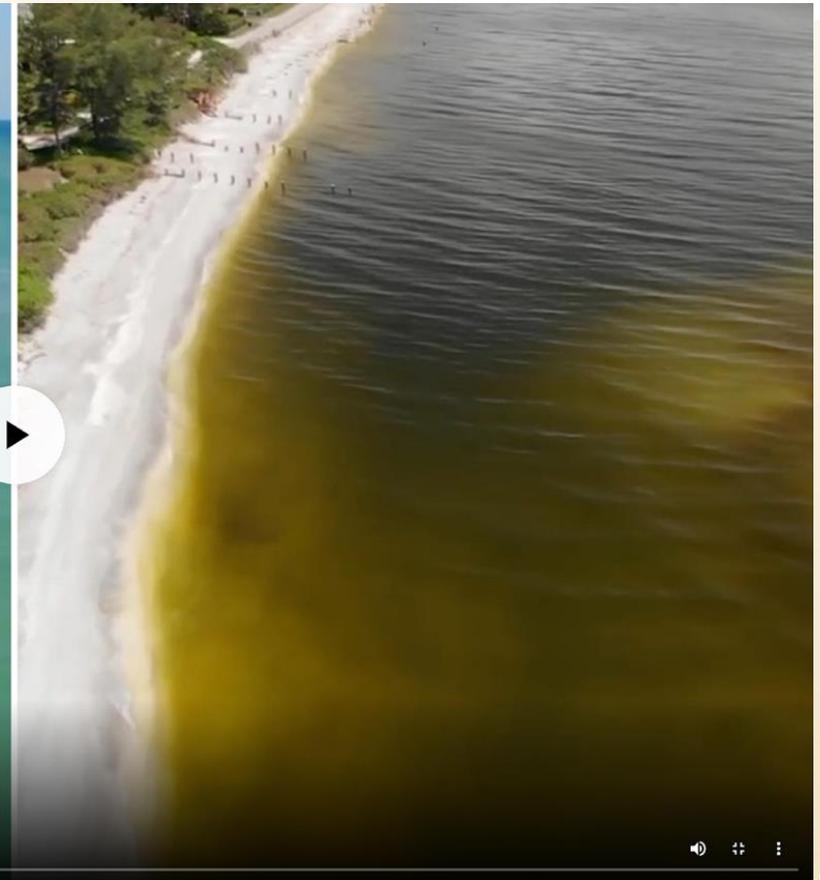
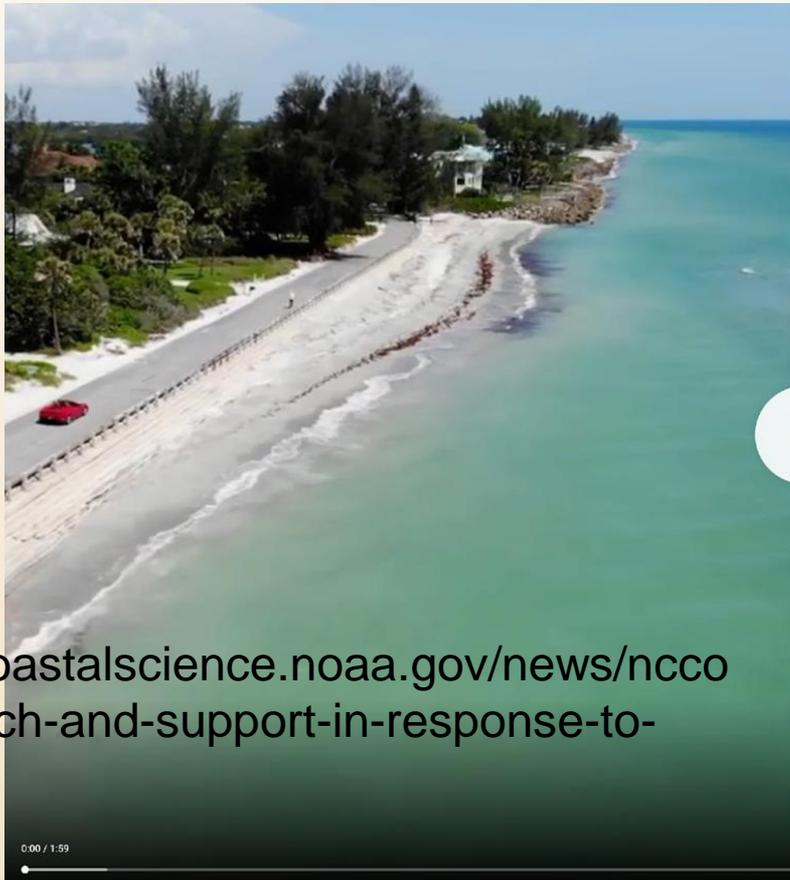
The New York Times

**Video of Casey Key, Florida, Before (June 2018) and During (August 2018) Red Tide**  
(video courtesy of Cody Johnson, @codesthedrones)

UPDATE

## A Red Tide on Florida's Gulf Coast Has Been a Huge Hit to Tourism

Though an algae bloom on the coast is improving, locals and business owners say it may be too little, too late.



<https://coastalscience.noaa.gov/news/nccos-research-and-support-in-response-to-red-tide/>

# Toxic *Karenia brevis* blooms

Microalga *K. brevis* forms extensive toxic blooms from Mexico from Texas to Florida

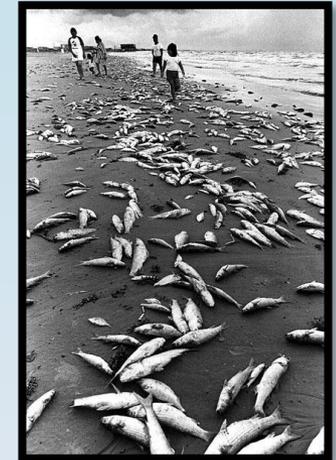
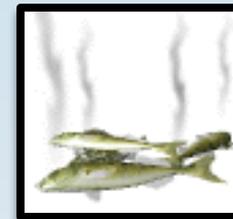
Late summer/early fall to year long  
Brevetoxins, sodium channel activators

Toxins kills fish, birds, dolphins and manatees, sea turtles

Neurotoxic shellfish poisoning

Economic losses in Florida and Texas

Respiratory illness in humans



# *Karenia brevis*: brevetoxins

Brevetoxins can aerosolize - particles 3-20  $\mu\text{m}$  range

Healthy people: upper airway irritant.

Coughing watery eyes, sinus pain

People with chronic lung disease (like asthma) become ill.

Early-mid 2000s NIH study quantified effects on lung function



# Effect of Exposure

Asthmatics 9% of population

One hour walk on the beach during a red tide;  
5 days for pulmonary function to return to  
baseline

54% increase in ER respiratory (asthma,  
pneumonia, bronchitis)

Sarasota County alone, ER costs increase up  
to \$4 million, depending on bloom severity

Lifeguards (occupational healthy group) - no  
pulmonary function normal effect

Loss revenue to area businesses (\$6  
million/month per county)

Critical need to accurately warn the public

Everyone reacts, useful indicator exposure



# Why does this matter?



Health » Florida's toxic algae problem and your health: 'Red tide' and 'green slime'

## Story highlights

Algae produce toxins that can cause a host of symptoms in humans at high concentrations

These toxins may be inhaled or ingested in contaminated water and seafood

"brought on by the red tide," she said.

**(CNN)** — When Marcy Cornell's toddler son "couldn't breathe" on the first day of their recent Florida vacation, she took him straight to the emergency room.

"Before they even asked me anything else ... they said, 'Did you go to the beach today?' " she recalled.

Doctors said her son had upper airway inflammation

Florida's toxic algae problem and your health: 'Red tide' and 'green slime'

By Michael Nedelman, CNN

Updated 2:00 PM ET, Sat August 18, 2018



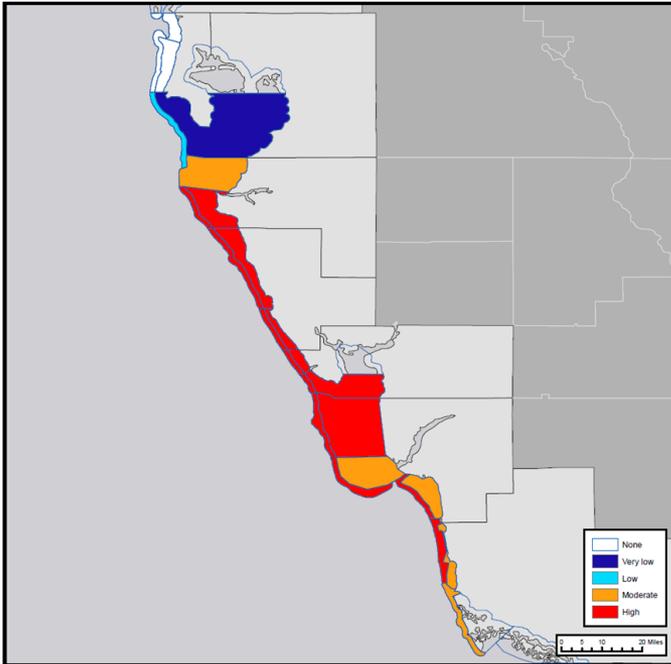
# Parts of current NOAA Bulletin



## Gulf of Mexico Harmful Algal Bloom Bulletin

Monday, August 20, 2018  
 NOAA National Ocean Service  
 NOAA Satellite and Information Service  
 NOAA National Weather Service

Instructions for viewing this geospatial pdf are available at: <https://go.usa.gov/xn9g2>.



In the map above, the highest level of potential respiratory irritation forecast is displayed as a layer for each day from 08-20-18 to 08-23-18. See next page for a table of the respiratory irritation forecasts.

## Region: Southwest Florida



### Conditions Report

Not present to high concentrations of *Karenia brevis* (commonly known as red tide) are present along-and offshore portions of southwest Florida, and not present in the Florida Keys. *K. brevis* concentrations are patchy in nature and levels of respiratory irritation will vary locally based upon nearby bloom concentrations, ocean currents, and wind speed and direction.

#### Recently Reported Impacts (Listed by County):

**Respiratory irritation:** Manatee, Sarasota, Lee, and Collier  
**Dead fish:** Manatee, Sarasota, Charlotte, Lee, and Collier

#### Definition of respiratory irritation levels.

| RESPIRATORY IRRITATION LEVEL | AFFECTED POPULATION |                               |                       |                                |                                   |
|------------------------------|---------------------|-------------------------------|-----------------------|--------------------------------|-----------------------------------|
|                              | NONE                | CHRONIC RESPIRATORY CONDITION | SENSITIVE TO RED TIDE | GENERAL PUBLIC (MILD SYMPTOMS) | GENERAL PUBLIC (INTENSE SYMPTOMS) |
| None                         | X                   |                               |                       |                                |                                   |
| Very low                     |                     | X                             |                       |                                |                                   |
| Low                          |                     | X                             | X                     |                                |                                   |
| Moderate                     |                     | X                             | X                     | X                              |                                   |
| High                         |                     | X                             | X                     | X                              | X                                 |

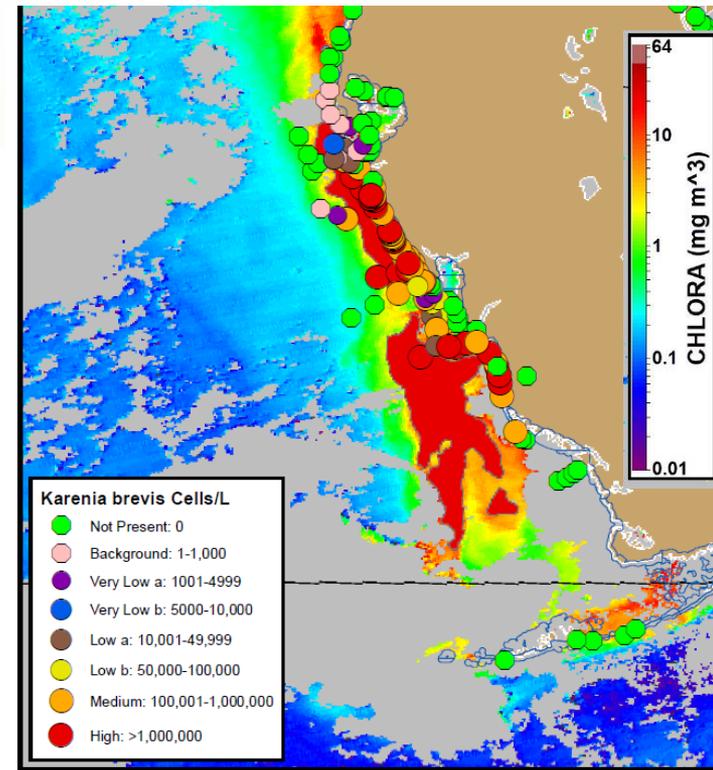
### Additional Resources

#### Health Information:

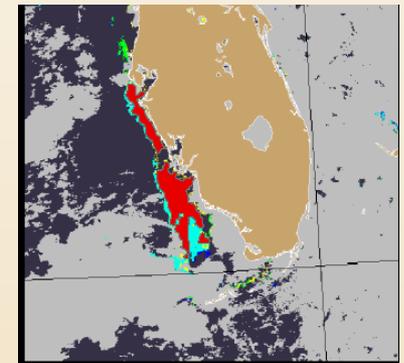
**Florida Department of Health:**  
<http://www.floridahealth.gov/environmental-health/aquatic-toxins/red-tide.html>  
**Other resources:** <https://go.usa.gov/xQNWp>

#### Recent, Local Observations and Data:

**Mote Marine Laboratory Daily Beach Conditions:**  
<http://visitbeaches.org>  
**Florida Fish and Wildlife Conservation Commission:**  
<http://myfwc.com/redtidestatus>



*Karenia brevis* cell concentration sampling data from: 08/10/18 through 08/17/18.

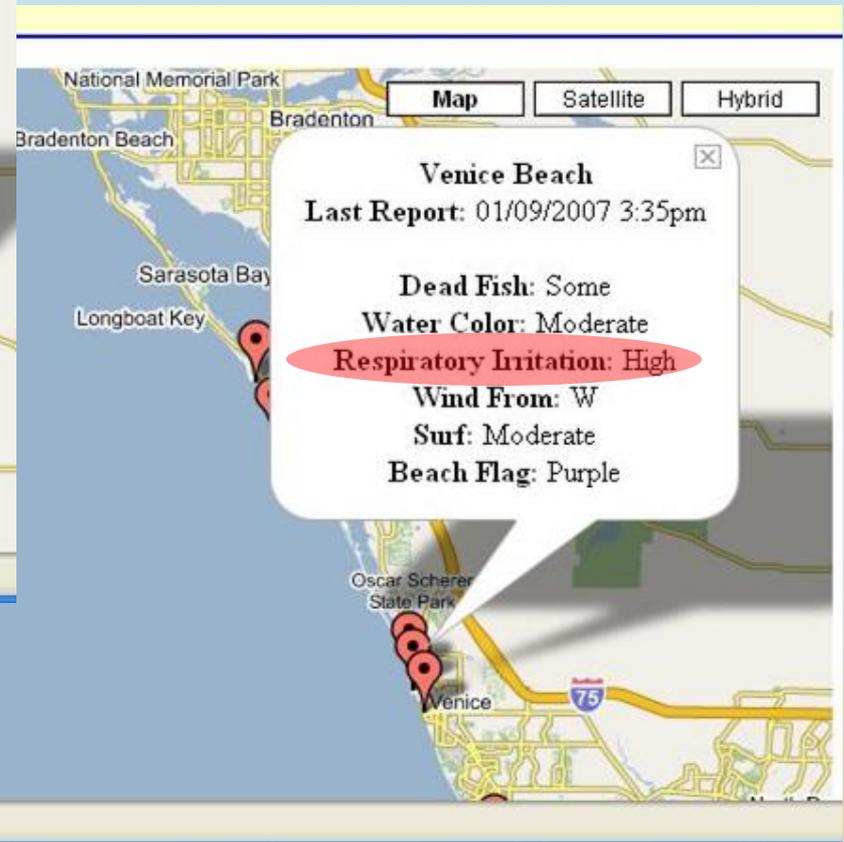
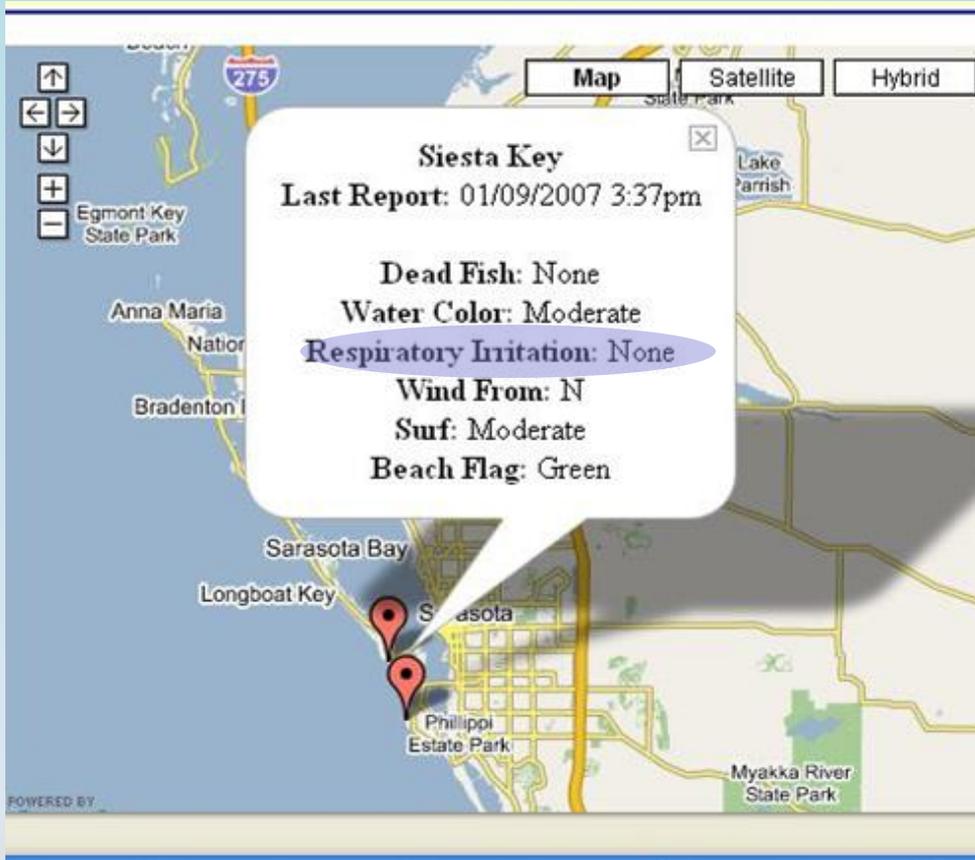


Verified and suspected HAB areas shown in red. Other areas with *K. brevis* optical characteristics shown in yellow (see p. 4 analysis for interpretation).

# Respiratory forecast is over entire county only twice a week

# Cell concentration patchy from beach to beach

~10 km apart



Impact changes with cells and wind direction

# Strategy: Use satellite data to inform sampling to improve resolution with volunteer monitoring goal of “every beach, every day”

Satellite identifies Bloom area

Local wind field models

Provide near real-time exposure levels

Measure cell and toxin concentrations

Respiratory risk proportional to *K. brevis* concentrations and windspeed when onshore

# Integrating with existing volunteer sampling programs

Mote Marine Laboratory, Education & Outreach Dept.  
Texas Red Tide Rangers. Master Naturalist Program supported by UTRGV, Texas Sea Grant, Texas Parks and Wildlife Dept. (TPWD)

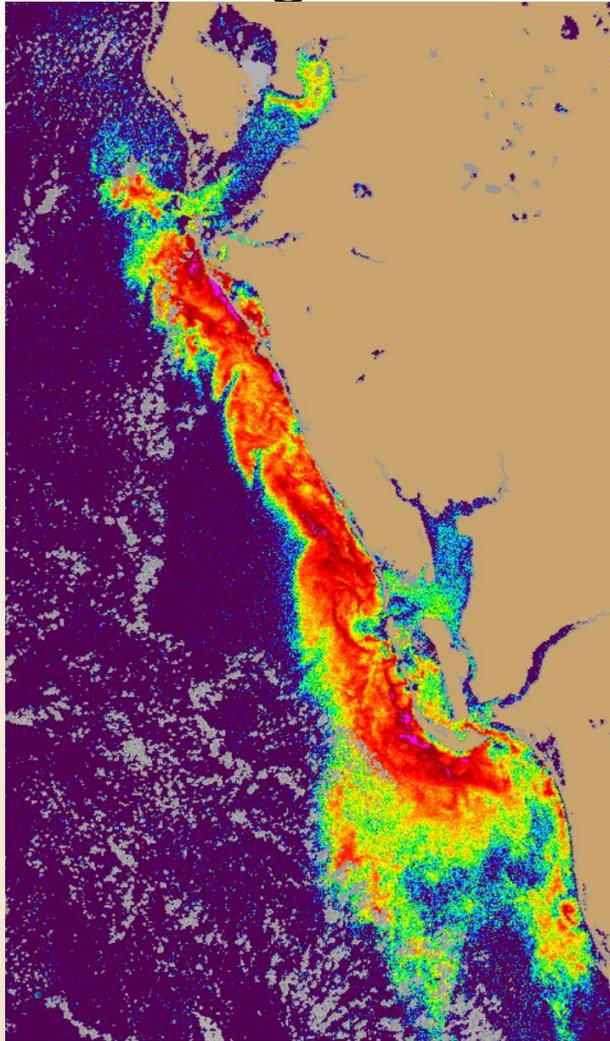
TexHAB program, coordinated by TPWD

Expansion: Florida Fish and Wildlife Research Institute (primary agency in Florida for coastal HAB monitoring)

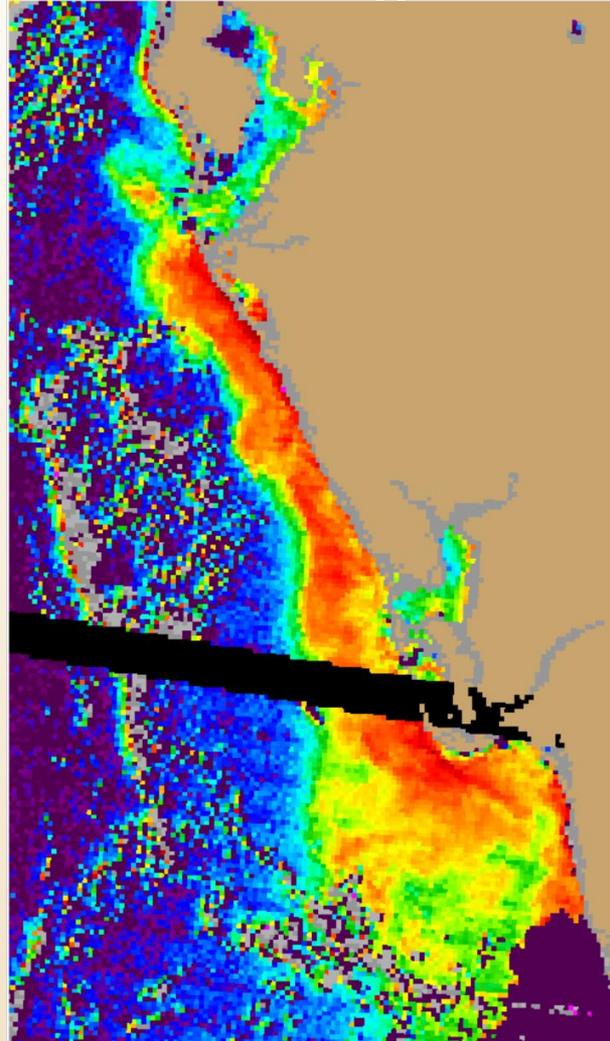
Collier County Pollution Control

# MODIS and Sentinel-3 fluorescence detection

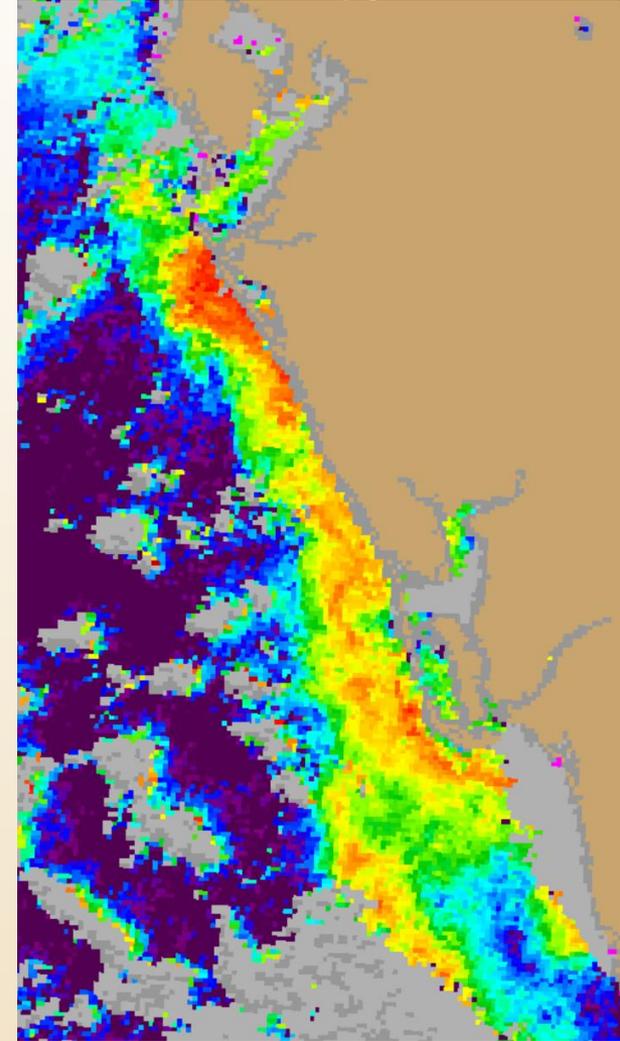
S3 Aug 09



Terra Aug 08



Aqua Aug 09



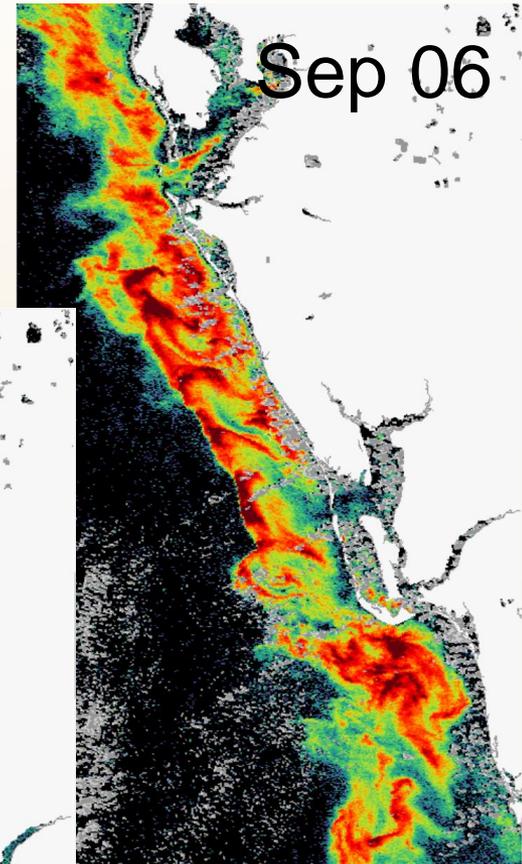
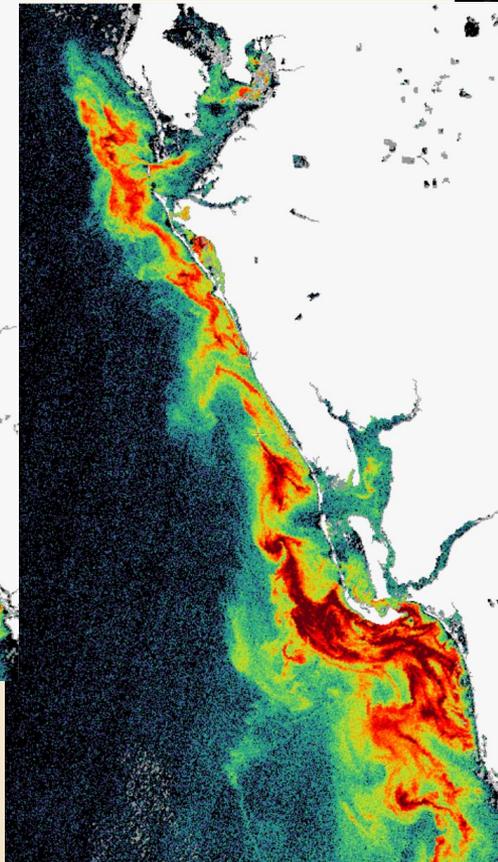
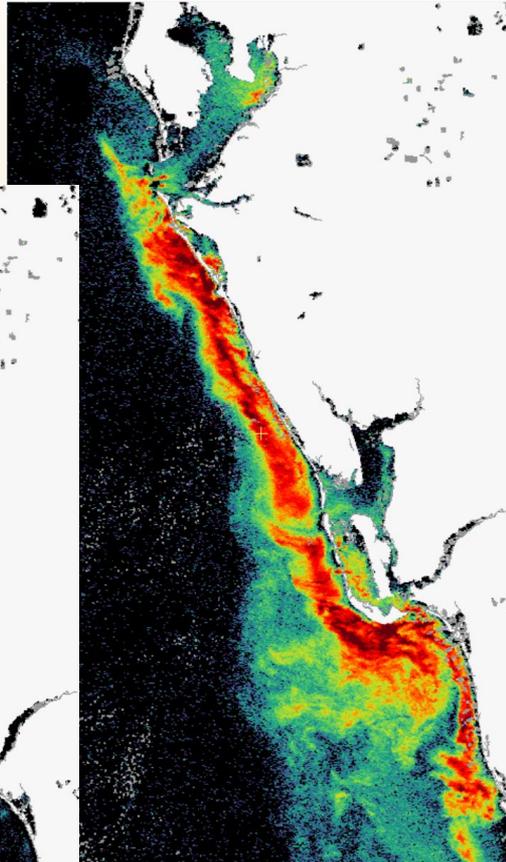
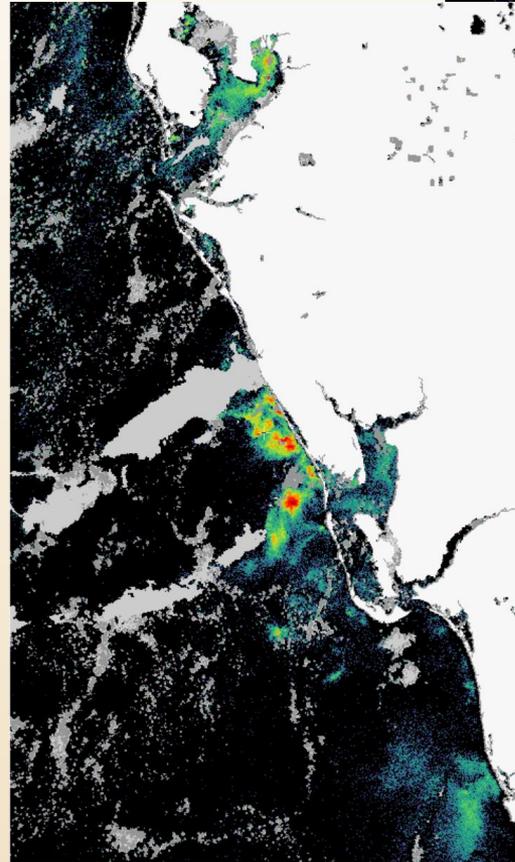
# Fluorescence provides area of likely bloom Sentinel-3 2018

July 17

Aug 06

Aug 28

Sep 06

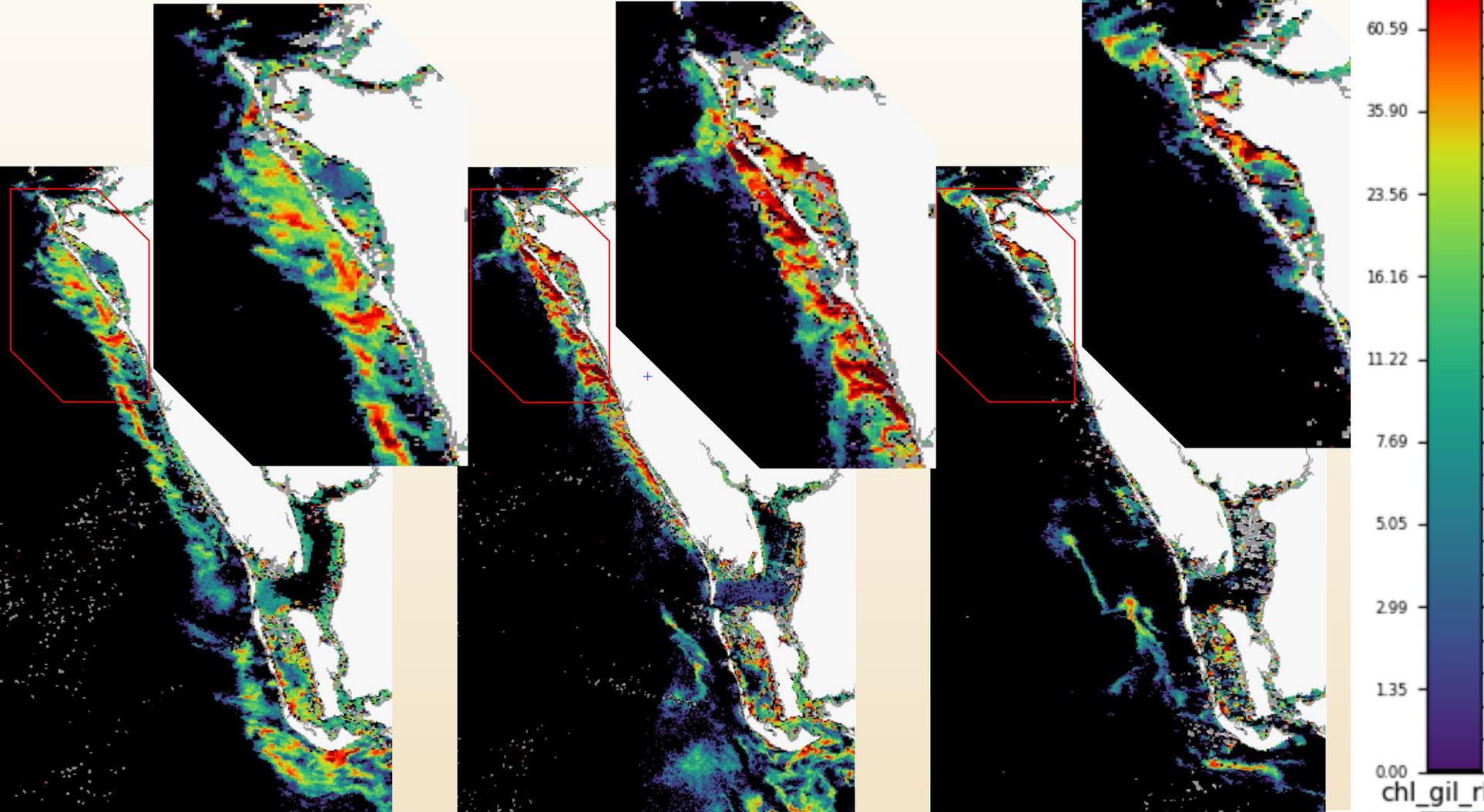


# S3 chlorophyll, $chl_a > 5 \mu\text{g L}^{-1}$ has major impact

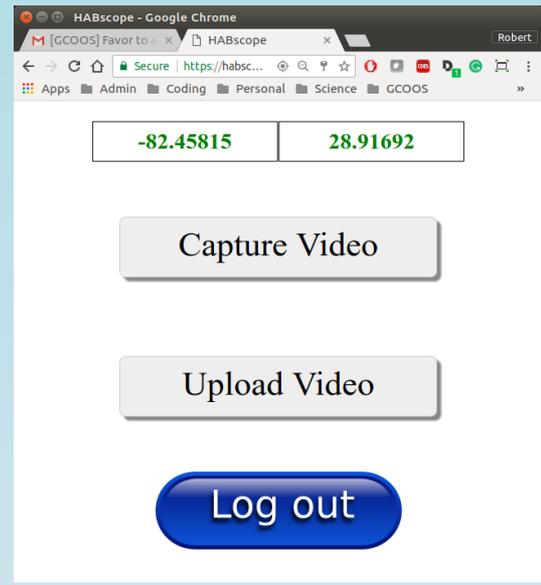
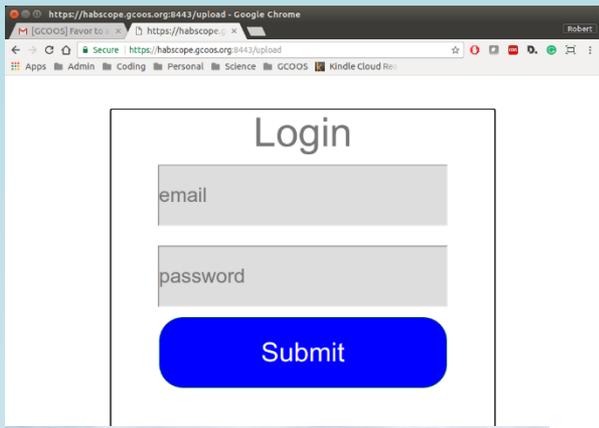
Aug 06

Aug 17

Sep 02



# HABscope Upload Ap working



| Timestamp (UTC)                         | Sentinel       | Organization | Lat      | Lon       | Raw Video | Analyzed Video | Estimated c/L |
|---|----------------|--------------|----------|-----------|-----------|----------------|---------------|
| Tue Sep 05 2017 15:05:14 GMT+0000 (UTC) | Linda Powers   | Mote         | 26.93296 | -82.36493 |           |                | 120000        |
| Tue Sep 05 2017 13:51:59 GMT+0000 (UTC) | Sia Maleknasri | Mote         | 27.46240 | -82.65463 |           |                | 0             |
| Fri Sep 01 2017 12:07:01 GMT+0000 (UTC) | Cindy Potzer   | Mote         | 27.07906 | -82.45255 |           |                | 120000        |
| Fri Sep 01 2017 11:16:42 GMT+0000 (UTC) | Cindy Potzer   | Mote         | 27.05909 | -82.38917 |           |                | 0             |
| Thu Aug 31 2017 15:19:31 GMT+0000 (UTC) | Lindsey Flynn  | CMA          | 27.97723 | -82.81944 |           |                | 120000        |
| Thu Aug 31 2017 15:13:34 GMT+0000 (UTC) | Lindsey Flynn  | CMA          | 27.97734 | -82.81943 |           |                | 120000        |
| Tue Aug 29 2017 13:25:11 GMT+0000 (UTC) | Linda Powers   | Mote         | 26.93299 | -82.36488 |           |                | 1156000       |
| Tue Aug 29 2017 12:40:58 GMT+0000 (UTC) | Sia Maleknasri | Mote         | 27.46219 | -82.65462 |           |                | 120000        |
| Fri Aug 25 2017 14:51:42 GMT+0000 (UTC) | Tony Tabeck    | Mote         | 27.97720 | -82.81943 |           |                | 120000        |
| Fri Aug 25 2017 14:43:04 GMT+0000 (UTC) | Tony Tabeck    | Mote         | 27.97723 | -82.81937 |           |                | 120000        |
| Fri Aug 25 2017 10:47:05 GMT+0000 (UTC) | Cindy Potzer   | Mote         | 27.07963 | -82.45197 |           |                | 120000        |
| Wed Aug 23 2017 12:09:24 GMT+0000 (UTC) | Tony Tabeck    | Mote         | 27.26662 | -82.55452 |           |                | 279000        |
| Wed Aug 23 2017 12:05:02 GMT+0000 (UTC) | Tony Tabeck    | Mote         | 27.26675 | -82.55467 |           |                | 348000        |
| Wed Aug 23 2017 10:41:20 GMT+0000 (UTC) | Cindy Potzer   | Mote         | 27.08005 | -82.45242 |           |                | 0             |
| Tue Aug 22 2017 15:14:53 GMT+0000 (UTC) | Linda Powers   | Mote         | 26.93300 | -82.36487 |           |                | 120000        |

# Observer training



**1 Components Illustration**

**HABscope Quick List:**

1. Place exactly 3 drops of sample on slide.
2. Condenser must be at the highest possible setting to avoid crystallization.
3. Scope to lightness should be at maximum intensity.
4. Begin with the diaphragm lever all the way to the right (closed position) and slide it back slightly to the left (open) and there is a crisp black circle around your field of view.
5. Adjust zoom so that the words appears directly above the "G" in video or roughly 50%.
6. Use fine and coarse adjustment knobs to focus. Coarse scope will move in and out of focus periodically.
7. Tap screen on top to engage manual location.
8. Record 30 seconds. Avoid focusing the HABscope during this time so as to prevent shattering the video.
9. Select "Upload video". If all goes well you will see a smiling rainbow fish.
10. Document your experience in the HABlog.

|                            |                               |
|----------------------------|-------------------------------|
| 1 Eyepiece WFOV            | 14 Rotating Head Stage Screw  |
| 2 Diaphragm Adjusting Ring | 15 Coarse Focus Knob          |
| 3 Eyepiece Tube            | 16 Fine Focus Knob            |
| 4 Nosepiece                | 17 2X Stage Moving Knob       |
| 5 Objective                | 18 Power Switch               |
| 6 Slide Holder             | 19 Magnitude Intensity Dial   |
| 7 Mechanical Stage         | 20 Immersion Oil              |
| 8 Light Collector          | 21 Stage Center               |
| 9 Microscope Base          | 22 Condenser Lock Thumb Screw |
| 10 Eyepiece WFOV           | 23 Condenser Control Knob     |
| 11 Color Filter            | 24 Condenser                  |
| 12 Viewing Head            | 25 Color Filter Holder        |
| 13 Microscope Body         | 26 3X Diaphragm Lever         |

Mote Education Dept.  
 Volunteers  
 Texas Red Tide Rangers  
 Retrained Aug 2018  
 FWRI bringing in parks

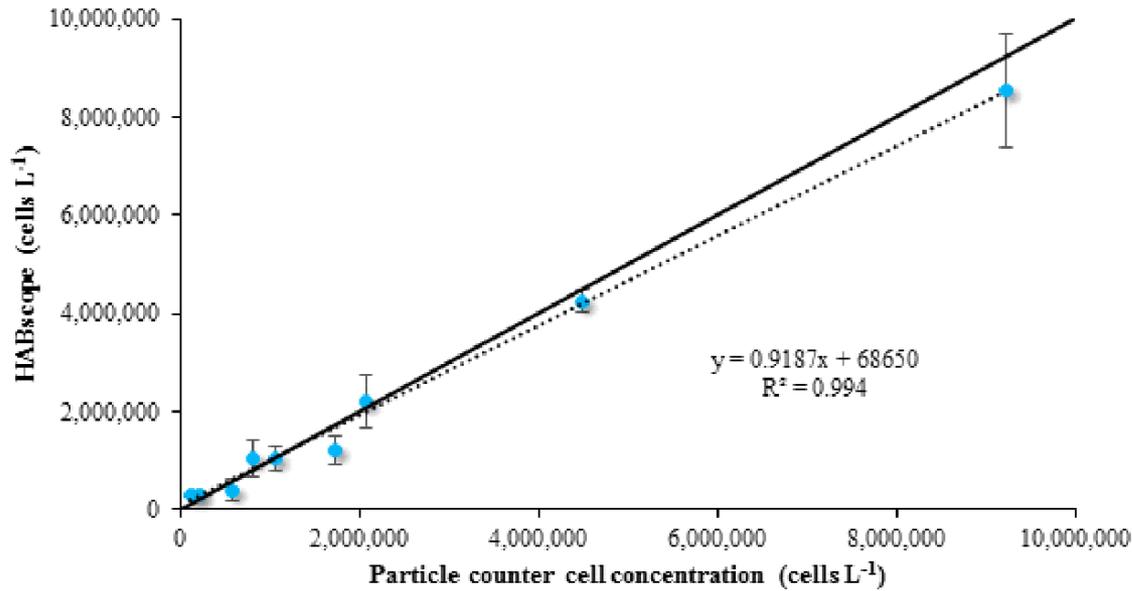


S. Padre Island, UTRGV Coastal Lab

# Example video, worst case

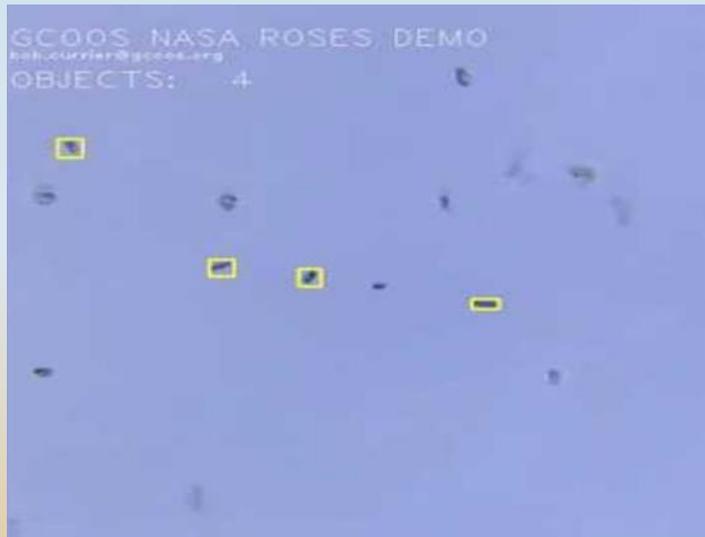


## HABscope Calibration



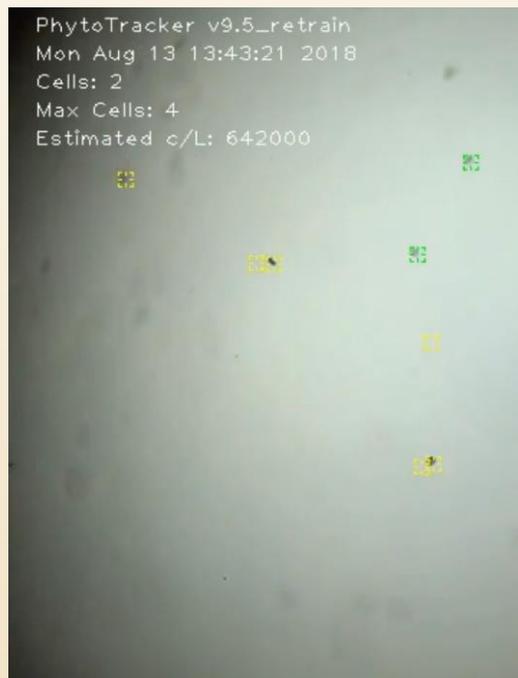
## Validation

Aug 21, 2018  
Sarasota County

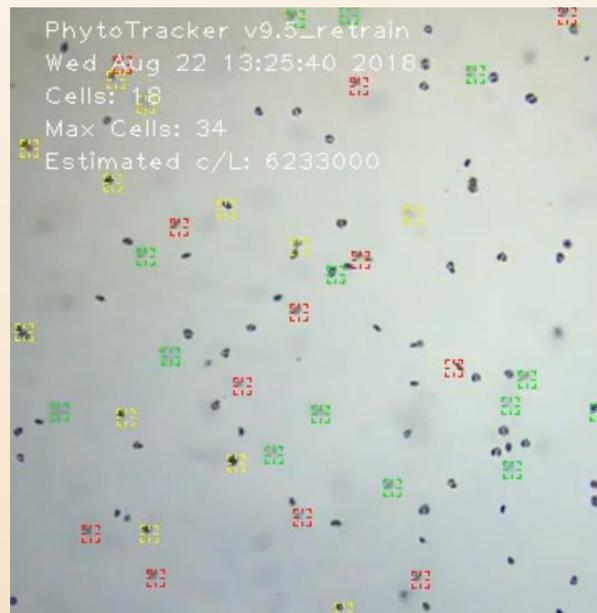


# Video assessment

| Timestamp (UTC)     | Site                | GPS              | Video | Status        | Analyst       | HABscope c/L | Manual c/L | Admin |
|---------------------|---------------------|------------------|-------|---------------|---------------|--------------|------------|-------|
| 2018-09-08 18:53:35 | Little Sarasota Bay | -82.5173 27.2442 |       | Pending       |               | 590000       | 0          |       |
| 2018-09-08 18:52:27 | Little Sarasota Bay | -82.5173 27.2442 |       | Pending       |               | 590000       | 0          |       |
| 2018-09-08 16:38:26 | Venice Beach        | -82.4524 27.0830 |       | Pending       |               | 694000       | 0          |       |
| 2018-09-06 13:42:18 | Longboat Key        | -82.6546 27.4625 |       | Approved      | Chris Holland | 642000       | 0          |       |
| 2018-09-06 13:15:06 | NaN                 | -82.5774 27.3330 |       | Approved      | Chris Holland | 50000        | 0          |       |
| 2018-09-06 13:11:26 | Manasota Key        | -82.3648 26.9329 |       | Overestimated | Chris Holland | 642000       | 0          |       |



***Karenia red tide forecasts***



**2018 NASA Public Health Summary**

# What are all the pieces that have to work?

## Field:

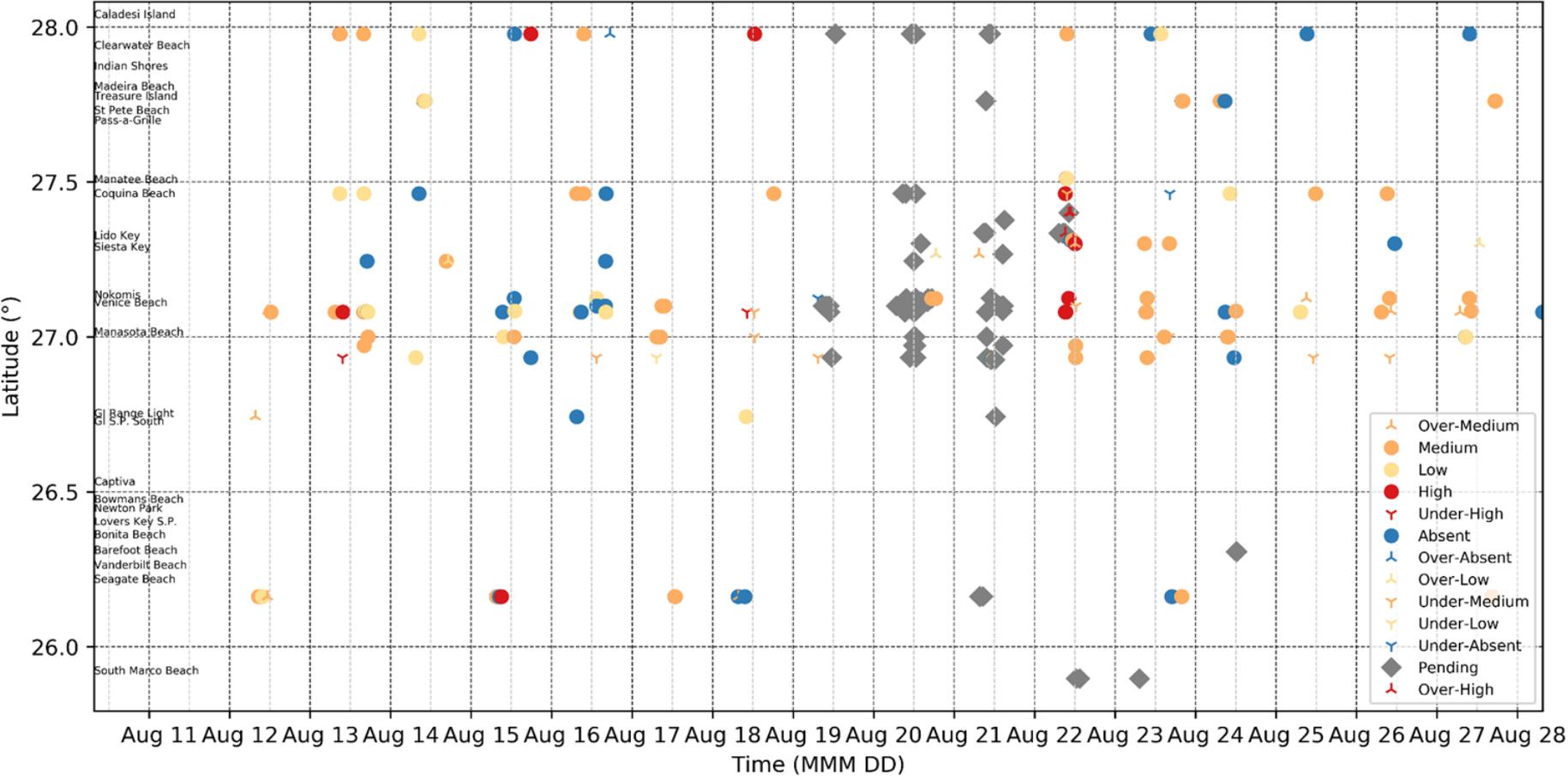
Functioning HABscope,  
microscope and app  
Find location, upload  
Training materials and  
trained volunteers  
Volunteer sampling  
near daily  
Video software review  
Validation

## Post-process:

Review of all videos  
System management  
Forecast model  
Web posting  
  
Find the gaps, fix, and  
repeat

# Sampling frequency

28-day Cell Count Summary from 2018-08-10 07:37:00 to 2018-08-28 07:31:00 EDT

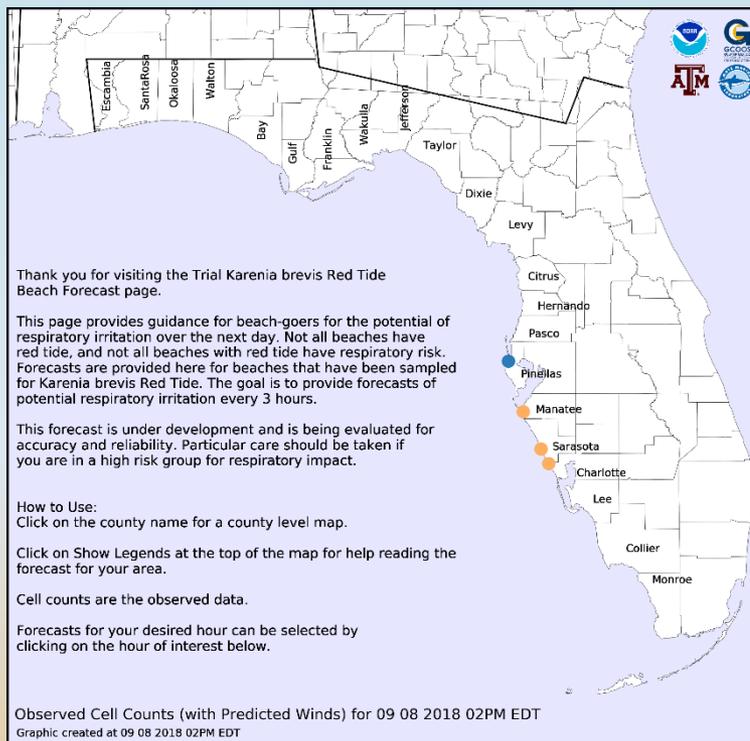


# Respiratory model

Model. Python-based, uses NDFD winds and cell counts to predict respiratory over time at each beach.

Deliver products to GCOOS, BCRS, NOAA/CO-OPS

Visual review of model for forecasts



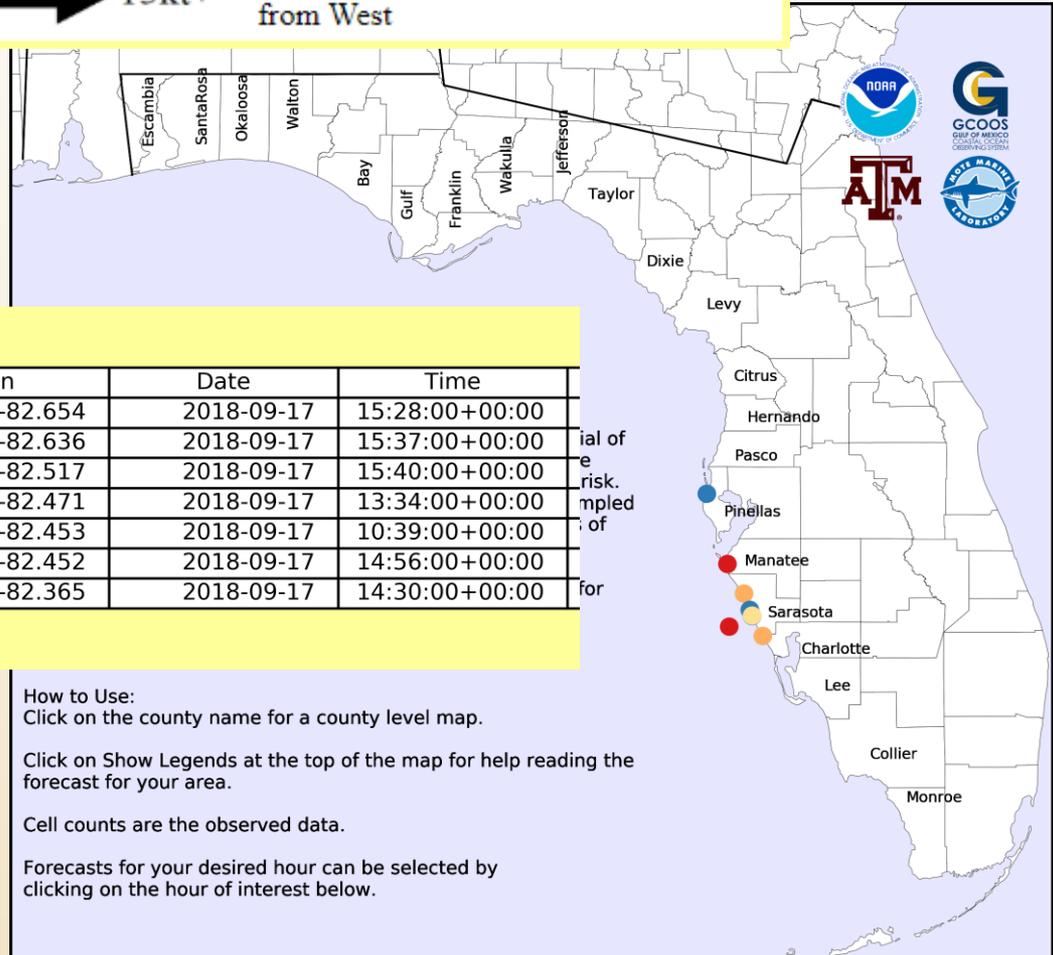
# Forecast

Python-based, uses NDFD winds and cell counts

[Click to Show Legends](#)

|                    |         |          |          |                           |      |
|--------------------|---------|----------|----------|---------------------------|------|
| <b>Cell Counts</b> | Absent  | Very low | Low      | Medium                    | High |
| <b>Forecasts</b>   | Absent  | Very low | Low      | Moderate                  | High |
| <b>Winds</b>       | → 0-5kt | ➔ 5-15kt | ➔➔ 15kt+ | Winds in legend from West |      |

Intent to deliver to GCOOS and other locations



| Num | Cell Count | Lat    | Lon     | Date       | Time           |
|-----|------------|--------|---------|------------|----------------|
| 02  | High       | 27.462 | -82.654 | 2018-09-17 | 15:28:00+00:00 |
| 03  | High       | 27.0   | -82.636 | 2018-09-17 | 15:37:00+00:00 |
| 04  | Medium     | 27.244 | -82.517 | 2018-09-17 | 15:40:00+00:00 |
| 05  | None       | 27.125 | -82.471 | 2018-09-17 | 13:34:00+00:00 |
| 06  | None       | 27.08  | -82.453 | 2018-09-17 | 10:39:00+00:00 |
| 07  | Low        | 27.083 | -82.452 | 2018-09-17 | 14:56:00+00:00 |
| 08  | Medium     | 26.933 | -82.365 | 2018-09-17 | 14:30:00+00:00 |

**How to Use:**

Click on the county name for a county level map.

Click on Show Legends at the top of the map for help reading the forecast for your area.

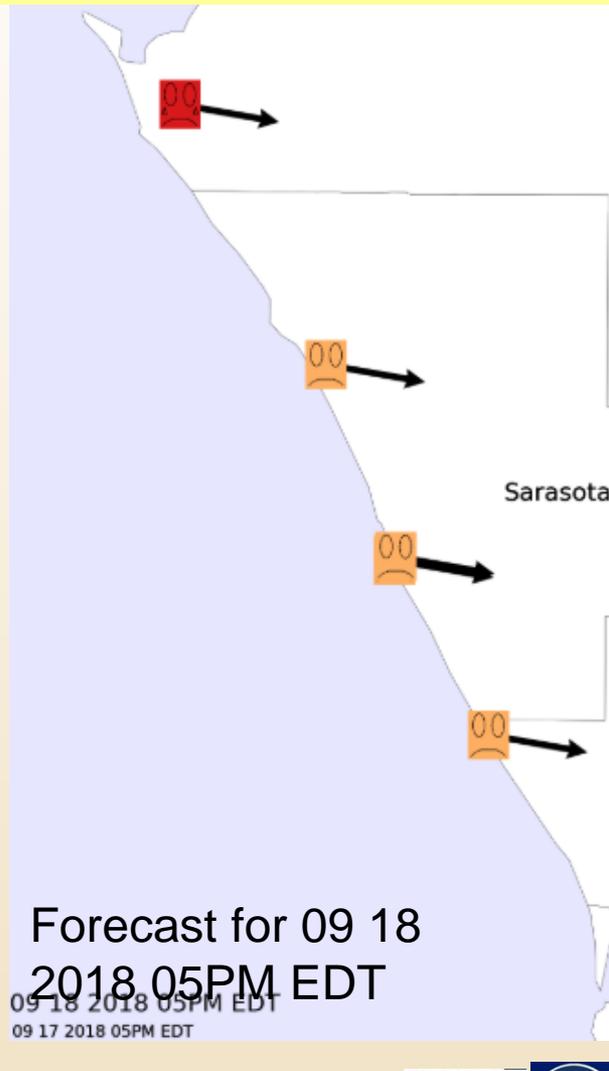
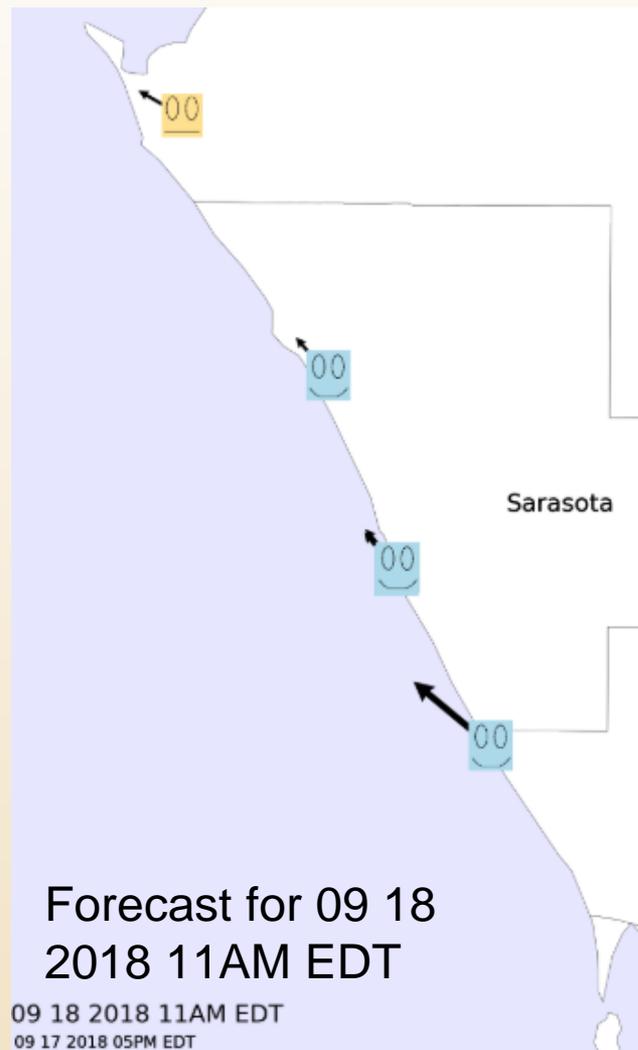
Cell counts are the observed data.

Forecasts for your desired hour can be selected by clicking on the hour of interest below.

Observed Cell Counts (with Predicted Winds) for 09 17 2018 05PM EDT  
Graphic created at 09 17 2018 05PM EDT

# Forecast turnaround every 3 hours. As fast as video review

| Cell Count | Lat    | Lon     | Date       | Time           |
|------------|--------|---------|------------|----------------|
| High       | 27.462 | -82.654 | 2018-09-17 | 15:28:00+00:00 |
| High       | 27.0   | -82.636 | 2018-09-17 | 15:37:00+00:00 |
| Medium     | 27.244 | -82.517 | 2018-09-17 | 15:40:00+00:00 |
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| Medium     | 26.933 | -82.365 | 2018-09-17 | 14:30:00+00:00 |



| <b>Milestones</b>   | <b>2019 continuation year</b>  |
|---|--|
| <p>Started at ARL 3, Viability established<br/>           Currently ARL 6 Potential demonstrated</p> <p>Satellite Modeling Development (RS)</p> | <p>ARL 7: functionality demonstrated<br/>           Late 2019, ARL 8 functionality proven</p> <p>Satellite data being posted for state use</p> |
| <p>Forecast Creation (RS)<br/>           Code developed, python based</p> <p>Integrate weather (NDFD) &amp; data</p>                            | <p>Continue model validation, design “gap filling” for missing days</p> <p>Bring in other data to expand forecast</p>                          |
| <p>Forecast Distribution (RS/BK)</p>  | <p>Review of products,</p>   |
| <p>Skill Assessment (RS)</p>  | <p>Complete skill assessment</p>   |
| <p>Smartphone Communication (BK)</p>  | <p>Maintain app</p>  |
| <p>Community group recruit/training (BK)</p>  | <p>Expanding network</p>   |
| <p>Training materials for sentinel groups and forecasters. (BK)</p>   | <p>Multiple trainers</p>   |
| <p>End User workshops (BK)</p>  | <p>Comment by a variety of users</p>   |
| <p>Public outreach (BK)</p>   | <p>Design media engagement</p>   |

# Risks to project

Major risk: consistency, reliability  
and public perception

Weekends, holidays, hurricanes  
for review

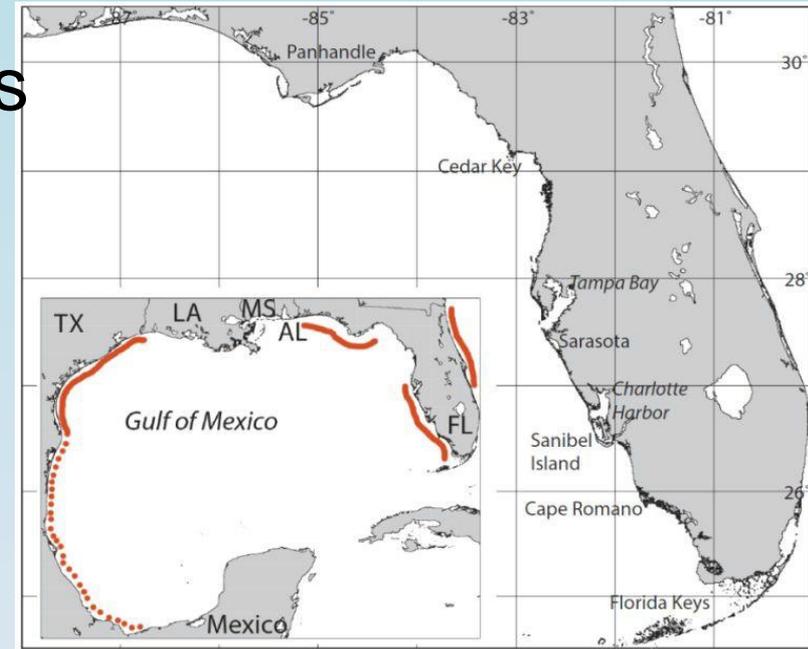
May be working through 2019  
bloom season, potential  
additional extension.

Papers are starting now, drafts  
now for:

HABscope validation

Bloom severity metric

Chlorophyll algorithm assessment



Red indicates regions where *K. brevis*  
blooms adversely impact coastal  
communities most often.

# Performance Metrics

| Metric                 | Measures  |                                  |
|------------------------|---|----------------------------------|
| Forecast resolution    | # of beaches during red tide  |                                  |
| Forecast frequency     | # daily forecasts during red tide   |                                  |
| Skill                  | Accuracy of risk prediction   | Accuracy of wind forecasts       |
| Visibility             | Number of Web hits, Feeds, # and freq. media outlets                          | # of media outlets and frequency |
| Training               | Organizations trained in field program  | Managers informed of products    |
| Monitoring skill       | Accuracy of volunteer beach reports   |                                  |
| Operational Efficiency | Total time per week required for forecasts                                    |                                  |
| End user satisfaction  | Quantitative assessment<br>Qualitative assessment<br>Feedback/concern logbook | Initial and then ongoing annual  |

