

# Florida Red Tide Mitigation and Technology Development Initiative

## Technology Advisory Council

Kevin Claridge

Vice President, Sponsored Research and Coastal Policy Programs

February 18, 2022



# TAC Meeting Agenda

- Meeting Facilitation
  - Council Questions Anytime and Public Comment Period
- Council Members Role Call and Chair Remarks
- Red Tide Initiative Overview
- Research Process
- Mitigation and Technology Development Facility
- Projects at a Glance
- Initiative Reporting
- 4<sup>th</sup> Request For Proposals and Webinar
- Promising Tools and Technologies
- Looking Ahead
- Public and Partner Comments
- Closing Council Member Remarks
- Facility Tour!



# Technical Advisory Council

Dr. Michael P. Crosby, Chair – Mote President & CEO

Dr. James Powell – House Speaker Appt

Dr. Sherry Larkin – Senate President Appt

Dr. Katherine Hubbard – FWC Appt

David Whiting – DEP Appt

Governor Appointee Pending



# Red Tide Initiative Overview

- Signed into law by Governor DeSantis in June 2019
  - 379.2273 Florida Statutes
  - Mote Marine Laboratory partnership with Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute
- \$18 million over 6 years (\$3 million per year) contracted by FWC-FWRI to Mote
- Reporting requirements (FWC Contract, TAC, and Annual Report)
- Legislative intent:
  - develop **mitigation** technologies and approaches to address the impacts of red tide on coastal environments and communities in Florida
- General Structure:
  - Lab space, *Karenia brevis* culture, and mesocosms for:
  - Projects leading to red tide mitigation tools



# Red Tide Initiative Research Process

Tier 1



Tier 2



Tier 3

Laboratory  
Experiments &  
Literature Search

Mesocosms  
Raceways

Canals/Marinas  
Nearshore  
Offshore



Does it kill cells and  
eliminate toxins  
in the lab?

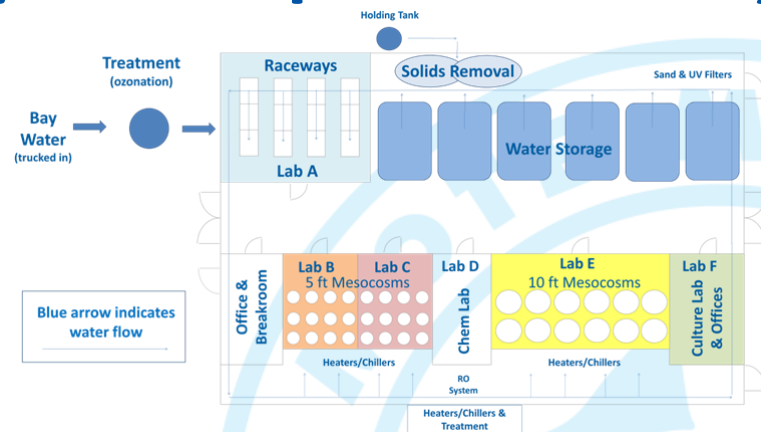
Is it effective with natural  
communities?  
Are there adverse impacts?  
Logistical issues?  
Economically feasible?

Pilot Studies  
Field Demonstrations  
Federal/State/Local  
Regulatory Approvals



# Mitigation and Technology Development Facility

- Mote Aquaculture Research Park
- 150K gallons treated and recirculated seawater
- Tiered safe setting research through lab-based, large-scale 5ft and 10ft mesocosms, and raceways
- Large volumes of *K. brevis*
- Ecosystem-based testing of mitigation compounds in a controlled setting to prepare for field implementation
- Enhanced air treatment, PPE provided, and air testing
- Do no additional health or environmental harm
- No charge for facility use, culture, and assistance as part of Initiative



Research Mesocosms



Research Raceways



Red Tide Culture



Facility Grand Opening



Partnership Signage



# Year 1 and 2 Projects

1. Dr. Kathryn J. Coyne, University of Delaware: *Optimizing production of a dinoflagellate–specific **algicide** for control of *Karenia brevis**
2. Dr. Sumit Chakraborty, Mote Marine Laboratory, *Development and Validation of New and Existing Technologies: Expanding PHySS's (Programmable Hyperspectral **Seawater Scanner**- PHySS(2.0)) Role in Mitigation of Harmful Impacts Caused by the Florida Red Tide*
3. Dr. Allen Place (Taylor Armstrong presenting), University of Maryland: *Pushing *Karenia* Over the Edge with Beer Derived **Flavonoids***
4. Dr. William Haskell, Mote Marine Laboratory, ***Automated in situ Advanced Sensing** Technology Development for Red Tide Mitigation and Control (PHySS-C)*
5. Dr. Vijay John, Tulane University: *A Thin Shroud with Integrated **Algaecide to Flocculate and Sink** *Karenia brevis**
6. Dr. Richard Pierce, Mote Marine Laboratory, *Testing the **Efficacy of Products for Mitigating Harmful** Effects of *Karenia brevis* Red Tide Events along the Florida Gulf Coast*
7. Dr. Don Anderson, Woods Hole Oceanographic Institute: *Fate and Effects of *Karenia brevis* Cells, Toxins, and Nutrients Following **Clay Application** for Bloom Control*
8. Dr. Vincent Lovko, Mote Marine Laboratory, *Developing **UAV-based Red Tide Detection** System*
9. Dr. Michael Parsons, Florida Gulf Coast University: *Examining the Feasibility of **Removing and Composting Fish Carcasses** to Mitigate Red Tide*
10. Sarah Caywood and Aspen Cook, Mote Marine Laboratory, *Expansion and Updates to the **Beach Condition Reporting System***
11. Dr. Dana Wetzel, Mote Marine Laboratory, ***Natural Compound Control** and Mitigation for Red Tide*



# Year 1 and 2 Projects

1. Neil Williams, nTec solutions LLC: *A Chemical-Free Red Tide Mitigation Technology Utilizing **UV-C LEDs***
2. Dr. Vincent Lovko, Mote Marine Laboratory, *BloomZoom: A Portable **Phone-based Microscope for Quantitative Detection** of *K. brevis* Through Citizen Science*
3. Dr. Alexis Wells Carpenter, AxNano LLC: *Evaluation of Controlled Release **Oxidants** for Red Tide Treatment and Mitigation*
4. Ralph Elliott, Ecological Laboratories: ***Microbe-Lift** Mitigation 96 Hour Testing with *K brevis**
5. Dr. Cynthia Heil, Mote Marine Laboratory, *Citizen Science Detection and Quantification of Florida Red Tides via Personal and **Smartphone-enabled PCR Technology***
6. Dr. Regina Rodriguez, Carbonxt: *In-situ Mitigation of Florida Red Tide via **Activated Carbon***
7. Dr. Cynthia Heil, Mote Marine Laboratory, *Evaluation of **QUAT Efficacy** for Red Tide Mitigation*
8. Annarie Lyles, Solaris Cybernetics, LLC: *Efficacy of **EVIE Robot** against *K. brevis**
9. Dr. Dana Wetzel, Mote Marine Laboratory, *A Rapid Field Red Tide Toxin **Biosensor for Commercially Important Shellfish and Seawater***
10. Dr. Jamie Lead, University of South Carolina: *A preliminary study to assess the feasibility of a **nanotechnology** approach to the removal of *Karenia brevis* cells and brevetoxin from estuarine and marine waters*
11. Dr. George Philippidis, University of South Florida: *Bioprospecting of natural **algicidal bacteria** associated with Harmful Algal Blooms to develop a sustainable mitigation strategy for red tides*



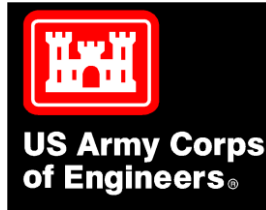


# Year 3 Projects

1. Dr. Jennifer McCall, University of North Carolina at Wilmington, *Enabling **accurate field-based testing for shellfish farmers** with optimized toxin extraction and stable standards*
2. Dr. William Haskell, Mote Marine Laboratory, *Development of a low-cost propelled autonomous **underwater vehicle for red tide mitigation** and early response*
3. Dr. George Philippidis, University of South Florida, *Red tide mitigation through natural **algicidal bacteria** suppression of *K. brevis* during HAB progression*
4. Dr. Julia Darcy, AxNano LLC, *Controlled Release **Oxidants** for Red Tide Treatment and Mitigation*
5. Dr. Vijay John, Tulane University, *A Thin Shroud with **Integrated Algaecide to Flocculate and Sink Karenia Brevis***
6. Dr. Kathryn Coyne, University of Delaware, *Continued development of **bacteria-derived algicidal compounds** for mitigation of *Karenia brevis**
7. Dr. James Ivey, University of South Florida, **Karenia* Mitigation Platform: means and method for enhancing, vetting, and **deploying red tide mitigation** technologies within open water conditions.*
8. Dr. Donald Anderson, Woods Hole Oceanographic Institute, *Fate and Effects of *Karenia brevis* Cells, Toxins, and Nutrients Following **Clay***
9. Thoram Charanda, Prescott Clean Water Technologies, LLC, *Innovative Use of Advance **Oxidation, Nanobubble-Cavitation** for Rapid Deployment to Restore Severely Impacted Red Tide Areas Back to Natural Condtions*
10. Vinay Patel, Enviro Science Technologies, Inc, *Establishing the Efficacy of SEBS (**Specific Enzyme Bacterial System**) for *K. brevis* Cell and Brevetoxin Mitigation*



# Thanks to All Our Red Tide Initiative Research Partners



# Initiative Reporting

## [379.2273\(2\)\(d\) Florida Statutes:](#)

Beginning January 15, 2021, and each January 15 thereafter until its expiration, the initiative shall submit a report that contains an overview of its accomplishments to date and priorities for subsequent years to the Governor, the President of the Senate, the Speaker of the House of Representatives, the Secretary of Environmental Protection, and the Executive Director of the Fish and Wildlife Conservation Commission.

## [FWC-FWRI Contract Reports](#)

Regular partnership interaction and reports with FWC

## [Mote Red Tide Initiative Website – Initiative Progress Subpage](#)



# 4<sup>th</sup> Request For Proposals

- 379.2273(2)(c)(1) Florida Statutes: Mote may use a portion of awarded funds to facilitate additional engagement with other pertinent marine science and technology development organizations...
- Open to any/all interested parties to **bring international best and brightest ideas**
- Proposal guidelines and proposal submission:
  - Mote.org
  - **February 24<sup>th</sup> 10am Webinar to answer questions and provide guidance**
  - **Coordinating efforts** for research success through partnership and **avoid duplication**
  - Support not to exceed 1 year - may request longer in next RFP – **several continuing**
- Use of Mote facilities/infrastructure is **available at no charge**
- Partner Led Proposal Review Process:
  - **Diverse reviewer expertise** from NOAA, EPA, FWC, DEP, Universities, Estuary Programs, private consultants, and Mote
  - Each scientist reviewed 3-5 proposals using provided questionnaire
  - Additional Non-Conflicted Mote Scientist Review and **Encouraged Coordination**
- Subcontracts from Mote – 50%, 25% at Interim Report, 25% at Final Report



# Red Tide Initiative Progress



FLORIDA RED TIDE MITIGATION AND TECHNOLOGY DEVELOPMENT INITIATIVE 379.2273(2)(d)

## ACCOMPLISHMENTS AND PRIORITIES REPORT

JANUARY 2022

Red tides, or red tide harmful algal blooms, are a higher-than-normal concentration of microscopic alga that occur in ocean and coastal waters. Red tides in Florida have been documented since the 1700's and their likely impacts date back to records from Spanish explorers. In Florida, the toxin producing *Karenia brevis* is the species causing most red tides. These blooms can harmfully affect sea life, lead to massive fish kills, cause human respiratory problems, close beaches, and determinately impact shellfish, fishing, hotel, restaurant, recreational, and tourism industries. This report is being provided to meet the requirement of 379.2273(2)(d) Florida Statutes, which states: "Beginning January 15, 2021, and each January 15 thereafter until its expiration (2025), the initiative shall submit a report that contains an overview of its accomplishments to date and priorities for subsequent years to the Governor, the President of the

Senate, the Speaker of the House of Representatives, the Secretary of Environmental Protection, and the Executive Director of the Fish and Wildlife Conservation Commission."

### MITIGATING RED TIDE IMPACTS FOR FLORIDA

The Florida Red Tide Mitigation & Technology Development Initiative is a partnership between Mote Marine Laboratory (Mote) and the Florida Fish and Wildlife Conservation Commission (FWC) codified under 379.2273 Florida Statutes that establishes an independent and coordinated effort among public and private research entities to develop prevention, control and mitigation technologies and approaches that will decrease the impacts of Florida red tide on the environment, economy and quality of life in Florida.

- ✓ 125+ Potential Mitigation Compounds Examined for Tiered Testing
- ✓ 4 RFP's and 3 Webinars (1 more soon)
- ✓ 5 TAC Meetings
- ✓ 70+ Proposals Reviewed
- ✓ 25+ Projects Underway
- ✓ 16 Funded External Partners
- ✓ 20+ Business, Academic & Agencies
- ✓ Mitigation Tools to Fast Track
- ✓ Research Facility Constructed
- ✓ Private/Federal Funding Leveraged
- ✓ Public Website & Technology Advisory Council Meetings
- ✓ Report to Governor, Legislature, & Agencies on Accomplishments & Priorities

1

Available on Mote's Red Tide Initiative Website



MOTE.ORG

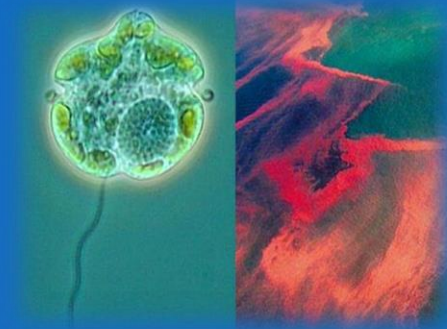
# Some Promising Mitigation Tools

(Project summaries available in Report)

- 6 algicidal compounds from natural macroalgae
- ozonation, cavitation, oxidation water treatment process
- controlled release oxidant pellets
- polymer coated iron oxide nanoparticles
- UV-C radiation from LEDs
- quaternary ammonium compounds
- Metal phenolic networks combined with polyaluminum chloride and an algaecide
- 2 amino acids that enhance algicidal effects of algae-mitigating bacteria
- clay application
- Curcumin



# The Biological Manipulation of Red Tide- Nature vs Nature



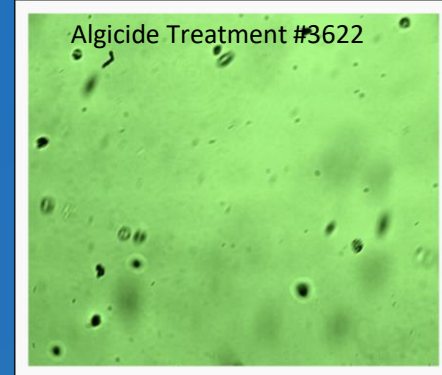
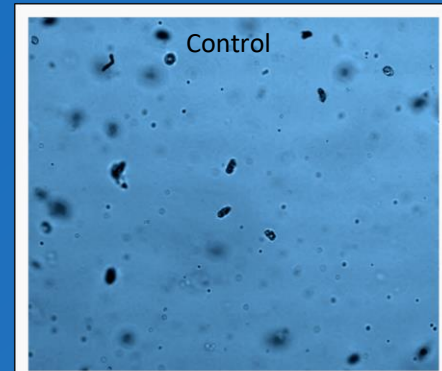
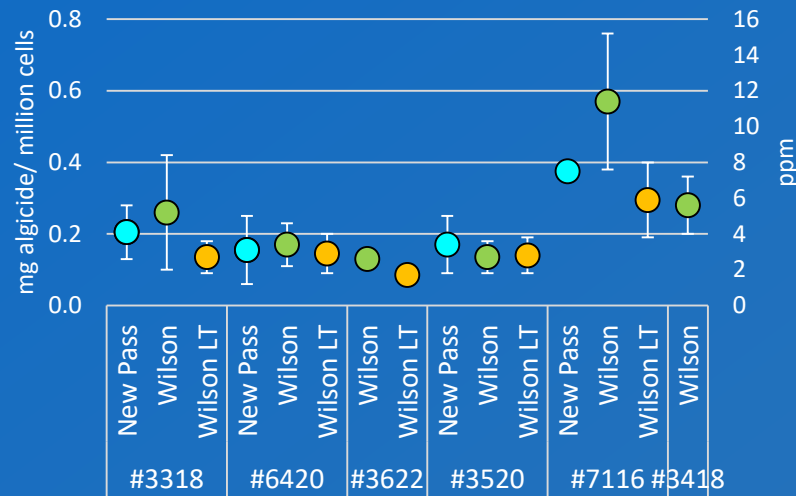
Dana Wetzel, Ph.D.  
Senior Scientist and Program Manager  
Rebecca Medvecky  
Lab Technician  
Environmental Laboratory for Forensics



## Macroalgae and Seagrasses

- Indigenous macroalgae analyzed for algicidal chemical compounds
- Six compounds kill 100% of red tide in less than 5 minutes
- Toxicity testing of candidates
- Mesocosm simulations

Macro-Algicide Treatment  
90-100% Mortality @ 0.5 hr



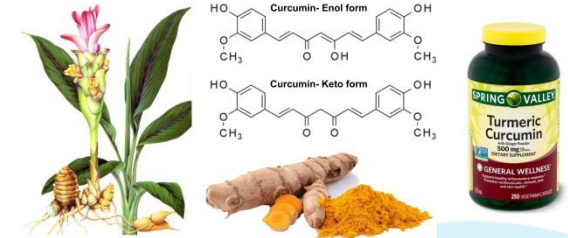
# Prescott Clean Water Technologies Slide



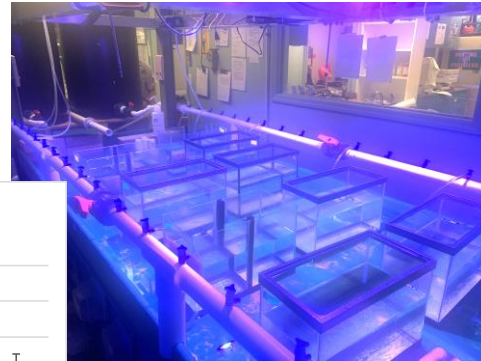


# Curcumin (Extract of Turmeric Root)

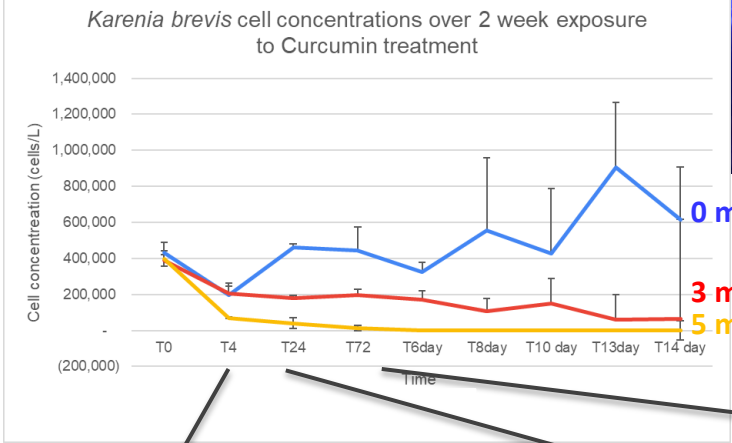
Collaboration: J. Cutler, E. Hall, C. Heil, V. Lovko, A. Moldonaro, R. Pierce



**Dose Range Tested: 1-40 mg L<sup>-1</sup>**  
**Effective Dose: 3-5 mg L<sup>-1</sup>**



## Cells



**Xavier et al (2021):** Curcumin as a dietary supplement enhance fish larvae robustness

**Yuan et al (2021):** curcumin inhibits diarrheal shellfish toxin accumulation in mussels

**Liu et al (2016):** curcumin inhibits *Chattonella marina* growth

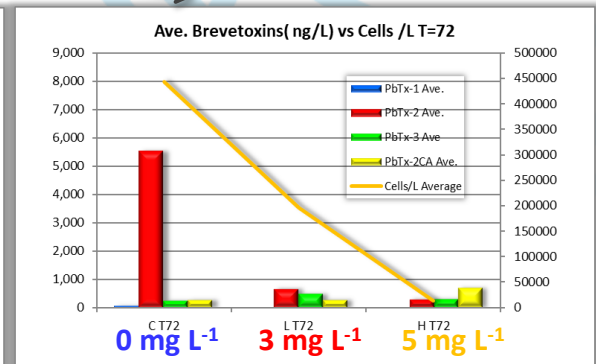
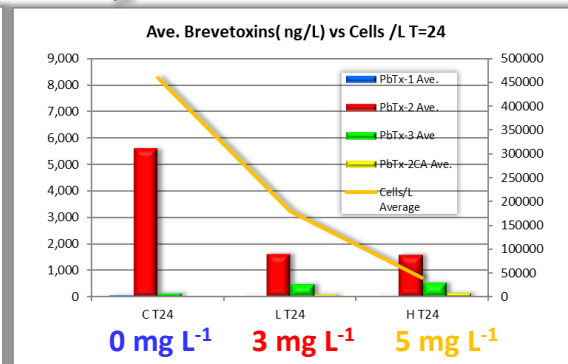
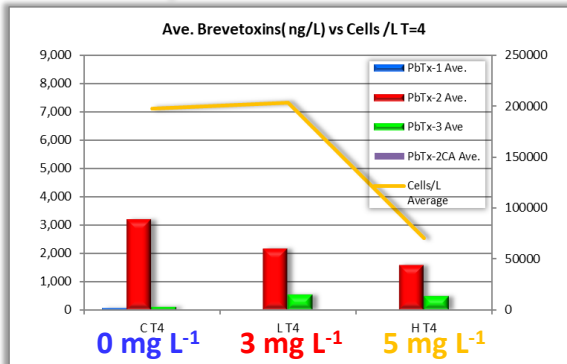
**Rajasekar et al (2013):** curcumin had a neuroprotective effect on okadaic acid induced memory impairment in mice

## Toxins

4 hrs

24 hrs

72 hrs



**Mesocosm Test Planned: March 2022**

# QUATs (Quaternary Amines)

Collaboration: E. Hall, C. Heil, R. Pierce, A. Muni-Morgan, E. Cuyler, S. Klass & J. Frankle

- ✓ FDA approved cationic surfactants. Bind to negatively charged algal cell walls, disrupt membranes, enzymes & cell processes.
- ✓ Easily absorbed onto substrates (e.g. concrete, fiberglass), so can be placed in a water and then easily removed.

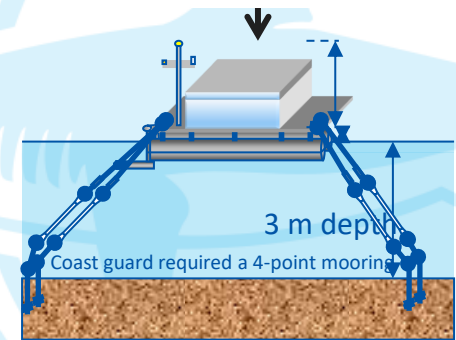
**Mesocosm Test Planned:**

March 2022

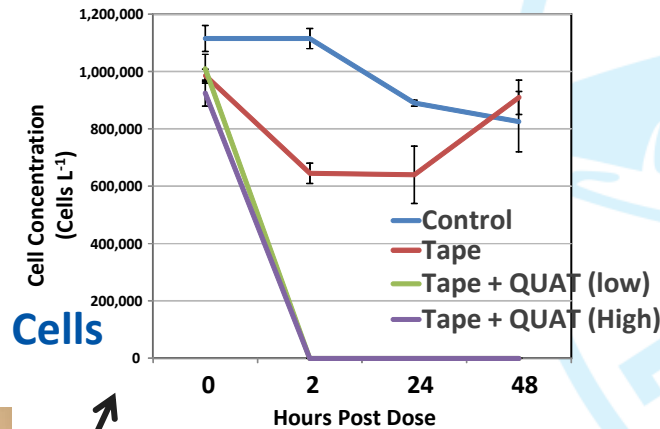
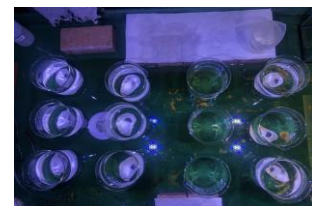
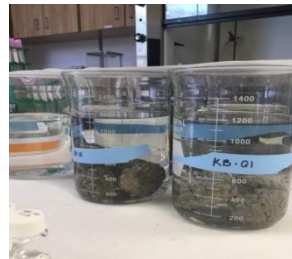
**Platform Test Planned:**

April 2022

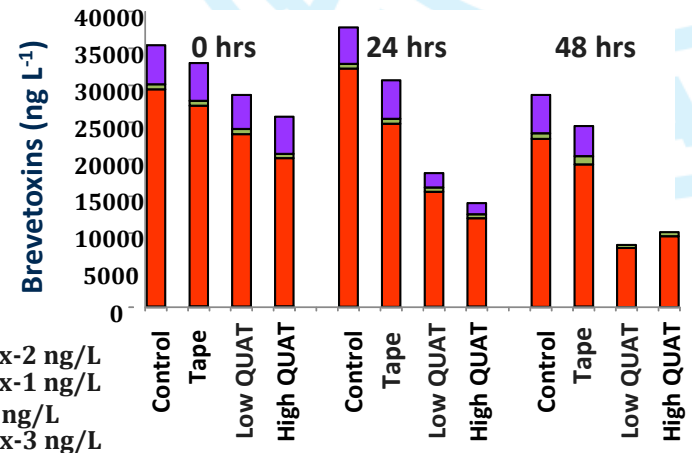
With Jim Ivey



*K. brevis* with QUATs



**Toxins**



Concrete Aggregates (UCA)

Fiberglass Tape

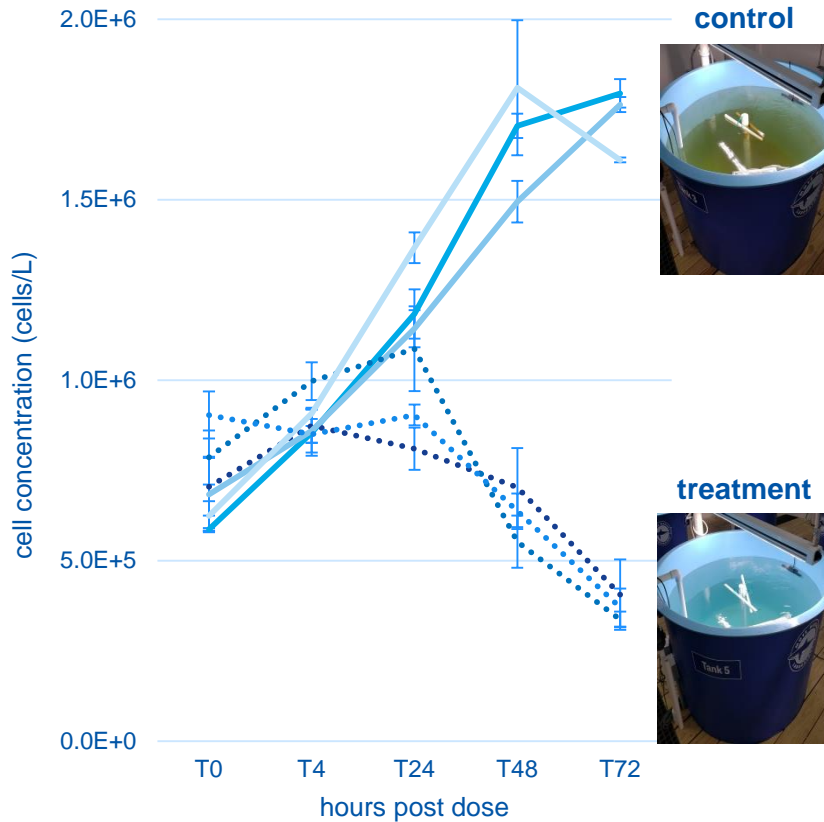
Oyster Shell

# RemRx<sup>®</sup> CRP – controlled release oxidant for treatment and mitigation of *K. brevis*

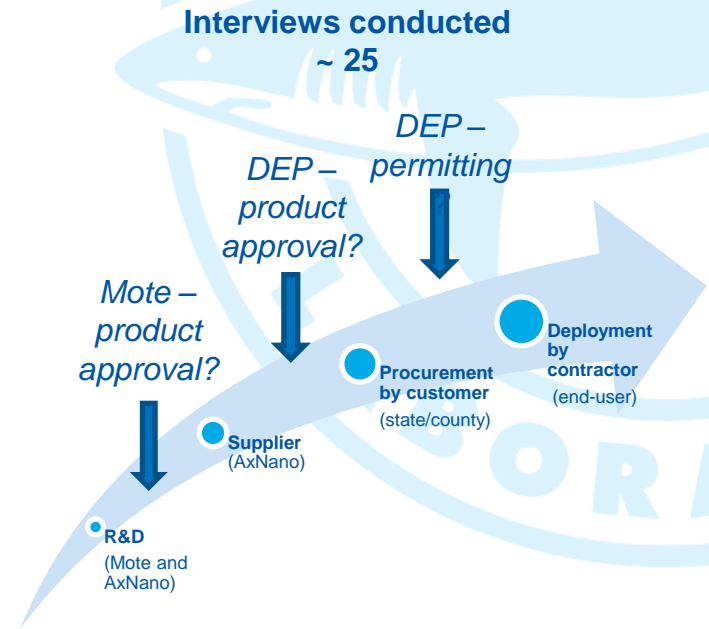


Dr. Julia Darcy (AxNano), Dr. Cynthia Heil (Mote), Dr. Rich Pierce (Mote)

**Technical goal:** evaluate RemRx<sup>®</sup> CRP in mesocosms



**Business goal:** identify procurement pathway to bring product to market



# nTEC



# FIU

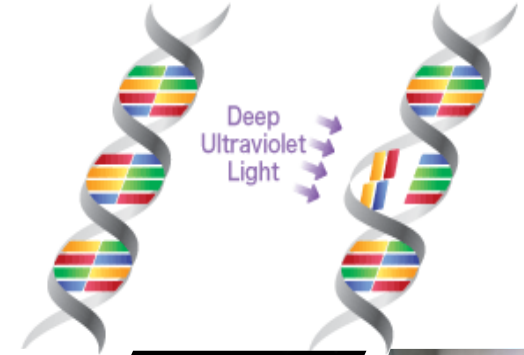
FLORIDA  
INTERNATIONAL  
UNIVERSITY

## *A Chemical Free Red Tide Mitigation Technology Utilizing UVC LEDs*

*Large scale environmental applications have not been feasible due to power requirements and environmental concerns.*

*The advent of UVC LEDs has changed this.*

DNA before UV irradiation      DNA after UV irradiation



# Conclusions

- ❖ Even at the same dose, high power treatments are more effective than low power.
- ❖ Fold reduction is higher at lower starting cell densities
- ❖ Continuous illumination is more effective than pulsing
- ❖ UV absorbing materials reduce effectiveness of UV treatments
- ❖ PTFE is UV-C transparent and may be used in the fabrication of a field device
- ❖ 500 unit high power LEDs is highly effective against *K. brevis*.
- ❖ Toxins can be reduced by UV-C treatment

# Red Tide Initiative – Looking Ahead

- Governor, Legislature, Agency Report
- Moving Projects to Tier 2 and 3
- Red Tide Facilities Tours
- 4th RFP Feb 11 – April 15
  - Subawards June/July
- 2022 Fall TAC Meeting
- Parallel Hurdles
  - Deployment/Monitoring
  - Scalability
  - Permitting/Compliance
  - Economic Feasibility
- Red Tide Initiative Workshop

2022 Florida Oceans Day



# Red Tide Mitigation and Technology Development Initiative Research Workshop

- Mote Aquaculture Park – Late Summer 2022
- Gulf of Mexico Conference – Gulf of Mexico Alliance, April 25-28, Baton Rouge, LA
- 2022 11<sup>th</sup> US Symposium on Harmful Algae, Oct 23-28, Albany, NY



# Public Comments and/or Submitting Written Comments for the Minutes

Kevin Claridge  
[kclaridge@mote.org](mailto:kclaridge@mote.org)





# Florida Red Tide Mitigation and Technology Development Facility Tour



# Thank You! Questions?

Kevin Claridge  
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