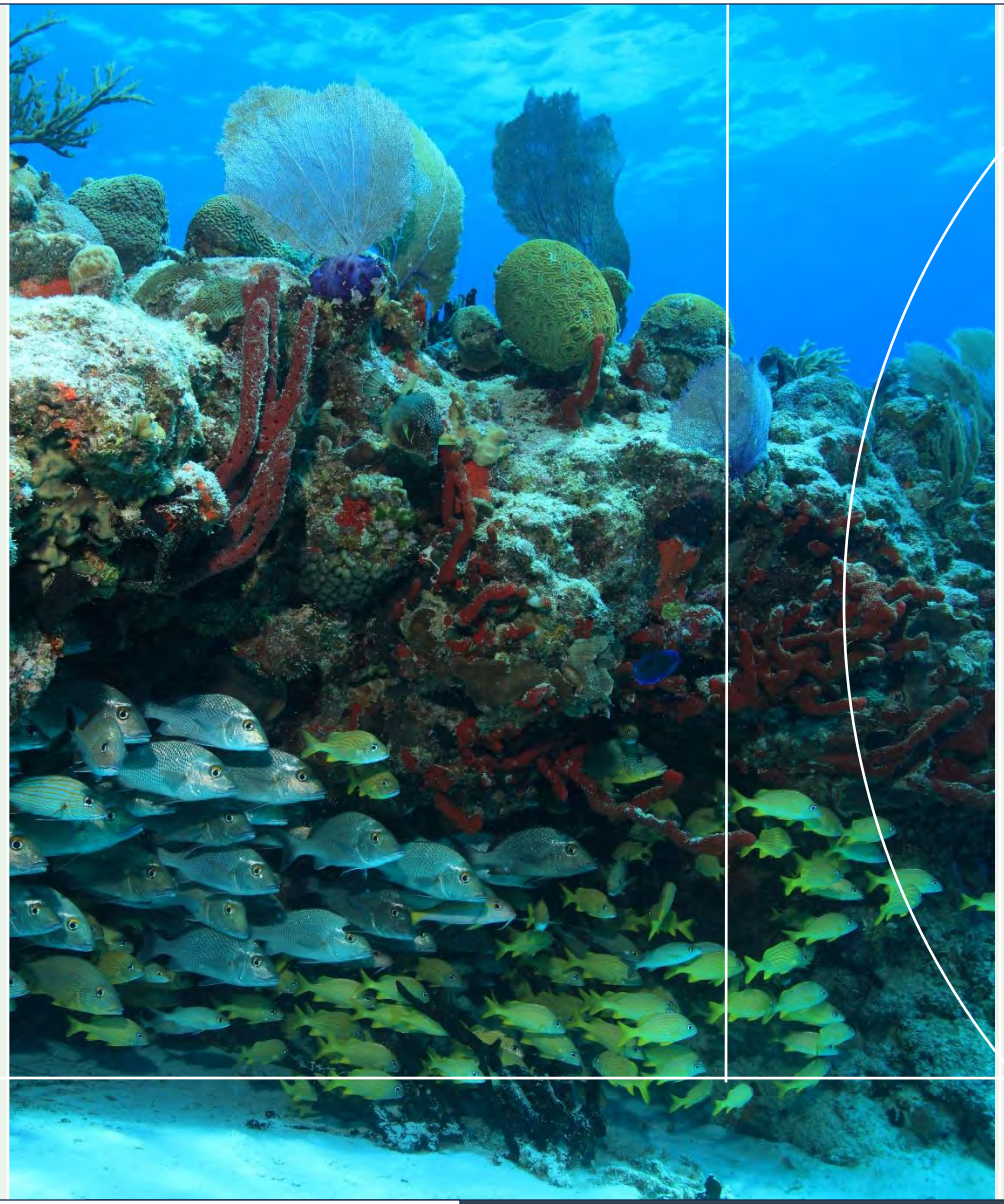


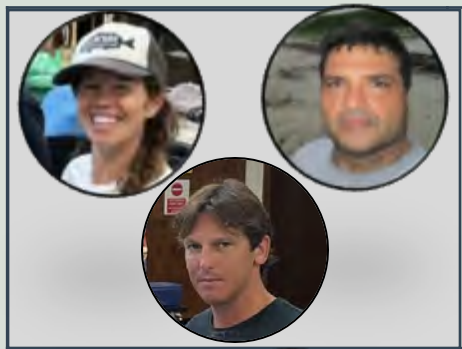
Research Theme 4:

Fish Ecology

Meet The Team

Dr. Rick Nemeth
Research Professor

Dr. Kayla Blincow-Israel,
Post-Doc / Assistant Professor



Research Collaborators

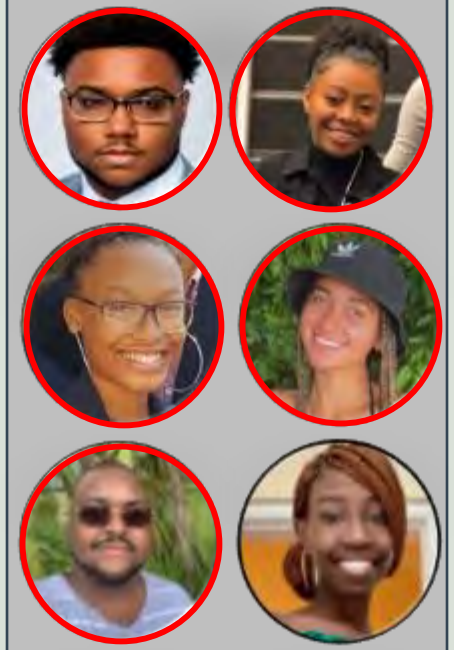
Dr. Chelsea Harmes-Tuohy
Dr. Nicolas Schizas
Dr. Evan Tuohy

Research Technicians

Shaun Kadison, MSc*
Sarah Heidmann, MSc*
Jenna Cheramie, MSc*

MMES Graduate Students

Stefanie Maxin*
Madison Miele*
Sierrah Mueller*
Taylor Hobbs*
Greg O'Neill*
Jenna Cheramie*
Kayla Budd*
Danielle Olive
Sophie Costa

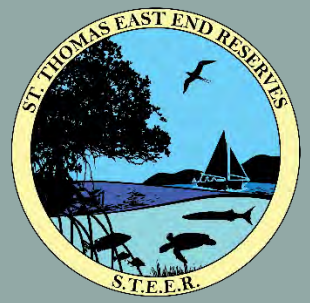


Undergraduate Students

Arbelson Mora*
Jonicia Cardin*
Ver Néle Callwood
Chloe Camacho
Samuel Gittens
Keedencia Harris

*current lab members — Virgin Islanders

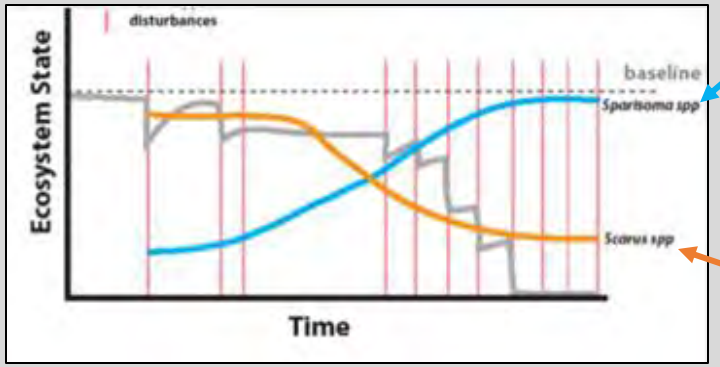
Collaborations



Introduction – Fish Ecology

How does terrestrial sedimentation affect the feeding & reproduction of parrotfishes?

Hypothesis: Parrotfish populations change with ecosystem state



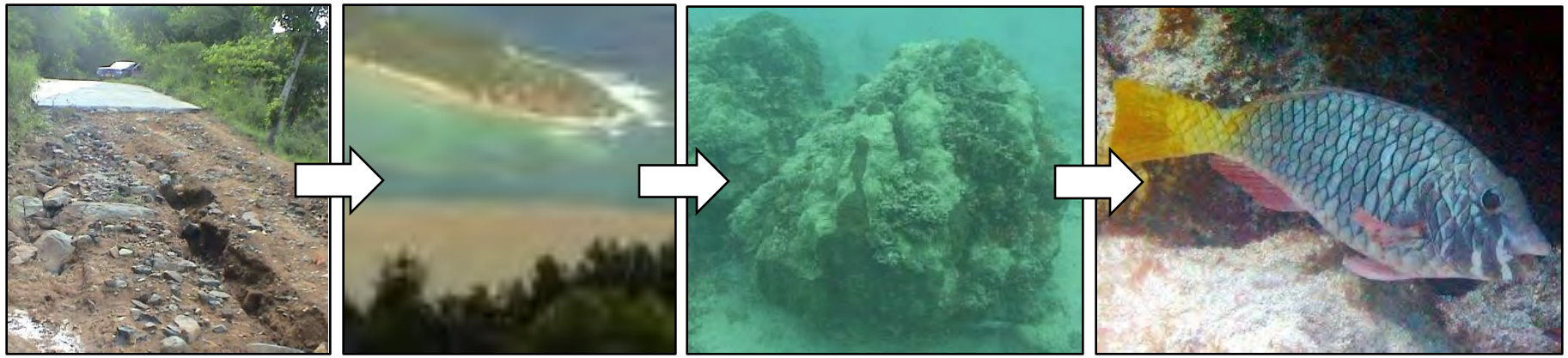
Terrestrial sediments in marine environment

Benthic impacts
Decreased coral
Increased algae

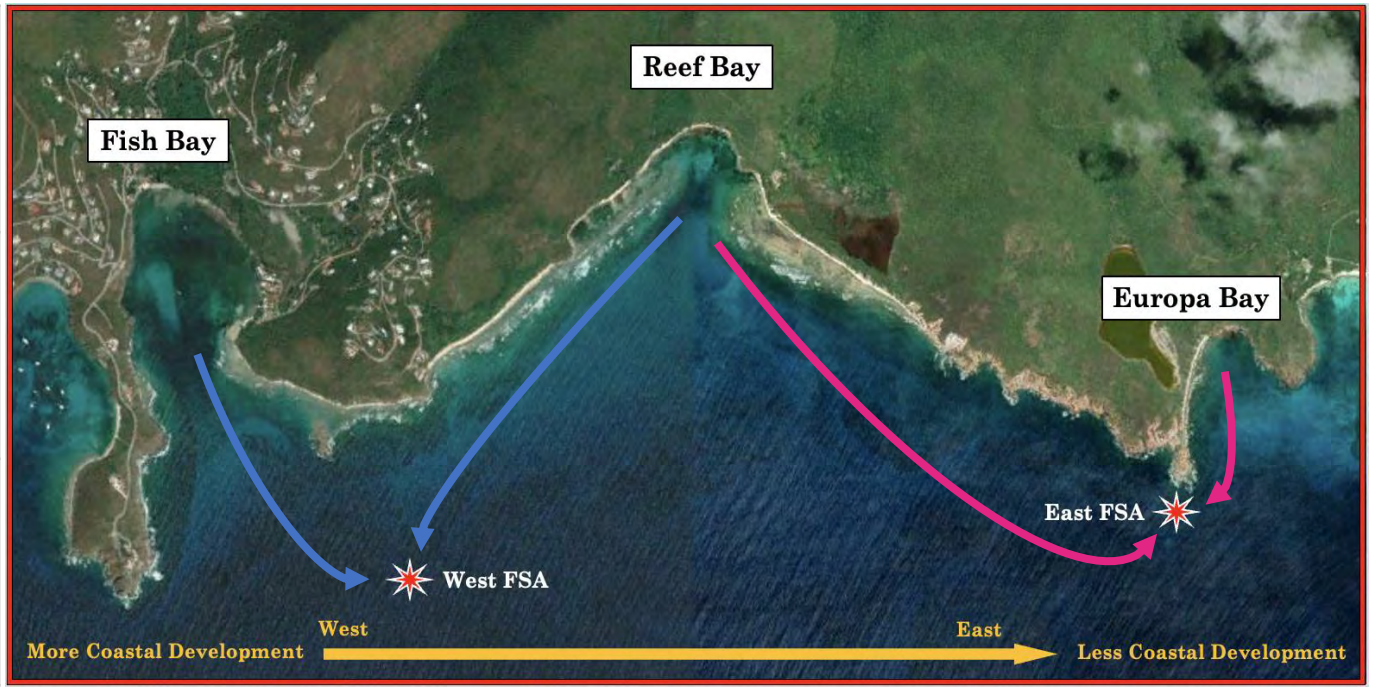
Changes in parrotfish species composition and foraging rates

How will these changes affect parrotfish spawning frequency & fecundity?

Research Goals and Objectives



Goal FE1	ANALYZE HISTORICAL DATA TO DETERMINE HOW NATURAL AND HUMAN STRESSORS ON CORAL REEFS AFFECT PARROTFISH ASSEMBLAGES.
Goal FE2	DETERMINE IF SEDIMENTATION AND BENTHIC CHARACTERISTICS AFFECT FEEDING AND REPRODUCTION OF PARROTFISHES.
Goal FE3	INCREASE OUR UNDERSTANDING OF OCEANOGRAPHIC AND ENVIRONMENTAL VARIABLES THAT INFLUENCE REPRODUCTIVE RATES OF PARROTFISHES



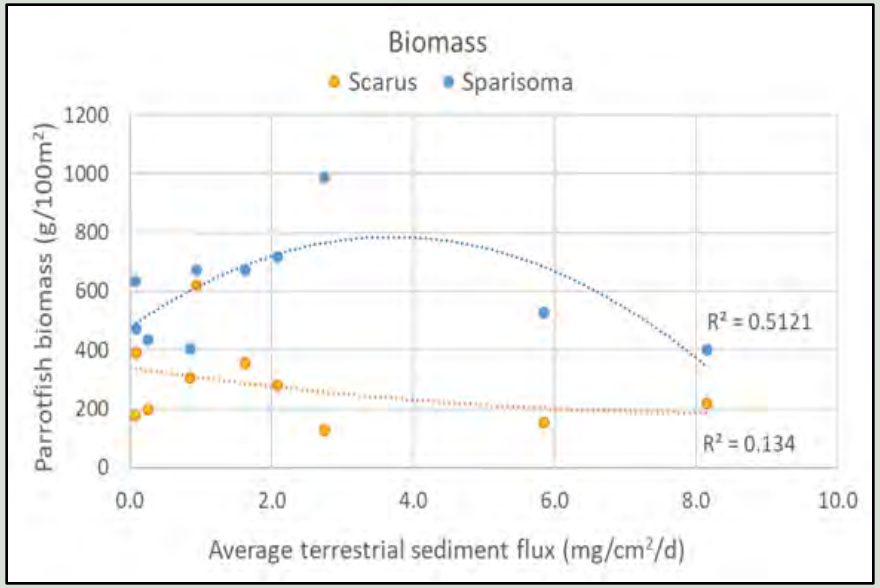
Research, Outcomes & Accomplishments

Historical Data: 1999 – 2020

- Sediment collection sites (n=14) mostly associated with coral health assessments
- Fish surveys sites: 10 of 21 sites associated with sediment data
- Differences in parrotfish assemblages tested across all sediment monitoring sites

GOAL 1: ANALYZE HISTORICAL DATA TO DETERMINE HOW NATURAL AND HUMAN STRESSORS ON CORAL REEFS AFFECT PARROTFISH ASSEMBLAGES

1.2. Effect of terrestrial sedimentation on composition of parrotfish communities



Major Findings 1.2

***Scarus* spp. biomass declined**

***Sparisoma* spp. biomass increased initially then declined at higher sediment flux**

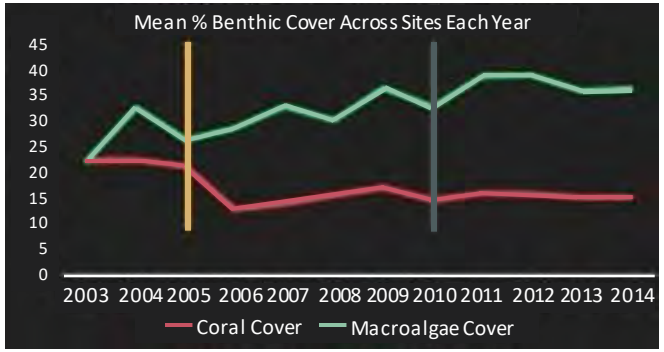
Research, Outcomes & Accomplishments

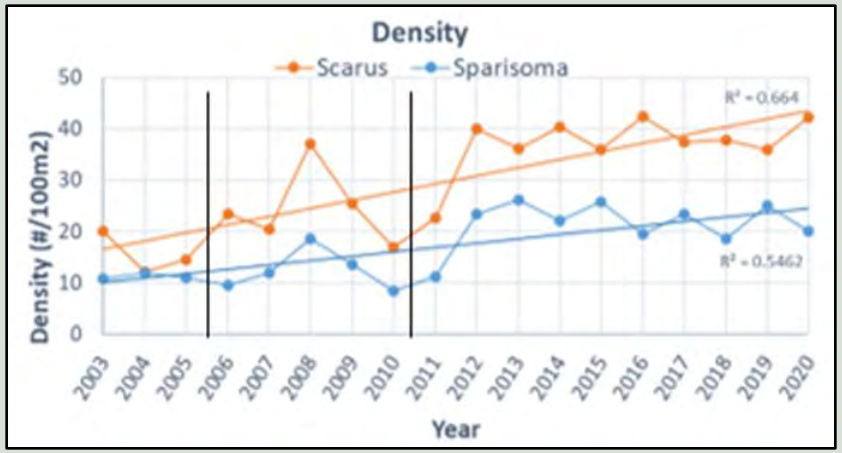
Historical Data: Territorial Coral Reef Monitoring Program (TCRMP 21 sites)

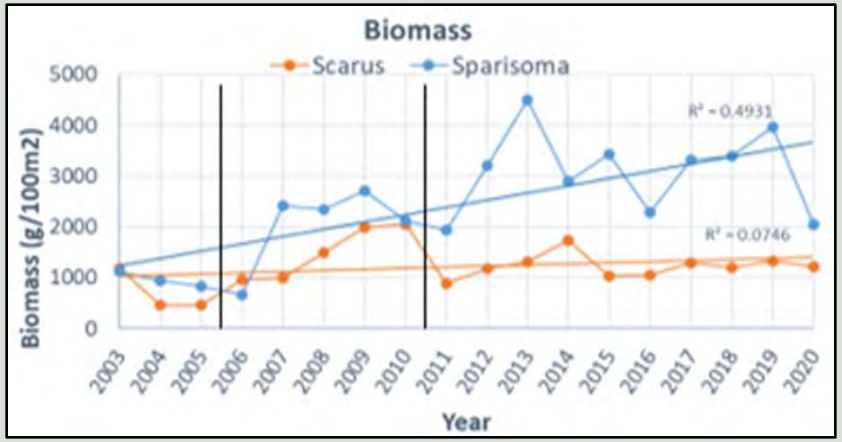
- 2003-2005 (pre-bleaching)
- 2006-2010 (post 2005 bleaching)
- 2011-2014 (post 2010 bleaching)

- Rapid increase in macroalgae & decrease in coral cover following bleaching events

Changes In Macroalgae & Coral Cover







GOAL 1: ANALYZE HISTORICAL DATA TO DETERMINE HOW NATURAL AND HUMAN STRESSORS ON CORAL REEFS AFFECT PARROTFISH ASSEMBLAGES

1.1. Effect of 2005/2006 and 2010 coral bleaching / mortality events on parrotfish communities.

Major Findings 1.1

Rapid increase in *Scarus* spp. & *Sparisoma* spp. density post-disturbance

Increase in biomass of *Sparisoma* spp. but not *Scarus* spp.

RIDGE → REEF

SEDIMENT — ALGAL COMPOSITION — FORAGING — REPRODUCTION

Reef Bay

Fish Bay

Europa Bay

Sediment: **195** tiles analyzed

Algae: **432** benthic transects

Foraging: **169** fish follows

Acoustic Array: **55** receivers

Fish tracking: **60** fish for **374** days = **2,532,749** detections

West FSA

East FSA

More Coastal Development — West — East — Less Coastal Development

Map Credit: Jenna Cheramie M.S. Thesis

Research, Outcomes & Accomplishments

Sedimentation Stations

- 5 x 3 tile matrices (n = 18) deployed across study area
- Terracotta tiles mimicked reef substrate
- Loss-on-ignition procedure to calculate sediment composition

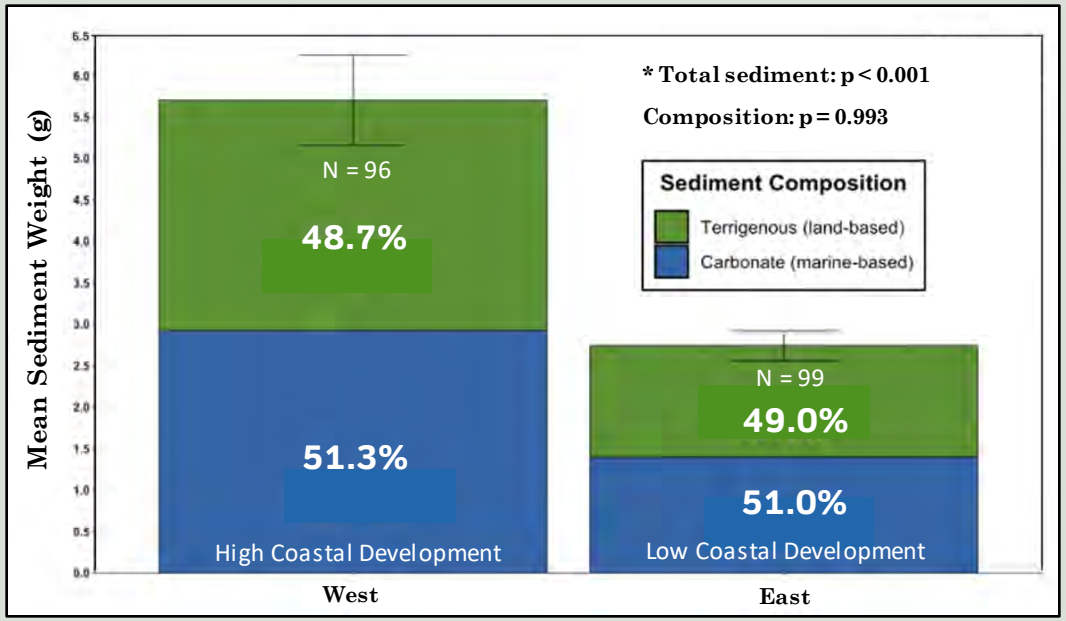
GOAL 2: DETERMINE IF **SEDIMENTATION** AND BENTHIC CHARACTERISTICS AFFECT FEEDING AND REPRODUCTION OF PARROTFISHES

2.1. Determine how sediment load differs between high and low development areas

Major Findings 2.1

- **West has double the amount of sediment than the East**
- **Half of sediment is land-based**
- **Proportional composition of sediment is nearly identical between sides**

Cheramie et al. in prep

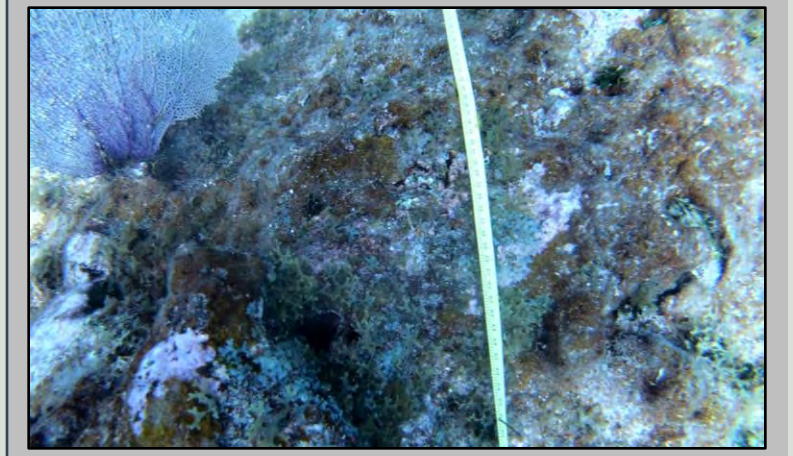


Research, Outcomes & Accomplishments

GOAL 2: DETERMINE IF SEDIMENTATION AND **BENTHIC CHARACTERISTICS** AFFECT FEEDING AND REPRODUCTION OF PARROTFISHES

Algae Composition

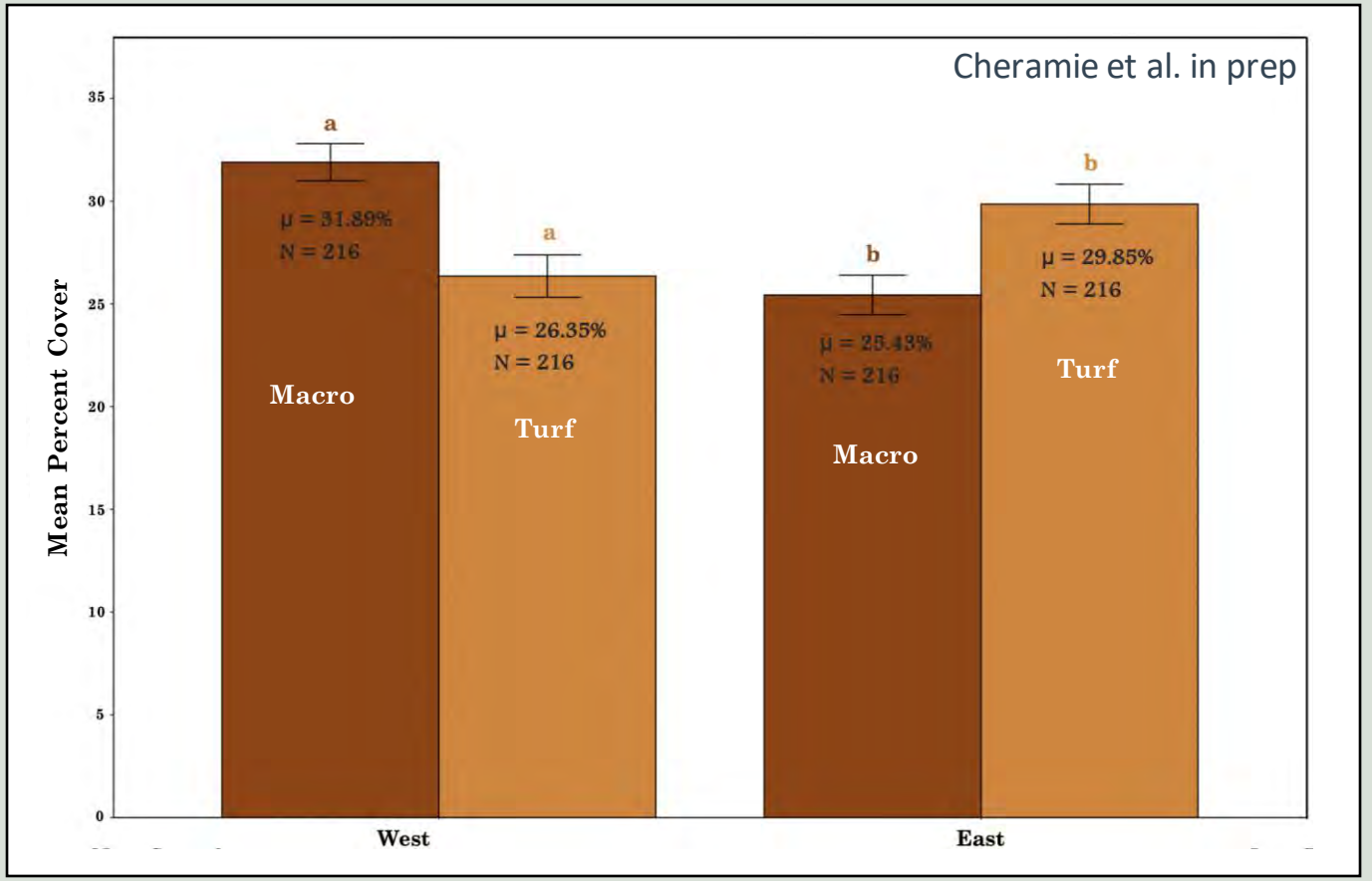
- 432 benthic transects conducted



Major Findings 2.2

West has significantly higher % cover macroalgae than East

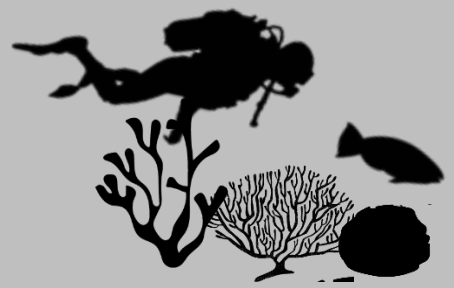
East has significantly higher % turf algal cover than West



Research, Outcomes & Accomplishments

Parrotfish Feeding on Algae

- 169 fish follows conducted
- Classified food type & substrate



GOAL 2: DETERMINE IF SEDIMENTATION AND BENTHIC CHARACTERISTICS AFFECT **FEEDING** AND REPRODUCTION OF PARROTFISHES

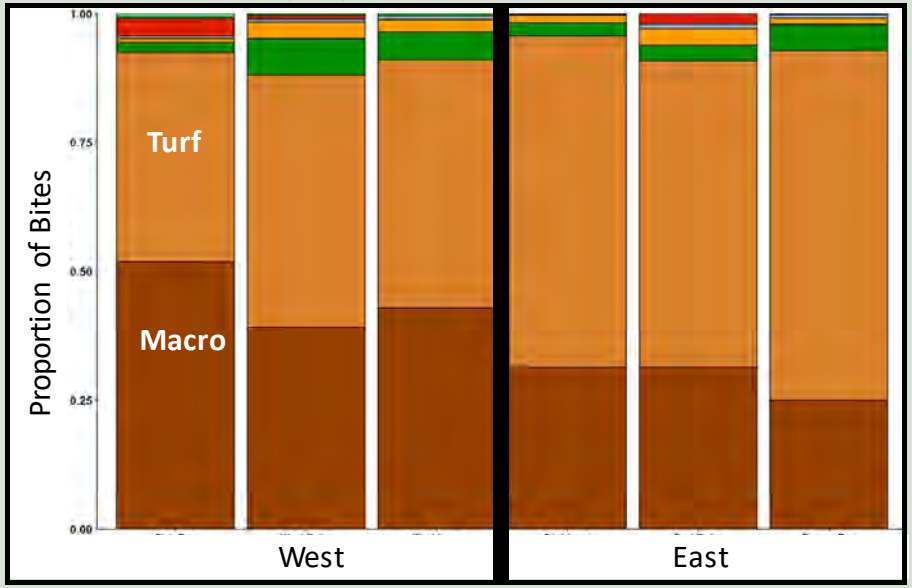
2.3. Determine how sediment load and algal composition affect *Sparisoma rubripinne* feeding

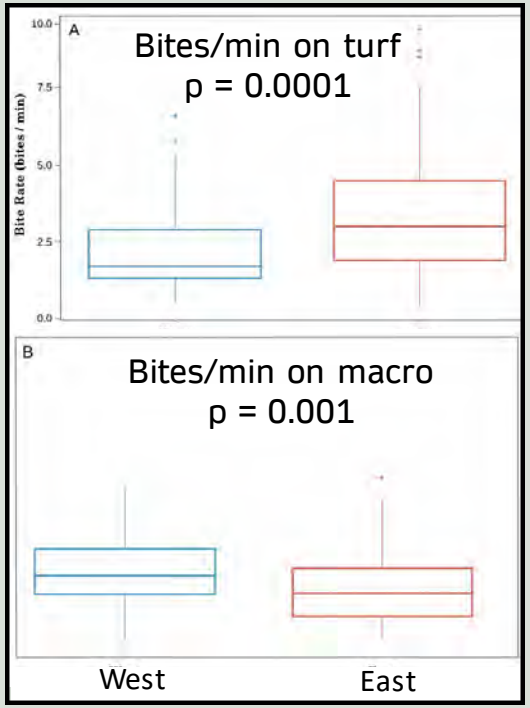
Major Findings 2.3

Fish in West consumed significantly more brown macroalgae

Fish in East consumed significantly more turf algae

Cheramie et al. in prep





University of the Virgin Islands

VIRGIN ISLANDS EPSCoR

NSF EPSCoR

Research, Outcomes & Accomplishments

Parrotfish Diet

- Metabarcoding of gut contents

GOAL 2: DETERMINE IF SEDIMENTATION AND BENTHIC CHARACTERISTICS AFFECT **FEEDING** AND REPRODUCTION OF PARROTFISHES

2.4. Assess dietary differences in areas with higher sediment and macroalgae

Major Findings 2.4

- **202 parrotfish collected from 4 sites, 150 analyzed for diet**
- **All samples have been processed and sequenced**
- **Preliminary data shows presence of seagrass, brown/green/red algae, and cyanobacteria**

Drs. C. Harmes-Tuohy & N. Schizas
University of Puerto Rico

Research, Outcomes & Accomplishments

Analysis of Sediment in Fish Guts

- Same methods used for sediment analysis

GOAL 2: DETERMINE IF SEDIMENTATION AND BENTHIC CHARACTERISTICS AFFECT FEEDING AND REPRODUCTION OF PARROTFISHES

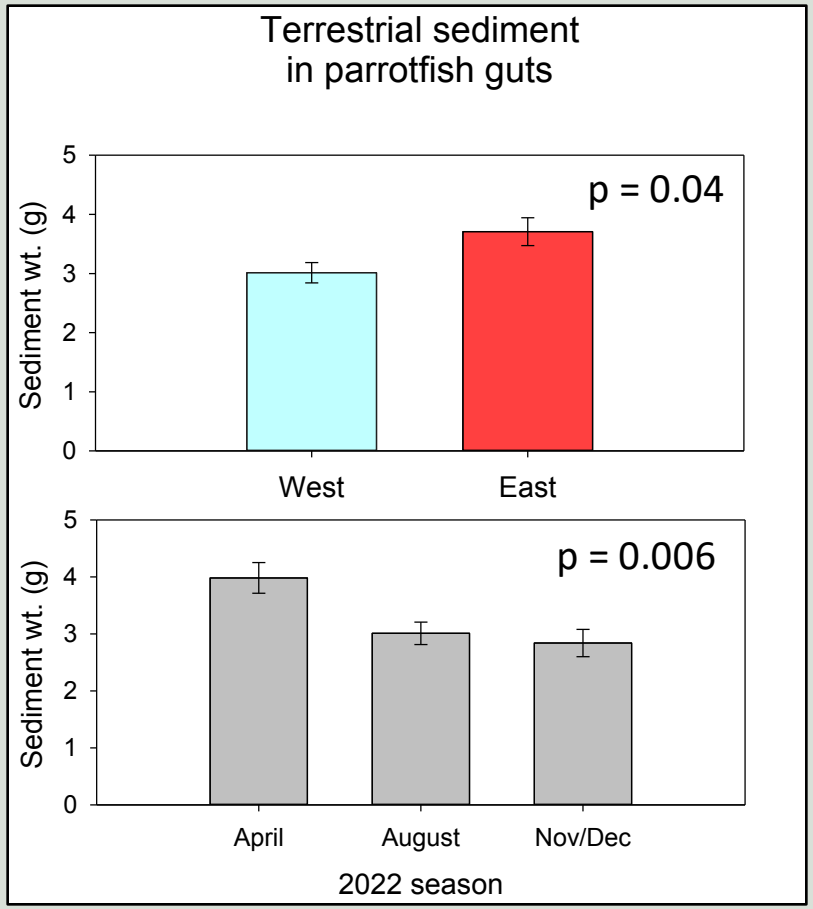
2.4. Assess dietary differences in areas with higher sediment and macro-algae

Major Findings 2.4

Fish from East sites had significantly more terrestrial sediments in guts than West

- **Fish feeding on macroalgae bite off tips of algae whereas fish feeding on turf scrape the substrate**
- **Fish that fed more on turf in the East may have ingested more sediments since turf tends to trap sediment**

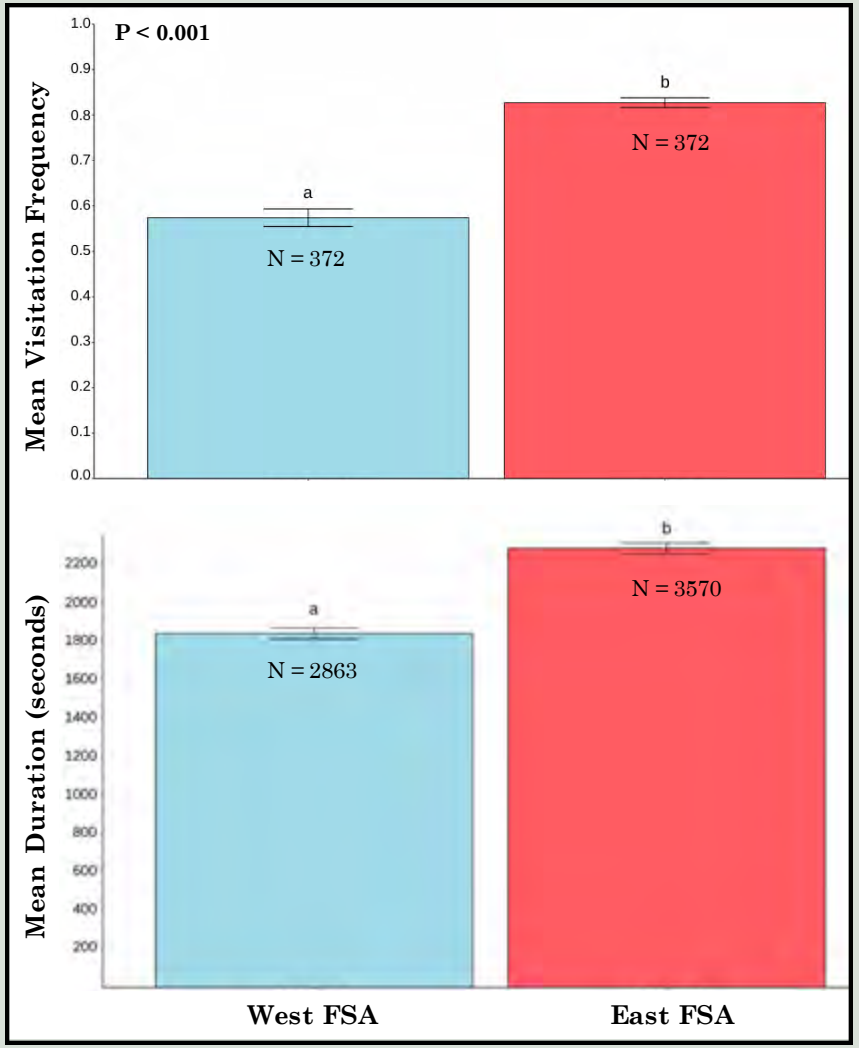
April had significantly higher sediment in guts than August or Nov/Dec



Research, Outcomes & Accomplishments

Parrotfish Spawning Frequency

- Tracked presence/absence of 60 fish at 2 spawning sites using array of 55 acoustic receivers
- 2.5 million detections across 374 tracking days



GOAL 2: DETERMINE IF SEDIMENTATION AND BENTHIC CHARACTERISTICS AFFECT FEEDING AND **REPRODUCTION** OF PARROTFISHES

2.5. Effects of sedimentation and benthic composition on frequency of spawning and fecundity

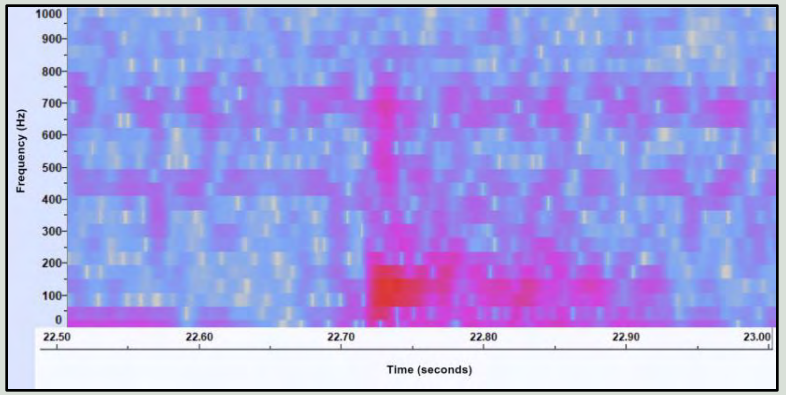
Major Findings 2.5

- **Fish visited East FSA significantly more often than West FSA**
- **Fish spent significantly more time at the East FSA**
- **No effect of monthly sediment or algae composition on spawning frequency or duration**

Research, Outcomes & Accomplishments

Oceanographic & Environmental Parameters

GOAL 3: INCREASE OUR UNDERSTANDING OF OCEANOGRAPHIC AND ENVIRONMENTAL VARIABLES THAT INFLUENCE REPRODUCTIVE RATES OF PARROTFISHES

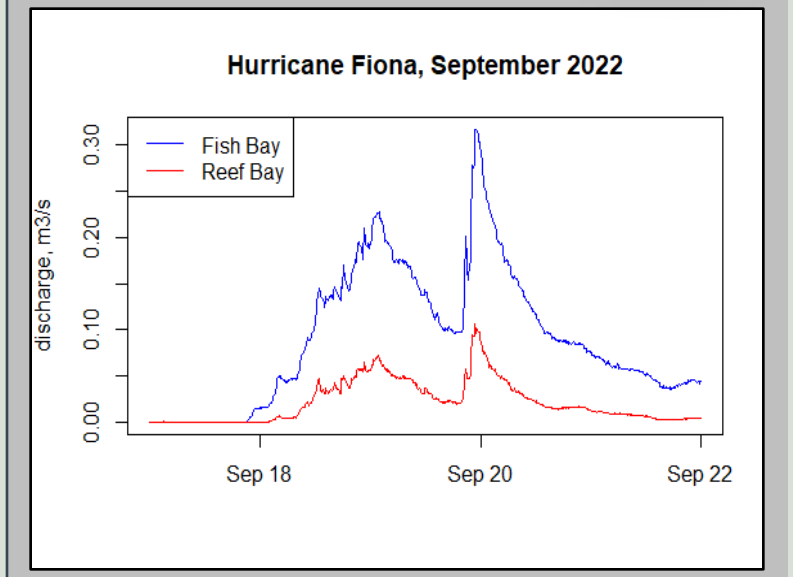


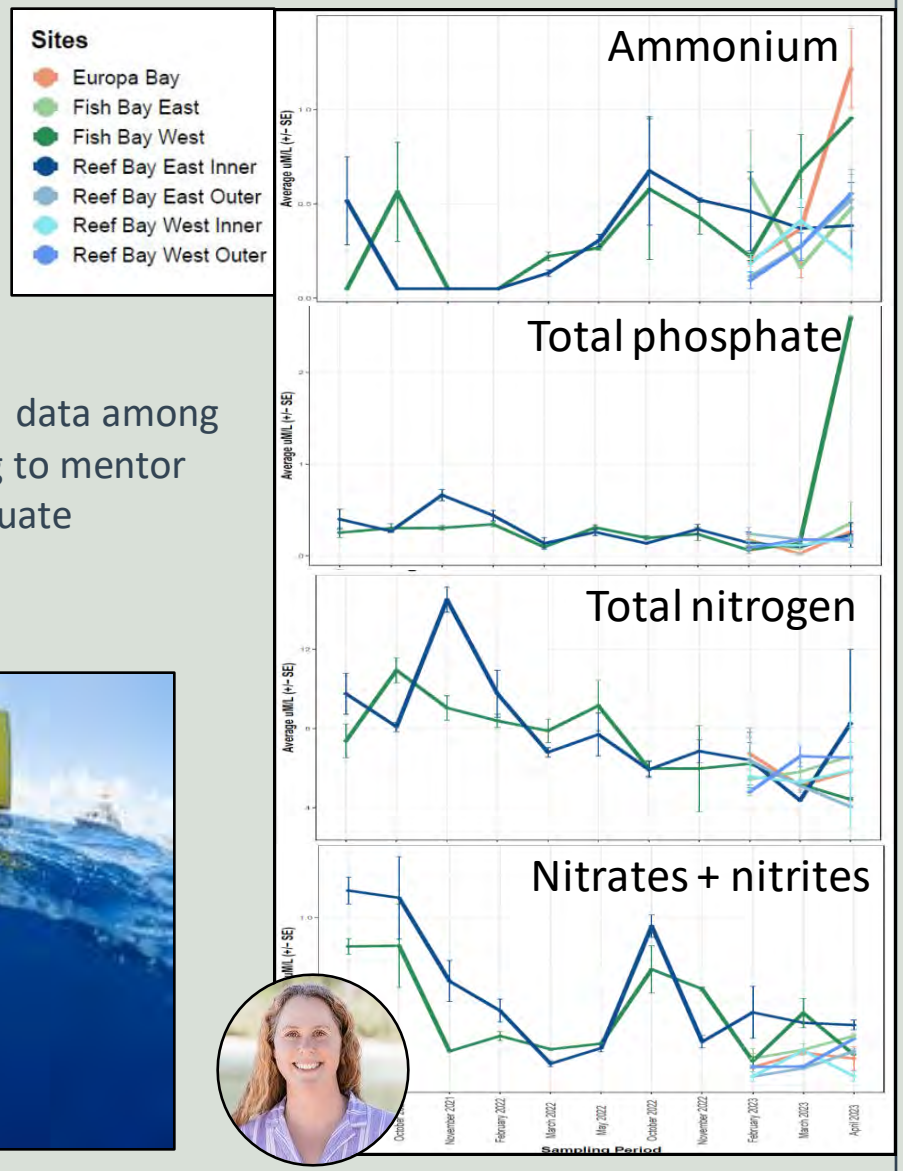
Major Findings 3.0

- Deployed ADCP and collected oceanographic and echo-sounder data for over 12 months
- Working with Nortek to extract and interpret ADCP data
- Successfully identified sound associated with parrotfish spawning

Research Interdependencies

Collaborating with team leads Marilyn Brandt, David Hensley and Doug Wilson to integrate oceanographic and environmental data among research areas. We are continuing to mentor and train graduate and undergraduate students.





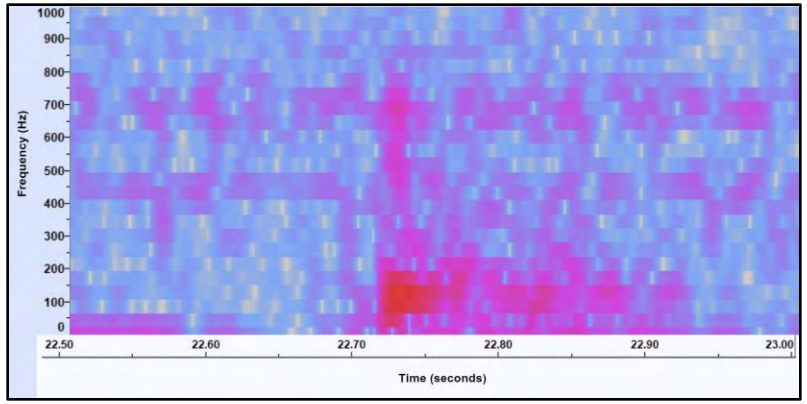
Broader Impacts, Intellectual Merits, & Sustainability

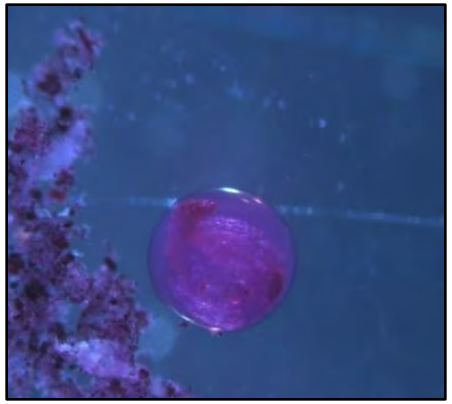
SCHOLARSHIP	OUTREACH	TRAINING	NEW INSIGHTS GAINED	FUNDING SUSTAINED
➢ 2 Master's theses completed ➢ 15 presentations at national & international conferences ➢ 9 peer-reviewed publications	➢ 350 people engaged at UVI's Afternoon on the Green ➢ Produced video documentary ➢ 70 citizen scientists reporting on watershed awareness	➢ 1 post-doc ➢ 3 research techs ➢ 24 MMES & 10 undergrads trained in research diving & fisheries techniques.	➢ Research is guiding new insights into factors affecting parrotfish herbivory and reproduction	➢ 5 grants totaling $916,000 received to support fish ecology research (NOAA, NMFS, WRRI, Ocean Kind, VI Department of Planning and Natural Resources)

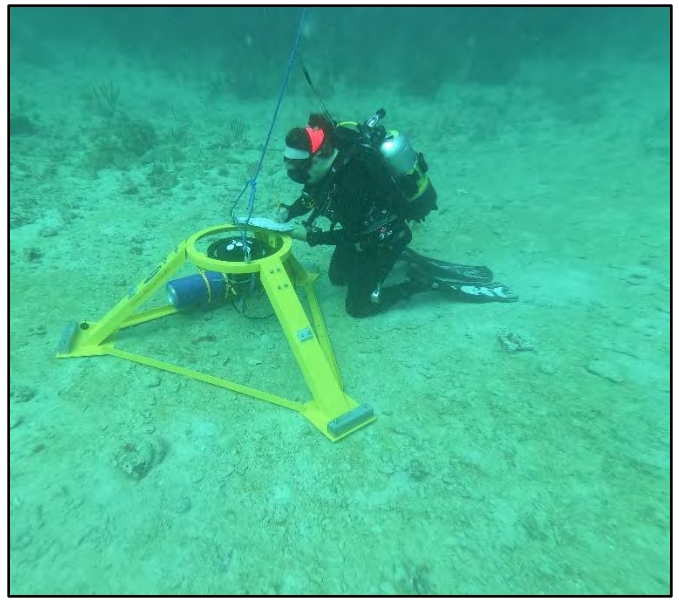
Heat map from citizen science data showing hot spots of erosion and sedimentation

Year 4 Goals

- Use hydrophone to estimate frequency of spawning events.
- Collect parrotfish eggs from spawning rushes to calculate reproductive output.
- Integrate oceanographic data to understand the influence of currents on spawning
- Begin analysis of environmental data from water quality sampling
- Synthesize benthic and sediment data and fish movement patterns for publication







Spawning parrotfish at Reef Bay
Western aggregation site

Thank you!

Dr. Rick Nemeth

rnemeth@uvi.edu

Ocean Glider Deployment, St. Thomas
Dan Mele Photo

Research Theme 5:

Oceanography

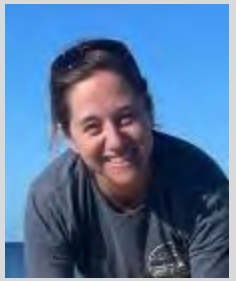
Oceanography

- Physical processes from the dee p ocean to the coastline impact regional ecosystems' functionality, health, and resilience.
- Functions include thermal stress response, recovery after disturbance, animal reproduction, and connectivity of organisms and materials, such as sediment, in the marine environment.
- Oceanic, atmospheric, and terrestrial processes are coupled and interdependent, making OCEANOGRAPHY a critical research element.

Meet The Team

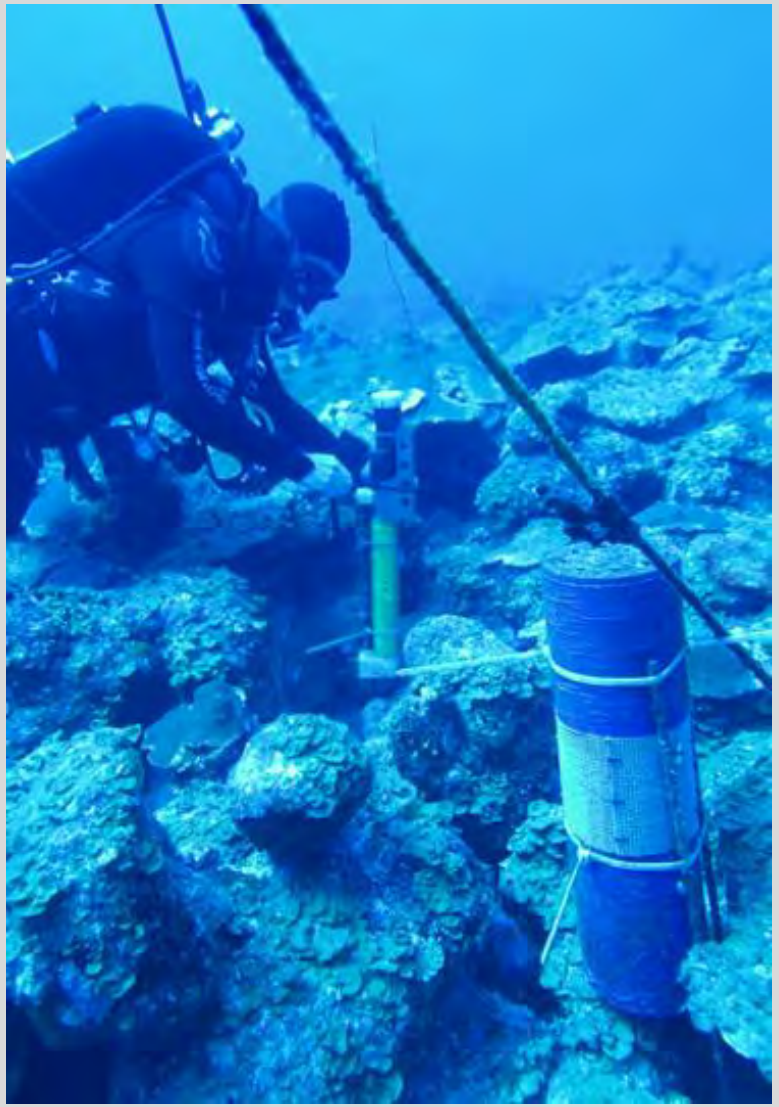
Dr. Tyler Smith
VI-EPSCoR co-P.I.
Professor, UVI

Mr. Doug Wilson
Courtesy Professor, CMES

	Dr. Rick Nemeth VI-EPSCoR co-P.I. Professor, UVI		Ms. Vanessa McKague Oceanographic Technician
	Dr. Paul Jobsis Director, CMES		Mr. Travis Hamlin Data Manager Glider Technician
	Dr. Dan Holstein Asst. Professor LSU		Dr. Kayla Blincow Asst. Professor UVI

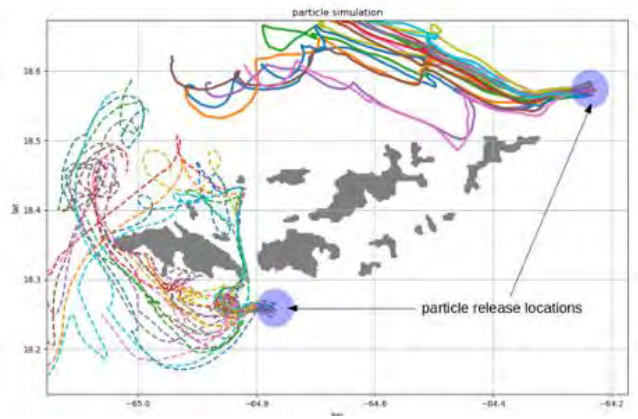
OCEANOGRAPHY

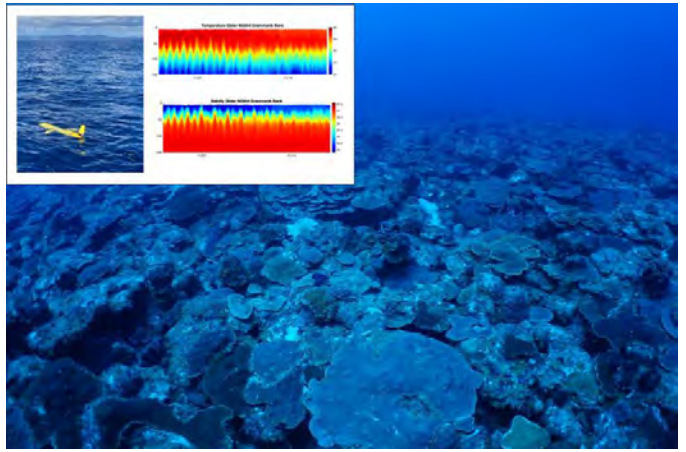
- **Our overall GOAL is to develop and perpetuate the human, physical, and cyber infrastructure to support oceanographic research that contributes to a deeper understanding of ocean processes and their influence on USVI ecosystems, coastlines, and population.**



Years 1-3 Goals & Activities

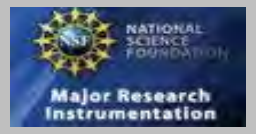
Initial	Quantify the influence of oceanographic and environmental variables on significant R2R processes (fish behavior, larval dispersal)
Years 1- 3	Reef Bay spawning studies
Years 1 -3	USCROMS model studies (dispersal + new Sargassum award)
Years 1 - 3	Share USVI Oceanography Research with Stakeholders & Provide Opportunities for New Partnerships



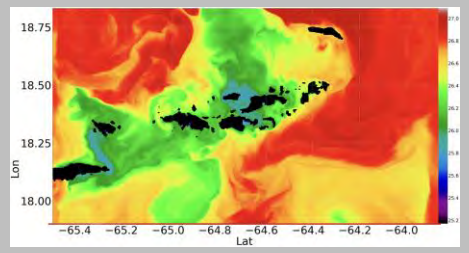


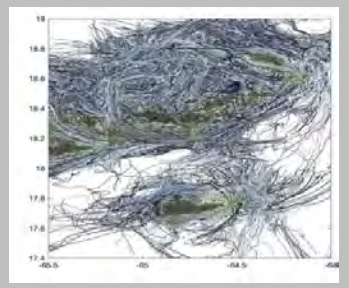
Year 4 Goals

- Focus on new strategies and partnerships while continuing to address wider impacts and student opportunities.



UVI Ocean Glider Lab (NSF MRI)





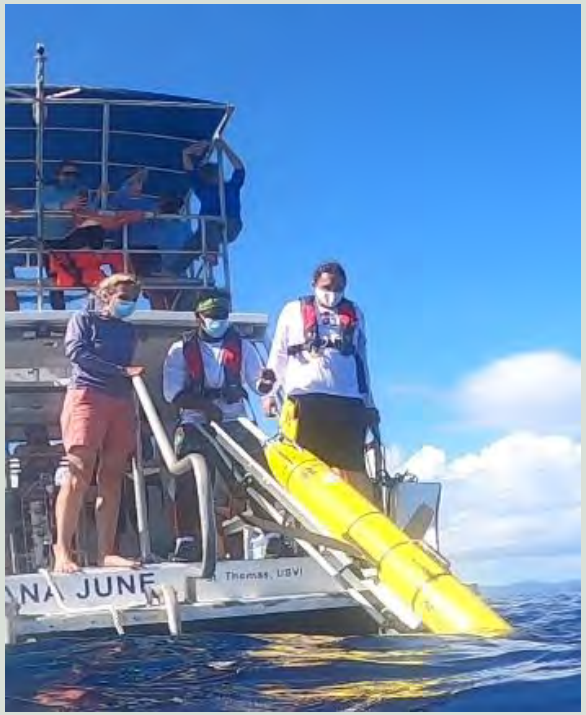
Developing New Ocean Modeling Capabilities through partnerships

Exploring new ocean research partnerships – Roxsi

UVI Ocean Glider Lab

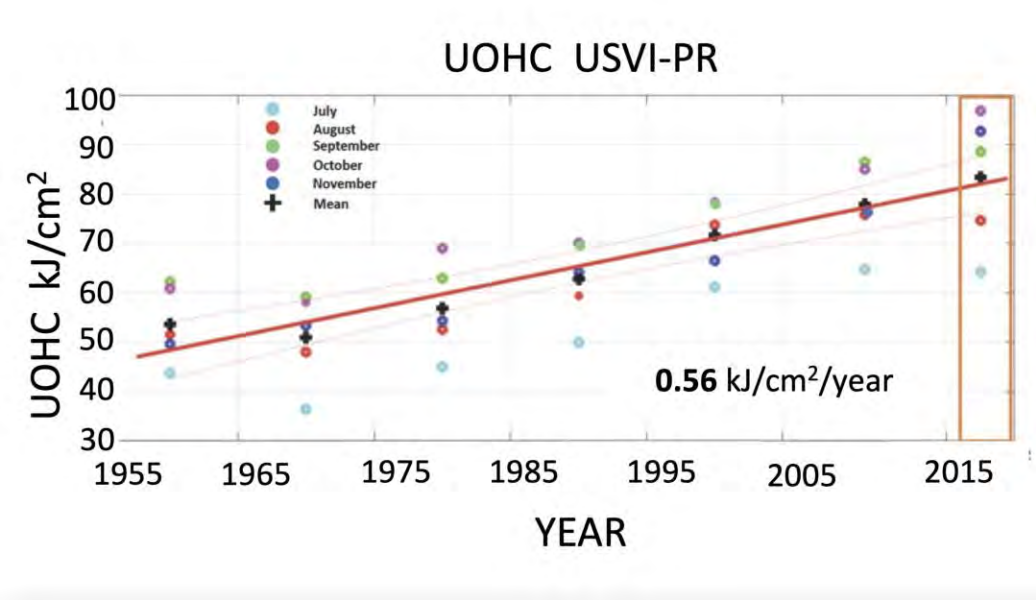
Glider Lab – NSF MRI

- Supports multiple aspects of UVI R2R research
- VI Marine Mammal studies with NOAA SEFSC
- Opportunities for new partnerships
- Supports other unmanned assets
- Attractive to diverse array of student interests



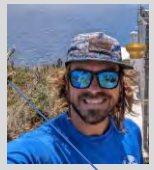
All these will provide new outreach opportunities to community, students, and UVI researchers – including STEM engagement from other disciplines – and will provide a long-term base capability for the Oceanography program and supporting researchers and faculty.

Impacts and Research Results



MMES Graduate Students 2023-

Cole Sheeley, Joshua Solls



Jesse Joy

Undergraduates – Rutgers U. Glider Workshop, 2022

Dishon Heyliger

Zach Briggs

Recent Papers and Presentations

Mukherjee, S., D. Wilson, P. Jobsis, and S, Habtes, 2023. Numerical modeling of internal tides and submesoscale turbulence in the US Caribbean regional ocean. Sci Rep 13(1) DOI 10.1038/s41598-023-27944-2

Gradone, J, W. Wilson, S. Glenn, T. Miles, 2023. Upper Ocean Transport in the Anegada Passage from Multi-Year Glider Surveys. J. Geophys Res, 128(7), https://doi.org/10.1029/2022JC019608

Wilson, D., 2022. Gliders, climatology, and ocean models – what we can learn about the NE Caribbean by increasing upper ocean observation density. Underwater Gliders Users Group Workshop Seattle '22, https://drive.google.com/drive/folders/1QFua98fWN6yAlyWmtnVS22kjX89t0Rg6

Collaborations

MMES
MASTER OF MARINE AND ENVIRONMENTAL SCIENCE
University of the Virgin Islands

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

RUTGERS
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Marine Mammal & Turtle Division

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sanctuaire mammifères marins
sanctuarium zeezoogdieren
AGOA
sanctuaire mammifères marins
french west indies ANTILLES FRANÇAISES

Thank you!

Dr. Tyler Smith

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Research Theme 6:

Marine Disease and Restoration

Introduction

Coral Disease and Restoration

Meet The Team

Faculty & Staff

Dr. Marilyn Brandt
Research Professor

Sonora Meiling, M.Sc.*

Sonora Meiling, M.Sc.*

Kayla Budd*

Samuel Gittens Jr.*

Nicholas Durgadeen*

Kathryn Cobleigh, M.Sc.*

Jason Quetel

Dan Mele, M.Sc.*

Brad Arrington, M.Sc.*

Rachel Ionata, M.Sc.

Natasha Bestrom, M.Sc.*

Chloe Camacho*

Sarah Von Hoene

*UVI graduate ○ Ancestral Virgin Islander

Meet The Team

Students

Amanda Badai

Dr. Becky Gibbel

Shamoy Bideau

Davis Strobel

Avery Coble

Veronica Williamson

MMES
MASTER OF MARINE AND ENVIRONMENTAL SCIENCE
University of the Virgin Islands

Emerging Caribbean Scientist

NSF INCLUDES SEAS Islands Alliance

Odessa Matthew

Kadejsha Tonge

Kahlifah Powell

Ancestral Virgin Islander

Meet The Team

Coral Restoration Ecology Lab

Dr. Robin Smith
Research Assistant Professor

Casey Whalen
Coral Larval Technician

Alexandra Cormack

MMES
MASTER OF MARINE AND ENVIRONMENTAL SCIENCE
University of the Virgin Islands

Makayda Gustave
Undergraduate Researcher

Ancestral Virgin Islander

Coral Disease

Research Goals And Objectives
Marine Disease

MD1	Determine how species biodiversity affects the spread and impact of coral disease
MD2	Determine how local stressors (e.g., nutrients, turbidity) and global stressors (e.g., temperature stress) drive temporal and spatial distributions of disease.
MD3	Predict the spread and impact of multi-species coral disease.
MD4	Share disease research with stakeholders through participation in outreach and education activities

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MD1: Disease & Diversity

Quantify disease across species assemblages

Test how variability in species assemblages affects disease prevalence across reef habitats

Results, Outcomes & Accomplishments –
MD1: Disease and Diversity

Quantify disease across species assemblages

✓Brandt et al. 2021 – Species susceptibility

✓Costa et al. 2021 - Impact of diversity on disease

frontiers in Marine Science

ORIGINAL RESEARCH

The Emergence and Initial Impact of Stony Coral Tissue Loss Disease (SCTLD) in the United States Virgin Islands

Marilyn E. Brandt[1], Rosmin S. Ennis[1], Sonora S. Meiling[1], Joseph Townsend[1,2], Kathryn Cobleigh[1], Adam Glahn[1], Jason Quetel[1,3], Viktor Brandtneris[1], Leslie M. Henderson[4] and Tyler B. Smith[1]*

frontiers in Marine Science

ORIGINAL RESEARCH
published: 28 June 2021
doi: 10.3389/fmars.2021.682688

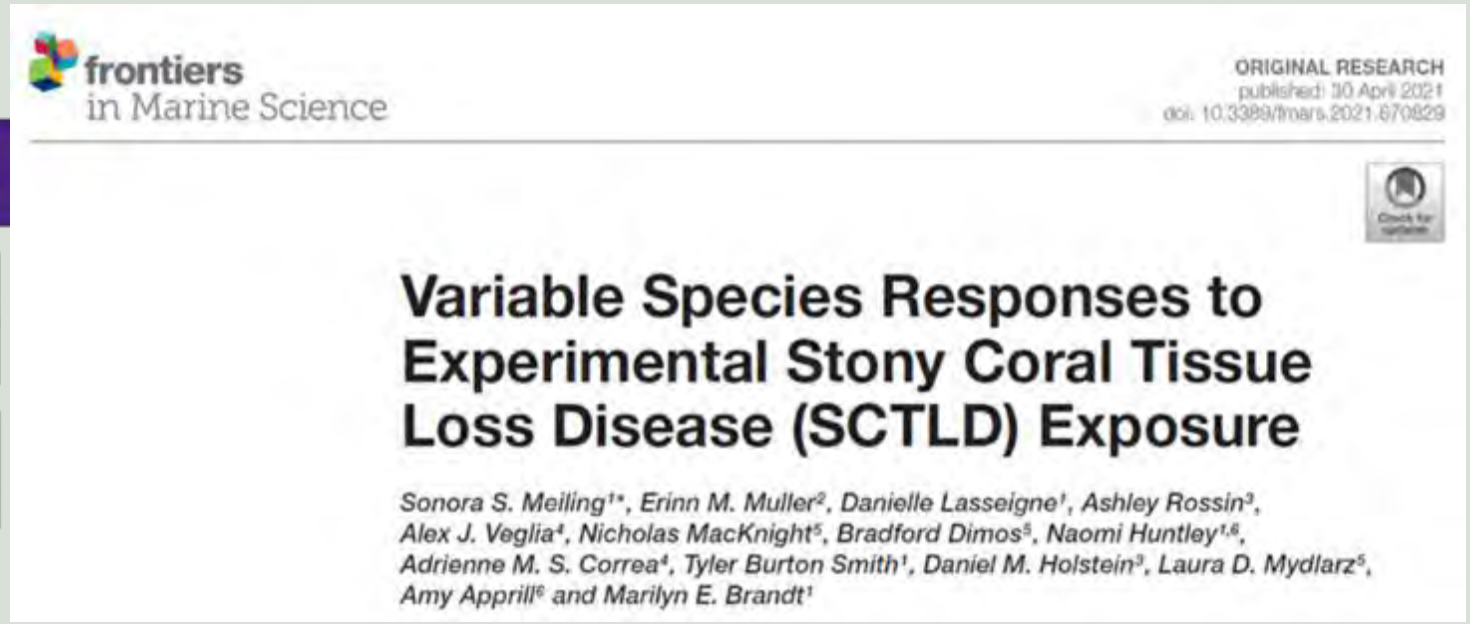
Diversity and Disease: The Effects of Coral Diversity on Prevalence and Impacts of Stony Coral Tissue Loss Disease in Saint Thomas, U.S. Virgin Islands

Sophia V. Costa[1], Stephanie J. Hibberts[1]*, Danielle A. Olive[1,2], Kayla A. Budd[1†], Alexys E. Long[1†], Sonora S. Meiling[1†], Madyson B. Miller[1†], Kelsey M. Vaughn[1†], Claudia I. Carrión[1], Maksym B. Cohen[1], Annie E. Savage[1], Matthew F. Souza[1], Lorraine Buckley[1], Kristin W. Grimes[1], Renata Platenberg[1], Tyler B. Smith[1], Jeremiah Blondeau[3] and Marilyn E. Brandt[1]*

Results, Outcomes & Accomplishments –
MD1: Disease and Diversity

Compare disease incidence among experimental species assemblages

- ✓Experimental transmission experiment accelerated due to emergence of SCTLD
- ✓Meiling et al. 2021



frontiers in Marine Science

ORIGINAL RESEARCH
published: 30 April 2021
doi: 10.3389/fmars.2021.670829

Variable Species Responses to Experimental Stony Coral Tissue Loss Disease (SCTLD) Exposure

Sonora S. Meiling[1], Erinn M. Muller[2], Danielle Lasseigne[1], Ashley Rossin[3], Alex J. Veglia[4], Nicholas MacKnight[5], Bradford Dimos[5], Naomi Huntley[1,6], Adrienne M. S. Correa[4], Tyler Burton Smith[1], Daniel M. Holstein[3], Laura D. Mydlarz[5], Amy Apprill[6] and Marilyn E. Brandt[1]*

NSF Collaborative RAPID grant – analyze samples from a multi-species SCTLD transmission experiment

AMERICAN SOCIETY FOR MICROBIOLOGY | Microbiology Resource Announcements

Alphaflexivirus Genomes in Stony Coral Tissue Loss Disease-Affected, Disease-Exposed, and Disease-Unexposed Coral Colonies in the U.S. Virgin Islands

A. J. Veglia,[a] K. Beavers,[b] E. W. Van Buren,[b] S. S. Meiling,[c] E. M. Muller,[d] T. B. Smith,[c] D. M. Holstein,[e] A. Apprill,[f] M. E. Brandt,[c] L. D. Mydlarz,[b] A. M. S. Correa[a]

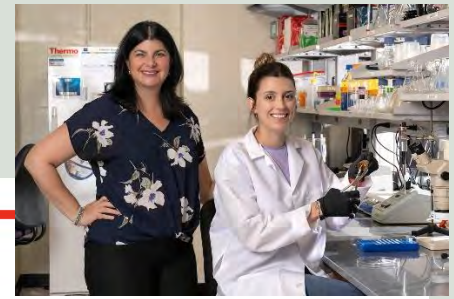
ISME

www.nature.com/ismecom

ARTICLE OPEN

Experimental transmission of Stony Coral Tissue Loss Disease results in differential microbial responses within coral mucus and tissue

Naomi Huntley[1,2], Marilyn E. Brandt[1], Cynthia C. Becker[2,3], Carolyn A. Miller[2], Sonora S. Meiling[1], Adrienne M. S. Correa[4], Daniel M. Holstein[5], Erinn M. Muller[6], Laura D. Mydlarz[7], Tyler B. Smith[1] and Amy Apprill[2]



nature communications

Article

https://doi.org/10.1038/s41467-023-38612-4

Stony coral tissue loss disease induces transcriptional signatures of in situ degradation of dysfunctional Symbiodiniaceae

Received: 3 November 2022

Accepted: 10 May 2023

Published online: 22 May 2023

Check for updates

Kelsey M. Beavers[1], Emily W. Van Buren[1], Ashley M. Rossin[2], Madison A. Emery[1], Alex J. Veglia[3], Carly E. Karrick[3], Nicholas J. MacKnight[1], Bradford A. Dimos[1], Sonora S. Meiling[4], Tyler B. Smith[4], Amy Apprill[5], Erinn M. Muller[6], Daniel M. Holstein[2], Adrienne M. S. Correa[3], Marilyn E. Brandt[4] & Laura D. Mydlarz[1]

Research Goals And Objectives
Marine Disease

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MD4	Share disease research with stakeholders through participation in outreach and education activities

MD2: Disease, Water Quality & Temperature Stress

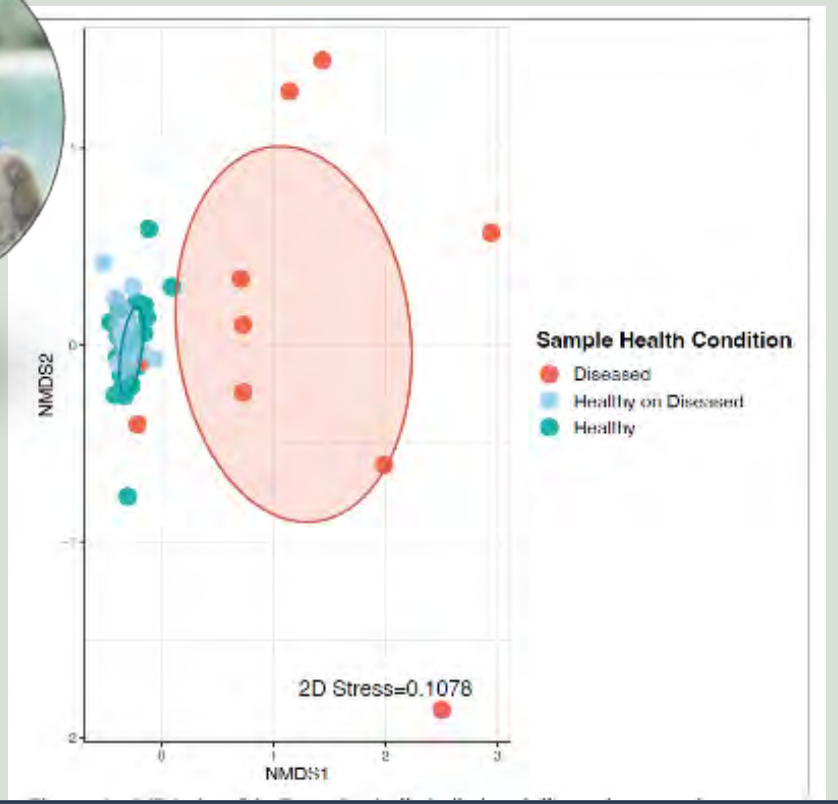
Test effect of water quality and temperature stress on disease prevalence

Test effect of water quality and temperature stress on disease transmission

Results, Outcomes & Accomplishments –
MD2: Disease, Water Quality & Temperature Stress

Test effect of water quality and temperature stress on disease prevalence

- ✓Water quality sampling for two consecutive years (ongoing)
- ✓NASA EPSCoR grant for satellite comparison (C of C, KSU)
- ✓WRRI grant for microbial sampling and analysis (WHOI)

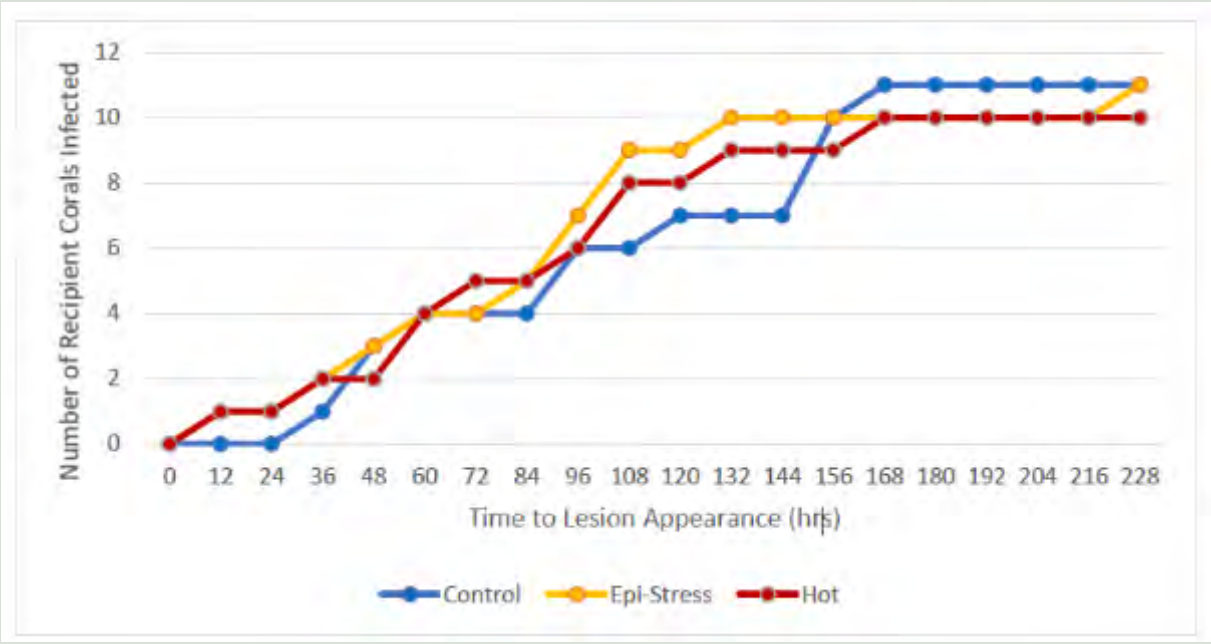


Results, Outcomes & Accomplishments –

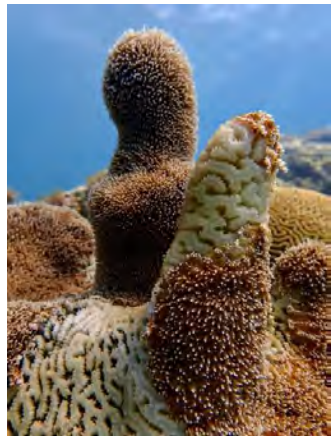
MD2: Disease, Water Quality & Temperature Stress

Test effect of water quality and temperature stress on disease transmission

✓Temperature stress disease transmission experiment completed in 2022



Research Goals And Objectives
Marine Disease



MD1	Determine how species biodiversity affects the spread and impact of coral disease
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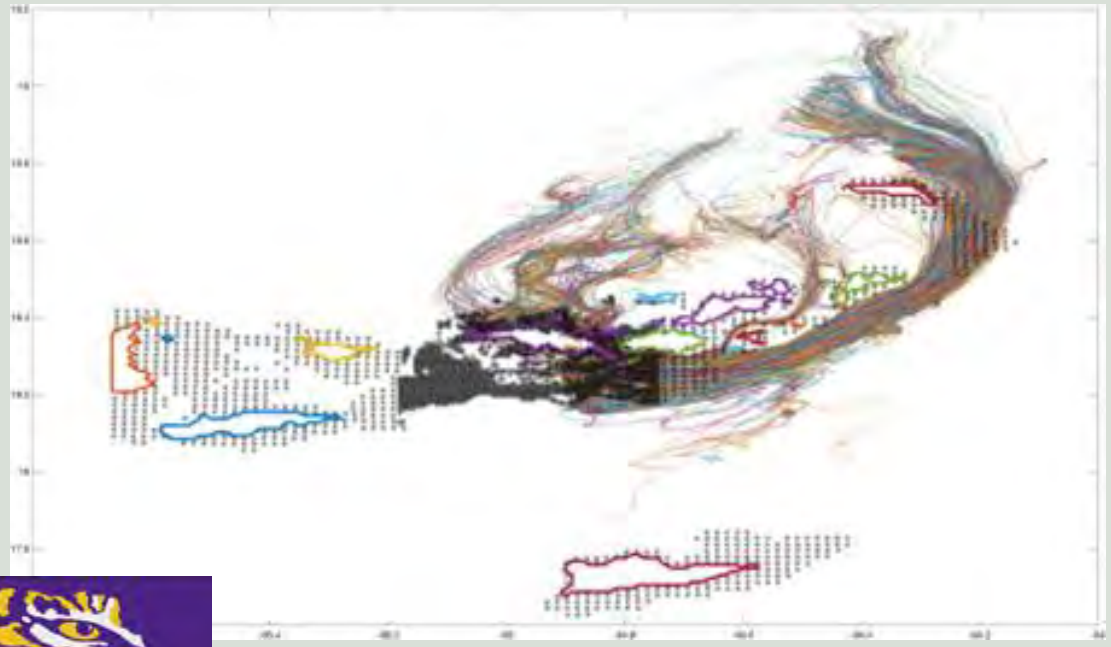
MD3: Predict the spread of disease

Use hydrodynamic model outputs to parameterize a connectivity model

Produce coral species grid

Results, Outcomes & Accomplishments –
MD3: Predict the spread of disease



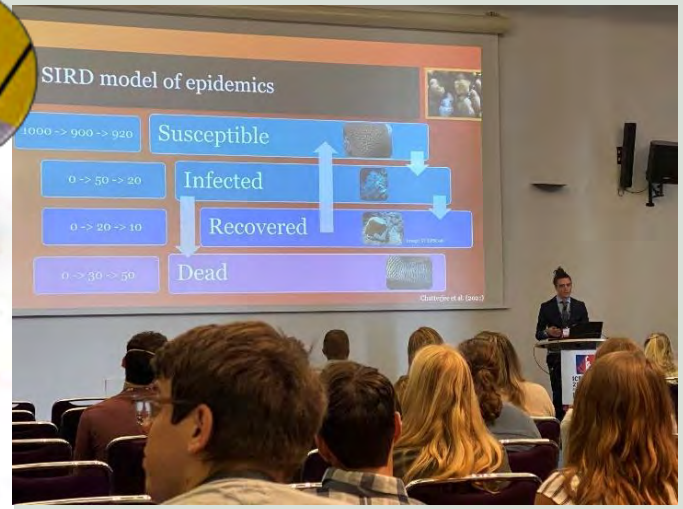
Use hydrodynamic model outputs to parameterize a connectivity model

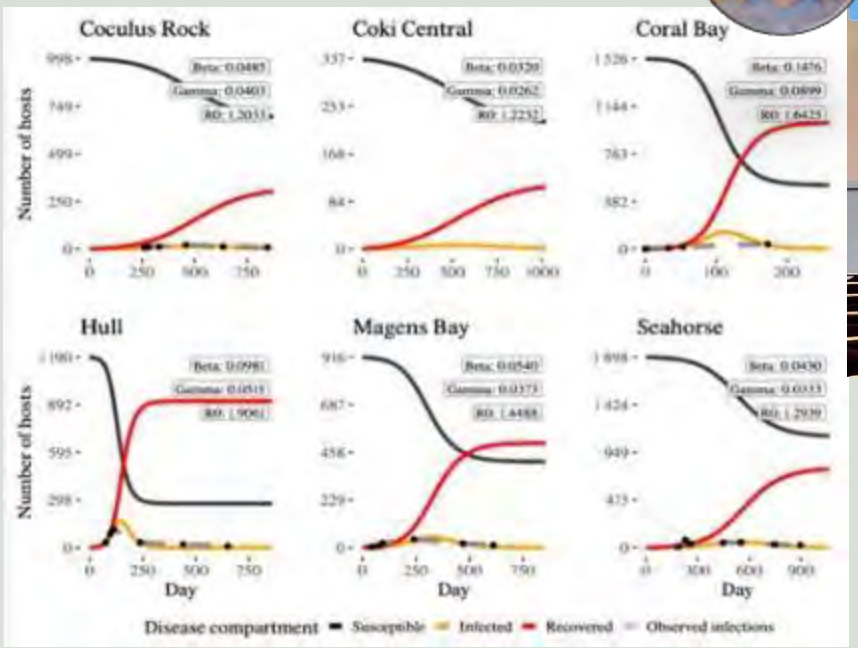
✓Hydrodynamic model runs completed and used by D. Holstein's lab in initial testing. More work needed.

Results, Outcomes & Accomplishments –
MD3: Predict the spread of disease

Produce coral species grid

- ✓Ph.D. student Benjamin Farmer dissertation work (M. Brandt a committee member)
- ✓As part of NSF Ecology and Evolution of Infectious Disease (EEID)-funded work, Ben working on SIRD model to increase accuracy of model predictions (presented at ICRS)

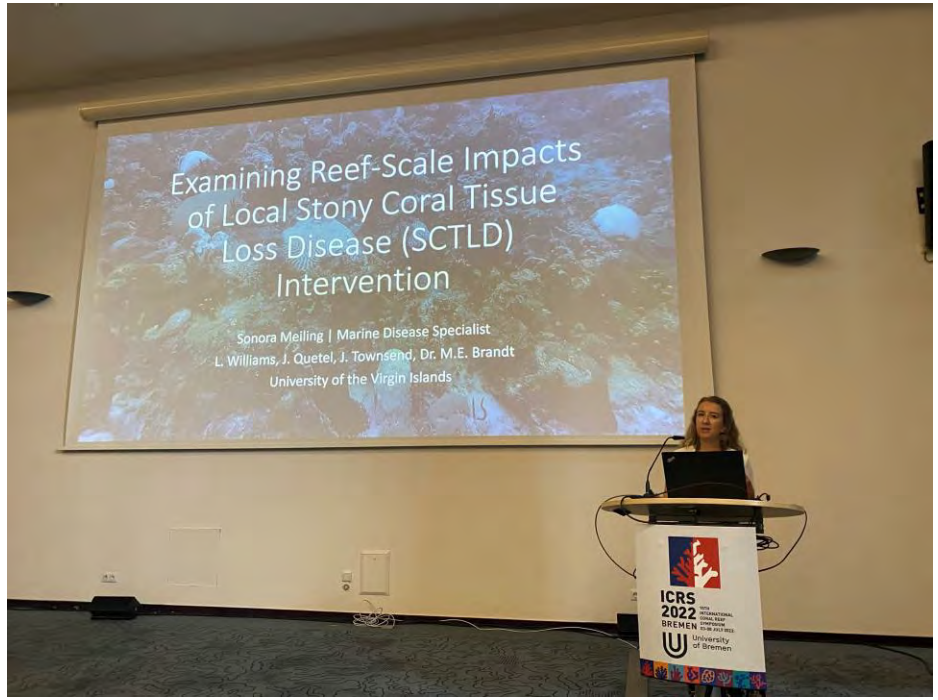




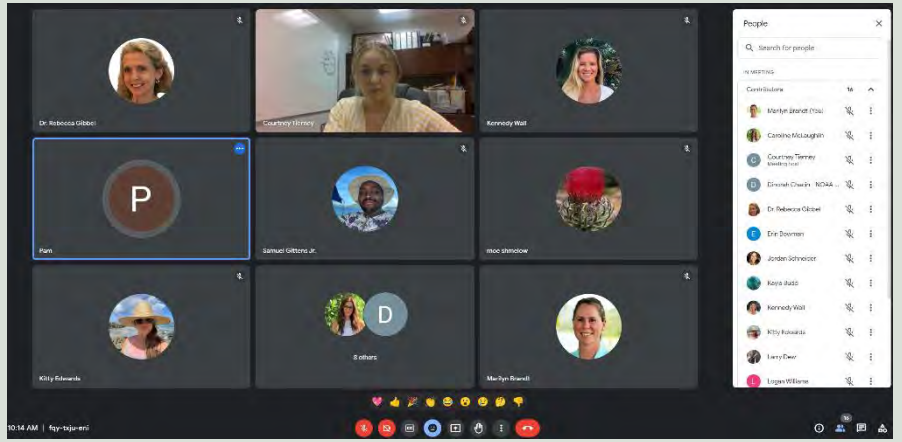
Research Goals And Objectives
Marine Disease

MD4: Share disease research (all years)

MD1	Determine how species biodiversity affects the spread and impact of coral disease
MD2	Determine how local stressors (e.g., nutrients, turbidity) and global stressors (e.g., temperature stress) drive temporal and spatial distributions of disease.
MD3	Predict the spread and impact of multi-species coral disease.
MD4	**Share disease research with stakeholders through participation in outreach and education activities**



Results, Outcomes & Accomplishments –
MD4: Share disease research



Vicoraldisease.org

- ✓Vicoraldisease.org hosted by Brandt lab and managed by VI Department of Planning and Natural Resources (DPNR)
- ✓M. Brandt, S. Meiling and other Brandt lab members are regular contributors to the Virgin Islands Coral Disease Advisory Committee (VI-CDAC)
- ✓Regular interviews with local news agencies

THE St. Thomas Source US VIRGIN ISLANDS

Researchers Uncover Some Secrets of Stony Coral Disease, Still Search for Its Cause

By Bernetia Akin July 24, 2023

THE St. Thomas Source US VIRGIN ISLANDS

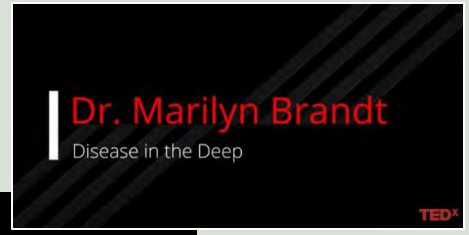
Specter of Coral Bleaching Hangs Over V.I.

By Bernetia Akin August 23, 2023

Results, Outcomes & Accomplishments –
MD4: Share disease research

- ✓1 poster and 9 oral presentations about USVI coral disease research at the 2022 International Coral Reef Symposium
- ✓2 posters and 1 oral presentation at the 2023 Association of Marine Laboratories of the Caribbean meeting

TEDx Saint Thomas



Coral Restoration

Research Goals And Objectives

Restoration

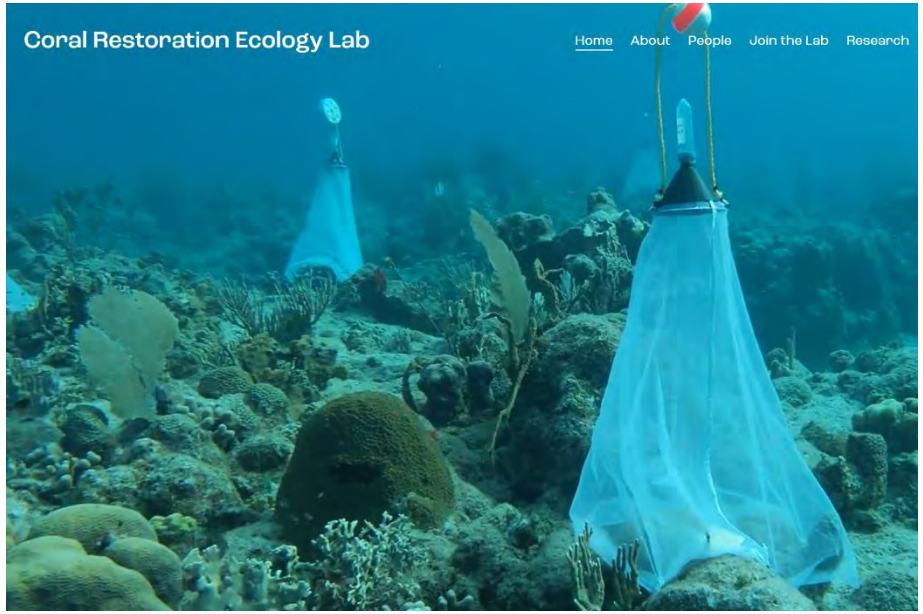
MR1	Expand capacity for restoration ecology research in the U.S. Virgin Islands
MR2	Determine how diversity affects success of coral outplanting
MR3	Determine how gradients in water quality affect success of coral outplanting
MR4	Share restoration research with stakeholders through participation in outreach and education activities

Research Goals And Objectives
Restoration

MR1	**Expand capacity for restoration ecology research in the U.S. Virgin Islands**
MR2	Determine how diversity affects success of coral outplanting
MR 3	Determine how gradients in water quality affect success of coral outplanting
MR4	Share restoration research with stakeholders through participation in outreach and education activities

MR1: Expand capacity

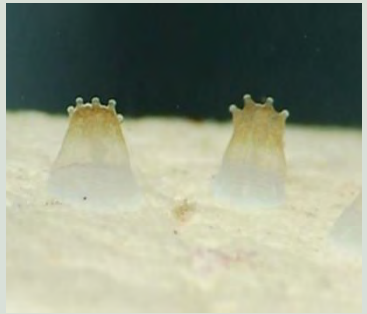
Hire Restoration Ecology Research faculty



Results, Outcomes & Accomplishments

National Marine Sanctuary Foundation

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM



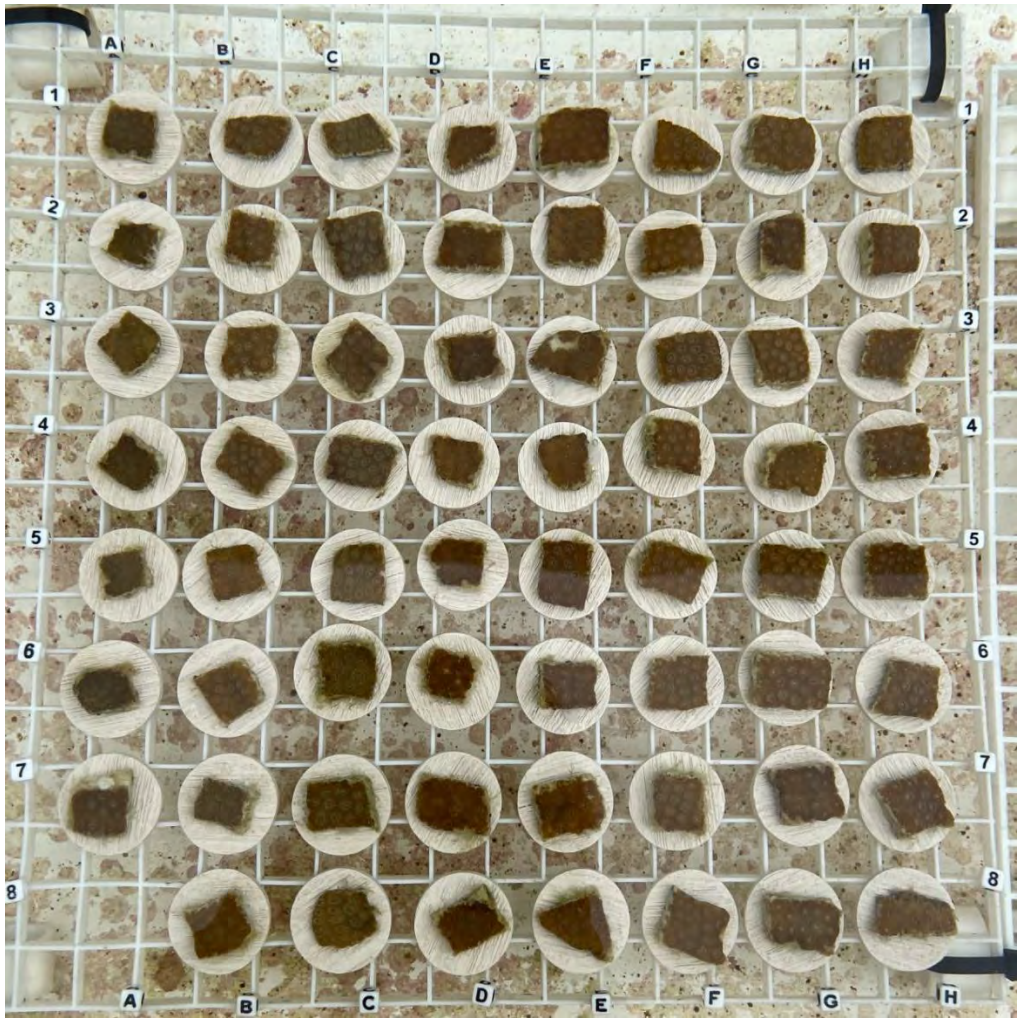
Scalable Coral Restoration using Selective-Breeding and Assisted Evolution Technologies

- ✓ Construction of large-scale Larval Rearing Units
- ✓ Symbiont diversity surveys for parental selection.
- ✓ Completed 12-month captive gametogenesis & spawning
- ✓ Pre-trial fertilization and settlement onto RFID substrates.

Results, Outcomes & Accomplishments

Evaluating Micro-fragmentation as a Coral Restoration Technique

- ✓ Created over 500 micro-fragments of coral and 15 large fragments
- ✓ Monitored post-fragmenting mortality rates
- ✓ Comparing:
  - ✓ Rate of instantaneous skeleton growth
  - ✓ Symbiont community shifts
  - ✓ Tissue Biomass
  - ✓ Tissue surface area
  - ✓ Buoyant weight
  - ✓ Symbiont density



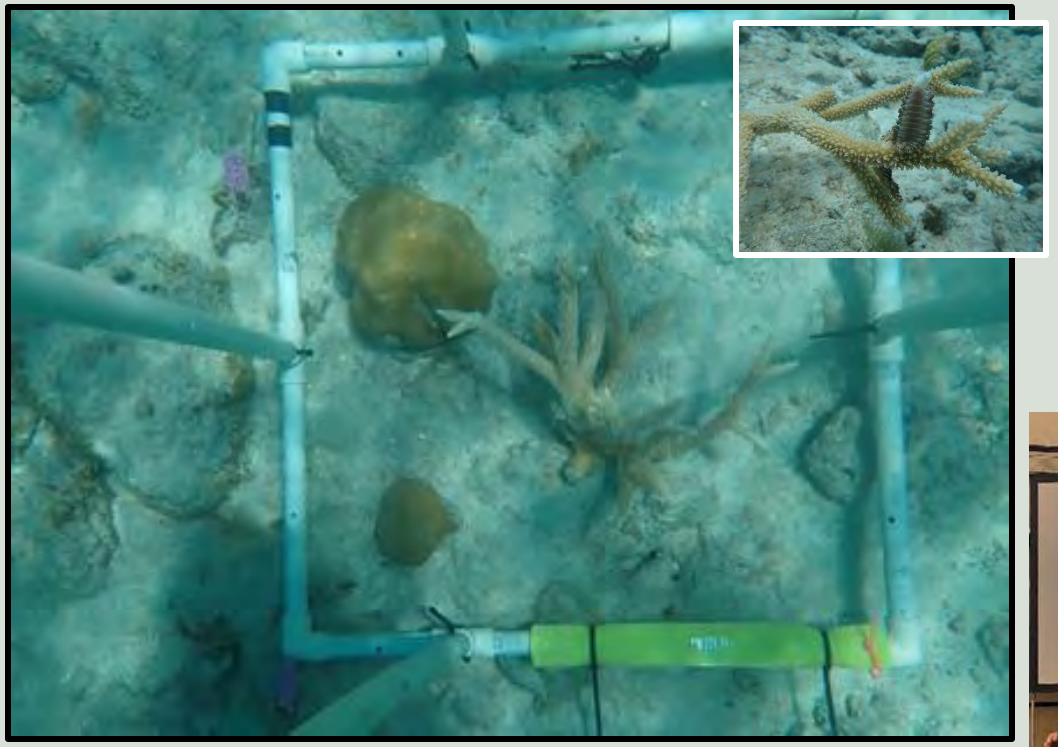
Research Goals And Objectives
Restoration

MR1	Expand capacity for restoration ecology research in the U.S. Virgin Islands
MR2	**Determine how diversity affects success of coral outplanting**
MR 3	Determine how gradients in water quality affect success of coral outplanting
MR4	Share restoration research with stakeholders through participation in outreach and education activities

MR2: Diversity and Outplanting

Perform diversity outplanting experiment

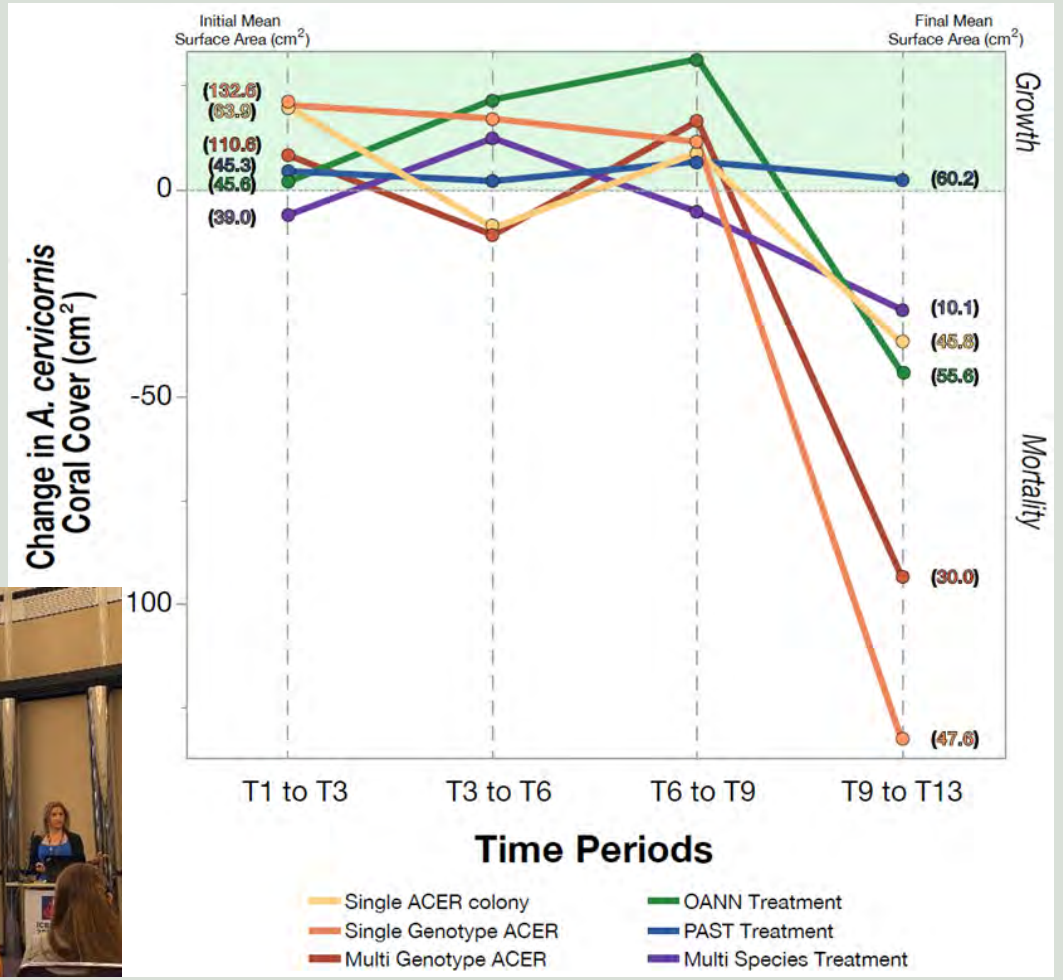
Results, Outcomes & Accomplishments –
MR2: Diversity and Outplanting



Perform diversity outplanting experiment

✓Experiment deployed in January 2022

✓Preliminary results presented at ICRS July 2022



Research Goals And Objectives

Restoration

MR1	Expand capacity for restoration ecology research in the U.S. Virgin Islands
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MR 3	Determine how gradients in water quality affect success of coral outplanting
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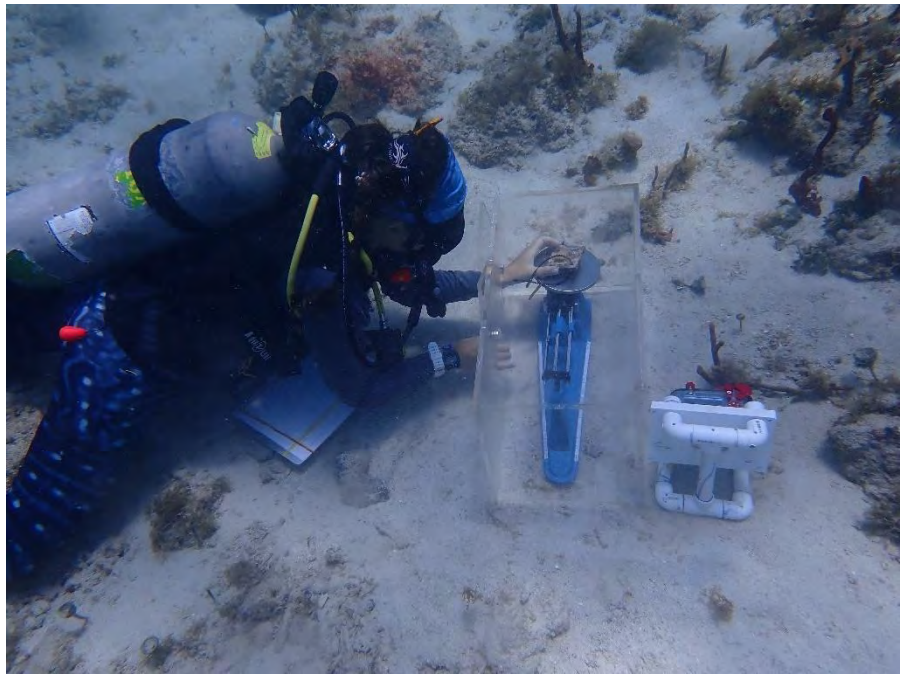
MR3: Water quality and restoration

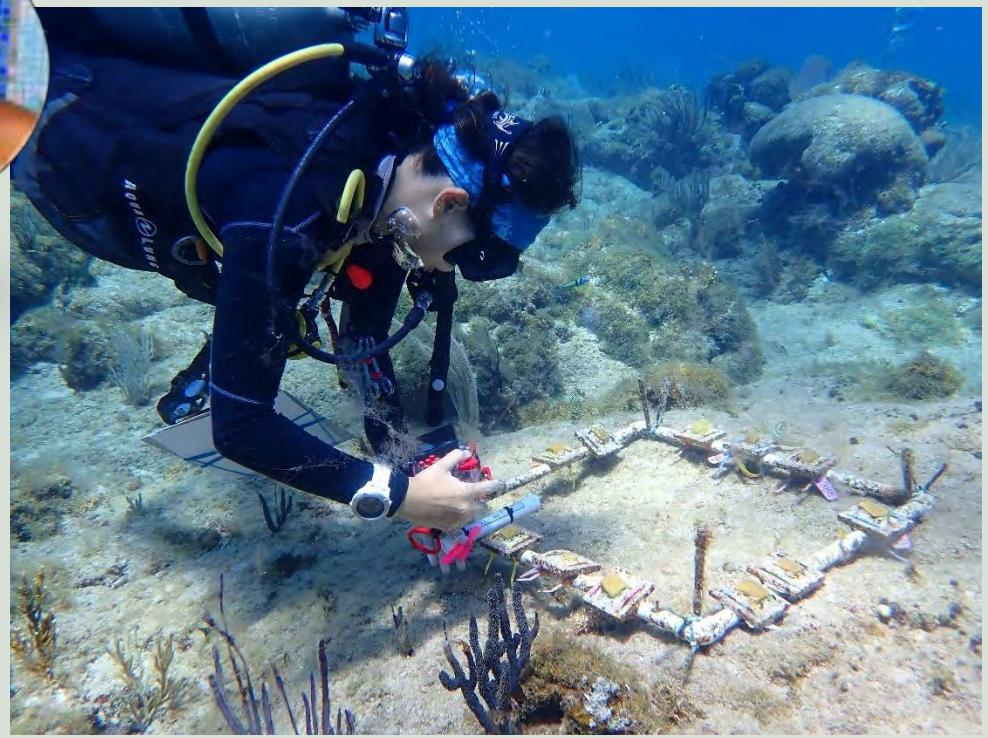
Perform water quality outplanting experiment

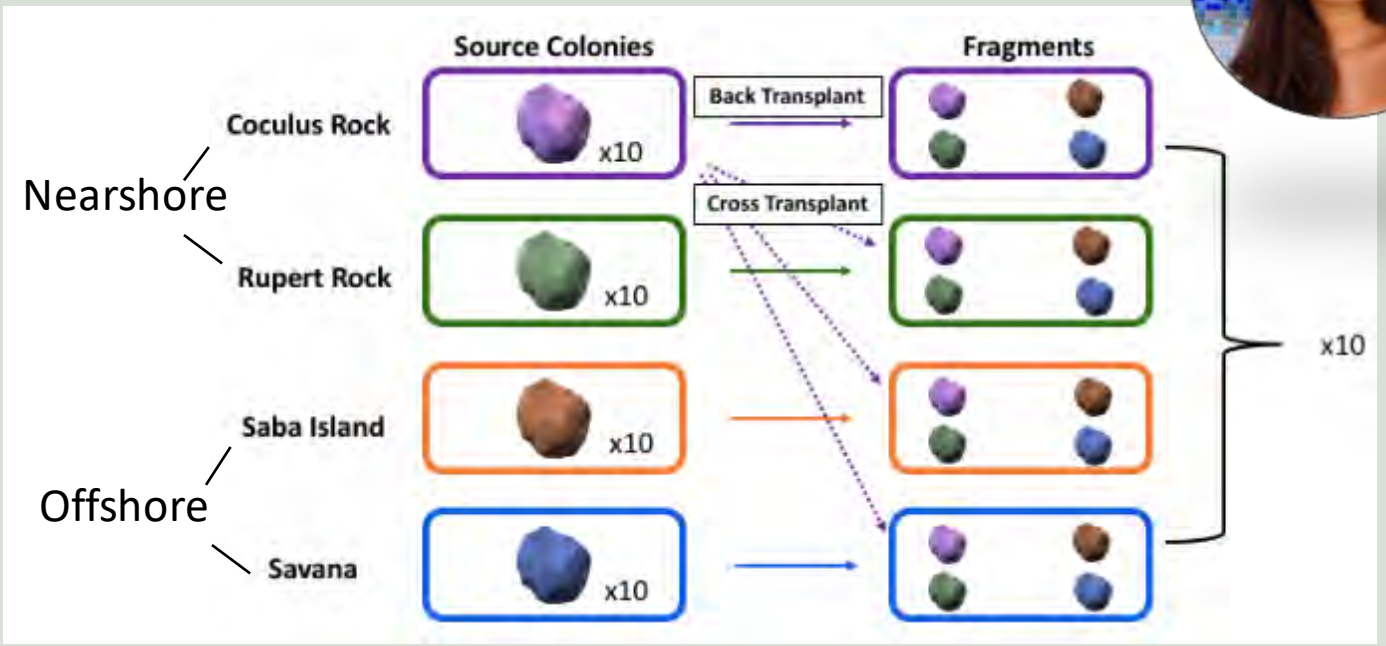


Results, Outcomes & Accomplishments –
MR3: Outplanting and Water Quality

Perform water quality outplanting experiment

- ✓Adeline Shelby's MMES thesis experiment deployed in January 2023
- ✓Complemented with water quality sampling





Research Goals And Objectives
Restoration

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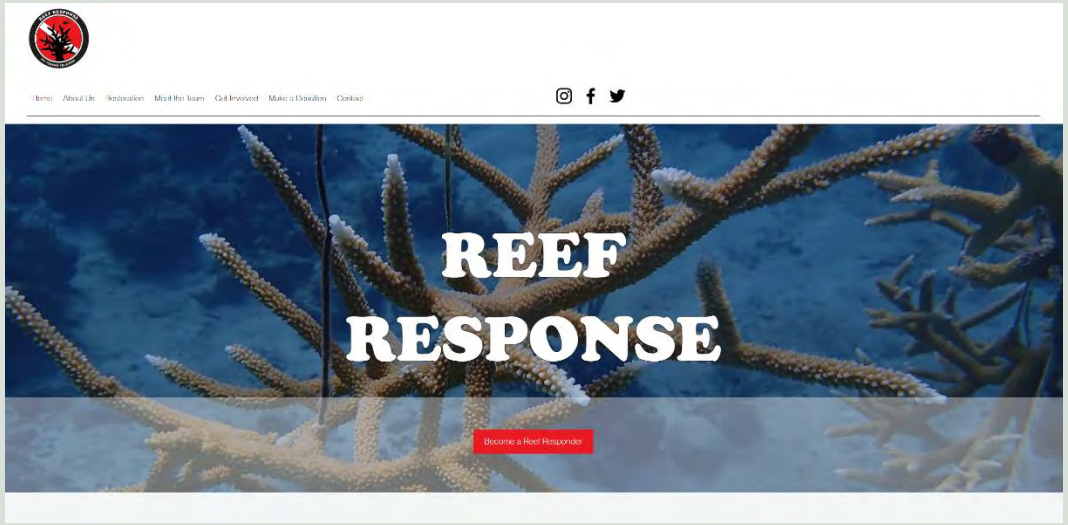
MR4	**Share restoration research with stakeholders through participation in outreach and education activities**

MR4: Share restoration research

Results, Outcomes & Accomplishments –
MR4: Share restoration research

- ✓Reefresponse.org
- ✓Educational signage at Lovango Cay, in process for Hull Bay

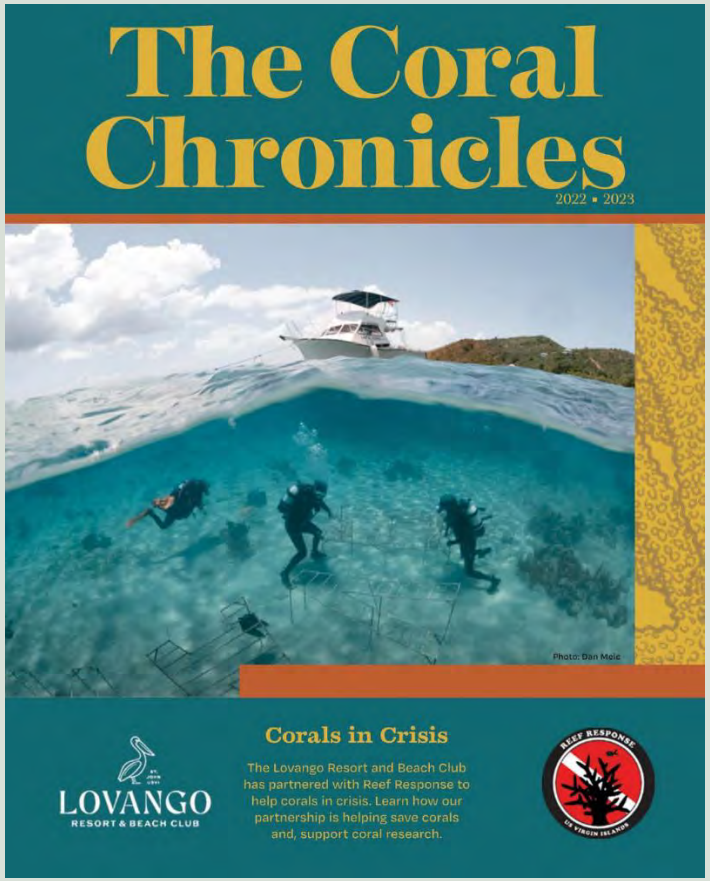


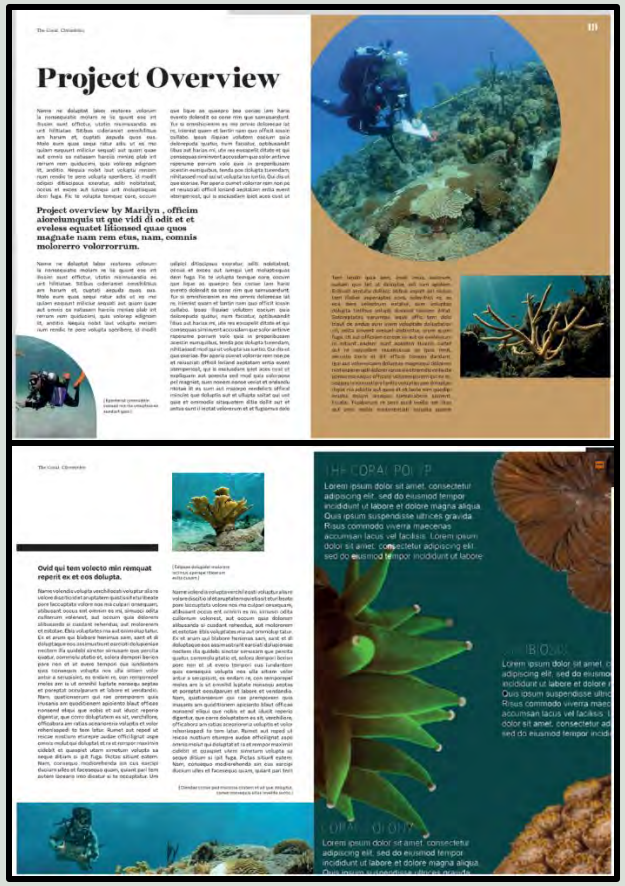
Reefresponse.org

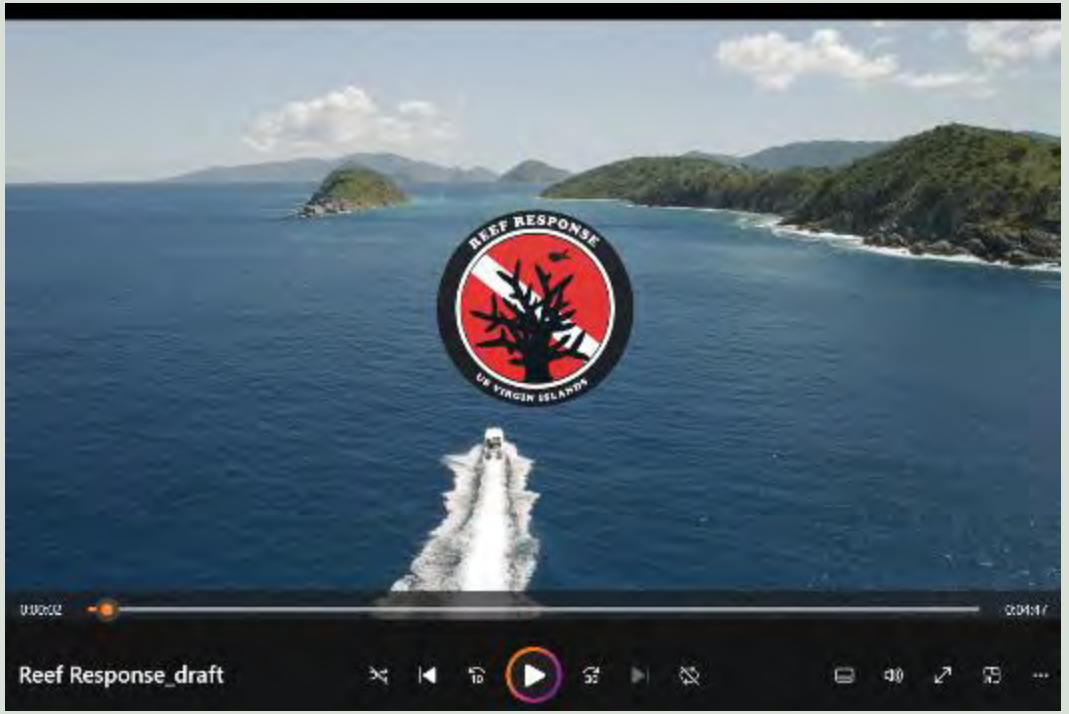
Results, Outcomes & Accomplishments –

MR4: Share restoration research

✓Coral Chronicles booklet published
✓Reef Response video almost complete



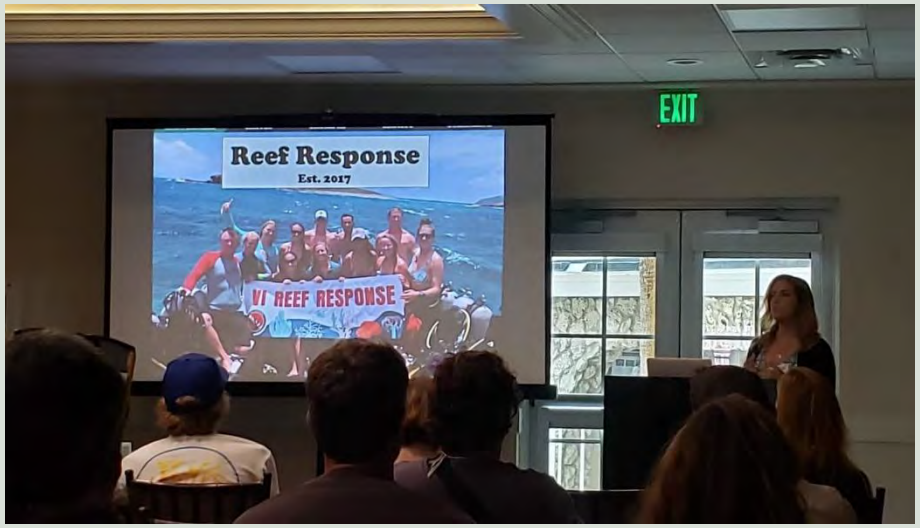




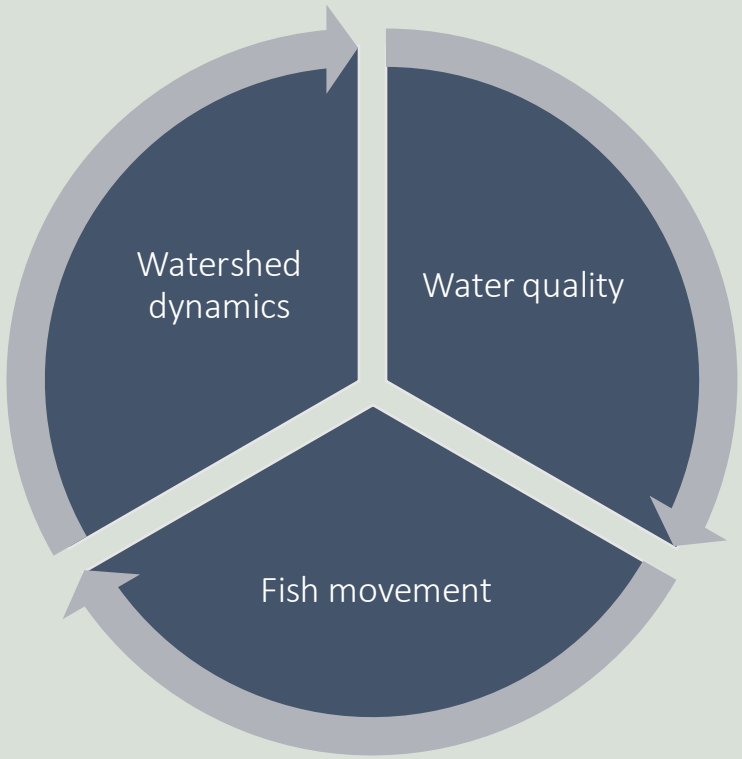
Results, Outcomes & Accomplishments –

MR4: Share restoration research

- ✓1 poster and 2 oral presentations focused on coral restoration at the 2022 International Coral Reef Symposium
- ✓1 poster and 4 oral presentations at Reef Futures 2022
- ✓3 posters at Association of the Marine Labs of the Caribbean meeting 2023

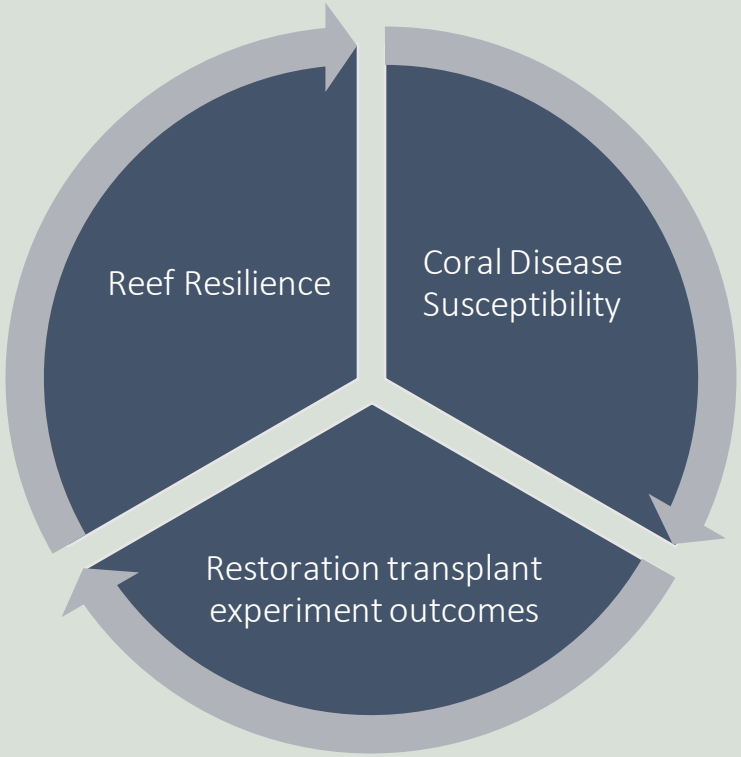


Research Interdependencies



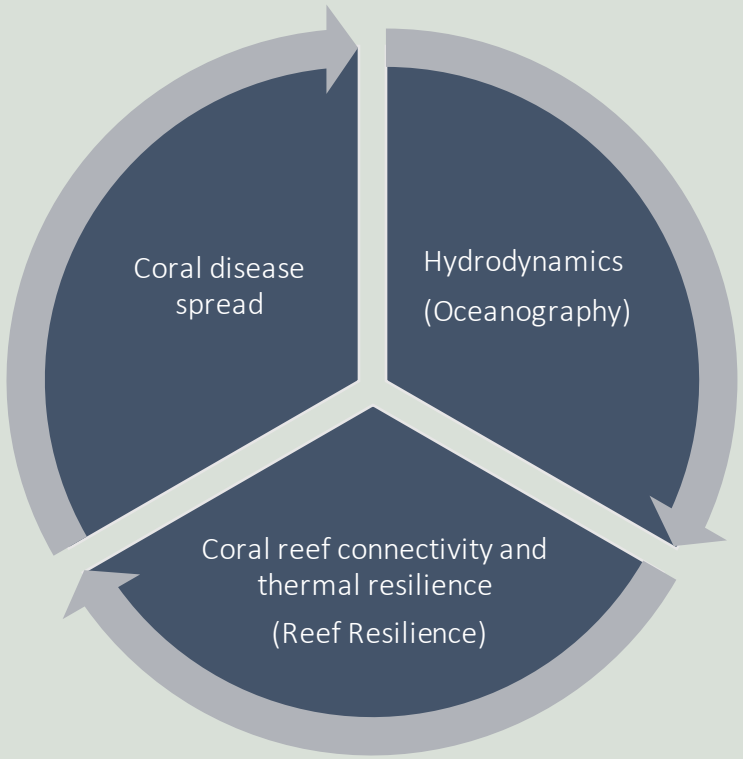
- Water quality data collected for Marine Disease and Restoration complementary to Watershed water quality data and is being used by the Fish Movement work

Research Interdependencies

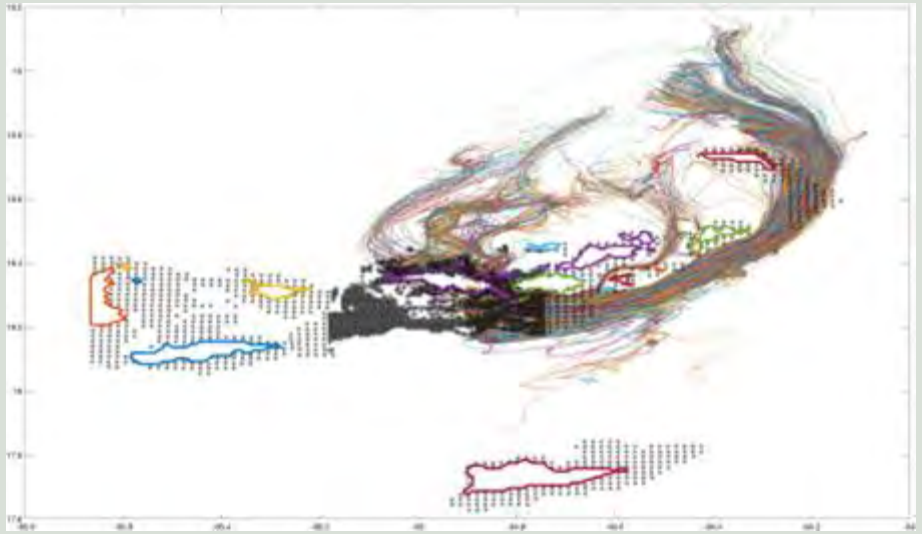


- Disease susceptibility and restoration success informing reef resilience

Research Interdependencies



- Hydrodynamics from Oceanography and coral reef distribution and histories from Reef Resilience will inform Coral disease spread models



Research Interdependencies

- Coral and Mangrove habitat restoration overlapping goals for coastal protection and community engagement

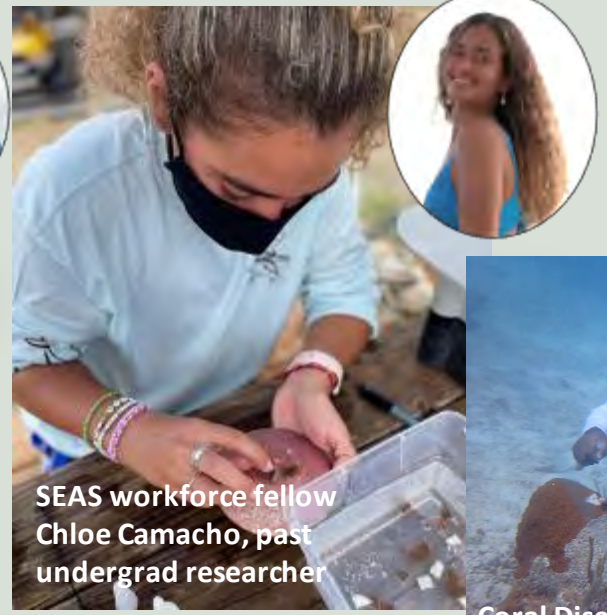
Diversity

Emerging Caribbean Scientist

College

Reef Response undergraduate SEAS intern Kahlifah Powell, accepted into 2024 MMES cohort

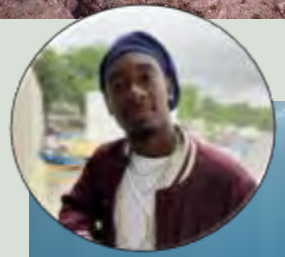
Workforce



SEAS workforce fellow Chloe Camacho, past undergrad researcher

Coral Disease Treatment Specialist Sam Gittens Jr., past SEAS undergrad intern

Pre-college



Graduate

SEAS Graduate fellow Shamoy Bideau, past ECS

Coral Restoration Specialist Nicholas Durgadeen, past SEAS undergrad intern

Broader Impacts

UVI faculty & staff

MMES alumni

Current MMES student

Broader Impacts

ACKNOWLEDGEMENTS

Dr. Nicole Angeli
Department of Planning and Natural Resources, Division of Fish and Wildlife

Dr. Larry Dew
University of the Virgin Islands

Nicholas Durgadeen
University of the Virgin Islands

Kristen Ewen
National Park Service

Megan Fraser
National Marine Sanctuary Foundation in support of Florida Keys National Marine Sanctuary

Dr. Sean Griffin
National Oceanic and Atmospheric Administration, Restoration Center

Gabrielle Johnson
National Oceanic and Atmospheric Administration, Office for Coastal Management

Caitlin Lustic
The Nature Conservancy

Dr. Michael Nemeth
National Oceanic and Atmospheric Administration, Restoration Center

Pedro Nieves
Department of Planning and Natural Resources, Division of Coastal Zone Management

Dr. Robin Smith
University of the Virgin Islands

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The Nature Conservancy

Catherine Toline
National Park Service

Dr. Shay Viehman
National Oceanic and Atmospheric Administration, National Centers for Coastal Ocean Science

Jordan Wolfe
National Oceanic and Atmospheric Administration, Southeast Regional Habitat Conservation Division

SUGGESTED CITATION

Virgin Islands Restoration of Coral Squad (VI-RoCS). 2023. US Virgin Islands Coral Reef Restoration Plan. 65 pp. https://doi.org/10.xxxx/xxxxxx

Authors & Acknowledgements

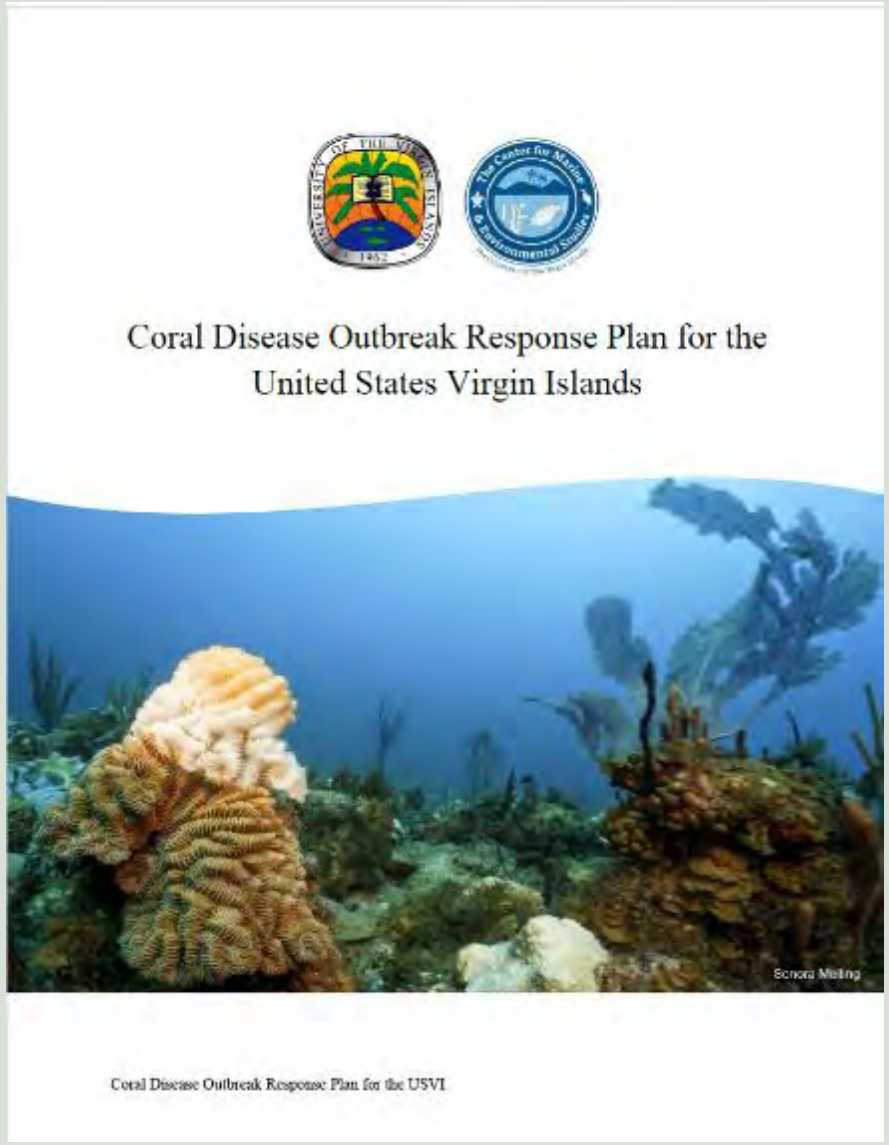
USVI CORAL REEF RESTORATION PLAN 3

- UVI faculty & staff
- MMES alumni or past student

Broader Impacts

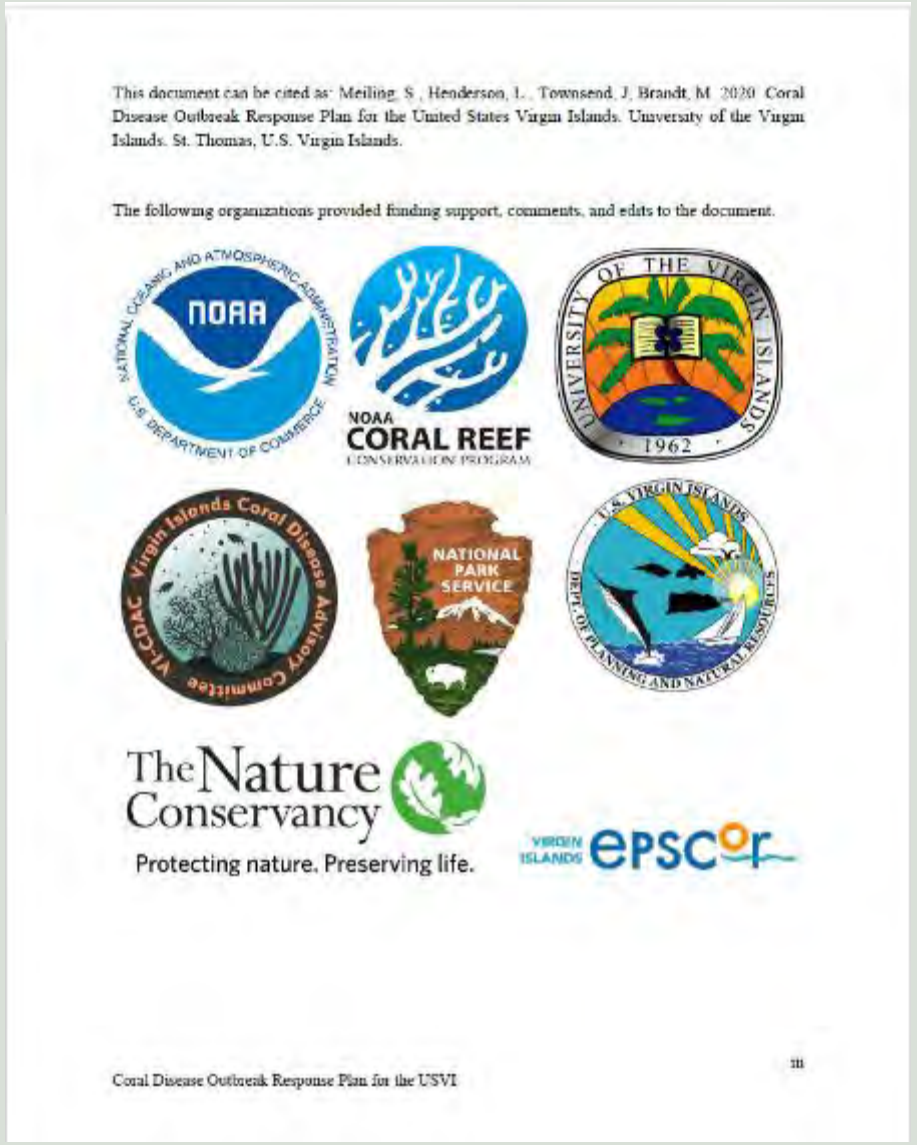
~41% of authors & contributors UVI/MMES associates and alumni

Broader Impacts



Coral Disease Outbreak Response Plan for the United States Virgin Islands

Coral Disease Outbreak Response Plan for the USVI



This document can be cited as: Meiling, S., Henderson, L., Townsend, J., Brandt, M. 2020. Coral Disease Outbreak Response Plan for the United States Virgin Islands. University of the Virgin Islands. St. Thomas, U.S. Virgin Islands.

The following organizations provided funding support, comments, and edits to the document.

Protecting nature. Preserving life.

Coral Disease Outbreak Response Plan for the USVI iii

Collaborations

Year 4 Goals

Hire post-doc	Advertise and hire post-doctoral associate in Disease and Restoration
Integrate modeling	Work with Oceanography theme and D. Holstein's laboratory to integrate data and begin modeling
Further transmission and restoration experiments	Dependent on the Marine Science building completion

Thank you!

Dr. Marilyn Brandt

EMAIL: mbrandt@uvi.edu

PHONE: 340-693-1376

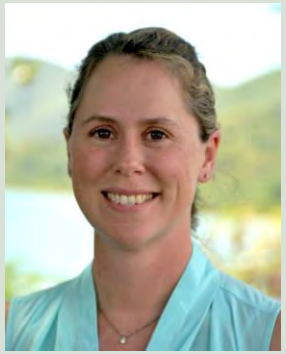
Research Theme 7:
Coral Reef Resilience

The Virgin Islands
Reef Resilience Study

Collaborations

Meet The Team - VIRRS

Tyler B. Smith, Ph.D.



Marilyn E. Brandt, Ph.D.

Lauren K. Olinger, Ph.D.

Peter J. Edmunds, Ph.D.

And 38 more!

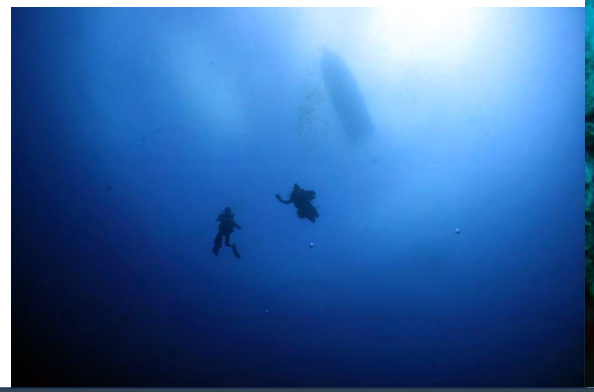
Virgin Islands Reef Resilience Study

Goal 1

Determine the internal and external drivers most critical to coral reef ecosystem resilience in the USVI and identify targets for restoration of resilience.

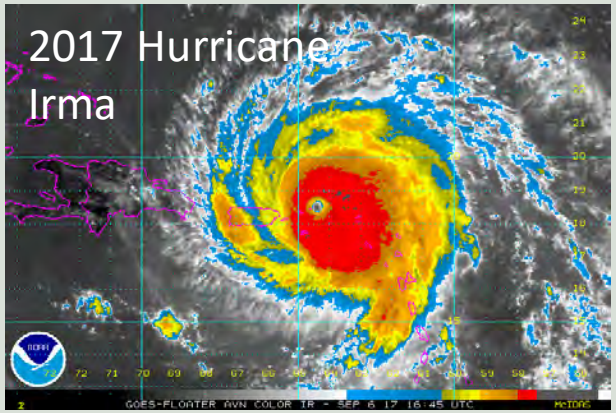
Hypothesis I (H I): The resilience of USVI's marine ecosystems is reduced through interacting stress drivers but may be modulated through increased genetic and species diversity.

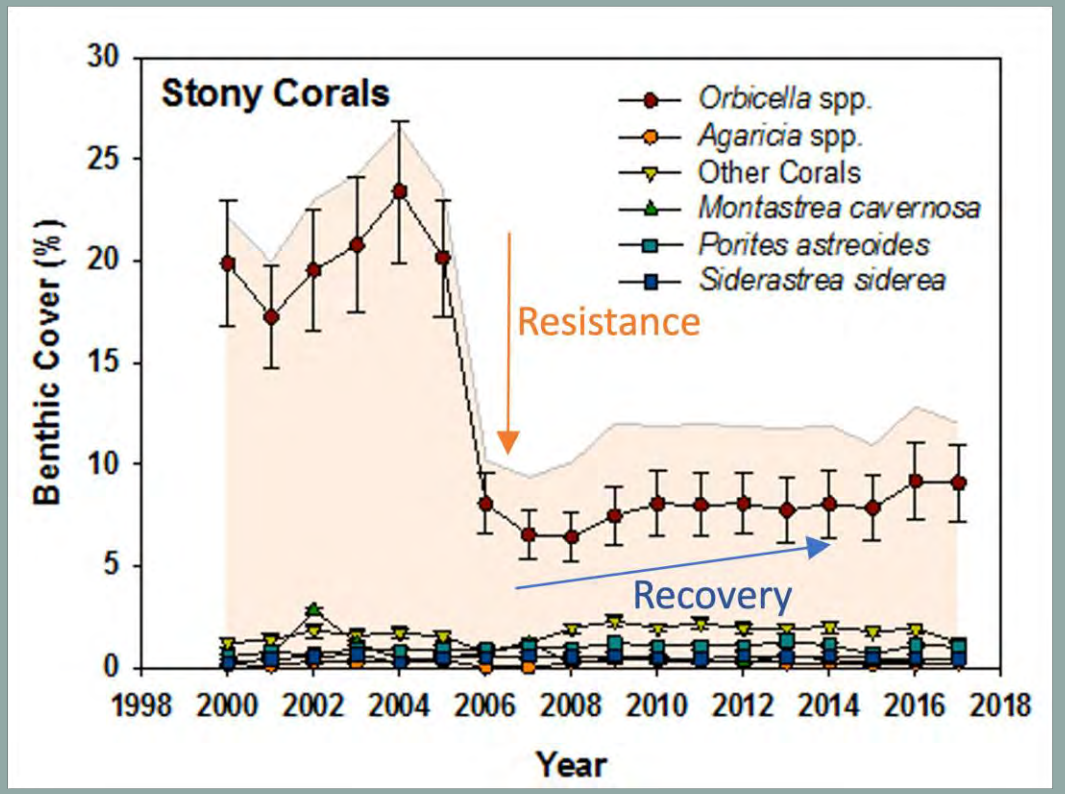
Sonora Meiling



Approach

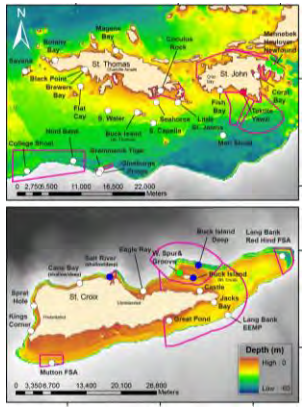
Virgin Islands Reef Resilience Study



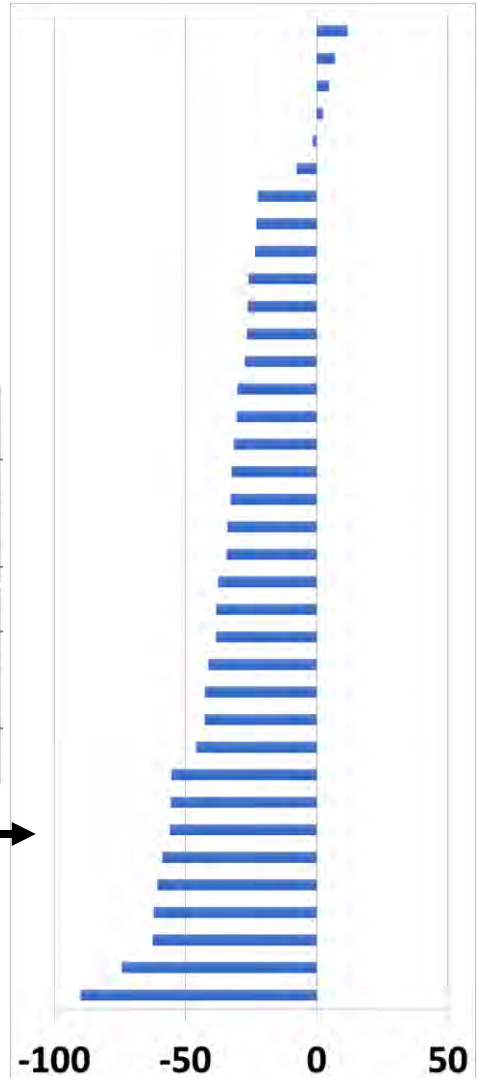


Mennebeck Reef, St. John. Data courtesy of the National Park Service

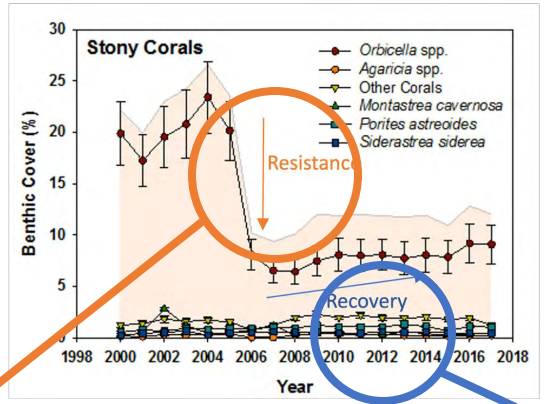
Resistance
2005



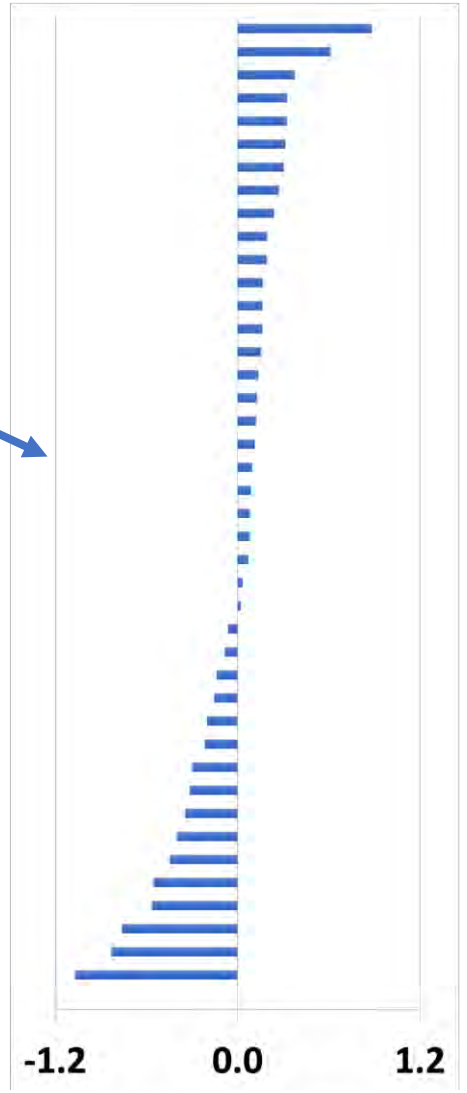
Study Sites →



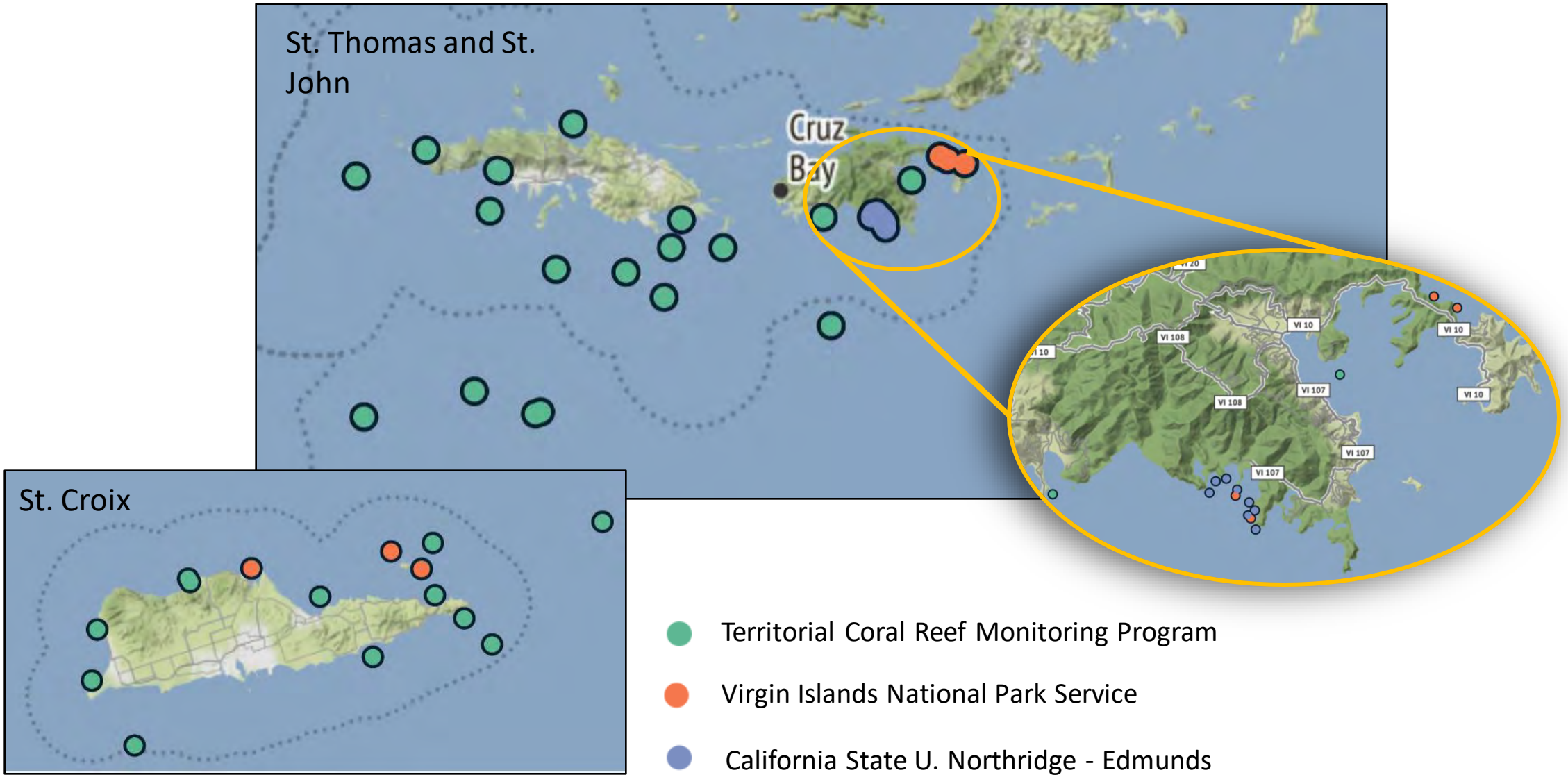
Relative change in coral cover (%)



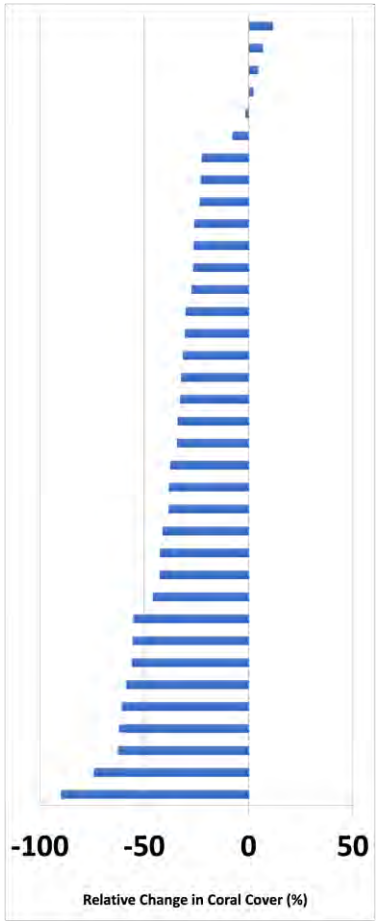
Recovery
2007-2017



Absolute change in coral cover (% per year)


St. Thomas and St. John
Cruz Bay
St. Croix
VI 10
VI 108
VI 107
Territorial Coral Reef Monitoring Program
Virgin Islands National Park Service
California State U. Northridge - Edmunds

Resistance



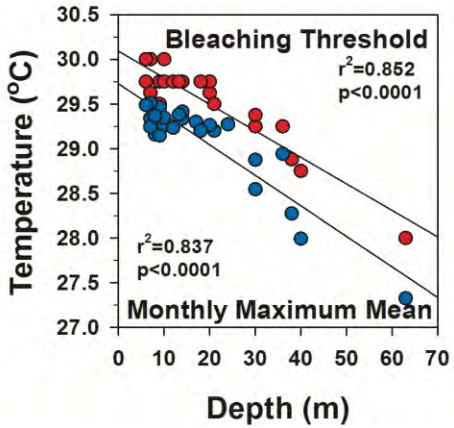
Community Susceptibility

+

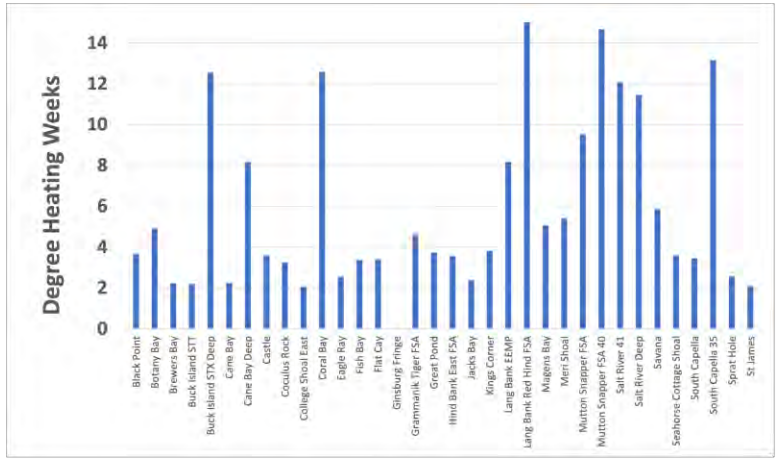
Realized environmental stress

Genetic Susceptibility

Acclimation



Smith et al. 2016



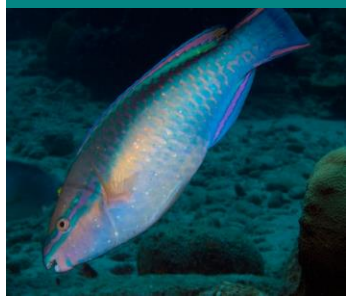
Degree Heating Weeks Calculated from TCRMP sites in bleaching year 2019

Some examples of potential drivers of recovery

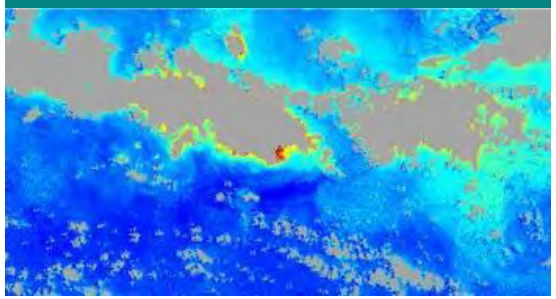
Internal

External

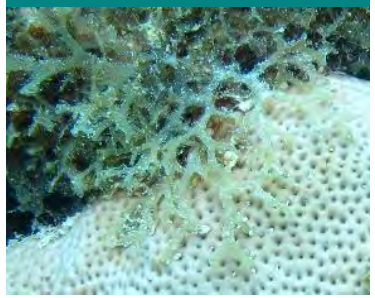
Herbivory



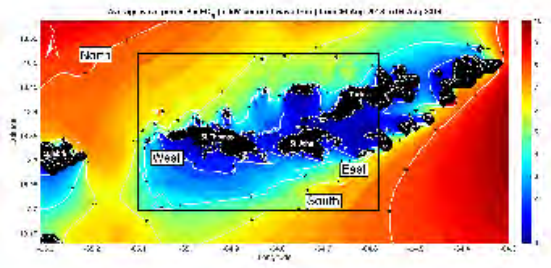
Satellite Chlorophyll a

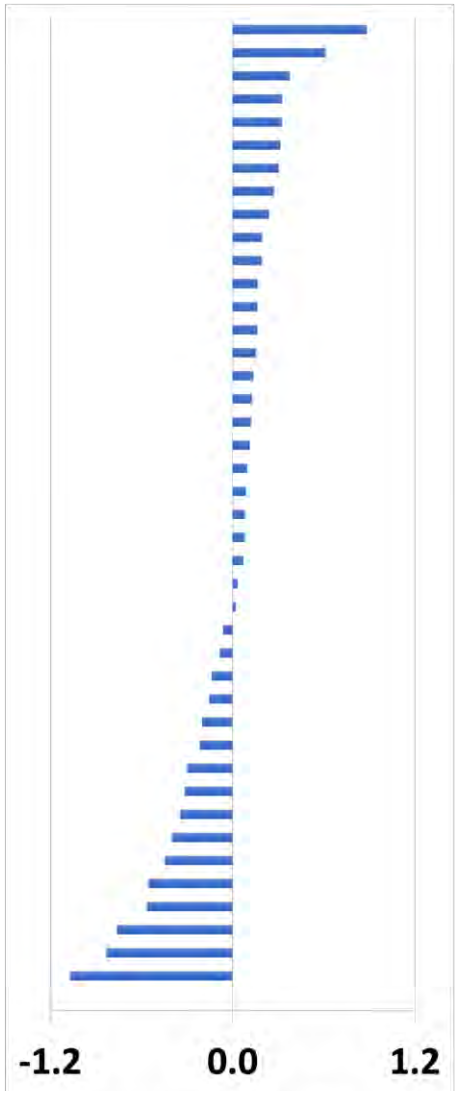


Coral Competition



Modeled Wave Power





Recovery 2007-2017

Absolute change in coral cover (% per year)

Article

Coral reefs benefit from reduced land–sea impacts under ocean warming

https://doi.org/10.1038/s41586-023-06394-w
Received: 21 July 2022
Accepted: 30 June 2023

Jamison M. Gove[1,17], Gareth J. Williams[2,17], Joey Lecky[3], Eric Brown[4], Eric Conklin[5], Chelsie Counsell[6], Gerald Davis[3], Mary K. Donovan[2,8], Kim Falinski[3], Lindsey Kramer[3], Kelly Kozar[10], Ning Li[11], Jeffrey A. Maynard[12], Amanda McCutcheon[10], Sheila A. McKenna[10], Brian J. Neilson[13], Aryan Safale[14], Christopher Teague[15], Robert Whittier[16] & Gregory P. Asner[2,16]

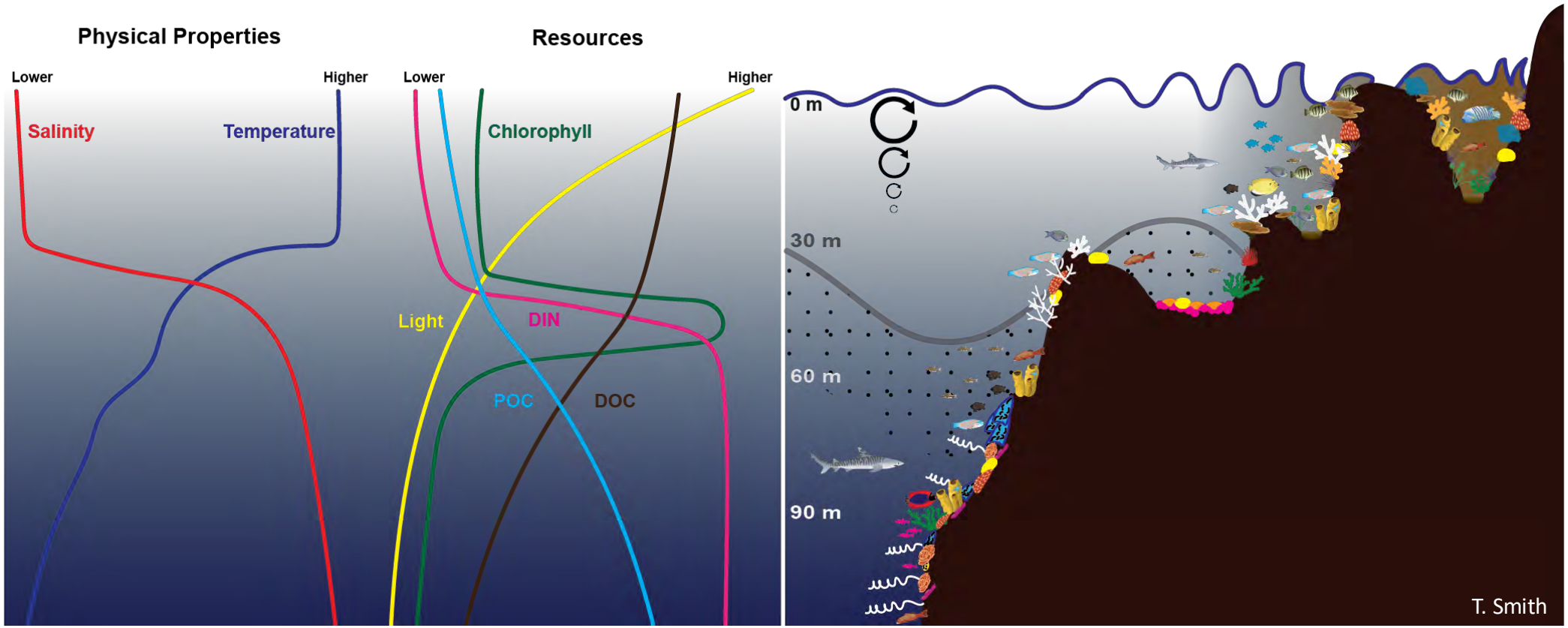
ARTICLES
https://doi.org/10.1038/s41559-019-0832-3
nature ecology & evolution

Water quality mediates resilience on the Great Barrier Reef

M. Aaron MacNeil[1*], Camille Mellin[2,3], Sam Matthews[2,4], Nicholas H. Wolff[5], Timothy R. McClanahan[6,7], Michelle Devlin[8], Christopher Drovandi[9,10], Kerrie Mengersen[9,10] and Nicholas A. J. Graham[11]

Spatial resilience of the Great Barrier Reef under cumulative disturbance impacts

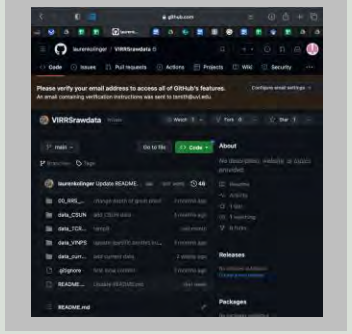
Camille Mellin[1,2] | Samuel Matthews[1,3] | Kenneth R.N. Anthony[1,4] | Stuart C. Brown[2] | M. Julian Caley[5,6] | Kerryn A. Johns[1] | Kate Osborne[1] | Marjetta Puotinen[7] | Angus Thompson[1] | Nicholas H. Wolff[8,9] | Damien A. Fordham[2,10] | M. Aaron MacNeil[1,11]



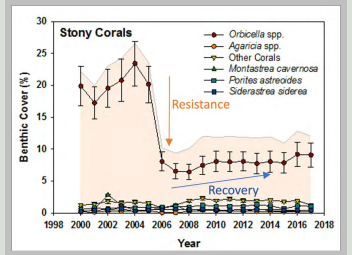
Year 4 Goal 1

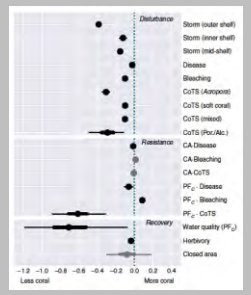
Determine the internal and external drivers most critical to coral reef ecosystem resilience in the USVI and identify targets for restoration of resilience.

- Objectives →

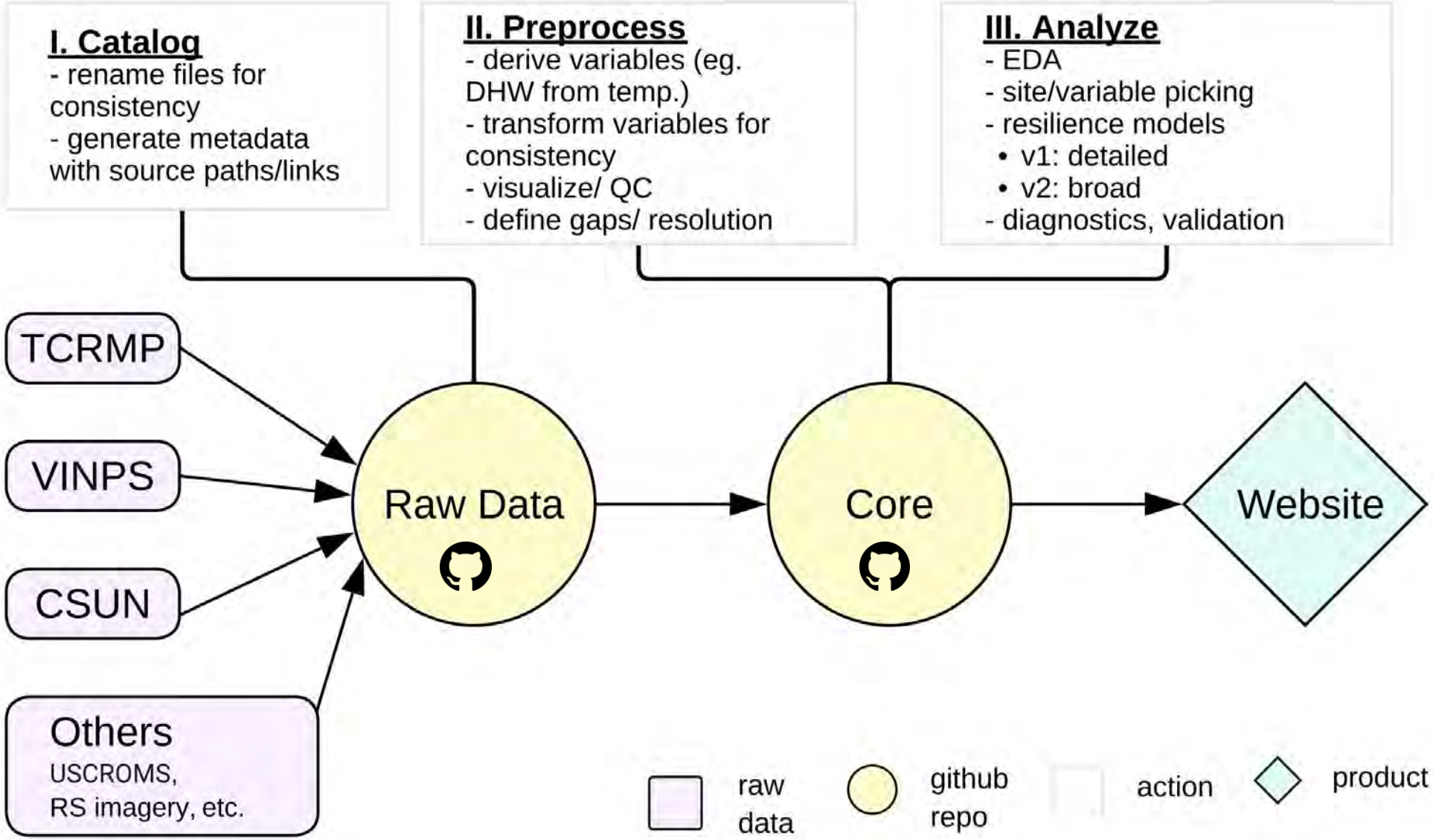


Objective 1: **Database Development**	✓ **Create a comprehensive database (50 long-term coral reef monitoring sites) and identify gaps**
Objective 2: **Metric Development**	✓ **Develop metrics of resilience**
Objective 3: **Analyses**	✓ **Analyses of long-term coral reef data to uncover drivers of resilience**

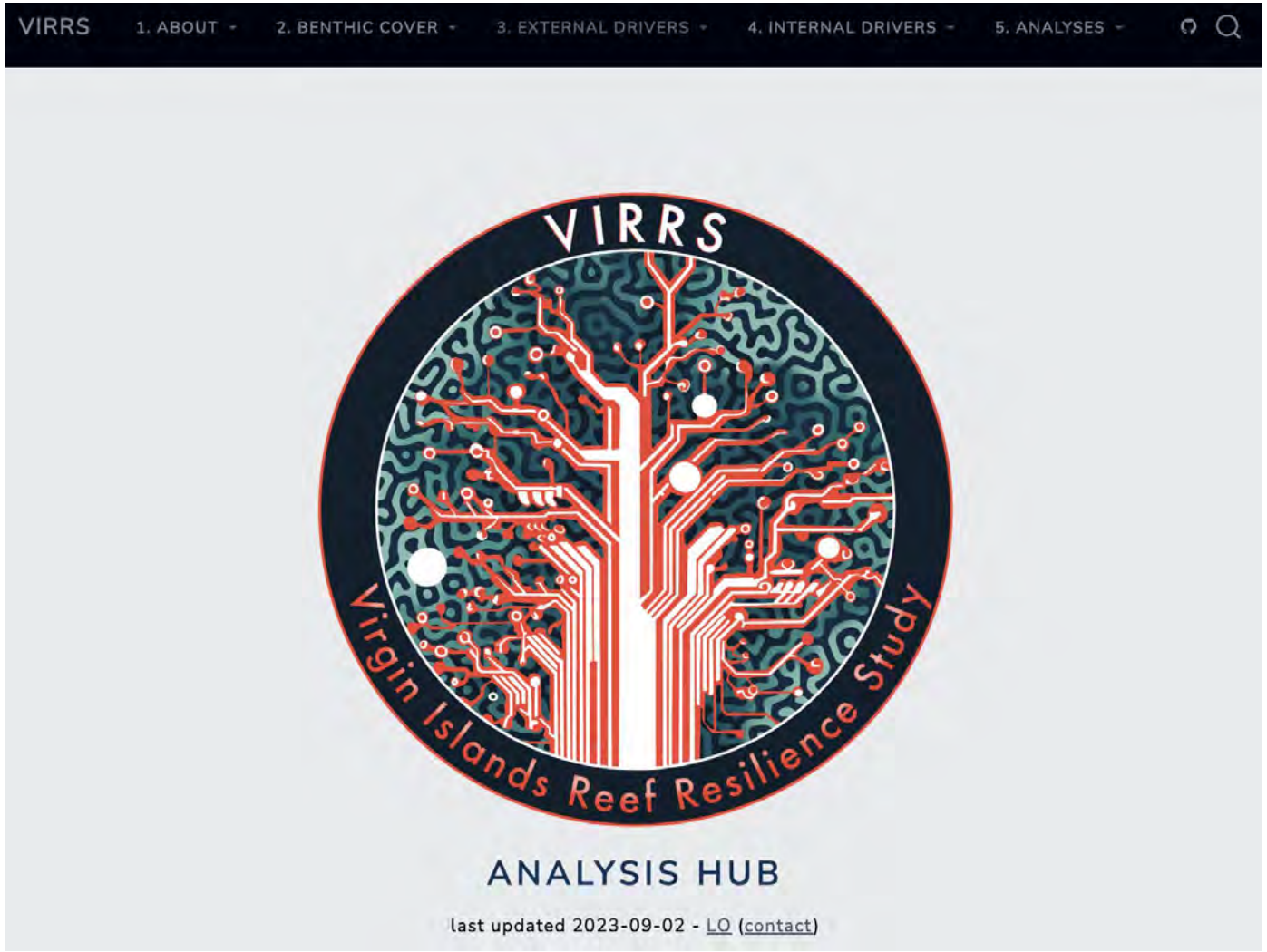




MacNeil et al. 2019


I. Catalog
- rename files for consistency
- generate metadata with source paths/links
II. Preprocess
- derive variables (eg. DHW from temp.)
- transform variables for consistency
- visualize/ QC
- define gaps/ resolution
III. Analyze
- EDA
- site/variable picking
- resilience models
• v1: detailed
• v2: broad
- diagnostics, validation
TCRMP
VINPS
CSUN
Others
USCROMS,
RS imagery, etc.
Raw Data
Core
Website
raw data
github repo
action
product

Website homepage of core data repository



website homepage of core data repository

- 1.1 OVERVIEW
- 1.2 LIST OF STUDY SITES
- 1.3 MAP OF STUDY SITES
- 1.4 DATA GAPS AND RESOLUTION
- 1.5 LITERATURE MAP
- 1.6 CONCEPTUAL MODEL

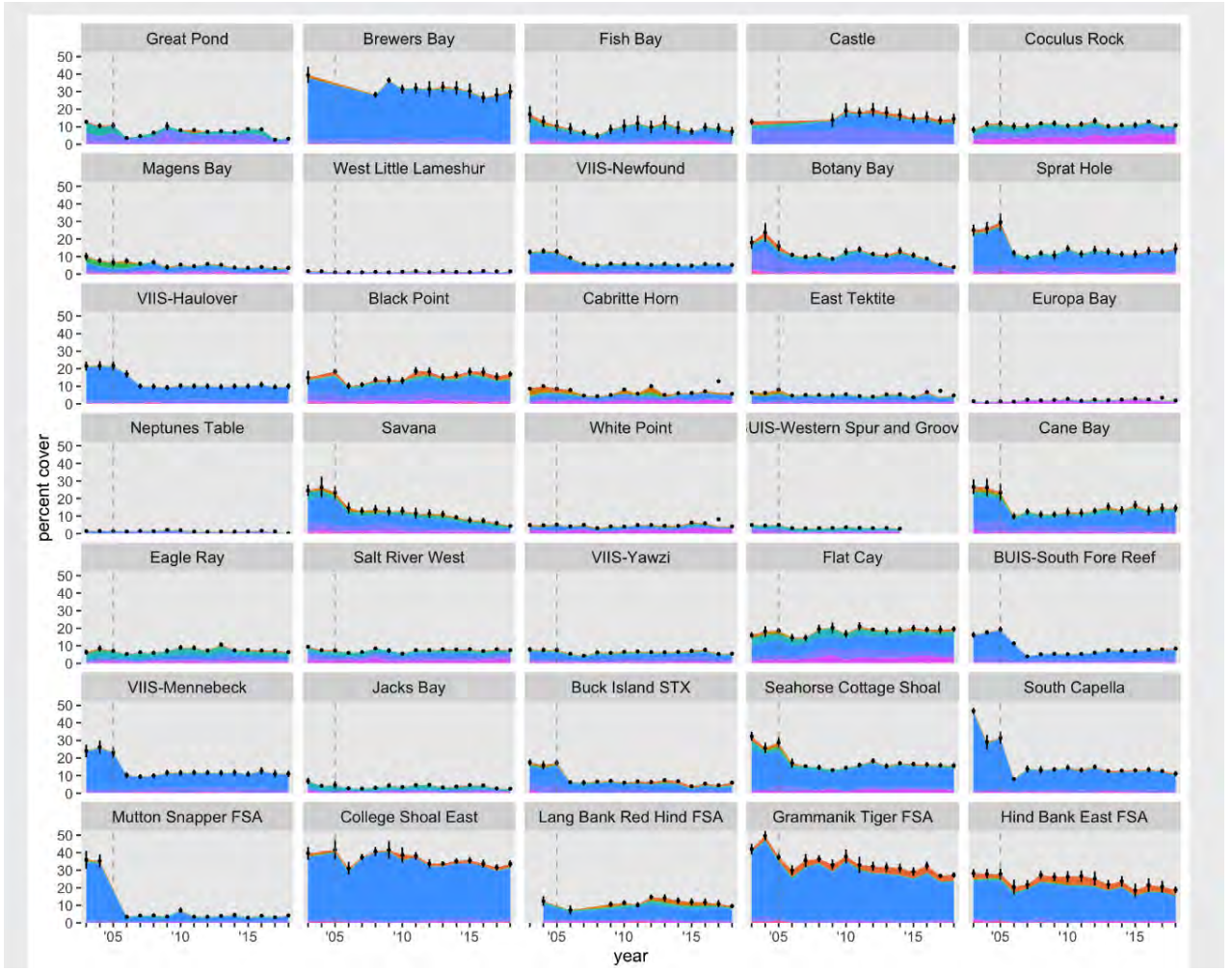
- 3.1 SITE RUGOSITY
- 3.2 SITE DEPTH
- 3.3 SITE DISTANCES FROM SHORE
- 3.4 REFORMAT RAW TEMPERATURE DATA
- 3.5 MONTHLY AND ANNUAL TEMPERATURE
- 3.6 WAVES (DATA MISSING)
- 3.7 CURRENTS
- 3.8 WATER QUALITY (DATA MISSING)
- 3.9 MANAGEMENT STATUS (COMING SOON)
- 3.10 CONNECTIVITY (DATA MISSING)

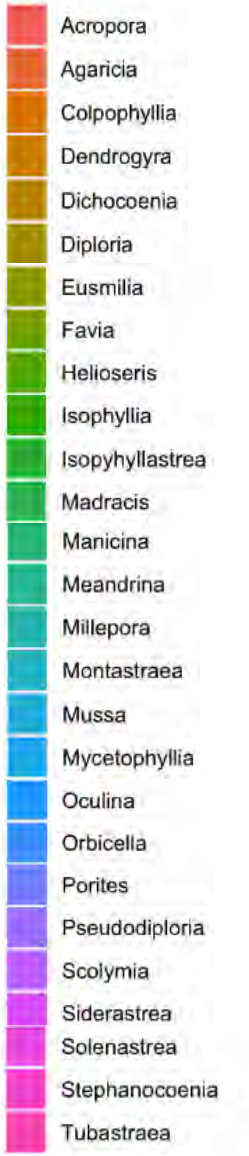
1. ABOUT ▾ 2. BENTHIC COVER ▾ 3. EXTERNAL DRIVERS ▾ 4. INTERNAL DRIVERS ▾ 5. ANALYSES ▾

- 2.1 REFORMAT RAW BENTHIC COVER DATA
- 2.2 CROSS REFERENCE BENTHIC CODES
- 2.3 PERCENTAGE COVER OF MAIN BENTHIC CATEGORIES
- 2.4 PERCENTAGE COVER OF CORAL GENERA
- 2.5 PERCENTAGE COVER OF CORAL TRAIT GROUPS
- 2.6 PERCENTAGE COVER OF ALGAE TAXA
- 2.7 PERCENTAGE COVER OF SPONGE MORPHS

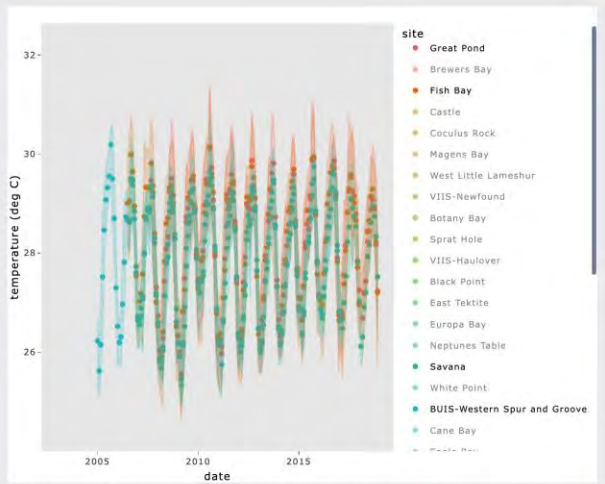
- 4.1 CORAL HEALTH
- 4.2 NUISANCE SPECIES (COMING SOON)
- 4.3 INVERTEBRATE BIODIVERSITY (COMING SOON)
- 4.4 FISH BIODIVERSITY
- 4.5 HERBIVORY
- 4.6 CORAL INTERACTIONS
- 4.7 CORAL BIODIVERSITY (COMING SOON)

2.4 PERCENTAGE COVER OF CORAL GENERA

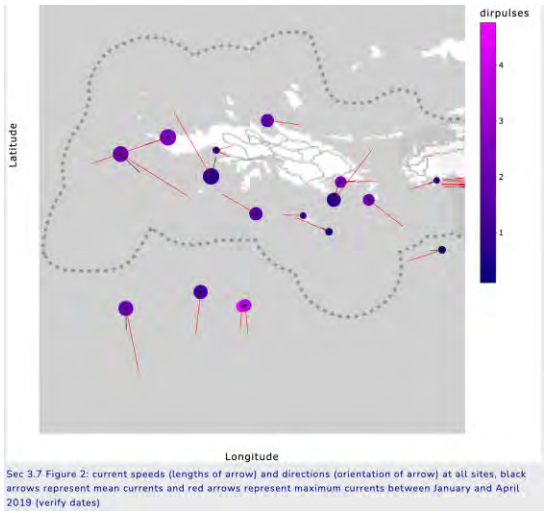




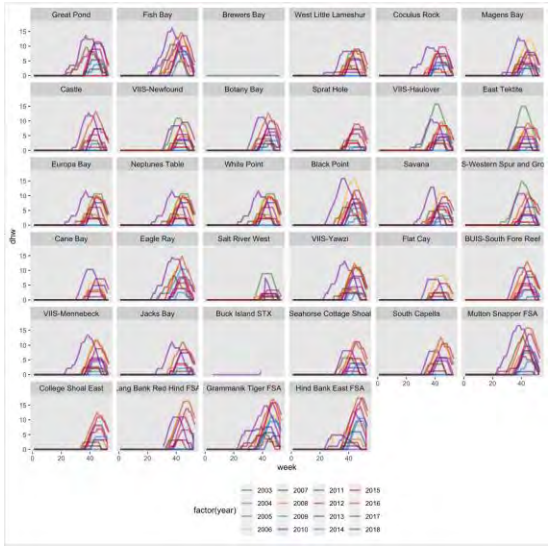
35 sites, 27 genera, 15 years (link)

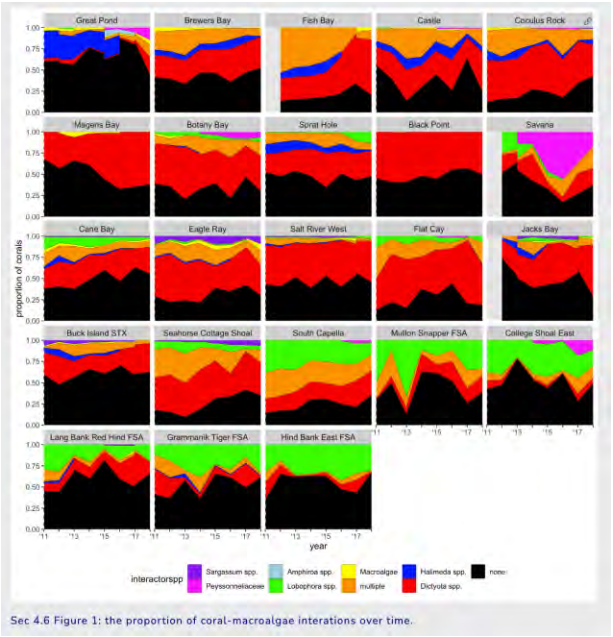


Sec 3.5 Figure 3: Monthly mean temperatures at each site, with individual monthly means and minimum and maximum temperatures colored by site. Sites are superimposed for comparisons in the interactive legend.

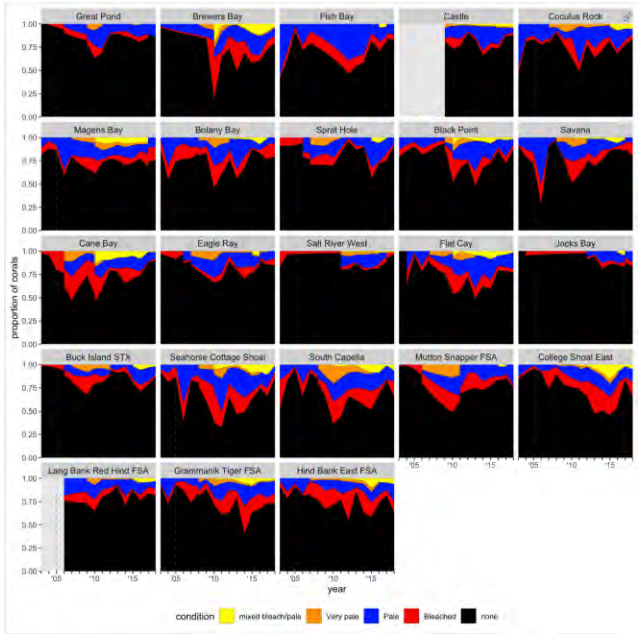


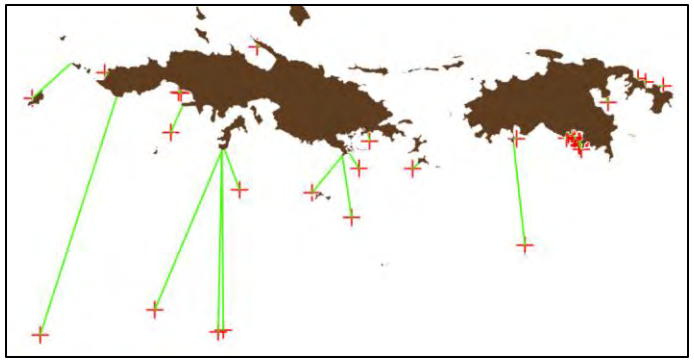
Sec 3.7 Figure 2: current speeds (lengths of arrow) and directions (orientation of arrow) at all sites, black arrows represent mean currents and red arrows represent maximum currents between January and April 2019 (verify dates)

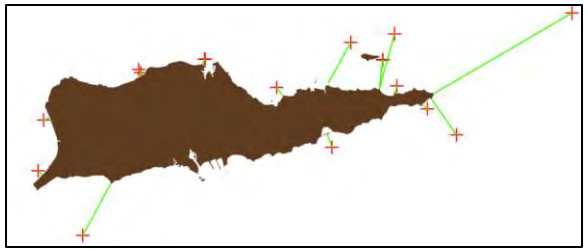




Sec 4.6 Figure 1: the proportion of coral-macroalgae interations over time.







Goal	Type	Category	Data Collected	Data QA/QC'ed	Data Analyzed	Reported/ Published	Ready for Analysis	Workshop	Planned Outputs
CR1	External	Rugosity							*
		Depth							*
		Distance from Shore							*
		Temperature							Manuscript : x-shelf thermal regimes
		Waves							Manuscript: hurricane disturbances
		Currents							Manuscript: hurricane disturbances
		Water quality							Ali et al. (2023) Frontiers in Remote Sensing 4
		Disease							Manuscript: multiple published/in prep (Disease)
		Management							*
		Connectivity							Manuscript: multiple
	Internal	Coral Health							Manuscript: multiple, thermal stress/disease
		Nuisance species							Manuscript: multiple published/in prep
		Biodiversity - Invertebrates							*
		Biodiversity - Fishes							Manuscript: Heidmann et al. (in revision)
		Herbivory							Manuscript: MMES capstone
		Coral Interactions							Manuscript: Masters thesis
		Biodiversity - Coral							*
		Coral Abundance							*

Completed **Near Complete** **In Progress**

Results, Outcomes & Accomplishments

The VIRRS workshop is scheduled

- ✓Up to 42 participants from within and outside the USVI
- ✓At UVI on November 3 & 4

VIRGIN ISLANDS EPSCoR

Virgin Islands Established Program to Stimulate Competitive Research

August 16, 2023

Dear Colleagues,

We are pleased to invite you to the Virgin Islands Reef Resilience Study (VIRRS) Workshop on November 3-4, 2023! The VIRRS workshop is hosted by the Virgin Islands Established Program to Stimulate Competitive Research (VI-EPSCoR) and will be held at the University of the Virgin Islands on the St. Thomas campus. Continue reading for more details about the workshop, and please **RSVP to indicate your availability by Wednesday August 30** by replying to the invite email or by sending a separate email to lauren.olinger@uvi.edu.

The primary goal of the workshop is to discuss the core VIRRS study. This study integrates benthic survey and biophysical data that comprise external (physical oceanography) and internal (coral reef health and biodiversity) drivers of reef resilience. Data sources include three long-term monitoring programs and recent models of oceanographic circulation, connectivity, and satellite-based water quality, spanning ~40 sites and two decades. The goal of this study is a unified analysis of these datasets to determine the internal and external drivers that are most critical to coral reef ecosystem resilience and identify targets for restoration in the region.

Workshop discussion topics will include overview of the findings, validity of the analyses and underlying data, management implications, and timeline for publication. Participants may divide into working groups to (1) discuss follow-up research questions and approaches to answering those with either existing data or new experiments and (2) develop driver- or site-specific metrics for resistance and recovery after disturbances. This research is timely given the current unprecedented SST and likely bleaching in the next few months.

We will host two zoom meetings, one before the workshop (mid-October) to orient everyone to the data and analyses, and the second after the workshop to share progress on the core study and any follow-up research. We may offer short virtual sessions during the in-person workshop for those who cannot travel, but we highly recommend attending in person to get the full experience.

Travel and lodging costs for participants will be covered by VI-EPSCoR, and we will provide more details about coordinating travel plans in the coming weeks. Please let us know if you have any questions. We look forward to hearing back and working with you all on this exciting project!

Regards,

Lauren Olinger
Tyler Smith
VIRRS Workshop Organizers

2 John Brewers Bay | St. Thomas, USVI 00802 | www.viepscor.org

Meet The Team – Connectivity & Biodiversity

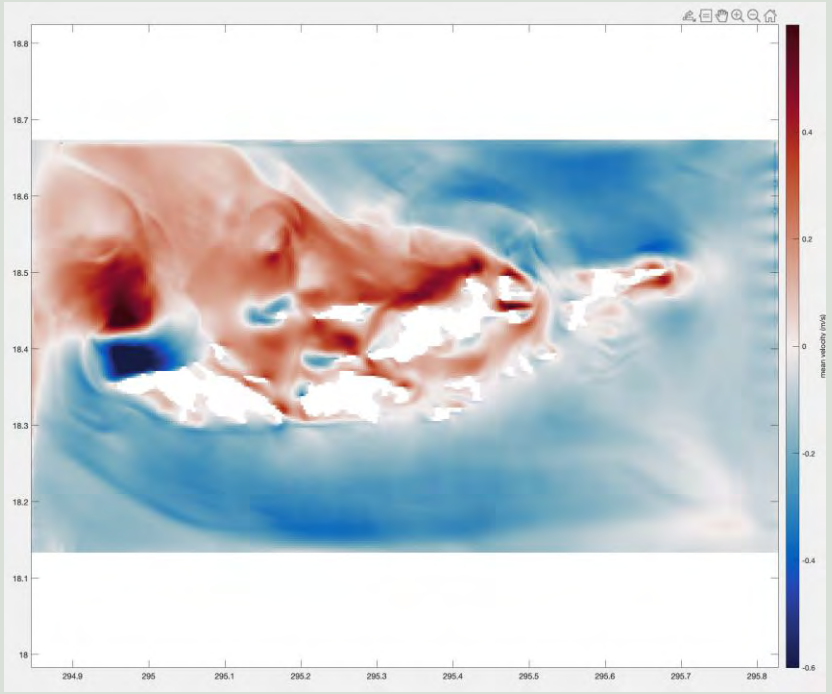
Tyler B. Smith, Ph.D.

Lauren K. Olinger, Ph.D.

Sonaljit Mukherjee, Ph.D.

Daniel M. Holstein, Ph.D.

Benjamin Farmer

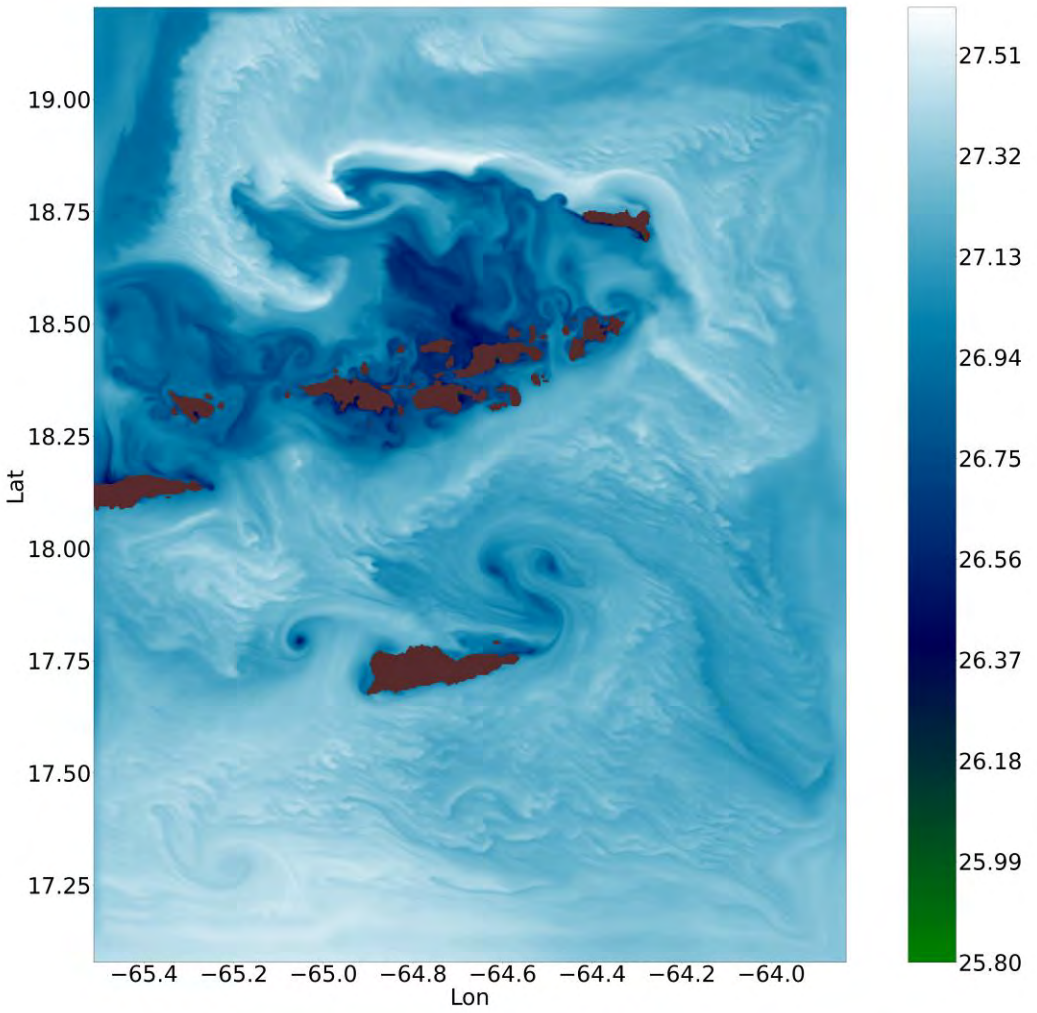


Connectivity and Biodiversity Study

Goal 2.

Understand the impact of regional larval connectivity patterns on biodiversity patterns.

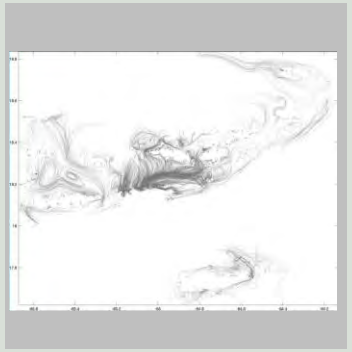
Hypothesis: Stronger larval sink locations, or high centrality habitats, that receive coral larval input from diverse upstream habitats are areas of increased species diversity and, hence, resilience

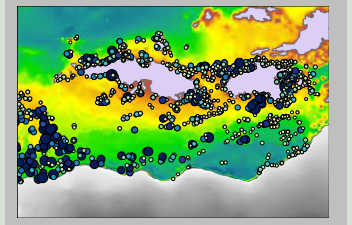


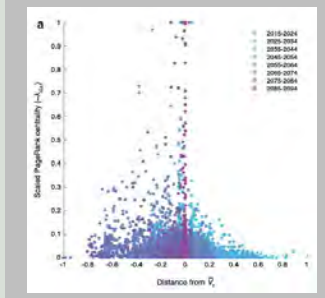
Year 4 Goal 1

Understand the impact of regional larval connectivity patterns on biodiversity patterns

- Objectives →







Objective 1: **Database Development**	**Develop regional connectivity model for coral reef organisms**
Objective 2: **Metric Development**	**Determine network and habitat connectivity metrics and corresponding estimates of biodiversity**
Objective 3: **Analyses**	Analyze the relationship between realized diversity and connectivity, stress, and past disturbances

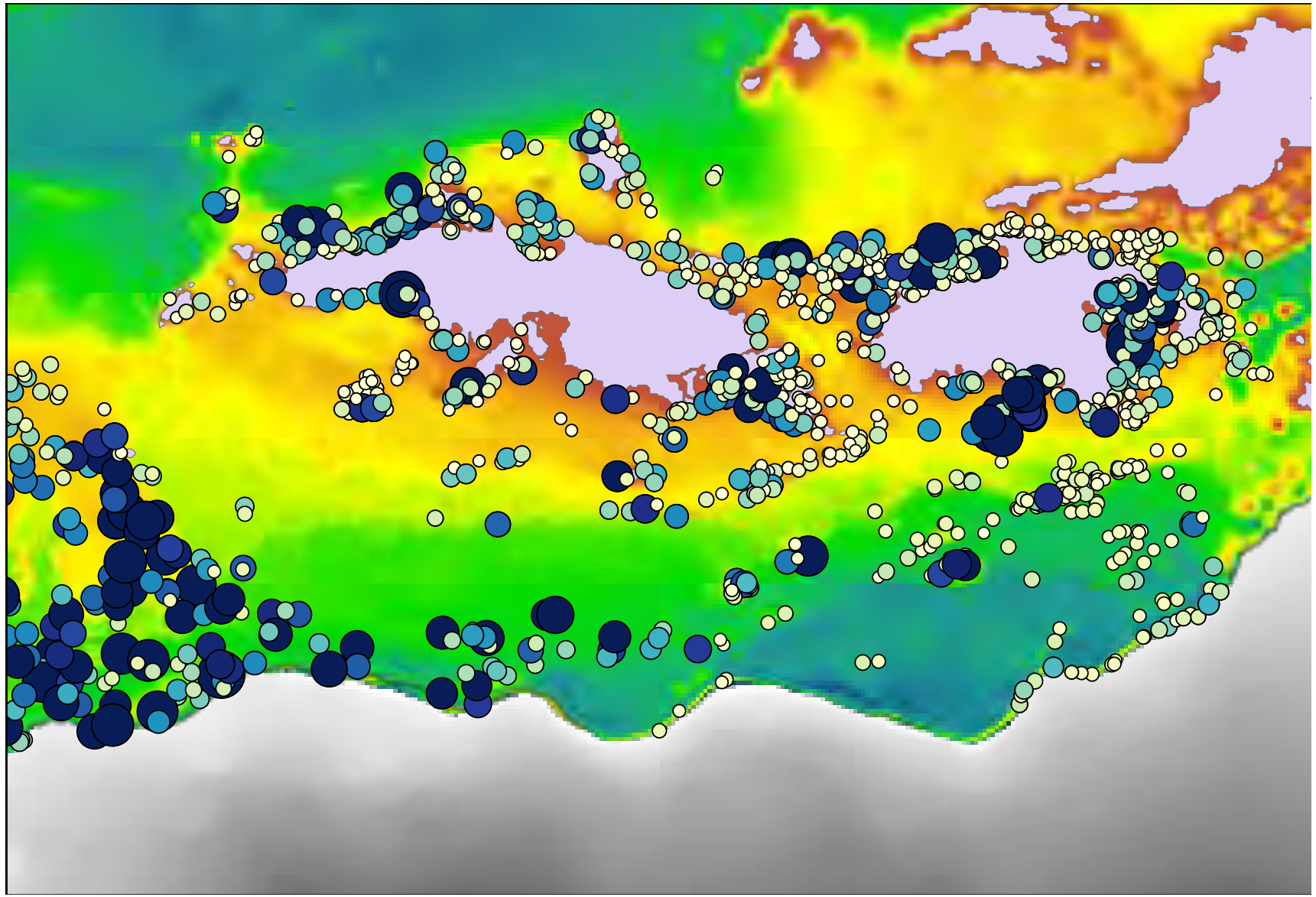
Example biological data:

The National Coral Reef Monitoring Program

Coral Cover Legend

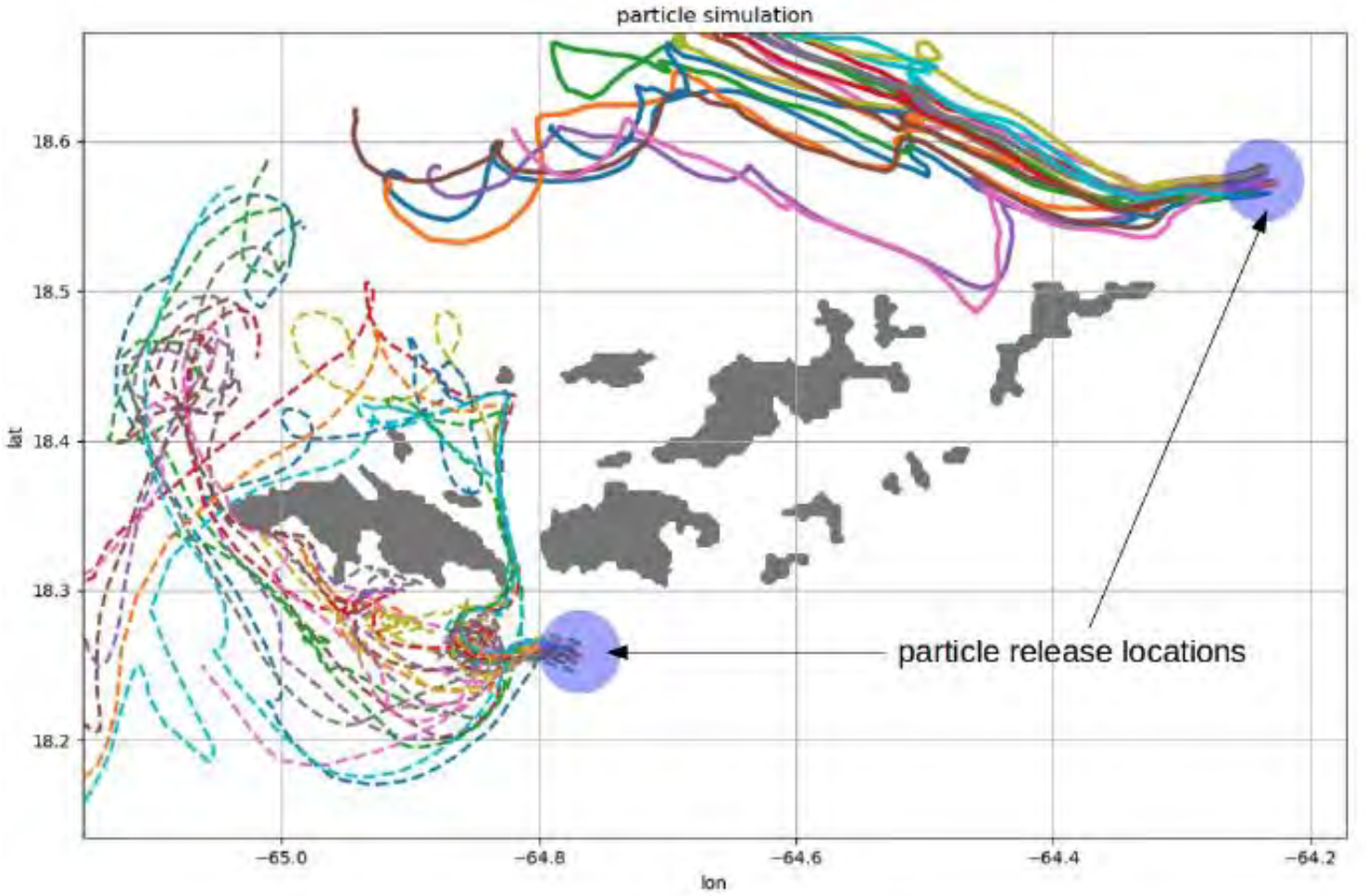
0 23 46%

1272 surveys total
264 > 30 m depth



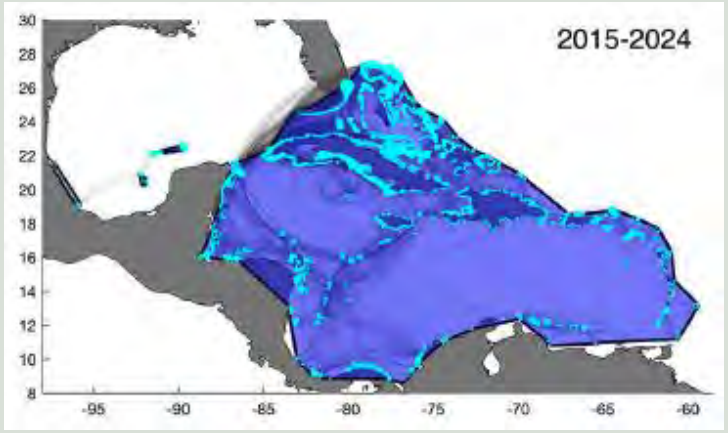
Connectivity

- US Caribbean Regional Ocean Model allows the tracking of virtual particles with the Connectivity Modeling System



Paris CB, Helgers J, van Sebille E, Srinivasan A (2013) Connectivity Modeling System: A probabilistic modeling tool for the multi-scale tracking of biotic and abiotic variability in the ocean. Environmental Modelling & Software 42:47-54

Research, Outcomes & Accomplishments



Coral Reefs
https://doi.org/10.1007/s00338-022-02252-9
REPORT

Predicting coral metapopulation decline in a changing thermal environment

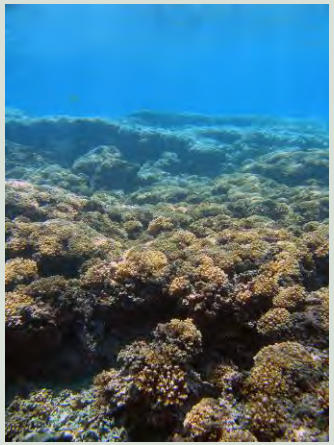
Daniel M. Holstein[1] · Tyler B. Smith[2] · Ruben van Hooidonk[3,4] · Claire B. Paris[5]

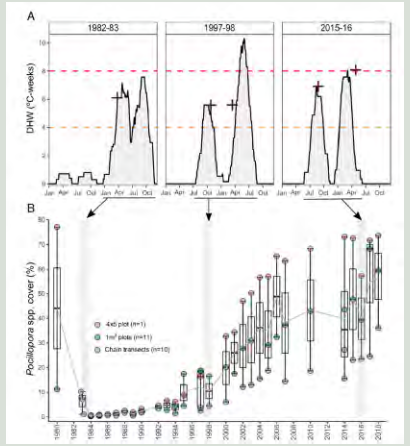
41:961–972

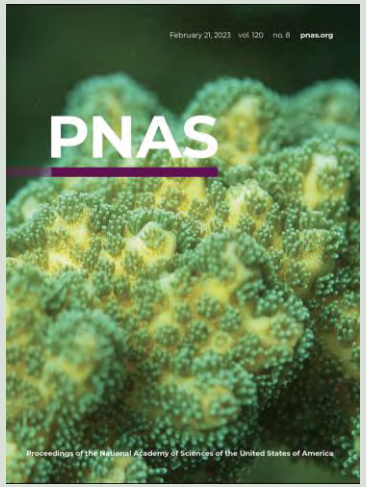
PNAS RESEARCH ARTICLE | ECOLOGY

Increased dominance of heat-tolerant symbionts creates resilient coral reefs in near-term ocean warming

Ana M. Palacio-Castro[a,b,c,1], Tyler B. Smith[d], Viktor Brandtneris[d], Grace A. Snyder[a], Ruben van Hooidonk[b,c], Juan L. Maté[e], Derek Manzello[f], Peter W. Glynn[a], Peggy Fong[g], and Andrew C. Baker[a]







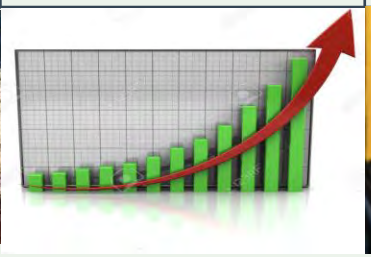
Research Interdependencies

The marine resilience theme is strongly dependent on past and current research investments and will feed directly into management (e.g., restoration) and education and outreach

Broader Impacts, Intellectual Merit, & Diversity

Data for the masses!	Engagement	Management & Restoration	What is Possible with Investment	Training Tomorrow's Scientists
A quality-controlled database of multiple coral reef and oceanographic data sets for the territory.	Engagement of multiple professionals on a central project of high importance for understanding coral reef resilience	Evidence-based directions for more effective resource management and restoration	Highlights the utility of multiple investments in ecosystem data collection and will be an attractor for more funding	Contributes to the training of students and post-doctoral researchers



Thank you!

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