VI-EPSCoR ANNUAL REPORT 2022

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2. OVERVIEW

The Ridge to Reef (R2R) project derives its title from our efforts to take a detailed look at the land-based inputs that can originate along the islands' ridges and stream beds that, following rain events, flow down the hillsides and enter the marine environment. These inputs from the land include sediments, debris, organic wastes from animals and septic tanks leaks, and complex hydrocarbons and heavy metals- all which can enter into our mangrove forests, rocky coastlines, and beaches and eventually into the offshore seagrass beds and coral ecosystems. While studying the content and frequency of these run-off events, the R2R teams also seek to understand the other impacts of the changing environmental conditions on our small islands' social and ecological systems.

The ability of our coastal and marine resources to resist and recover from disruptions and activities is key to their long-term resilience. Understanding these disruptions (the drivers of change) is the overarching focus of the R2R project. The R2R teams will advance our understanding of the various factors including those exacerbated by climate change that drive environmental degradation, decrease resistance to disturbance, and reduce the resilience of Caribbean coral reef ecosystems. To help counter the impacts of these disruptions, we are also developing and implementing science-based ecological restoration approaches that emphasize biodiversity. These approaches will complement ongoing ecosystem studies that in turn will inform the best available management strategies to increase the resilience of marine and coastal habitats. The Ridge to Reef project will also work to develop the next generation of Islanders who can ensure a resilient future for the Territory's natural resources - a key element for sustaining our tourism-based economy here in the Caribbean in the years ahead.

THE VISION of R2R is to improve understanding of the drivers, processes, interdependencies, and consequences of ecological change driven by natural and anthropogenic disruptions in Caribbean coastal and marine ecosystems.

THE MISSION of the project is to advance science-informed knowledge that guides managers, researchers and communities to more effectively manage the natural resources of the Territory while we adapt and respond to the impacts of climate change.

The R2R Project is making significant progress in Year 2 but remains impacted by the lingering and persistent effects of the COVID-19 pandemic. That said, the host institution, the University of the Virgin Islands (UVI), and the VI-EPSCoR team has adapted to the circumstances and restrictions posed by the pandemic. UVI transitioned to a hybrid virtual and in-person learning campus for both the Fall 2021 and Spring 2022 semesters, with researchers and teaching faculty using Zoom and other virtual communication platforms while others returned to in-person activities between emerging variant surges to engage their students, colleagues, and collaborators. Research activities as well as most outreach and informal learning activities were scheduled with flexibility for all participants, allowing individuals to self-determine their comfort with risk vs. opportunities for the activities planned.

The R2R component teams were remarkably productive and managed to address many of their Year 2 goals and objectives. Faculty, staff, and students alike are familiar (or simply resigned to) working in the hybrid learning environment. Researchers accelerated some of their field research efforts to compensate for the time lost in Year 1 due to the pandemic restrictions, although a few collaborators were facing some restrictions with traveling to the Virgin Islands. As we approach the end of Year 2 R2R, our researchers are mostly transitioning from setting up their respective projects to begin collecting and analyzing data. Others are accelerating their R2R efforts as their research support grows from successful non-EPSCoR-related grant proposals. At the same time, new proposals and publications are being submitted as the R2R teams increase their impact and relevance here in the Territory.

The Impacts of the R2R Project

The impacts of our research this year are numerous and diverse. The following impacts are just a few of the many reported throughout this report. Leaders from our Education, Workforce and Development (EWFD) team were invited by the National Academies of Science, Engineering and Medicine (NASEM) to share at a national Town Hall meeting the critical work happening at historically Black colleges and universities (HBCU) throughout the nation and at UVI in preparing African American students to enter into and persist in STEM careers. Presentations showcased a sample of faculty and staff innovations used to engage students throughout their academic journey using community outreach, teacher professional development programs, culturally relevant curriculum, student research opportunities, faculty mentoring and continued structures of support for novel STEM professionals. These programs and efforts boost the economic possibilities for students and the surrounding community by embracing being historically American, uniquely Caribbean, and globally interactive.

Meanwhile, the work by our Fish Ecology team were able to confirm spawning site fidelity of the parrotfish populations at their study sites– a critical ecologically relevant observation that sets up a strong experimental design to test one of their hypothesis which is: "As the severity and frequency of disturbance increases, the ecosystem state also declines leading to changes in the parrotfish community, specifically, a shift from parrotfishes that function as scrapers (genus *Scarus*) to grazers (genus *Sparisoma*)." It may appear as a purely basic science-type discovery but understanding the relationship between habitat quality and species distribution is a powerful tool for natural resource management and helps us anticipate some of the impacts of a changing environment in our local waters.

Our oceanography team created a Caribbean Ocean Model for the U.S. Virgin Islands with a resolution capacity much higher than previous regional ocean models. This new model can more accurately characterize ecologically relevant ocean processes across or research area here in America's Caribbean. This is a critical tool for our marine and coastal researchers to increase their understanding of ocean processes such as tidal energy dissipation, cross-shelf thermal regimes and internal tides. Understanding these physical oceanographic processes will facilitate our colleagues and collaborators' understanding of how our marine ecosystem functions, how marine life might respond to increasing temperatures due to climate change, as well as the frequency and location of *Sargassum* beaching events – which has a growing consequence for our tourism-based economy.

Summary of Key Accomplishments Achieved During the Reporting Period

Watershed Monitoring and Land Use

The Watershed and Land Use (WL) team focused on data and sample collection from their various studies that were established in Year 1. Unfortunately, historically dry conditions from Year 1 into Year 2 (and that persisted) ultimately led to very little water flow observed in any of the stream reaches under their monitoring program. However, hydrographs of the limited flow that did occur have been collected, their accuracy was validated, and will serve in further hydrological analysis to improve their understanding of small watershed hydrology in the Virgin Islands. Sediment samples were collected from all environments to fully characterize particle size distributions and spectral data for source tracking. Water samples were not collected due to a lack of flow, but all the equipment for water quality analysis has now been set up and alert systems have been put into place for rapid reaction and sampling for nutrient and bacteriological flux measurements.

In their land use studies, soil moisture data was collected under varying mulch ground covers in plantain production and breadfruit agroforestry for comparisons with natural forests. In their initial analysis, data suggests that there is substantial buffering in forest plots, but less than expected differences in estimated runoff in mulched ground cover treatments. Continued data analysis will be necessary, combined with some modeling, to fully elucidate the results of this year's soil moisture data, while ongoing soil sampling and characterization (bulk density and infiltration data), is expected to provide further insights into mechanistic explanations for the observations in soil moisture. These research activities have been collated and documented for both reporting purposes, scientific presentations, and for public engagement activities.

Mangrove Ecosystem Function, Recovery and Restoration

The Mangrove Ecosystem System Function & Recovery and Mangrove Restoration (M) team made significant progress towards its three goals: (1) investigate current and historic USVI mangrove distribution, recovery, and loss, (2) grow USVI mangrove restoration opportunities, and (3) share USVI mangrove research with stakeholders and provide opportunities for new partnerships. They completed field surveys of 19 mangrove forests across the territory and set up the expansion and maintenance of their land-based mangrove nursery. For their mangrove forest mapping efforts, the team successfully completed certification for drone flying with the FAA. For their outreach and education efforts, the team successfully submitted the necessary materials to UVI's Institutional Review Board for community listening sessions, surveys, and the site-specific restoration potential index workshop. The team recruited 7 UVI undergraduate and 6 graduate students on this theme's research and restoration goals. In Year 2, the team published 4 peer-reviewed journal articles and have 2 submissions that are in review.

Emerging Areas: Seagrass Ecology and Beach Dynamics

The Emerging Areas (EA) team (led by Cruz-Rivera) focusing on *Sargassum* and invasive seagrasses in Year 2 has completed experiments on feeding behavior of Caribbean herbivores, seagrass mechanical properties, and some of the nutritional quality assessments of the seagrass. Five sites were sampled for invertebrate densities on different seagrass beds utilizing both linear and suction sampling techniques. Samples from the latter are being presorted for shipment to their collaborator at University of Kansas-Dr. Rogers- who will do the final taxonomic identification of the fauna.

In the research examining *Sargassum* golden tides, the team has collected replicate samples of golden tides and benthic *Sargassum* of two species for comparison purposes. These samples have been dried and shipped to the team's other collaborator at the University of Alabama, Birmingham- Dr. Krueger-Hadfield- for genotyping and assessment of genetic diversity. They were able to obtain additional floating *Sargassum* samples from a French group doing cruises across the Sargasso Sea for additional genotypic comparisons. The Cruz-Rivera-Rogers efforts have produced one peer-reviewed publication. Two grant proposals were submitted, of which one was funded (NASA) to expand on the *Sargassum* research.

The second of our three EA research teams (led by Jobsis) made significant progress in Year 2 with their Brewers Bay animal movement studies. They met nearly all of their goals and objectives as detailed in the Strategic Plan. The team successfully recruited and hired a new acoustic tracking post-doctoral fellow- Kayla Blincow-Israel. The team worked together during July and early August of 2021 to install a comprehensive suite of acoustic tracking equipment throughout their study sites in Brewers Bay and Hawksbill Cove. Jobsis was added to Dr. Kristin Hart's National Marine Fisheries permit which allowed his team of students and local volunteers to start collecting and tagging sea turtles. To date the team has caught, marked, and released 52 Green and 15 Hawksbill sea turtles. A subset of green and hawksbill turtles, and 9 giant hermit crabs were tagged with acoustic tags. Water quality measurements and seagrass monitoring have also been started and will continue throughout the two years of this project.

The third of our EA research team (led by G. Guannel) developed a new dataset for beaches across the USVI. They compiled the location of all the beaches and began gathering information about their physical characteristics: erosion or accretion rate, sediment size, and beach profile. This database does not currently exist for the territory. The team also compiled information about offshore wave climate around the different islands by post-processing decades of model hindcast results. The key working component to this research effort - PhD student, Ms. Deborah Fernandez has finally been able to join the research team. Her arrival from Portugal and work have been delayed due to COVID-related travel restrictions. She begins her training this summer (2022) at the University of South Alabama.

Fish Ecology and Herbivory

The Fish Ecology (FE) team had three goals and made substantive progress on all three. Their first goal was to analyze historical data for changes in parrot fish assemblages due to disturbance. Their analyses used benthic cover and fish abundance and diversity data from our Territorial Coral Reef Monitoring Program as well as historical sedimentation data over the past 20 years and across 23 sites. They found that parrotfish density increased rapidly about 1-2 years following the 2005 and 2010 disturbance events, especially for *Scarus* species. *Sparisoma* species, however, showed greater increase in biomass over time than *Scarus* especially after 2010, where *Scarus* biomass remained flat. These data suggest that *Scarus* may be more sensitive to coral reef degradation from natural disturbance. Our analysis of sedimentation on parrotfish composition found that *Scarus* species biomass declined steadily with increasing sediment load, whereas *Sparisoma* biomass showed a temporary increase at low sediment flux but then biomass declined as sediment flux continued to increase. These results partly fit our model and suggest sediment affects parrotfish species differently, but at higher sediment loads, all parrotfishes are affected negatively.

With their second goal, the team investigated how benthic characteristics affect feeding and reproduction of parrotfish. With the installation of acoustic receivers, the tagging of the fish, and the use of ultrasound to determine their sex, the team was able to track fish from feeding grounds to spawning sites. They observed that the fish displayed consistent migration pathways and strong spawning site fidelity. Six sites were established near fish tagging areas to measure sediment flux, benthic composition and foraging rates of parrotfish. Preliminary analysis of benthic algae varied between 20% and 40% cover but were not significantly different between east and west sites. However, they found yellowtail parrotfish feeding rates were significantly higher on turf at eastern sites (low sediment) compared to western sites (high sediment). They believe that higher sediment loads adjacent to land development may be reducing parrotfish feeding rates on turf algae due to sediment-laden turf.

The team is just beginning to explore their objectives for Goal 3 wherein they examine whether ocean and environmental variables affect parrotfish reproductive output. The team deployed a Nortek Acoustic Doppler current profiler, or ADCP, at each fish spawning aggregation site in Reef Bay early this year and data is just being analyzed.

The team has generated four peer review papers with three of these including graduate students. Two Citizen Science projects focused on sediment awareness using a smartphone App that allows users to report on sedimentation and erosion sites. Another project allowed divers to report sightings of endangered rainbow parrotfish in the USVI with 70 sightings to date.

Oceanography

The Oceanography (OC) research team is on schedule despite the departure of senior faculty leading this area, Dr. Sennai Habtes. Dr. Habtes is now the fisheries chief for the Division of Fish and Wildlife and the USVI Department of Planning and Natural Resources. He remains a participant through a courtesy appointment with UVI. His oversight role has been assumed by Dr. Tyler Smith, who is keeping the project on track to fulfill most of the strategic plan. The Oceanography team has been productive and on schedule with the strategic plan. Highlights include the finalization of the United States Caribbean Regional Ocean Model (USCROMS), with outputs from years 2019 and 2020 in hand, and the model published (Mukherjee et al. 2022, https://doi.org/10.1080/1755876X.2022.2059885). This model greatly improves on previous ocean models by providing a high resolution model (330 m grid) that is expanded to cover the entire US Caribbean, including Puerto Rico. This model is being linked to the connectivity modeling system developed by Lousiana State University Lousiana EPSCoR (LSU/LA EPSCoR) collaborator, Daniel Holstein, to conduct a variety of research questions. Together these models are a significant increase in the regional research infrastructure. A recent proposal was submitted to the US Office of Insular Affairs to use the models to understand the transport of the nuisance floating seaweed *Sargassum*. Further, new capabilities have been explored with an effort to acquire ocean gliders for upper ocean oceanographic profiling through a proposal to the Major Research Instrumentation program at NSF.

Coral Disease and Restoration

The Coral Disease (MD) & Restoration (MR) research team has been very successful in addressing their objectives and reaching milestones for Year 2. Under the Disease section the team has completed the goal of determining how species biodiversity affects the spread and impact of coral disease through the completion and publication of a capstone project by students in UVI's Master of Marine and Environmental Science (MMES) program (Costa et al. 2021), coupled with publication of the collation of disease data from the Territorial Coral Reef Monitoring Program (Brandt et al. 2021). These publications and associated datasets also contain the species assemblage maps needed for the goal of predicting the spread and impact of multi-species coral disease. Understanding how the role of local and global environmental stressors drive disease dynamics has also made strides. The publication of Meiling et al. (2020) documents disease dynamics through a thermal stress event. In addition, team lead M. Brandt and Woods Hole Oceanographic Institution (WHOI) collaborator Amy Apprill received funding from the Virgin Islands Water Resources Institute to sample diseased stony corals and examine them in relationship to water quality at seven sites across the northern U.S. Virgin Islands. The project was completed as the focus of MMES student Natasha Bestrom's thesis project, who sampled with Dr. Brandt in the field and then was hosted in Dr. Apprill's laboratory to process microbial samples. The project is ongoing and awaiting microbial sequences for analysis and results will inform future disease and water quality studies under this goal.

Under the Restoration area, the team expanded with the hiring of Restoration Ecology expert Dr. Robin Smith. In addition, the coral restoration staff have increased with the hiring of three additional personnel through funding by the National Park Service. The Restoration team has implemented a study to determine how coral diversity affects the success of coral outplanting. All work in the Coral Disease and Restoration section has involved graduate and undergraduate students. In Year 2, six graduate and four undergraduate student interns were trained in coral restoration techniques. Additionally, four graduate and four undergraduate students participated in coral disease transmission experiments. The Disease and Restoration group has also been actively involved in outreach and education efforts, including maintaining and updating the vicoraldisease.org and vireefresponse.org websites and maintaining a social media presence for VI Reef Response. In Year 2, six manuscripts in addition to those mentioned above were published in peer-reviewed journals including in the journals *Ecography, Communications Biology, and Environmental Microbiology*. Presentations on disease and restoration were given at two local workshops, and one international conference. A $2.5 million grant to study multi-species coral disease transmission was also awarded to Dr. Brandt by the NSF Ecology and Evolution of Infectious Disease Program.

Coral Reef Resilience

The Coral Reef Resilience (CR) team has made progress with each of their objectives—in the study of resilience drivers on USVI coral reefs, assessing larval connectivity's influence on marine biodiversity patterns, and developing content for outreach to the wider community. For the study of drivers, the team has recruited and assigned collaborators into numerous subgroups working on databases of individual internal and external drivers. Most of the individual studies of drivers will also have independent research outputs, and with the compiled databases, they have resulted in one peer-reviewed publication published, one publication in revision, and five manuscripts currently in preparation. A particular highlight (cross linked to the Oceanography research theme) was the finalization of the US Caribbean Regional Ocean Model, with outputs from years 2019 and 2020 in hand, and the model published (Mukherjee et al. 2022, https://doi.org/10.1080/1755876X.2022.2059885). This model greatly improves on previous ocean models by providing a high-resolution model (330 m grid) that is expanded to cover the entire US Caribbean, including Puerto Rico.

Education and Workforce Development

The Education and Workforce Development (EWFD) team made very good progress with building structures of change for improving the Science, Technology, Engineering and Mathematics (STEM) Workforce pathways through 1) Teacher Professional Development (Teacher PD), 2) Undergraduate Enrichment and Mentoring, and 3) Early-Career Support for STEM professionals. In the 2nd year of R2R, the EWFD team met nearly all of their specified goals and objectives. The Teacher PD component planned and hosted the 2021 STEM Institute, serving 89 local teachers. The virtual intensive training was done in partnership with the Knowles Teacher Initiative and Dr. Dara Hamilton, a clinical psychologist at UVI. During the academic year, STEM Institute facilitated 6 pedagogy-focused events (3 virtual and 3 in-person) spanning skills in Math language use, distance learning pedagogy, Science, Technology, Engineering, the Arts and Mathematics (STEAM) educational strategies (integration of art), and experiential science learning strategies from home. In partnership with Microsoft, Subsume, and Code.org; four *TechKnowledge for Teacher* events, the EWFD team facilitated training teachers in coding skills applicable across the curricula. Their STEM Institute, in partnership with collaborators from Georgia Tech, launched a local chapter of the Computer Science Teacher Association within the USVI, (and recruited 40 local teachers as members). In response to a needs assessment in completed in Year 1, the Teacher Talk Fridays support group was formulated. The Teacher PD program has been actively disseminating research results at conferences hosted by the American Educational Research Association (AERA), the National Academies of Sciences, Engineering, and Medicine (NASEM), the Center for Culturally Responsive Evaluation and Assessment (CREA) and the *Mindsets for STEM* conference. The team received the Caribbean and African Studies in Education Sig Outstanding Research Paper Award at AERA, on April 22, 2022. They hired two master teachers and a doctoral student researcher after losing both undergraduate student workers due to COVID-19 requirements.

The Mentoring and Research Infrastructure (MRI) team completed 2 faculty mentoring trainings with UVI's Eastern Caribbean Scientists (ECS) program and developed partnerships for faculty mentoring development for two recently submitted proposals to the National Institute of General Medical Sciences (NIH) Undergraduate Research Training Initiative for Student Enhancement (U-RISE) proposal and NSF EPSCoR Research Infrastructure Improvement Program: Bridging EPSCoR Communities (RII-BEC). The Professional Development for Emerging Educational Researchers (PEER) Field school, through Rochester Institute of Technology (supported by NSF BSCER), facilitated 2 virtual and 1 in-person events. UVI graduate students, faculty, and staff participated in the Voices of Women in STEM (VOWS) writing group through a subaward from Jackson State University's NSF ADVANCE grant with an initial 16 participants. Outputs from the writing group include a completed grant proposal, a published article, and 4 accepted publications. The MRI team has actively been disseminating program findings with 7 research conference presentations, 1 video for the *STEM for ALL* showcase, and has 2 papers accepted to an edited volume. MRI hosted for NASEM the "University of the Virgin Islands Virtual Town Hall: Successes in STEM Education, Research, and Workforce Preparedness", showcasing 7 VI-EPSCoR initiatives in November 2021. The VI-ISERP (STEM Institute) team has launched presence on social media (Facebook, LinkedIn, Twitter, and Instagram) and the Slack network to build virtual community during COVID-19.

The Undergraduate Education Research team (led by M. Guannel) made progress in Year 2 primarily by creating capacity in support of their objectives. They created a Community Engagement Fellow position in Year 2 to support Science 100 (SCI 100) and Social Science 100 (SSC 100) students in planning, conducting, and reflecting upon their projects, and to facilitate integration of the resilience-themed experiential learning projects across these two freshman-year courses. The two fellows, one a MMES graduate student (Madyson Miller) and the other a community member with experience in community-based learning (Lucy Hutcheson), worked closely with students to design and implement projects in both SCI 100 and SSC 100. Dr. Kendell Daughtry, Visiting Assistant Professor on the St. Croix campus, engaged with the team in Spring 2022 around discovery-based learning that he implemented in one class of SSC 100 students. In total, eleven UVI undergraduate students and four MMES students were supervised by M. Guannel as (undergraduate) Peer Instructors or (graduate-level) Teaching Assistants/Lab Instructors. VI-EPSCoR funding was utilized for student research and community engagement positions - with two undergraduate students supported as Service Learning Coordinators, Within UVI, the team expanded its working relationship with the Center for Student Success, partnering with Ms. Julie Cruz and the Dean of Innovation and Student Success, Dr. Moolenaar-Wirsly, to consider the structure and tracking options for Resilience Leaders program development, and for students to continue community-engaged learning past the first-year experience with additional research experiences and internships.

Informal Learning

While still affected by the setbacks brought on due to the COVID-19 pandemic, the Informal Learning (IL) team has continued to adapt and innovate its outreach initiatives and products geared towards the underserved communities of the USVI. In Year 2, the team made significant progress across each of IL's target areas. Specifically, IL component has seen growth in the realms of community engagement, citizen science, k-12/school outreach, and product and resource development.

Through the IL team's community engagement efforts, a total of 1,085 community members have been reached by IL. Of that number, 383 were engaged through community engagement and citizen science events that took place throughout Year 2. Such events include, but are not limited to, the 2022 Great Mangrove Cleanup that took place on St. Thomas, the International Coastal Cleanups kickoff event, and the Annual St. John Earth Day Fair. The team has developed new ways, using both existing and new partnerships, to launch several community engagement initiatives that have the potential to both access communities and further diversify IL's audience(s).

In IL's k-12/school-based outreach efforts, the team has worked with over 700 local k-12 students through several STEM/Geoscience-themed enrichment and professional development opportunities. Alongside partners such as the Virgin Islands Marine Advisory Service, Virgin Islands Eco-Schools, and R2R researchers, the team's outreach efforts with their youth programs has improved with successful introduction of hybrid models of engagement with youth has improved. IL has maintained its financial and programmatic support for the Youth Ocean Explorers (YOE) summer program, and its STEM enrichment collaboration with the University Bound (UB) program. Both of which have seen the successful introduction of hybrid models of engagement. Professional development opportunities for educators and students have also emerged through funding for SCUBA certifications, as well as the new Adopt a Classroom program, which aims to give STEM teachers the tools they need.

IL continues to make advancements regarding co-created STEM education resources and products that can, and do, improve citizen science, public outreach, and youth engagement efforts. During Year 2, dozens of at-home STEM learning kits were created and distributed to participants both in YOE and UB to ensure student engagement at home. In partnership with VIMAS, educator kits are also being prototyped for distribution with STEM teachers in the upcoming year.

Communication and Dissemination

The Communication and Dissemination (CD) team's efforts in Year 2 continue to focus on informing the community about the Ridge to Reef Project and its accomplishments. One of the ways that goal is being achieved is through continued refinements and updates to the website viepscor.org and a new video "VI-EPSCoR Ridge to Reef Grant Update" which was posted to the YouTube channel and shared widely on social media. The Spring 2022 Newsletter has also been published and shared on-line. Printed copies are currently being distributed. MMES graduate Dan Mele is a new hire for the team, and in addition to filming and editing the EPSCoR Ridge to Reef Grant Update YouTube video, he is focusing efforts on photographing the activities of the R2R team for promotional and educational purposes. The Communication team is in the process of creating a second video focused on the work of the Alien Seagrass Emerging Area. Additionally, assistant Dan Mele applied for and received his commercial drone pilot certification in May 2022, an accomplishment that will lead to even greater opportunities to document via photo and video the work of R2R researchers.

3. RESEARCH PROGRAM

Project Outcomes Report

Intellectual Merit

The R2R research project is in its second year of addressing the impacts of changing environmental conditions on small island social-ecological systems. Healthy coastal and coral reef ecosystems are essential components of the tourism-driven economy in the US Virgin Islands. Previous research, including earlier NSF-EPSCoR Track 1 projects, has shown that the USVI's coral reefs and associated habitats are becoming increasingly more vulnerable to stress drivers such as increases in oceanographic temperatures and related climatic perturbations such as major hurricanes. Moreover, land- and water-based human activities, such as land development, dredging, and overfishing, cause elevated sedimentation and subsequent coral disease and reduced herbivory, often magnifying the negative effects of natural disturbances.

The ability of coral reefs and associated ecosystems (i.e., mangrove forests, seagrass meadows, beaches) to resist and recover from acute and chronic stressors, is key to their resilience. Understanding and quantifying these drivers of change is the focus of the "Ridge to Reef" (R2R) project. They are synthesizing historical data about the various factors (including those affected by climate change) that drive degradation, decrease resistance to disturbance, and reduce the resilience of Caribbean coral reef ecosystems. The science-based ecological restoration that emphasizes biological biodiversity is being implemented at a large scale for many species of corals and mangroves to complement ecosystem studies that inform the best available management strategies to increase the resilience of marine and coastal habitats. The R2R Project is also actively integrating research in watershed dynamics, fish ecology and herbivory, and oceanographic processes to understand the more complex linkages among interconnected ecosystems. The R2R project is developing and nurturing a science-based approach to environmental stewardship in the next generation of Virgin Islanders to ensure a resilient future for their natural resources - a key element of the dominant tourism-based economy of the U.S. Virgin Islands.

Collectively, this project, which incorporates research, education, and community engagement, is beginning to identify and highlight the multidisciplinary approaches needed to inform small Caribbean Island communities and their decision-makers of the environmental threats that range from local, such as poor land-use practices, to global, such as the increased sea-level rise and coral disease incidence exacerbated by warmer ocean waters.

SYNOPSIS: Watershed and Land Use
Research Lead: David Hensley

The second year of activity for the WL team focused on data and sample collection in the various studies that were established in Year 1. Although most of the instrumentation was ultimately deployed before the full onset of the rainy season of 2021, historically dry conditions ultimately led to very little water flow observed in any of the stream reaches under our monitoring program. However, hydrographs of the limited flow that did occur have been collected, their accuracy was validated, and will serve in further hydrological analysis as we deepen our understanding of small watershed hydrology in the Virgin Islands. Sediment samples were collected from all environments, though less than expected due to low rainfall, and streambed sediment samples were also collected to permit full characterizations of particle size distributions and spectral data for source tracking. These lab analyses will be performed on the samples starting in May or June, as the last pieces of lab equipment arrive for the analysis. Water samples were not collected due to a lack of flow, but all necessary equipment for water quality analysis has now been acquired and alert systems have been implemented for rapid reaction to water flow events to take grab-samples for this analysis goal (nutrient and bacteriological flux). In land use studies, soil moisture data has been collected under varying mulch ground covers in plantain production, as well as in natural forests versus breadfruit agroforestry In our initial analysis, data have begun to reveal substantial buffering in forest plots, but less than expected differences in estimated runoff in mulched ground cover treatments. Continued data analysis will be necessary, combined with some modeling, to fully elucidate the results of this year's soil moisture data, while ongoing soil sampling and characterization (bulk density and infiltration data collection in May), may provide further insights into mechanistic explanations for the observations in soil moisture. These research activities have been collated and documented for both reporting purposes, scientific presentations, and for public engagement activities.

Major Accomplishments and Research Findings: Watershed and Land Use

Goal WL1: *Identify sediment flux sources via sediment fingerprinting, and nutrient flux and microbial flux monitoring to characterize the role of runoff in two Virgin Islands watersheds.*

Since Year 1 reporting, major progress has occurred for all objectives in Goal WL1, including the completion of objectives that were incomplete at the time of writing the Year 1 report.

Continuing reporting obligations to the National Park Service have been fulfilled (WL1.1b and WL1.2b), and an initial round of data analysis and preliminary conclusions has been completed in time for this report (WL1.1f and WL1.2e). Despite challenges with a lack of water sampling stemming from a lack of water flow observed during Year 2 (WL1.2c), all other objectives have seen major progress since Year 1, and equipment for water sample processing has been purchased and tested, as is ready for use (WL1.2a). All sediment traps in all environments (land-based, in-stream depth integrated, in-stream time-integrated, and mangrove-marine) have been installed and are being purged for samples on a regular basis (WL1.1c, WL1.1d, and WL1.1e), including by internal collaborators on other project teams (e.g., Fish Ecology) with interdependencies with our work (WL1.2d). Currently, initial data analysis and interpretation, as well as continuing sample collection and processing, have allowed us to complete current reporting requirements and submit this work to present at conferences (WL1.1f, WL1.2e), such as the American Society of Agricultural and Biological Engineers (ASABE) "Soil Erosion Research under a Changing Climate" Symposium to be held next year.

These early results organize around the theme of a very dry year in 2021, which is borne out by weather data showing one of the driest years on record and an ongoing drought, though we did notably see our hydrological monitoring stations record valid data that will therefore be useful to relate these dry conditions with predictions of flow in the future. Sediment samples collected have been assessed for volumetric flux where possible, though because of the low discharge conditions, it is estimated that no major new sediment inputs occurred in our watersheds in the past rainy season. Observed sedimentation in mangrove-marine sediment traps is provisionally assumed to be resuspension, though further analysis with datasets from elevation tables in Salt River mangroves should allow for some calibration of this sedimentation data.

Goal WL2: *Estimate the downstream impact and ecosystem services rendered by conservation land use interventions.*

The three field studies involved in Goal WL2 are successfully operating and collecting data, and despite minor setbacks, all three are tracked to provide useful conclusions related to hydrology and land use on schedule.

Objective WL2.1 related to the Before-After Control-Impact (BACI) design intended to measure the impact of a conservation buffer on sediments mobilized by crop fields and unpaved roadways. The design of this study involves two years of study without any applied "impact" (i.e., before-after), and so this conservation buffer has not yet been established. The equipment which was installed for sediment collection and monitoring in Year 1 has been maintained (WL2.1a), and regular samplings are ongoing (WL2.1b), with these samples currently being processed in the lab, the first of which have been processed for data collection (WL2.1c) on volumetric flux.

These early findings have been summarized for reporting requirements (WL2.1d) and are yielding data in the form of a mass of sediments collected per unit of area in the upslope catchment area of each. Because of extremely low rainfall in the previous year, values at most of the collection sites were low or near-zero in many sampling events, though unpaved road sites are yielding samples of >50g routinely and are expected to increase if rain events increase in the following years. The purpose of the "before" period in a BACI design is provide for an unreplicated quasi-control, which means that intrinsic differences between sites will be partially statistically accounted for by the comparison (and normalization) of the two sites against one another during the period in which neither one was subjected to the conservation treatment. Thus, no initial conclusions as regards the original study aims can yet be made, other than to note that the crop fields have been notably unproductive of sediment, possibly indicating the success of the contour planting management that occurs in those fields.

Objective WL2.2 involves a hydrological land-use comparison between natural forests and breadfruit agroforestry production orchards. Major progress has also been made in this study but was delayed more than expected because of the discovery of soil-moisture heterogeneity within the study plots which had to be accounted for before the instruments could be fully deployed. As of this writing, the problems with heterogeneity have been resolved by conducting a stratified random sampling of 20 points in each of the six study plots for soil moisture, to allow for a determination of where to place the permanent soil moisture sensors. Sensors have been installed in 3 of the 6 plots, with active plans to install the remaining sensors in April and early May. However, weather stations have been recording continuously since Year 1 and are being maintained with data collection (WL2.2a). Soil bulk density samples are also planned for these plots, in addition to the soil chemical and soil moisture sampling already done. This sampling is in progress, with locations identified but the field campaign for sampling is planned for May (WL2.2b). Because the bulk density samples (a measure of soil porosity and major parameter of hydraulic conductivity) have not been completed, all samples related to this study have not yet been processed for this year (WL2.2c); completion of this process is expected in May. Initial weather and soil moisture data have been analyzed for reporting requirements (WL2.2d), and early results show a buffering effect of forest cover on soil moisture, with some sites displaying minimal dry-down as compared to breadfruit orchard sites, which have measurably lower canopy densities in their early phases of the establishment.

Objective WL2.3 is a plot-scale experiment on the soil-moisture and crop-growth effect of mulch and ground cover strategies in plantain production. The maintenance of this experiment and the equipment installed in Year 1 was completed successfully as of this writing (WL2.3a), but the detection of a lethal plantain disease (*Fusarium* wilt fungus) in the field has necessitated that the crop be terminated after the first year's harvest, which is expected around the end of Year 2. Before this, however, soil bulk density samples are to be collected to assess the effect of mulching strategies on compaction and soil porosity. These samples have not yet been collected but are planned for the months of April and May (WL2.3b). Similarly, the processing of these samples has yet to occur but is also expected before the end of Year 2, in May or June (WL2.3c). The data collected thus far in this experiment has been collated, performed QA/QC, and analyzed for an oral presentation at a research symposium held in March (WL2.3d). This analysis revealed a distinct effect of hay mulch on the growth and expected yield of plantain, but the same effect was not revealed in soil moisture and infiltration rate variables. However, this initial analysis did not consider the high-frequency time-series of the moisture data, and more analysis will be conducted in the coming months for more finalized conclusions. The initial conclusion may be that the hay mulch improved yield in plantain through a mechanism other than water conservation, but more in-depth analysis is awaited before this conclusion is finalized.

Goal WL3: *Share communication, community education, and integration activities to support public and stakeholder benefit of the land use research.*

The WL team has made continuing progress in the third major goal of our team, to make our scientific work more accessible and relevant to community partners and educators by communicating, sharing, and participating in events and activities.

Although no SCI-100 student was recruited so far for mentorship (WL3.1a), our team did engage in presentations with teachers in the Project-Based Learning program to integrate Watershed and Land Use research methods in their classroom instruction techniques (WL3.1c). A presentation was made on the "Wolman Pebble Count" method which is used in Goal WL1 and characterizes the dominant sediment and particle types found on the streambeds within a watershed and is accessible to students of all ages for participation. Further plans to integrate this into a teacher's class were developed and will be continued in Year 3. Additionally, regular contributions were made in photographs and text for the R2R public-facing newsletter (WL3.1b).

In Year 2, both an undergraduate (WL3.2a) and a graduate (WL3.2b) student were engaged in paid research activity. N'Quoia Christian, UVI undergraduate student, participated in data collection in the plantain field experiment (WL2.3), and Race Stryker, graduate student, participated in the watershed monitoring objectives of WL1, especially in the Fish Bay watershed on St. John. Stryker is expected to continue to be engaged throughout Year 2, whereas a new undergraduate student will be recruited in Year 3.

We also presented WL research at scientific conferences. In March, a talk entitled "Soil moisture regimes under mulch covers in tropical plantain production" was presented at the 2022 Auburn Research Student Symposium at Auburn University, Alabama. In preparation for additional conferences, abstracts have been created (and some submitted) for both WL1 and WL2 projects, including a planned presentation on soil erosion research methods in ephemeral watersheds, to be presented in Year 3.

SYNOPSIS: Mangrove Ecosystem Function & Recovery and Mangrove Restoration
Research Lead: Dr. Kristin Wilson Grimes

The Mangrove Ecosystem System Function & Recovery and Mangrove Restoration is led by Dr. Kristin Wilson Grimes and includes Postdoctoral Researcher, Dr. Heather Stewart (hired in Year 1 with a start date in July 2021) and Watershed and Marine Specialist, Allie Durdall, M.Sc. In Year 2, this theme made significant progress towards its three goals: (1) investigate current and historic USVI mangrove distribution, recovery, and loss, (2) grow USVI mangrove restoration opportunities, and (3) share USVI mangrove research with stakeholders and provide opportunities for new partnerships. Key accomplishments include field surveys of 19 mangrove forests across the territory completed and preliminary analyses of data started, expansion and maintenance of the land-based nursery, successful completion of the Federal Aviation Administration part 107 certification for drone flying, submission of all materials to UVI's Institutional Review Board for community listening sessions, surveys, and the site-specific restoration potential index workshop, and significant engagement of UVI undergraduate (7) and graduate (6) students on this theme's research and restoration goals. In Year 2, this area had 4 peer-reviewed journal articles published at the time of this report and 2 more that are in-review. This group gave 11 oral presentations at local, national, and international conferences. In this reporting period, a total of 15 proposals were submitted with 5 successfully awarded, 9 pending, and 1 declined. Six of these proposals are directly related to expanding R2R mangrove research objectives. One graduate student (K. Vaughn) successfully defended her thesis within the Master of Marine and Environmental Science program in December 2021.

Major Accomplishments and Research Findings: Mangrove Ecosystem Function & Recovery and Mangrove Restoration

This research team is led by Dr. Kristin Wilson Grimes and assisted by Postdoctoral Researcher, Dr. Heather Stewart, and Marine and Watershed Specialist, Allie Durdall. The team has made significant progress in Year 2 in each goal, objective and strategy, as described below.

Goal M1. *Investigate current and historic USVI mangrove distribution, recovery, and loss.*

Tragically, MMES graduate student, Stephanie Hibberts passed away in mid-July 2021 due to COVID-19. This was incredibly difficult for the lab, friends, and family who knew Stephanie; it also delayed aspects of the historical analysis work, as Stephanie had assisted in the compilation of images and other historical documents as part of the mangrove atlas creation and change over time analyses. Stewart has picked up where Stephanie left off and has had productive conver-

sations with collaborators at The Nature Conservancy, Pennsylvania State University, and the Smithsonian Institute, who have created different current mangrove base maps and have expertise in mapping change over time (M1.1a-d).

The lab has made significant progress on documenting the current status and recovery of USVI mangroves (M1.2). In Year 2, the Grimes lab completed a field survey of 19 mangrove forests across the U.S. Virgin Islands (M1.2f-h). Many students and partners (Virgin Islands Department of Planning & Natural Resources, Division of Coastal Zone Management, Division of Fish & Wildlife, National Park Service, Virgin Islands EcoTours, St. Croix Environmental Association, U.S. Geological Survey, local fisherman) were involved in this work, strengthening partnerships and including MMES alumni who are now in professional positions across the territory. Field collected data include living aboveground biomass of adult trees, coarse, medium, and fine woody debris, regeneration (propagules, seedlings, saplings), canopy cover, marine debris, wildlife presence, continuous light and temperature measurements, water quality, groundwater, and geologic cores. This is the most robust data set of its kind for mangroves in the USVI. The Grimes lab has begun analyzing these data to understand differences in forest stand structure and composition by mangrove habitat type (fringe and salt pond), site, and island and to provide new information about natural regeneration - where it's occurring and where it's not for each species, and thus which sites may require assisted planting. The lab plans to use field-collected data and a stakeholder workshop, to create a site-specific mangrove restoration potential index, which will be used to guide future outplanting efforts in the territory.

The lab has also made progress in the steps needed to obtain the proper licensure and accreditation to legally fly in the different air spaces of the USVI. In March 2022, Durdall successfully completed Federal Aviation Administration 107 certification, satisfying territorial permitting, and giving the ability to apply for waivers to fly within the National Parks and restricted airport-adjacent airspace with this certification. In May 2022, Durdall will work with partners from the Virgin Islands Department of Planning & Natural Resources and The Nature Conservancy to collect our first drone images (M1.2c-e).

Goal M2. *Grow USVI mangrove restoration opportunities.*

The Grimes lab continued to grow its expertise in mangrove grow-out best practices and to expand nursery operations in Year 2 (M2.1b). Construction of the land-based nursery is largely finished in its current parking lot location, although it continues to expand as we bring more tables onto the flow-through seawater system and add unplumbed tanks. This system will be moved to the new Marine Science Center when that building is completed. Currently, there are 25 tanks fully plumbed with fresh and salt water on the flow-through system, and 9 unplumbed tanks and the nursery is continuing to grow.

The lab continues to collect phenology data - data that are critical for restoration activities and are new information for the USVI (M21.b, c). The lab has successfully collected propagules of all three mangrove species (*Rhizophora mangle, Avicennia germinans*, and *Laguncularia racemosa*) from sites across the territory (M2.1c). The lab created new in-take protocols so individual propograules can be tracked over time and more information learned about which propagule characteristics are ultimately the most important predictors of germination, plant growth, and seedling survival (M2.1c, d,e). All three mangrove species are now being grown at the land-based nursery (M2.1b). At the time of this report, 1,070 *R. mangle* (red mangrove) propagules have been planted with 65% survivorship, 3,410 *L. racemosa* (white mangrove) propagules with 32% survivorship, and 478 *A. germinans* (black mangrove) propagules with a survivorship of 85% (M2.1b, c, e). The lab is especially proud of the success achieved with the white and black mangrove seedlings, as these species aren't as commonly grown for restoration (*R. mangle* is the most common species grown for restoration efforts in the Florida-Caribbean region).

The lab is working to improve survivorship and growth rates through adaptive learning at the nursery (e.g., mixed species tanks, shading, pest checks, container transplants, mixed sand and soil substrates, neem oil treatments) and experimentation with different grow-out techniques (M2.1d). For example, in Year 2, we started an experiment to test the effects of container type on red mangrove growth and survival. Five months into this on-going experiment, the data suggest that red mangroves survive and grow better in cone-tainers compared to tree pots or bio-bags. In addition, Masters student, Allison Hoelvoet, is beginning her experiment which will examine the effect of plant clumping and substrate on red mangrove growth and survival at the nursery (M2.1e, f). This includes testing the novel use of recycled, crushed glass as substrate, in a partnership with the Virgin Islands Marine Advisory Service (VIMAS) and VI EPSCoR's Informal Learning's, Glass Recovery Project. Both experiments will provide practical information for restoration practitioners and inform future outplanting efforts.

Another significant accomplishment of Year 2 was submission of materials for human subjects research to UVI's Institutional Review Board. These materials included: (1) mangrove perceptions survey to understand how USVI residents

perceive mangroves and to help guide citizen science programming and general education and outreach, (2) community listening session protocols to assist in the co-design of the citizen science program, (3) citizen science survey to understand participant motivations for learning and doing science, and (4) survey and interview protocols for the Site-Specific Restoration Potential Index Stakeholder Workshop. At the time of this report, materials had been reviewed and require modest revision; it is expected that IRB approval should be granted before the end of Year 2. Much of this work will be part of first year MMES student Laura Palomino's Master's thesis (more below).

Goal M3. *Share USVI Mangrove Research with Stakeholders & Provide Opportunities for New Partnerships*

The Grimes lab has committed to sharing mangrove research and restoration activities in several keyways in Year 2 of R2R, including the development of website content and newsletter items for VI EPSCoR (M3.1a, M3.1d, M3.1e). The lab also participated in a virtual, live Science Saturday event hosted by the Virgin Islands Department of Planning & Natural Resources in July 2021 at the mangrove nursery and has hosted 3 student groups from UVI and beyond in mangrove nursery tours, sharing R2R research in the past year (M3.1b). The lab plans to further highlight mangrove research and restoration work with a table at the April 2022 Friends of the St. John National Park Earth Day Event. Stewart gave 3 guest lectures to UVI and University of Miami students, Grimes 2 guest lectures to UVI students and the Grimes lab together developed a new lab for MES 501 in Fall 2021 focused on mangrove restoration.

The lab has also started drafting a mangrove nursery manual geared toward practitioners that is envisioned as a living document that will be shared on-line (M2.1f). The lab also launched its social media campaign, GRROE US Virgin Islands Mangroves, on Instagram at the end of March 2022. GRROE USVI Mangroves is Growing Research, Restoration, Outreach and Education (M3.1, M3.2). This effort is being led by graduate students Allison Hoelvoet and Laura Palomino with contributions from all Grimes lab members.

The Grimes lab held two Great Mangrove Cleanups in Year 2 (at the time of this report: 2021 St. John Great Mangrove Cleanup and the 2022 St. Thomas Great Mangrove Cleanup) with two more planned before July 1 2022 on St. John and St. Croix (M3.1b). Two new, culturally relevant infographics were created and shared with the community on social media and press releases with the assistance of VI EPSCoR (2 more expected). This effort was led by Grimes and Durdall, with support from Stewart and the lab, as well as many other territorial partners (Kitty Edwards, VI DPNR CZM; Leslie Henderson, NOAA; Howard Forbes Jr., VIMAS; Elisa Bryan VI EPSCoR; Jarvon Stout, VI EPSCoR; Avia Huisman, UVI; Zola Roper, UVI). Since 2018, these efforts have engaged more than 500 community volunteers and removed 7.6 tons of marine debris from mangrove shorelines across the territory.

The Grimes lab actively contributes to natural resource management in the territory relevant to mangroves. For example, Grimes, Durdall, and Stewart have been in discussion with Hull Bay, St. Thomas residents about a potential mangrove restoration project, as well as the Virgin Islands National Park about a planned hydrological restoration project in the mangrove system by Annaberg on St. John. They are also actively working with the NPS on St. Croix on a mangrove restoration project in Salt River. Grimes and Durdall both participated in the St. Thomas East End Reserves (STEER) Management Workshops, actively contributing to the revision of the STEER Management Plan. Grimes and Durdall also led a NOAA-funded effort to co-create the territory's first Marine Debris Action Plan with stakeholders, a two-year process that resulted in a final document shared with the public in December 2021 and available on the VI EPSCoR website.

The Grimes lab has provided opportunities for student training (M3.2a, M3.2b) to meet research objectives in M1 and M2. Six MMES graduate students helped to advance R2R mangrove research and restoration goals in Year 2, assisting with nursery operations, field work, and mentoring undergraduate students. Allison Holevoet successfully defended her thesis proposal in September 2021. She was selected as an NSF NRT Strong Coasts Fellow (Award #1735222) for which Grimes is a Co-PI and participated in the virtual 2021 Bridge to Graduate School Program, a program within the NSF INCLUDES SEAS Islands Alliance (Award #1930991). Allison was selected as a 2021 CERF Rising TIDES Fellow and as a 2022-2023 American Geophysical Union's Voices for Science Fellow. Her thesis will test the effect of clumping and a novel substrate type (crushed glass) on red mangrove growth and survival in a nursery setting. Kayla Halliday returned to UVI in Fall 2021 after her leave of absence. Her thesis will test the effect of co-restoration of different mangrove species with fiddler crabs in both nursery and field settings, concentrating at the NPS restoration sites on St. Croix. She was selected as a NSF S-STEM Scholar (Award #2030713). URM student Laura Palomino joined the lab in Fall 2021. Her thesis will focus on human dimensions of mangroves, including growth of the citizen science program. She worked with Grimes, Durdall, Stewart, and Peterman to submit a package to UVI IRB in March 2022. Her work will focus on people's perceptions of mangroves, community listening sessions to co-design the citizen science program, and motivations for learning and doing mangrove citizen science activities related to mangroves. Laura is supported by VI EPSCoR in a mangrove restoration RA. Lila Uzzell grew up on St. John and was also recruited to the lab this year. Her thesis work will focus on

the natural recovery of unique coral-mangrove communities in Hurricane Hole, St. John and testing novel techniques for co-restoration. Laura and Lila will participate in the 2022 NSF INCLUDES SEAS Islands Alliance's Bridge to Graduate School Program (Award #1930991). Julia Plotkin, a USVI resident who works for Virgin Islands Department of Planning & Natural Resources, also entered the lab this year. Her thesis work will focus on analysis of the geologic cores collected for the R2R project and how carbon (as measured by loss on ignition) varies in space and time. Julia, Laura, and Lila received tuition support from VI EPSCoR. Kelsey Vaughn, who was advised by Grimes, successfully defended her Masters thesis, entitled, "Assessment of the ability of the invasive species, *Halophila stipulacea*, to store sediment carbon in nearshore habitats of St. Thomas, U.S. Virgin Islands," and graduated in December 2021. She is applying to Ph.D. programs for admittance in Fall 2022. Stephanie Hibberts continued to work in this area up until her death in mid-July.

In Year 2, 7 UVI undergraduate students have engaged in R2R mangrove research, with another UVI undergraduate student joining the lab in June 2022. Five of these students have received support from VI EPSCoR and also participated in NSF INCLUDES SEAS Islands Alliance activities (Award #1930991). Summer 2021 undergraduate student VerNele Callwood's research project was shared at the 26th Biennial Conference of the Coastal & Estuarine Research Federation in November 2021.

The Grimes lab actively shared R2R mangrove research in local, national, and international meetings, with 11 presentations in Year 2 (M3.3b). The lab also participated in many additional meetings. For example, Stewart presented at, and members of the lab attended, Semanglares IV, an international meeting of mangrove scientists that happened virtually in July 2021. Stewart also attended the U.S. Forest Service Office of International Programs' Community-Based Ecological Mangrove Restoration training earlier this year and shared with the lab what she learned during that event. The lab also attended the Caribbean Regional Mangrove Symposium virtually in March 2022, which focused on sharing across mangrove restoration projects from small island states across the Caribbean. The lab attended the 26th Biennial Meeting of the Coastal & Estuarine Research Federation (CERF). Eight UVI undergraduate and graduate students participated in Rising TIDES, CERF's diversity program, which is an NSF GOLD-EN award for which Grimes is a Co-PI. Two UVI graduate students, Kelsey Vaughn and Allison Hoelvoet, presented their research and in total, the Grimes lab contributed eight presentations to the 2021 conference. Dr. Brandt and Grimes co-chaired a session entitled, "Coastal Restoration: Challenges, Successes and Innovation," and Allie Durdall co-chaired the session, "Why diversifying coastal and estuarine research and management matters." Grimes also presented at the International Coral Reef Society meeting, the VI EPSCoR annual meeting (both in July 2021) and was an invited speaker at the NOAA in the Caribbean Meeting in September 2021.

Grimes and Durdall also participated in the NSF-funded workshop, "Untapping the Power of Questions," in September 2021 and have since led three trainings in the use of the question formulation technique for research for students, postdoctoral researchers and other staff from the University of the Virgin Islands and the University of South Florida. Grimes participated in the NSF-funded Faculty Forum on Supporting Career Development in the Ocean and Coastal Sciences for Students at MSIs hosted by NCAR and the Coastal Society in January 2022. Grimes, Durdall, and Palomino participated in the NSF Design and Discovery Forum: Climate Science, Children, and the Media, in February 2022.

In this reporting period, a total of 15 proposals were submitted with 5 successfully awarded (total of $430,246, all as PI for Grimes), 9 pending, and 1 declined. Six of these proposals are directly related to expanding R2R mangrove research objectives; 4 were to NSF programs, including one led by Grimes to the NSF RII-BEC call (NSF 22-536) with Dr. Lawanda Cummings as Co-PI.

Four peer-reviewed papers were published at the time of this report and two are in-review. Finally, in January 2022, Grimes accepted a nomination to the National Science Foundation's Advisory Committee for Geosciences (January 2022-December 2024). Stewart was elected as the Vice President of the Northeastern Division of the American Fisheries Society in July 2021.

SYNOPSIS: Fish Ecology & Herbivory
Research Lead: Dr. Richard Nemeth

The FE project is both novel and interdisciplinary. It has strong linkages to other research themes including Watershed Dynamics, Coral Reef Resilience, and Oceanography. The FE research is focused on 3 primary goals. These include:

Goal FE1. *Analyze historical data for changes in parrot fish assemblages due to disturbance.*

In our proposal we hypothesized that disturbance, including major bleaching/disease events (i.e. 2005 and 2010) and sedimentation from land development may lead to changes in the parrotfish community, specifically a shift from parrot-

fishes that function as scrapers (genus *Scarus*) to grazers (genus *Sparisoma*). Our analyses used benthic cover and fish abundance and diversity data from our Territorial Coral Reef Monitoring Program as well as historical sedimentation data over the past 20 years and across 23 sites. We found that parrotfish density increased rapidly about 1-2 years following the 2005 and 2010 disturbance events, especially for *Scarus* species. *Sparisoma* species, however, showed greater increase in biomass over time than *Scarus* especially after 2010, where *Scarus* biomass remained flat. These data suggest that *Scarus* may be more sensitive to coral reef degradation from natural disturbance. Our analysis of sedimentation on parrotfish composition found that *Scarus* species biomass declined steadily with increasing sediment load, whereas *Sparisoma* biomass showed a temporary increase at low sediment flux but then biomass declined as sediment flux continued to increase. These results partly fit our model and suggest sediment affects parrotfish species differently, but at higher sediment loads, all parrotfishes are affected negatively.

Goal FE2. *Investigate how benthic characteristics affect feeding and reproduction of parrotfish.*

We installed 54 acoustic receivers in Reef Bay and tagged 60 yellowtail parrotfish with acoustic transmitters, to track fish from feeding grounds to spawning sites. Sex of each fish was determined using a portable ultrasound, which was the first time this novel approach was used on parrotfish. All fish were released at their capture location and only 5 fish were not detected migrating to spawning sites. All fish displayed consistent migration pathways and strong spawning site fidelity. Preliminary analysis of acoustic data showed significantly higher visitation rates for fish at western spawning site compared to eastern site, but fish visiting the eastern spawning site spent over twice as much time (29 min) than fish at the western site (14 min). Six sites were established near fish tagging areas to measure sediment flux, benthic composition and foraging rates of parrotfish. Preliminary analysis of benthic algae showed that turf and *Dictyota*, (a brown macroalgae), the two dominant algal types, varied between 20% and 40% cover but were not significantly different between east and west sites. However, we found yellowtail parrotfish feeding rates were significantly higher on turf at eastern sites (low sediment) compared to western sites (high sediment). We believe that higher sediment loads adjacent to land development may reduce parrotfish feeding rates on turf algae due to sediment-laden turf.

Goal FE3. *Examine if ocean and environmental variables affect parrotfish reproductive output.*

A Nortek Acoustic Doppler current profiler, or ADCP, was deployed at each fish spawning aggregation site in Reef Bay in mid-January. Our first data download occurred in mid-March and we are still examining the dataset. These ADCPs include echo sounders, which will provide a novel approach to measure reproductive output of parrotfish by tracking fish eggs released from each spawning site.

Broader Impacts: Four peer review papers published in 2021 with 3 of these including graduate students. Two Citizen Science projects focused on sediment awareness using a smartphone App that allows users to report on sedimentation and erosion sites (161 reports to date). The second project allowed divers to report sightings of endangered rainbow parrotfish in the USVI (27 reports and 70 sightings to date). The Nemeth lab hosted 1 post-doc, 8 graduate students, 3 undergraduate students and student training in fish ecology field techniques was provided to 29 undergraduate students.

Sustainability: In the past two years $566,000 in grant funding was awarded for fisheries ecology and conservation research to R. Nemeth.

Major Accomplishments and Research Findings: Fish Ecology & Herbivory

The fish ecology project is both novel and interdisciplinary. It has strong linkages to other research themes including Watershed Dynamics, Coral Reef Resilience, and Oceanography. This project will use data from each of these research focus areas to determine how they influence fish feeding and reproductive rates. This research also has indirect connections to other R2R research areas including coral disease, mangrove ecosystems, and *Sargassum* impacts.

Intellectual Merit: Fish Ecology research is focused on 3 primary goals. These include:

1. Analyze historical data for changes in parrot fish assemblages due to disturbance
2. Investigate how benthic characteristics affect feeding and reproduction of parrotfish
3. Examine if ocean and environmental variables affect parrotfish reproductive output

The Objectives for Goal 1. include

Objective FE1.1: *Determine if variability in resilience of coral reefs during 2005/2006 mortality event affected the composition of herbivore fish communities.*

Objective FE1.2: *Determine if variability in sedimentation rates onto coral reefs affected the composition of herbivore fish communities (negative relationship between sediment load and* Scarus spp.*).*

In our proposal we hypothesized that as the severity and frequency of disturbance increases the ecosystem state also declines. We proposed that this may lead to changes in the parrotfish community, specifically a shift from parrotfishes that function as scrapers (genus *Scarus*) to grazers (genus *Sparisoma*). Data used for this analysis was from our Territorial Coral Reef Monitoring Program located on St. Thomas, St. John and St. Croix. The time periods used for this analysis covered major bleaching/disease event in 2005/2006 and a smaller event in 2010.

a. Data from 2002-2005 represented the Pre 2005 bleaching / disease event
b. Years 2006-2010 represented the Post 2005 event , and
c. Years 2011-2014 represented the Post 2010 bleaching event

We found that parrotfish density increased rapidly about 1-2 years following disturbance events. This was especially true for the density of *Scarus* species but also *Sparisoma* species. We also found increases in biomass of both genera, but *Sparisoma* species showed greater increase in biomass over time than *Scarus* especially after 2010, where *Scarus* biomass remained flat. The results for biomass partly support our model where *Sparisoma* increased more than *Scarus* following decline in ecosystem state. These data suggest that *Scarus* may be more sensitive to coral reef degradation from natural disturbance.

To examine the effects of sediment on parrotfish, all available historical data over the past 20 years and across 23 sites was combined. Since most sediment studies focused primarily on coral health, they often omitted surveys of fish communities. Therefore, fish and sediment data sets were poorly associated. However, we went ahead and analyzed general trends averaging sediment flux and *Scarus* and *Sparisoma* biomass across all years and sites where both data existed. With this course analysis, we found an interesting trend where *Scarus* biomass declined steadily with increasing sediment load. However, *Sparisoma* biomass showed a temporary increase at low sediment flux but then biomass declined as sediment flux continued to increase. These these results partly fit our model and suggest sediment affects parrotfish species differently, but at higher sediment loads, all parrotfishes are affected negatively.

The Objectives for Goal 2. include

Objective FE2.1. *Determine if sediment load and algal composition affect yellowtail parrotfish feeding rates. Assess dietary differences in areas with higher sediment and macroalgae (scheduled to start April 2022) in collaboration with Dr. Chelsea Harmes-Tuohy and Dr. Nicholas Shizas.*

Objective FE2.2. *Determine if differences in benthic algal composition and sediment loads affect frequency of spawning and fecundity of yellowtail parrotfish.*

Objective 2.1: We installed 54 acoustic receivers in July 2021 from Fish Bay in the west to Europa Bay in the east to track parrotfish from feeding grounds to spawning sites. This acoustic array represents a gradient from reefs exposed to developed watersheds in the west compared to undeveloped watersheds within the VI National Park. Receivers were range tested in August and the first 6-month download was completed in February 2022. In Aug and Sept 2021, 60 parrotfish were caught within the acoustic array and surgically implanted with an acoustic transmitter. We determined the sex of each fish using a portable ultrasound, which was the first time this novel approach was used on parrotfish. All fish were released at their capture location. We had a high tagging success at all sites with a total of 55 out of 60 parrotfish migrating to the spawning aggregation sites. Only 5 fish were not detected, 2 in Fish Bay and 3 in eastern Reef Bay meaning that we had nearly equal numbers of fish tagged in the east and west study areas.

Based on a previous pilot study, we made the assumptions that parrotfish would display consistent migration pathways and strong spawning sites fidelity. These two assumptions were confirmed since fish tagged in west only migrated to western FSA and fish tagged in east only migrated to eastern FSA. This sets up a strong experimental design to test our hypotheses.

Preliminary analysis of acoustic data shows daily variation in a number of fish visiting each spawning site over several months. We found significantly higher visitation rates for fish in western sites compared to eastern spawning site. We also found daily variation in time spent at each spawning site over several months. Fish visiting the eastern spawning site spent over twice as much time (29 min) than fish in the western spawning site (14 min). These significant results will allow us to test if these spawning related differences in behavior are due to benthic characteristics or other environmental factors.

Objective 2.2: Six sites were established near fish tagging areas in September 2021 to measure sediment flux, benthic composition and foraging rates of parrotfish across the study area. Sediment monitoring used terra cotta tiles to simulate sediment accumulation on natural substrates and sediment cups were installed to measure total sediment flux. These are sampled monthly and processed in the lab. The experimental design also took into account the assumed sediment gradient where the highest sediment flux would be closer to land development in Fish Bay and lower rates of sediment flux cent to undeveloped National Park land. The benthic composition was measured monthly using six 10 m transects at each site. Parrotfish feeding rates are collected every 4 months to document seasonal changes.

Preliminary analysis of percent cover of benthic algae from transects showed similarities in turf and Dictyota algae, (a brown macroalgae that inhibits coral growth and recruitment). These dominant algal types varied between about 20% and 40% cover but were not significantly different between east and west. However, we found significant differences in feeding rates of yellowtail parrotfish among east and west sites and algae type. Feeding rates were higher on turf on eastern sites than in the west, but there was no difference in feeding rates on Dictyota among sites. The takeaway message here is that higher sediment loads adjacent to land development may reduce parrotfish feeding rates on turf algae at western sites due to sediment laden turf. This will be investigated further as sediment samples are analyzed.

The two Oceanographic objectives included:

Objective 3.1. *Determine which oceanographic variables (current speed and direction, seawater temperature, wave height, salinity, turbidity) are most important for frequency of spawning at aggregation sites.*

Objective 3.2. *Determine which Oceanographic and environmental variables are most important for reproductive output of yellowtail parrotfish.*

A Nortek Acoustic Doppler current profiler, or ADCP, was deployed at each fish spawning aggregation site in Reef Bay in mid-January. Our first data download occurred in mid-March and we are still examining the dataset. These ADCPs include echo sounders, which will provide a novel approach to measuring the reproductive output of parrotfish by tracking fish eggs released from each spawning site. These data will be analyzed by postdoc Kayla Blincow-Israel and integrated into connectivity models by Dr. Daniel Holstein.

Broader Impacts: Some research highlights include 4 peer review papers published in 2021. Three of these papers included graduate students who are listed as first author or coauthors. We are also sharing information and expert advice to local fisheries and marine protected area committees.

We collaborated with the Department of Planning and Natural Resources and Coastal Zone Management and Fish and Wildlife on the development of several outreach and education products. Funding from USGS Water Resources Research Institute supported the creation of the Toby the Cleaning Goby character that will be developed into a comic book to inform children and parents of the harmful effects of terrestrial sedimentation on the marine environment. This award also provided for the development and dissemination of an App that allows citizens to take photos and GPS coordinates to document erosion, sedimentation, and pollution. The 411 TIP app was promoted through a series of outreach and citizen science events. Data was compiled by DPNR and was used to generate a heat map to show hot spots of erosion on all 3 islands. Finally, a second Citizen Science project has provided critical information on the population status of the rainbow parrotfish in the USVI. The two maps show locations from 27 reports and 70 sightings of rainbow parrotfish, which is a major herbivore that was fished out decades ago. When this project was started in 2018 the rainbow parrotfish were very rare in USVI but they seem to be making a recovery. This work is a continuation of the previous VI-EPSCoR award.

In addition to formal mentoring of graduate students and post-docs, broadening participation of graduate and undergraduate students was achieved through a variety of activities including integrating research in the lab sections of several courses including fish biology and graduate research diving. Students learned a host of field techniques that are being used in the Fish Ecology research project. My lab also hosted 3 undergraduate students who worked on a variety of research projects in tandem with graduate student mentors.

In the past two years, $566,000 in grant funding was awarded for fisheries ecology and conservation research. Many of these are in collaboration with DPNR to help build capacity in fisheries research, increase awareness of fisheries regulations, Strategic planning for MPA effectiveness and, my favorite, rebuild endangered Nassau grouper populations. Over the past 17 years, the abundance of mature adults visiting the only known spawning aggregation site in the US Caribbean and located in St. Thomas has increased from 50 fish in 2004 to 800 in 2022. Last month we saw for the first time Nassau grouper spawning at this site.

Next steps for Fish Ecology Research include, start Parrotfish diet and fecundity analysis in April 2022, integrate remote camera video footage of parrotfish spawning at each site with the ADCP echo sounder data to calculate reproductive output, and complete the historical data analysis for publication.

SYNOPSIS: Oceanography
Research Lead: Dr. Tyler Smith

The OC research theme is on schedule despite the departure of senior faculty leading this area, Dr. Sennai Habtes. Dr. Habtes is now the fisheries chief for the Division of Fish and Wildlife and the USVI Department of Planning and Natural Resources. He remains a participant through a courtesy appointment with UVI. His oversight role has been assumed by Dr. Tyler Smith, who is keeping the project on track to fulfill most of the strategic plan. Two major changes have occurred with the departure of Dr. Habtes. These include (1) a discontinuation of the effort to use vessels to conduct plankton tows to capture fish eggs at parrotfish, snapper, and grouper spawning sites and the use of National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA NMFS) USVI Coral Reef Ecosystem Reserve (CRER) database of larval *Scaridae* and *Sparisoma* abundance in modeling studies. However, we still plan to use alternate means (diver-based egg collection) to parameterize the connectivity model at parrotfish spawning sites; The second major change is the plan to sell the medium sized research vessel Derektor purchased in the previous NSF EPSCoR award and use the proceeds and money earmarked in R2R for vessel outfitting to purchase a medium range light oceanographic and research diving vessel capable of reaching all the USVI in a day's time. We believe that an efficient, smaller vessel with the capability to reach any corner of the USVI within a day will greatly increase our research capacity in oceanography and other marine research themes.

Other areas of OC research have been productive and on schedule with the strategic plan. Highlights include the finalization of the United States Caribbean Regional Ocean Model (USCROMS), with outputs from years 2019 and 2020 in hand, and the model published (Mukherjee et al. 2022, https://doi.org/10.1080/1755876X.2022.2059885). This model greatly improves on previous ocean models by providing a high-resolution model (330 m grid) that is expanded to cover the entire US Caribbean, including Puerto Rico. This model is being linked to the connectivity modeling system under the leadership of Dr. Daniel Holstein to conduct a variety of research questions. Together these models are a significant increase in the regional research infrastructure. A recent proposal to the US Office of Insular Affairs proposes to use the models to understand the transport of the nuisance floating seaweed *Sargassum*. Further, new capabilities have been explored with an effort to acquire ocean gliders for upper ocean oceanographic profiling through a proposal to the Major Research Instrumentation program at NSF.

Major Accomplishments and Research Findings: Oceanography

Goal OC1: *Quantify the influence of oceanographic and environmental variables on the variability in reproductive rates (frequency of spawning and fecundity) of* S. rubripinnis.

Goal OC1 and its associated objectives are currently in progress or completed for Year 2. Four current, wave, and particle tracking equipment (Nortek Signature 1000 Acoustic Doppler Current Profiler - ADCP) have been purchased. Two will be used in the reef restoration ecology research area and two are being used in parrotfish spawning research. Two ADCP's were deployed at the Reef Bay study site in January 2022 after participants Vanessa McKague (oceanographic technician) and Kayla Blincow-Israel (marine tracking post-doctoral associate) worked with the manufacturer to learn the proper setup of the equipment. They are currently analyzing the first set of retrieved data and working with the manufacturer to determine if the equipment can be used to track parrotfish egg plumes as intended. Parrotfish (*Sparisoma rubripinne*) eggs may be just below the size capable of being tracked by the instrument. A second trial was conducted April 6-14, 2022. The team is also using remote camera technologies to capture parrotfish spawning and estimate egg densities. Other data to be compared to parrotfish spawning dynamics (temperature, currents, waves, terrestrial influences) are being synthesized. A graduate student (Taylor Hobbs) and undergraduate student (Tara Thompson) have been recruited to work with parrotfish eggs when they are collected and to review the parrotfish spawning videos to develop spawning metrics (fish abundance, spawning frequency), respectively. In May and June of 2022, the collection of eggs will be attempted with divers in situ in lieu of plankton tows that were to be conducted under the leadership of Dr. Habtes.

Goal OC2: Determine larval dispersal pathways from point-source spawning aggregation sites of S. rubripinne.

A particular highlight (cross-linked to the Marine Resilience research theme) was the finalization of the US Caribbean Regional Ocean Model, with outputs from the years 2019 and 2020 in hand, and the model published (Mukherjee et al. 2022, https://doi.org/10.1080/1755876X.2022.2059885). This model greatly improves on previous ocean models by providing a high-resolution model (330 m grid) that is expanded to cover the entire US Caribbean, including Puerto Rico. This model will be used to describe cross-shelf patterns in oceanographic variables, with another manuscript in preparation of the tidal generation of internal waves in the US Caribbean. The model will also feed into external drivers in the coral reefs resilience study of the Marine Resilience research theme. The model will also be linked to the Connectivity Modeling System (CMS) under the leadership of Dr. Daniel Holstein at Louisiana State University, and a courtesy appointment at UVI. Previous work with Dr. Holstein as a postdoctoral associate at UVI under the prior NSF EPSCoR award recently resulted in the related publication Holstein DM, Smith TB, van Hooidonk R, Paris CB (2022) Predicting coral metapopulation decline in a changing thermal environment. *Coral Reefs* https://doi.org/10.1007/s00338-022-02252-9. USCROMS outputs from 2019 and 2020 have been transferred to Dr. Holstein. The higher-resolution CMS linked to USCROMS will be used to investigate USVI connectivity networks and their relationship to coral reef biodiversity patterns (see Marine Resilience section) and dispersal patterns of larvae from parrotfish, snapper, and grouper spawning sites (link for Fish Ecology research theme). A proposal was submitted (Jobsis and Wilson) in March 2022 to the Office of Insular Affairs “Development of Strategies for Sargassum Mitigation in the US Virgin Islands Using Oceanographic Methods and Modeling” that would partially support Dr. Mukherjee if funded.

Goal OC3: Share USVI Oceanography Research with Stakeholders & Provide Opportunities for New Partnerships.

Outreach to stakeholders has been completed with a forthcoming blog post regarding the oceanography program. A presentation at the annual VI-EPSCoR conference (R. Nemeth) introduced the concept of using various technologies (remote video camera, AWAC) to document reproductive output at yellowtail parrotfish spawning aggregation sites. Dr. T. Smith contributed to the April 2022 EPSCoR newsletter with a segment “Oceanography”. Participation in STEM Faculty Support, Resilience Leaders, and Service Learning Program activities has been delayed because limited activities due to COVID-19.

Given the lack of focused leadership in the oceanography program that would support vessel-based coastal and blue water research and the lack of a clear stream of funding to support the medium-sized RV Derektor it was decided to sell the vessel. The proceeds and some of the funds in R2R earmarked to outfit the vessel would be used to purchase a smaller research vessel with a faster cruising speed. This vessel would put the entire USVI waters in a days range, support diving operations as the core of marine R2R activities, and other light oceanographic projects.

In a new area of development, the US Navy, Rutgers University, the Ocean and Coastal Observing Virgin Islands organization, and UVI have been successful in launching ocean gliders for the study of ocean heat content in relation to hurricane formation from 2019. This success led to a proposal (Wilson and Jobsis) to National Science Foundation Major Research Instrumentation Program in January 2021 “MRI:Acquisition of Ocean Gliders for Marine Science Research Support at the University of the Virgin Islands”. This would allow UVI to purchase and maintain two ocean gliders that could measure a suite of ocean variables throughout the US Caribbean and would be a boon for data collection that would feed into the Oceanography research theme. Two Undergraduate students recruited by Doug Wilson via lecturing in MSC 239 have participated in joint UVI-OCOVI-Rutgers University Ocean glider field activities; both have applied to the Rutgers summer 2022 Glider Camp.

Professional development has been completed by postdoctoral associate Dr. Mukherjee, who presented the USCROMS model (Mukherjee S, Wilson D, Habtes S, Jobsis P, Smith TB. “The impact of submesoscale turbulence and internal tides on the US Caribbean ocean circulation: A modeling study” at the 2022 Ocean Sciences Meeting, March 3, 2022). In addition, Doug Wilson was a Session Co-chair in Session OT17 Ocean Observation for the Small Island Developing State (SIDS) and presenter The Need for Innovative Ocean Observing Tools for Small Island Developing States. Archived Presentation, 2022 Ocean Sciences Meeting, March 2022

SYNOPSIS: Coral Disease & Restoration
Research Lead: Dr. Marilyn Brandt

The MD/MR research theme has been very successful in reaching or exceeding milestones. Under the Disease section we have completed the goal of determining how species biodiversity affects the spread and impact of coral disease through the completion and publication of a Master of Marine and Environmental Science (MMES) program capstone proj-

ect (Costa et al. 2021) and the completion and publication of the collation of disease data from the Territorial Coral Reef Monitoring Program (Brandt et al. 2021). These publications and associated datasets also contain the species assemblage maps needed for the goal of predicting the spread and impact of multi-species coral disease. The goal of determining how local (e.g., nutrients, turbidity) and global (e.g., temperature stress) stressors drive disease dynamics has also gotten a jump start. The publication of Meiling et al. (2020) documents disease dynamics through a thermal stress event. In addition, Research Theme lead Dr. Marilyn Brandt and collaborator Dr. Amy Apprill (Woods Hole Oceanographic Institution) received funding from the Virgin Islands Water Resources Institute to sample diseased *acroporid* corals and examine them in relationship to water quality at seven sites across the northern U.S. Virgin Islands. The project was completed as the focus of MMES student Natasha Bestrom's thesis project, who sampled with Dr. Brandt in the field and then was hosted in Dr. Apprill's laboratory to process microbial samples. The project is ongoing and awaiting microbial sequences for analysis and results will inform future disease and water quality studies under this goal. Under the Restoration area, we have also been very successful in accomplishing our objectives either on or ahead of schedule. We have achieved the goal of expanding capacity for restoration ecology research in the U.S. Virgin Islands through the hiring of Restoration Ecology expert Dr. Robin Smith. In addition, the coral restoration staff have increased with the hiring of three additional personnel through funding by the National Park Service. We have also implemented ahead of schedule a study to determine how coral diversity affects the success of coral outplanting. All work in the Coral Disease and Restoration section has involved graduate and undergraduate students. In Year 2, six graduate and four undergraduate student interns were trained in coral restoration techniques. Additionally, four graduate and four undergraduate students participated in coral disease transmission experiments. The Disease and Restoration group has also been actively involved in outreach and education efforts, including maintaining and updating the vicoraldisease.org and vireefresponse.org websites and maintaining a social media presence for VI Reef Response. In Year 2, six manuscripts in addition to those mentioned above were published in peer-reviewed journals including in the journals *Ecography, Communications Biology, and Environmental Microbiology. Presentations* on disease and restoration were given at two local workshops, and one international conference. A $2.5 million grant to study multi-species coral disease transmission was also awarded to Dr. Brandt by the NSF Ecology and Evolution of Infectious Disease Program.

Major Accomplishments and Research Findings
Coral Disease & Restoration

Goal MD1: *Determine how species biodiversity affects the spread and impact of coral disease.*

Three main papers were published addressing this goal. In Brandt et al. (2021), data from the Territorial Coral Reef Monitoring Program (TCRMP), along with citizen science data were used to document the initial spread and impact of stony coral tissue loss disease (SCTLD) in its first year and half in the U.S. Virgin Islands. In this paper, patterns in species susceptibility to the disease were documented and compared with other regional reports. While species susceptibility was found to be similar to other regions in the Caribbean, we were also able to identify susceptibility for species for which previously there was not enough data, including for *Agaricia* and *Madracis spp*., and *Porites astreoides*.

The second paper more specifically tested the relationship between species diversity and disease. The 2020 MMES program capstone project used data from the National Coral Reef Monitoring Program (NCRMP) taken before the emergence of SCTLD to select sites to resurvey. The first-year graduate students then repeated NCRMP methods at these sites and analyzed data to determine if diversity impacted disease prevalence or impact. They found and published in Costa et al. (2021) that more species-diverse reefs had a higher prevalence of SCTLD and showed larger impacts from SCTLD, including greater losses of diversity. This was the second MMES cohort to publish their capstone findings in a peer-reviewed journal.

The third paper came from an experiment testing SCTLD disease transmission among multiple species. Funding for this experiment came from VI EPSCoR and from an NSF RAPID grant to UVI with collaborating institutions including Woods Hole Oceanographic Institution, Louisiana State University, Rice University, University of Texas at Arlington, and Mote Marine Laboratory. VI-EPSCoR-funded Marine Disease Specialist Sonora Meiling (an alumna of MMES) led the analysis and coordination of resulting experimental data which resulted in a publication (Meiling et al. 2021). Results demonstrated that there was an overall similarity in disease prevalence among species when they were equally exposed to disease. This contrasts with field results in Brandt et al. (2021) which showed different disease prevalence among the same species. Histology confirmed SCTLD in the experimental corals; therefore, the discrepancy between lab and field results suggests something is causing there to be unequal exposure among species in the natural environment. We are pursuing this interesting difference with further research. Multiple additional papers resulting from the analysis of the microbial communities, the histopathology, and the gene expression of the corals in this experiment are forthcoming.

Goal MD2: *Determine how local stressors (e.g., nutrients, turbidity) and global stressors (e.g., temperature stress) drive temporal and spatial distributions of disease.*

MD/MR lead M. Brandt received a grant in collaboration with Amy Apprill from Woods Hole Oceanographic Institution from the Water Resources Research Institute (WRRI). The grant is investigating water quality and disease patterns, though it is focused on elkhorn coral and white pox disease (not SCTLD). The WRRI grant supports MMES student Natasha Bestrom to sample diseased and healthy *Acropora palmata* colonies at sites where EPSCoR water quality sampling has been ongoing over this past year. Ms. Bestrom traveled to Amy Apprill's lab at Woods Hole in the fall of 2021 and again in the spring of 2022 to perform microbial analysis of the samples.

Water quality sampling occurred at 11 sites around St. Thomas and St. John for 3 consecutive months in the fall (wet season) and again in the spring (dry season). This sampling consisted of collecting water samples for nutrient and fecal coliform analysis. Results are currently being analyzed as a focus of Ms. Bestrom's and Ms. Lindsay Dade's Master's thesis projects.

Goal MD3: *Predict the spread and impact of multi-species coral disease.*

Objectives in this area include developing a connectivity-based disease spread model with Dan Holstein's laboratory at Louisiana State University. Initial work on this has begun with his student experimenting with a pathogen dispersal model using the local ROMS model developed by VI-EPSCoR post-doc S. Mukherjee.

All of this work laid the foundation for a successful proposal to the NSF Ecology and Evolution of Infectious Disease program. The project is led by M. Brandt and was the highest ranked marine proposal and funded at $2.5 million. Collaborators include Amy Apprill at Woods Hole Oceanographic Institution, Dan Holstein at Louisiana State University, Adrienne Correa at Rice University, and Laura Mydlarz at the University of Texas at Arlington. Critical to this project will be the work of the oceanographic modeling component of VI EPSCoR as discussed above.

Goal MD4: *Share Disease Research with Stakeholders through participation in outreach and education activities.*

Theme lead M. Brandt maintains and contributes to the vicoraldisease.org website - the website that the territory uses to provide information on SCTLD in the U.S. Virgin Islands. Dr. Brandt and Marine Disease Specialist S. Meiling are also members of the Virgin Islands Coral Disease Advisory Committee (VI-CDAC). Dr. Brandt leads the Research sub team and is an Executive Team member of VI-CDAC. S. Meiling helps to lead the Research and Data Management sub teams.

M. Brandt, S. Meiling, and students presented information on disease in several venues, including the Gulf and Caribbean Fisheries Institute meeting, the U.S. Coral Reef Task Force SCTLD Surveillance in the Indo-Pacific Virtual Workshop, and the U.S. Caribbean Regional SCLTD Workshop.

Goal MR1: *Expand capacity for restoration ecology research in the US Virgin Islands.*

In the fall of 2021, Dr. Robin Smith joined the research faculty as a Research Assistant Professor of Restoration Ecology. In addition, through the awarding of a contract from the National Park Service to M. Brandt, Coral Restoration Specialist Bradley Arrington (an MMES alumnus) and Coral Aquarist Specialist Rachel Ionata were hired to support coral restoration activities.

Goal MR2: *Determine how diversity affects success of coral outplanting.*

A multi-species outplanting experiment was deployed at Perseverance Bay in January 2022 to test the effect of diversity on coral outplanting success. The experiment will look at the growth and mortality of *Acropora cervicornis* when outplanted with and without two other coral species, one of which is a known alternative prey for a common *Acropora spp.* predator and the other is thought to be a possible sink for a known *Acropora spp.* disease pathogen.

Goal MR3: *Determine how gradients in water quality affect success of coral outplanting.*

Experiments are planned to start in Year 3 and ongoing water quality sampling explained above will contribute to this goal.

Goal MR4: *Share Restoration Research with Stakeholders through participation in outreach and education activities.*

The VI Reef Response program - the umbrella name for our coral restoration work - developed a new partnership with the Lovango Resort and Beach Club which includes the installation of a new rebar table nursery that spells LOVANGO. The collaborative project is called the Lovango Rescue to Reef project and targets three aspects of restoration with corresponding "zones" located off of Lovango Cay. The "Rescue" zone is the site of the new rebar nursery. Due to its location between St. Thomas and St. John this Lovango nursery will provide outplants for both islands. The "Research" zone is where we are performing the multi-species experiment, and the "Restored" zone is where we are focusing intensive restoration efforts and have had more than 90% survival of outplants.

Another aspect of this project providing significant broader impacts includes erecting signage on Lovango Cay that provides information on restoration to the public. There are three signs corresponding to the three zones and content of these signs includes contributions from graduate student interns, and they were designed by EPSCoR's Communications Specialist Elisa Bryan, with artwork contributed by EPSCoR's Community Engagement Specialist Jarvon Stout. These signs have all just arrived and will be installed on the island in the summer of 2022.

The work of VI Reef Response, and particularly the land-based nursery, provides excellent opportunities for training in research. Coral Restoration and Communications Specialist D. Mele collaborated with Dr. Michele Guannel to provide opportunities for undergraduate project-based learning. In addition, 6 graduate and 5 undergraduate interns were trained on coral restoration techniques over the last year. VI Reef Response also has a very active social media presence where we highlight student involvement in research and M. Brandt's lab hosts the website vireefresponse.org which contains information on our restoration operations.

SYNOPSIS: Coral Reef Resilience
Research Lead: Dr. Tyler Smith

The CR research theme is largely on schedule despite limitations of the COVID-19 pandemic. Progress has been made in the study of resilience drivers on USVI coral reefs, larval connectivity's influence on marine biodiversity patterns, and outreach to the wider community. The marine resilience drivers study is broken into numerous subgroups working on databases of individual internal and external drivers. These drivers will become part of the larger analysis to be conducted on how drivers interact to influence the resistance and recovery of coral reefs following thermal disturbance (bleaching and mortality). Most of the individual studies of drivers will also have independent research outputs and the compiled databases have resulted in one peer-reviewed publication published, one publication in revision, and five manuscripts currently in preparation, with at least another four that will be developed from the data sets. A particular highlight (cross linked to the Oceanography research theme) was the finalization of the US Caribbean Regional Ocean Model, with outputs from years 2019 and 2020 in hand, and the model published (Mukherjee et al. 2022, https://doi.org/10.1080/1755876X.2022.2059885). This model greatly improves on previous ocean models by providing a high resolution model (330 m grid) that is expanded to cover the entire US Caribbean, including Puerto Rico. The Marine Resilience research theme has engaged five underrepresented minorities through participation of Masters students in research. The resilience theme is synthesizing data collected from numerous EPSCoR and non-EPSCoR activities in ways that can be used by future researchers as part of the data infrastructure of the USVI. For example, data layers of physical and biological conditions at long-term monitoring sites make these areas very attractive for the setting of research, leveraging data to inform other experiments. Economic benefits include assisting coral reef resource management by determining key management steps that can increase reef resilience. Progress made in the CR research theme can be leveraged to pursue external funding and increase our data and intellectual infrastructure.

Major Accomplishments and Research Findings: Coral Reef Resilience

Goal CR1: *Determine the internal and external drivers most critical to coral reef ecosystem resilience in the USVI and identify targets for restoration of resilience.*

The CR research theme is largely on schedule for Year 2 and some progress has been made on all of the individual objectives. Databases of internal and external drivers have been constructed for most variables. External driver databases have been constructed and QA/QCed for temperature regimes, wave regimes, and water quality regimes. A manuscript is in revision for water quality regimes [Adem K, *Flanagan D, Brandt ME, Ortiz J, Smith TB (in revision) Semi-analytical inversion modeling of Chlorophyll variability in the U.S. Virgin Islands. PLoS ONE]. A manuscript is in preparation on storm

wave impacts on coral reefs using outputs from the Simulation of Waves Nearshore Model. External driver databases have not been completed for the current regimes at the long-term monitoring sites. However, the US Caribbean Regional Ocean Model (USCROMS) has been completed and published (Mukherjee et al. 2022. Journal of Operational Oceanography doi.org/10.1080/1755876X.2022.2059885). Model runs have been completed for the years 2019 and 2020 and these can be used to extract current regime data for the long-term monitoring sites. Internal driver databases have been constructed for coral species and attribute diversity, marine disease, nuisance species, non-coral invertebrates, fish diversity, herbivory/herbivores, coral health, and coral interactions. Manuscripts and theses are being prepared from synthesized data on herbivores and coral interactions. Internal driver databases have not been completed for connectivity matrices (see Goal CR2).

Goal CR2: *Understand the impact of regional larval connectivity patterns on biodiversity patterns.*

The connectivity model is under development by Dr. Daniel Holstein at Louisiana State University. Internal driver databases have not been completed for connectivity matrices as the connectivity model was waiting for finalization of the USCROMS and model runs. With that now completed the connectivity model is currently being created and the matrices should be forthcoming. Database of coral reef biodiversity at >1000 coral reef sites has been compiled from the National Coral Reef Monitoring Program, Deep Coral Reef Monitoring Program, and the Territorial Coral Reef Monitoring Program administered by UVI, DPNR, and NOAA. This database will be used with the finalized connectivity model to text hypotheses concerning the influence of larval connectivity on biodiversity patterns.

Goal CR3: *Share Coral Reef Resilience Research with Stakeholders through participation in outreach and education activities.*

CR material has been contributed to EPSCoR promotions, bi-annual newsletters and the website viepscor.org.

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							*
		Temerature							Manuscript: x-shelf thermal regimes
		Waves							Manuscript: hurricane disturbances
		Currents							Manuscript: hurricane disturbances
		Water Quality							Manuscript: remote sensing and coral health
		Disease							Manuscript: multiple published/in prep
		Management							*
		Connectivity							Manuscript: multiple
	Internal	Coral Health							Manuscript: multiple, thermal stress/disease
		Nuisance species							Manuscript: multiple published/in prep
		Biodiversity - Invertebrates							*
		Biodiversity-Fishes							Manuscript: x-shelf community diversity
		Herbivory							Manuscript: MMES capstone
		Coral Interactions							Manuscript: Masters thesis
		Biodiversity-Coral							*
CR2		Coral Abundance							*
		Connectivity Model							Manuscript on Biodiversity-Connectivity
		Biodiversity Database							
CR3		Outreach							

SYNOPSIS: Education and Workforce Development (EWFD)
Research Lead: Dr. Lawanda Cummings

The Virgin Islands Institute for STEM Education Research and Practice (VI-ISERP) is tasked with building structures of change for improving the STEM Workforce pathways through 1) Teacher Professional Development, 2) Undergraduate Enrichment and Mentoring, and 3) Early-Career Support for STEM professionals. In the 2nd year of R2R, the EWFD team met all but one of our specified goals and objectives despite limitations to in-person activities due to COVID-19 restrictions.

The Teacher PD component planned and hosted the 2021 STEM Institute, serving 89 local teachers. The virtual intensive training was done in partnership with the Knowles Teacher Initiative and Dr. Dara Hamilton, a clinical psychologist at UVI. During the academic year, STEM Institute facilitated 6 pedagogy focused events (3 virtual and 3 in-person) spanning skills in Math language use, distance learning pedagogy, Science, Technology, Engineering, the Arts and Mathematics (STEAM) educational strategies (integration of art), and experiential science learning strategies from home. In partnership with Microsoft, Subsume, and Code.org; four *TechKnowledge for Teacher* events were facilitated to train teachers in coding skills applicable across the curricula. We funded 2 computer science undergraduate students that provide event day support to teachers through Dr. Boumedine (chair of computer science department). VI-ISERP, in partnership with Ms. Yolanda Payne of Georgia Tech, launched the Computer Science Teacher Association United States Virgin Islands (CSTA-USVI) chapter, through the Computer Science Teacher Association with 40 teacher members. In response to a needs assessment in Year 1, the Teacher Talk Fridays support group was formulated. The Teacher PD program has been actively disseminating research results through 5 research conference presentations including AERA, NASEM, CREA and the Mindsets for STEM conference. The team received the Caribbean and African Studies in Education Sig Outstanding Research Paper Award at AERA, on April 22, 2022. We hired two master teachers and a doctoral student researcher after losing both undergraduate student workers due to COVID-19 requirements.

The Mentoring and Research Infrastructure (MRI) component developed a constellation of student and early-career support to cultivate a research culture at UVI. The MRI team completed 2 faculty mentoring trainings with ECS and developed partnerships for faculty mentoring development for the U-RISE proposal and the EPSCoR RII BEC proposal. The Professional Development for Emerging Educational Researchers (PEER) Field school, through Rochester Institute of Technology (NSF BSCER), facilitated 2 virtual and 1 in-person event. The in-person-day intensive field school awarded 35 certificates to participants. Several graduate students, faculty, and staff participate in the Voices of Women in STEM (VOWS) writing group through a sub-award from Jackson State University's NSF ADVANCE grant with 16 participants. This group has maintained noted accomplishments with 1 completed grant proposal, 1 published article, 4 accepted publications, and various projects in process. The Student Support Network has sent out invitations to identify stakeholders for an initial meeting in May 2022. The MRI team has actively been disseminating program findings with 7 research conference presentations, 1 video for the STEM for ALL showcase, and has 2 papers accepted to an edited volume. MRI hosted for NASEM the "University of the Virgin Islands Virtual Town Hall: Successes in STEM Education, Research, and Workforce Preparedness", showcasing 7 VI-EPSCoR initiatives in November 2021. MRI completed the mini-grant call for proposals, review, and selection process with a graduate student and faculty member recipient. The VI-ISERP team has launched a presence on social media (Facebook, LinkedIn, Twitter, and Instagram) and the Slack network to build a virtual community during COVID-19. Platform analytics were analyzed and shared in the reverse site visit.

Major Accomplishments and Research Findings: Education and Workforce Development

Goal WF1. *To integrate resilience research themes (i.e. mangrove restoration, coral reef ecosystems, and land-sea interactions) into teacher professional development to improve K-12 student preparation.*

Objective WF1.1: *To build STEM community dedicated to developing and implementing research-based best practices in teacher development practices and in student learning using environmental resilience research within the local context.*

The STEM Institute met with the Virgin Islands Department of Education (VIDE) and R2R researchers and coordinated a needs assessment for the 2021 Summer Institute. Due to COVID-19 limitations, the 2021 summer session was virtual with a continued partnership with the Knowles Teacher Initiative. The STEM Institute was attended by 89 teachers from both St. Thomas and St. Croix. In response to teachers' identified psychological needs, a partnership with Dr. Dara Hamilton, a clinical psychologist in the Social Sciences department, was developed to provide mental health support and training. The

VI-ISERP Project Based Learning (PBL) certificate program recruited 3 R2R/UVI research faculty representing curricula expertise in mangrove restoration, coral reefs, and agriculture. Seven teachers were enrolled in the researcher-teacher partnerships. Due to increased responsibilities based on COVID-19 district requirements, the initial cohort experienced 42% attrition rate. Remaining teacher-researcher pairings will begin curricula review during the STEM Institute. The director for STEM Institute facilitated 10 Teacher Talk Fridays with local teachers to address identified needs from COVID-19 in technology, teacher-student wellness, and distance learning pedagogy. The Teacher PD team facilitated 6 pedagogy focused sessions for math, science, technology, and art integration across the curricula. The Teacher PD program had been actively disseminating research results through 5 research conference presentations including the AERA, the NASEM, CREA and the Mindsets for STEM conference. The team received the Caribbean and African Studies in Education Sig Outstanding Research Paper Award at AERA, on April 22, 2022.

Objective WF1.2: *To build long-lasting STEM community partnerships for increase sustainability of the VI-ISERP center.*

To hone skills in developing long-lasting STEM community partnerships, the team participated in training facilitated through the Center for Advancement of Informal Science Education (NSF-CAISE) in grant development and educational advocacy. The team also applied and was selected to participate in the The Center for the Advancement of STEM Leadership (NSF-CASL) pre-conference training, hosted through CREA, for NSF grant proposal development. VI-ISERP has submitted a grant in partnership with Dr. Grimes' lab for the NSF RII-BEC for bridge funding for graduating students in STEM career sites and another with the Emerging Caribbean Scientists National Institutes of Health (NIH) U-RISE to train faculty mentors. The VI-ISERP team has increased our partnership network with corporate businesses. In partnership with Microsoft and Subsume, VI-ISERP facilitated 4 computer science education events entitled, Teacher TechKnowledge, to promote computer science teaching skills and integration across the curricula. With facilitation with Yolanda Payne of Georgia Tech, we have launched partnerships with code.org ARMS/Micro:bit, Infosys, and established a Computer Science Teacher Association US Virgin Islands (CSTA-USVI) chapter through the Computer Science Teacher Association and the UVI Computer Science department (Marc Boumedine). We are the 100th Chapter and seek to address the lack of computer science-teachers in the USVI. This partner-supported initiative is showcased in the Teacher PD submission to the NSF STEM for ALL video showcase on May 10-17th, 2022. Two master teachers have been hired for St. Thomas and St. Croix to assist in local partnership development and a VI-ISERP newsletter template has been developed for distribution in July 2022 to our stakeholder network.

Goal WF3: *To support student/ faculty research infrastructure via support for pre and in-service STEM workforce, with the goal to increase STEM career interest, skills, and retention.*

Objective WF3.1: *To develop mechanisms of support and development for STEM students (undergraduate and graduate) for career skill development, research productivity, and retention.*

Objective WF3.2: *To develop mechanisms of support and development for early-career STEM faculty for career skill development, research productivity, and retention.*

The VI-ISERP Mentoring, and Research Infrastructure component have developed intra and inter intuitional support for STEM students. The MRI team completed 2 faculty mentoring training courses with ECS and developed partnerships for faculty mentoring development for U-RISE proposal and the RII BEC proposal. Training of faculty (2 sessions) has been completed for IDP/compact use with undergraduate STEM students. The use of IDPs was done with ECS students during summer 202 with student training in goal setting and orientation. No end-of-year assessments were administered to students due to COVID-19 shifts in academic offerings and format. Regarding our undergraduate practicum, the COVID-19 shifts have limited local schools' capacity to engage in novel partnerships and placement of students. VI-ISERP teachers and administrators will be approached during the STEM institute for the development of practicum sites for Fall 2022.

Instead of a formal launch of Professional Development Plans (PDP), MRI focused on mentoring graduate students in educational research pursuits. The Professional-development for Emerging Education Researchers (PEER) Field school, through Rochester Institute of Technology (NSF BSCER), facilitated 2 virtual and 1 in-person event. The in-person 5-day intensive field school awarded 35 certificates to graduate students, faculty, and staff participants. Several graduate students, faculty, and staff participate in the Voices of Women in STEM (VOWS) writing group. This program was launched through a sub-award from Jackson State University's NSF ADVANCE grant with an initial 16 participants. This research support group has maintained through 2 semesters with noted accomplishments with 1 completed grant proposal, 1 published article, 4 accepted publications, and various projects in process. This support group is showcased in the MRI submission to the NSF STEM for All video showcase on May 10-17th, 2022. The Student Support Network has sent out invitations to identified stakeholders for an initial meeting in May 2022. The MRI team has met with the Dean of Innovation to collaborate on committee facilitation.

The VI-ISERP team has launched presence on social media (Facebook, LinkedIn, Twitter, and Instagram) and the Slack network to build a virtual community during COVID-19. Platform analytics were analyzed and shared in the reverse site visit. The VI-ISERP Website is scheduled for launch on May 15th as a consistent space for center activities and resources. The VI-ISERP Educational Research Mini-Grants were launched with a call for proposals. A review committee was formed with an R2R researcher, UVI faculty, and team members. Mini-grant applications have been reviewed and awarded to 1 graduate student and 1 faculty member at UVI.

The MRI team used the Slack Network Listserv to share research opportunities, celebrate member successes, and broaden UVI participants' access to the research community through the PEER field school network. VI-ISERP has facilitated a NASEM town hall meeting showcasing UVI initiatives entitled "University of the Virgin Islands Virtual Town Hall: Successes in STEM Education, Research, and Workforce Preparedness." VI-EPSCoR contributed seven (7) presentations with closing remarks from Director, Kim Waddell, Ph.D., showcasing the impact of this on UVI and the surrounding community. Two researchers (Dr. Guannel and Dr. Cummings) and 2 UVI undergraduate students have since been presenters for NASEM forums on STEM success. The MRI team has actively been disseminating program findings with 7 research conference presentations, 1 video for the STEM for ALL showcase, and 2 papers accepted to an edited volume.

SYNOPSIS: Education and Workforce Development Undergraduate Education Research Project
Research Lead: Dr. Michele Guannel

The Undergraduate Education Research project is led by Dr. Michele Guannel. It includes Social Science 100 Instructor Dr. Molly Perry, Science 100 Instructor Dr. Michelle Peterson, and Social Sciences Department Chair Dr. Elizabeth Jaeger, each of whom began research efforts in Summer 2021. During Year 2, changes in personnel availability included the departure from UVI of Social Science 100 Instructor Ms. Nisha Clavier from the St. Croix campus and the continuation of Dr. Michelle Peterson in the Interim Dean role which limited her availability to implement active learning projects in Science 100 on St. Croix. A Community Engagement Fellow position began in Year 2 to support SCI 100 and SSC 100 students in planning, conducting, and reflecting upon their projects, and to facilitate integration of the resilience-themed experiential learning projects across these two freshman-year courses. The two fellows, one a MMES graduate student (Madyson Miller, advised by Dr. Cruz-Rivera) and the other a community member with experience in community-based learning Lucy Hutcheson), worked closely with students to design and implement projects in both SCI 100 and SSC 100. Dr. Kendell Daughtry, Visiting Assistant Professor on the St. Croix campus, engaged with the team in Spring 2022 around discovery-based learning that he implemented in one class of SSC 100 students.

In total, eleven UVI undergraduate students and four Masters of Marine and Environmental (MMES) students were supervised by Dr. Michele Guannel as (undergraduate) Peer Instructors or (graduate-level) Teaching Assistants/Lab Instructors. VI-EPSCoR funding was utilized for student research and community engagement positions - with two undergraduate students supported as Service Learning Coordinators, including Ms. Deanna Hunt (who has held this position since Spring 2020) and now in Spring 2022, bringing to the team, Ms. Kahlifah Powell (undergraduate researcher with Dr. Brandt's lab). Within UVI, the team expanded its working relationship with the Center for Student Success, partnering with Ms. Julie Cruz and the Dean of Innovation and Student Success, Dr. Moolenaar-Wirsiy, to consider the structure and tracking options for Resilience Leaders program development, and for students to continue community-engaged learning past the first-year experience with additional research experiences and internships.

Service Learning / Resilience-Themed Experiential Learning (RTEL) Highlights
RTEL projects were completed by a total of 33 students in SCI 100 and SSC 100, on both campuses of UVI. This number of freshman-level UVI students engaged in the Project Track in 2021-22 (33) is nearly twice the number engaged in the prior academic year 2020-21 (18 students). This increase represents substantial progress towards Objective WF2.1, to double the number of first-year students participating in STEM and resilience-themed experiential learning opportunities that promote an interest and affinity for STEM, from 10% (Year 1) to at least 20% (Years 2-5) of student enrollment across the two courses.

Resilience Leaders Highlights
During Year 2, nine current or former UVI students were co-authors, gave individual presentations, or collaborated on an accepted abstract– including one published book chapter, one peer-reviewed conference paper, three invited presentations, and one conference workshop. Included in this number are a total of five UVI students have been selected as co-authors on a peer-reviewed book chapter on student-centered learning (chapter due August 2020). Dr. Guannel submitted a proposal under the Building STEM Capacity in Education Research (BCSER) call, entitled "Application of Systems Thinking and Transdisciplinary Learning to Strengthen Retention and Preparation for a Resilience-Focused Workforce in the United States Virgin Islands" requesting $349,975 total funding for assessment of a Resilience Leaders

pathway in collaboration with Islands Systems Resilience courses and internships (centered in the Physics department). If funded, the BCSER grant would provide anthropological and social science methods professional development to Dr. Guannel, and it would fund a Research Assistantship for over two years, to replace the Community Engagement Fellow position.

Major Accomplishments and Research Findings: Undergraduate Education Research Project

Goal WF2: *Increase recruitment, retention, and persistence of URM undergraduates in STEM and resilience-related majors, minors, and certificate programs.*

Team members continued to build student-centered RTEL interventions into the First-Year curriculum of Science 100 (SCI 100) and Social Science 100 (SSC 100). These RTEL interventions, referred hereafter as the "Project Track" represent an alternative to the "Traditional Track," which constitutes a research paper for SCI 100, or a proposal for SSC 100. The two tracks for first-year students will enable us to explore two overarching research questions: "(1) How can high impact educational practices enhance student leadership and (2) elevate their lived experiences to address 'wicked problems' in the Caribbean?" The Undergraduate Education Research Project reports successfully achieving key goals while responding to the emerging challenges of the COVID-19 pandemic and its impact on the University of the Virgin Islands and the broader Virgin Islands community. Working across the two courses of SCI 100 and SSC 100 and across the two campuses of St. Thomas Orville E. Kean and St. Croix Albert E. Sheen, faculty members and undergraduate students created and implemented how RTEL interventions can increase student engagement. The primary creation of complementary student learning outcomes, and comprehensive assessment of recent RTEL interventions, will occur during Summer 2022.

WF2.1a: Develop and implement service learning (SL) within freshman-level courses (SCI 100 & SSC 100)

Despite the myriad challenges to community-based learning throughout the COVID-19 pandemic, the SCI 100/SSC 100 approach supports student-centered topic selection and project creation, therefore transforming two courses that are responsive in real-time to emerging issues and disasters. The resulting projects, then, have naturally varied over time with students pursuing a wide range of different forms of the Project Track. The RTEL Project Track includes the initial vision of service-learning and expands into new formats. In 2021-22, for example, the Project Track has included traditional service learning, course-based undergraduate research experiences (CUREs), and community-based learning (e.g., student creations of family educational discussions, public service announcements, and development of community events such as beach and mangrove cleanups). We have found that our students are best supported by a diversity of RTEL formats. Furthermore, different formats can permit synergistic alignment with their chosen majors and interdisciplinary student teams working on the same issue: for example, both Biology and Hospitality & Tourism Management students have worked with the lab of R2R Researcher, Dr. Marilyn Brandt, on coral micro fragmentation projects.

In the past year, the team has lost a major initial partner, the St Thomas Recovery Team (STRT), due to the dissolution of this non-profit organization (which is a common fate for grassroots-developed, volunteer-led organizations that are established in the wake of disaster). Community-based partnerships were integrated by students and instructors, into the Project Track, to support RTEL with governmental and non-governmental agencies and organizations spanning all three major Virgin Islands. Therefore, during Year 2, new partnerships represent the diversity of student-originated topics and emerging issues. For example, students followed the Project Track in collaboration with entities such as the Church of God (Holiness) Academy (St. Croix), an elder care organization on St. Thomas, the St. Croix Environmental Association, Gifft Hill School on St. John, and the Virgin Islands Department of Health. Research interdependencies emerged at UVI that will contribute to STEM pathways for students, including first-year experiences in the Brandt Lab and working with the UVI Campus Nurse and Health Services.

In AY 2021-2022, the Project Track was completed by a total of 33 students in SCI 100 and SSC 100, on both campuses of UVI. This number of freshman-level UVI students engaged in the Project Track in 2021-22 (33) is nearly twice the number engaged in the prior academic year 2020-21 (18 students). **This increase represents substantial progress towards Objective WF2.1, to double the number of first-year students participating in STEM and resilience-themed experiential learning opportunities that promote an interest and affinity for STEM, from 10% (Year 1) to at least 20% (Years 2-5) of student enrollment across the two courses.** Students have emerged from these courses expressing empowerment, as exemplified by the words of one SCI 100 student "I learned that anyone can help the coral reefs… and make a difference." As a SSC 100 student reflected, these community-based learning projects, "make you believe everyone in the class can change the world."

The team has been collaborating with the Center for Student Success (CSS) to share project ideas throughout the past academic year. We will now be working with CSS more actively to utilize the BucsConnect advising system to identify

participants in RETL interventions, starting from Spring 2018. This will enable tracking of students, through additional high-impact practices in other UVI courses, throughout their UVI careers, to gather data on the extent to which students take advantage of other high-impact practices after having completed RETL projects in the First-Year Experience.

The level of student engagement is a particular achievement given the ongoing COVID-19 pandemic and mixed instructional delivery methods of the courses across the two-year period (i.e., in-person, hybrid, and completely on-line). Enhanced student support was provided by two new student-level positions funded by VI-EPSCoR, in addition to the existing SCI 100 Service Learning Coordinator position held since Spring 2020 by Project Track alumna and undergraduate Computer Science student, Deanna Hunt. Namely, projects were supported by a new Community Engagement Fellow position, which was held by MMES student Madyson Miller in Fall 2021 (advised by R2R researcher Dr. Edwin Cruz-Rivera) and community member Lucy Hutcheson in Spring 2022 (a graduate of Warren Wilson College, which mandated service learning and work-based learning). We recruited and hired a Service Learning Coordinator to support SSC 100, senior Marine Biology student Kahlifah Powell. Ms. Powell has also been conducting research in the Brandt lab through AY 2021-2022 and acted as a bridge and advisor for both Project Track and Traditional Track students working on topics related to coral restoration.

In 2021-22, several of the projects spanned across SCI 100 into SSC 100, providing students with a year-long depth of engagement in their topics and experiences. By piloting the experiences across the required first-year courses, additional students were able to participate in one, if not both, semesters. Specifically, in Fall 2021, 20 undergraduate students engaged in active learning projects, with topics including coral micro fragmentation, COVID-19 awareness and impacts, mangrove restoration, water quality monitoring, natural hazard awareness, native plant restoration, climate change awareness, and public health. In Spring 2022, 13 undergraduate students engaged in active learning projects, with six in SCI 100 and seven in SSC 100. Topics included coral micro fragmentation, mangrove cleanup, COVID-19 awareness and impacts, improving cancer treatment in the Territory, and developing natural disaster education for elderly individuals.

WF2.1b: *Evaluate resilience-themed experiential learning on first year students' interest in and affinity for STEM.*

Year 2: Run two sets of focus groups:
1) Service learning participants (one focus group per semester & course; 2018-2021) and
2) Service partners (one focus group for each of SCI 100 & SSC 100) to gather data on outcomes and impacts to date.

This year, the team continued to pursue and accomplish major goals for Year 1 and 2 with forward progress on achieving goals slated for Year 3 on pursuing and securing additional grant funding as well as dissemination through presentation and publication of research findings. Notably, the dissemination by undergraduate Project Track alumni and undergraduate researchers served to clarify one major pathway of Resilience Leaders who reflect upon and share their experiences and research findings on RETL and other educational interventions, at the national level.

The ongoing COVID-19 pandemic created obstacles for planned data collection as the UVI Institutional Review Board (IRB) suspended in-person interviews and focus groups. In response, the team instead created and implemented surveys to gather feedback from students about their experiences in the Project Track compared to the Traditional Track (a research paper for SCI 100, or a proposal for SSC 100). Student survey feedback will be informative as we pursue IRB approval for in-person focus groups and similar data collection. Focus groups will be planned in the summer of Year 2, drawing from feedback and trends in final products of AY 2021-22. These data will include the role played by our newly created position of Community Engagement Fellow and our continued work piloting diversified research topics across SCI 100 and SSC 100 in response to student interest, their own lived experiences and community connections, and emerging 'wicked problems.'

To explore further the student experience of the Project Track since its first implementation in SCI 100 in Spring 2018, this year the team reached out and worked with past Project Track students to learn of their experiences and facilitate their critical reflections of what they accomplished during 2018, 2019, and semesters during the COVID-19 pandemic. We also pursued forums for Project Track students and undergraduate education research students to present their research on the lived experiences of UVI students, and the analysis of Project Track assignments and other educational interventions in the SCI 100 course, to regional and national conferences. We now view all students directly involved in conducting, researching, and mentoring the RTEL projects, as Resilience Leaders. Notably, these Resilience Leaders have been highlighted in diverse disseminations of their work, showing a refreshing student-centered, ground-up perspective.

The student-directed nature of these educational interventions has been acknowledged by leading organizations in STEM education and other scholars working in the field of student-directed learning. First, a cohort of Project Track alumni and EPSCoR-supported SCI 100 / SSC 100 Service Learning Coordinators will be co-authors on a chapter in a peer-reviewed book entitled *Breaching Hierarchy Students and Teachers Collaborating for Social Change*. The abstract written by the student and instructor team, entitled Student-directed service learning in the United States Virgin Islands: Resiliencing through disaster", was one of 14 submissions selected out of 43 internationally generated abstracts submitted to the book proposal. Second, also during Spring 2022, the National Academies of Sciences, Engineering, and Medicine (NASEM) invited two undergraduate students (George Francis and Deanna Hunt) and Dr. Guannel to present a total of four talks within three of four seminars on "Envisioning Undergraduate STEM Education in 2040." The final seminar featured graduating senior and service learning leader from the Spring 2018 semester, George Francis, as well as EPSCoR-supported SCI 100 Service Learning Coordinator Deanna Hunt, who followed the Project Track in Fall 2019 and has worked to support SCI 100 students in developing their projects from Spring 2020 to present. Moderators of the final NASEM seminar specifically referenced UVI SCI 100 service-learning responses to the 2017 hurricanes, Irma and Maria, as an exemplar for student-centered projects building STEM affinity and addressing community needs. A total of five students have taken the courses in their first year, served in other leadership roles across their UVI careers, and are now presenting talks and developing peer-reviewed educational research book chapter, therefore providing critical feedback from a student perspective on recruitment and design of SCI and SSC 100 courses.

Development of experiential learning in SCI 100 and SSC 100 revealed common themes that can serve as foundations for an integrated First-Year Experience grounded in high-impact practices. The Year 2 goal of establishing complementary learning outcomes and assessments across SCI 100 and SSC 100, builds upon the first full year of project development and implementation in both courses. During Summer 2022, the team will finalize student learning outcomes and assessments based on "lessons learned" during the first full year of implementation of RTEL in both SCI 100 and SSC 100 courses. Furthermore, our collaboration up to this point, structured through biweekly team meetings and smaller working group meetings, has revealed both common thematic overlap between the Natural and Social Sciences, as well as habits of mind critical to developing more engaged students (during their first year) and building further throughout their academic pathways as Resilience Leaders.

In Year 2 the team expanded to support these efforts. Through regular meetings and collaboration, the team included the voices and expertise of faculty members, staff, and undergraduate and graduate students. The centrality of students and recent graduates at these meetings has been informative to the process of creating a focus group methodology for IRB approval and data collection. Their work has also laid a strong groundwork for "resilience leader" as a UVI student researcher who is informed by their lived experiences and community engagement.

WF 2.2. The team will also provide 10% of sophomore and junior students with deeper, resilience-themed experiential learning opportunities that promote retention and persistence in a STEM major, minor or certificate program; and STEM-related career goals.

WF2.2a: Develop and implement a Resilience Leaders (RL) program.

Year 2: Recruit former SL participants for Cohort 1 of RL internships. Pursue selected option to institutionalize RL program at UVI

In Year 2, opportunities and collaborations have illuminated pathways for Resilience Leaders who have engaged in community-based learning throughout their UVI experience from Freshman to Senior year and beyond. We have now identified three categories of Resilience Leaders:

1. Undergraduate Peer Instructors, MMES Interns for SCI 100, MMES Teaching Assistants and other Lab Instructors (a total of 17 co-instructors for SCI 100 and 3 for both SSC 100 and SCI 100) guide current first-year students in their overall understanding of the natural science and human factors at play in disaster response and resilience-building in the Virgin Islands community.

2. Undergraduate and graduate student researchers and project ambassadors have now presented at conferences and co-authored publications related to this project. With support from VI-EPSCoR, during Year 2, nine current or former UVI students were co-authors or presented individually – including one published book chapter, one peer-reviewed conference paper, three invited presentations, and one conference workshop.

3. New UVI courses in Islands Systems Resilience, and complementary summer internships, represent next steps that build on the natural and social science of disaster recovery and resilience-building in the Territory. SCI 100 and SSC 100 students will be recruited for these two new courses, based in a new Engineering concentration of the Physics Department.

Below follow examples of the first category of Resilience Leaders (peer / near-peer instructional approach in SCI 100, being expanded to SSC 100). Shamir Smith, UVI Senior in Applied Math and SCI 100 Peer Instructor for seven semesters, summarized his experience to faculty and students: "We've been doing service learning in SCI 100 even through the pandemic! These teaching team members also introduce and coach students across the Project Track versus the Traditional Track. The majority of the Undergraduate Peer Instructors serve as STEM role models, as they include majors in Biology, Marine Biology, Applied Mathematics, and Computer Science. Peer Instructor Shamir Smith and MMES Teaching Assistant Naomi Scott (a Lab Instructor) were honored as 2022 nominees for Student Employee of the Year Award. A previous winner of Student Employee of the Year was LeAnn Horsford, SCI 100 Peer Instructor since 2019 and a graduating Senior who will be starting her medical career as a student at St. Georges University School of Medicine in Grenada in Fall 2022.

In the second category of Resilience Leaders, undergraduate and graduate students have continued to lead the dissemination of educational research findings and reflections on their experiences with the RETL intervention. The works include the book *Justice and Equity in Climate Change Education: Exploring Social and Ethical Dimensions of Environmental Education*, which features a chapter co-authored by UVI faculty and students entitled "A Course on Natural Disasters Gets Real: Living the Impacts of Climate Change in the US Virgin Islands." The chapter tells the community story of 'IrMaria,' the evidence for climate-change intensification of hurricanes, and indicators of Post-Traumatic Growth and strong pride in the Virgin Islands documented by student essays in SCI 100. The authors include three students, Dr. Michele Guannel, Dr. Greg Guannel, and former St. Thomas Recovery Team Executive Director and former RETL project partner, Ms. Imani Daniel.

Furthermore, the three student co-authors are an example of how the first-year program builds STEM and VI Workforce Development as well as Resilience Leaders pathways. One co-author is Ms. Nailah Copemann. A UVI English graduate, Ms. Copemann worked with Dr. M. Guannel on the qualitative analysis, after serving as a Peer Instructor in the SCI 100 course for three and a half years. Her experiences as a Peer Instructor informed her career path, as she is now teaching middle school on her home island of St. Croix and pursuing a master's degree in Education at UVI. Ms. Angelisa Freeman, one of the co-authors of the book chapter and the 2021 AERA presentation of a peer-reviewed paper (a Year 1 accomplishment), continued working with Dr. Guannel through the Emerging Caribbean Scientists program (Summer 2021) and Directed Independent Research during each of Fall and Spring semesters. Freeman, now a graduating Senior in Biology, is a co-author on a total of four presentations and publications, three of which were disseminated during Year 2. Notably, Angelisa Freeman and Dr. Guannel were invited to speak at the American Anthropological Association regarding "UnEnding Disasters" in November 2021. Their presentation examined formal and informal learning under conditions of disaster in the Virgin Islands, focusing on disruptions to formal learning as a result of Hurricanes Irma and Maria and COVID-19. Students are progressing vertically through opportunities at UVI in STEM, first excited by their first-year experiences in SCI 100/SSC 100 (Copemann, Hunt), or other research experience (Freeman) and then pursuing research in other grant-funded projects.

Student dissemination of their reflections and education research represents an important step towards inclusion as the vast majority of student authors are ancestral to the US Virgin Islands and other Caribbean locations. Their work will also make them more competitive in applying to graduate and professional schools in STEM fields.

Third, Dr. Guannel submitted an NSF Building Capacities in STEM Education Research (BCSER) grant during Spring 2022, focused on the analysis of a new track for Resilience Leaders at UVI. This track is embodied in a series of two courses on Islands Systems Resilience, which are part of a larger, new Engineering concentration in the Physics program. Here, our goal will be to recruit SCI 100 and SSC 100, including but not limited to RTEL participants, into upper-level courses that facilitate understanding of the systems thinking needed to mitigate, respond to, and recover from the ongoing recovery from the 2017 hurricanes, during the ongoing challenges of the COVID-19. These courses will be offered to sophomore- and junior-level students, with extended opportunities to complete summer internships with governmental and non-governmental organizations central to hazard mitigation, disaster response, and resilience-building across sectors in the VI. In March 2022, Dr. Guannel submitted a three-year Building Capacities in STEM Education Research (BCSER) proposal to fund the assessment of these courses and internships. Dr. Guannel's continued professional development would be supported by the BCSER grant through mentorship by UVI Physics faculty and two external researchers with expertise in the anthropology of disaster and resilience-building in other marginalized communities impacted by major disasters (Puerto Rico and New Orleans). Regardless of the proposal outcome, the team will pursue this track as one pathway to develop UVI Resilience Leaders.

In conclusion, the Undergraduate Education Research team has accomplished many of the central goals of this grant, while responding to the ongoing disruptions and uncertainties of the COVID-19 pandemic. Additionally, the team has moved ahead to exceed several of Year 3 goals centered on the dissemination of research findings and pursuit of additional grant funding to support efforts to improve the First Year Experience at UVI. The mission is more critical than ever as we see declining enrollments and the need to create a meaningful, engaging, and community-responsive college experience.

SYNOPSIS: Informal Learning
Led by Community Engagement Specialists Jarvon Stout & Kai Neilsen

While still affected by the setbacks brought on due to the COVID-19 pandemic, IL has continued to adapt and innovate its outreach initiatives and products geared towards the underserved communities of the USVI. Working with both internal and external partners, and by utilizing various science communication resources and technological tools, significant progress has once again been made across each of IL's target areas. Specifically, IL has seen growth in the realms of community engagement, citizen science, k-12/school outreach, and product and resource development.

Community Engagement and Citizen Science

A total of 1,085 community members have been reached by IL. Of that number, 383 were engaged through community engagement and citizen science events that took place throughout Year 2. Such events include, but are not limited to, the 2022 Great mangrove Cleanup that took place on St. Thomas, the International Coastal Cleanups kickoff event, and the Annual St. John Earth Day Fair. IL has also been rethinking the way that it approaches community outreach. Thanks in large part to both existing and new partnerships, IL has begun working on several community engagement initiatives that have the potential to both engage communities in accessible ways, and further diversify IL's audience(s). Two such initiatives are 1) Partnering with the Virgin Islands Children's Museum and St. John National Park Service to create R2R focused educational exhibits in community spaces, and 2) Working with groups such as VI Crawl and St. Croix Environmental for the creation of STEM/Geoscience focused educational video platforms and species field guides that will be available to the public. Also, regarding citizen science, conversations have begun around IL working with R2R researchers to support coastal sampling and mangrove restoration initiatives.

K-12/School Outreach

Throughout Year 2, k-12/school-based outreach has remained IL's most productive and impactful component. A total of 702 local k-12 students were reached through several STEM/Geoscience-themed enrichment and professional development opportunities. Alongside partners such as the Virgin Islands Marine Advisory Service, Virgin Islands Eco-Schools, and R2R researchers, the methods typically used in youth outreach have also improved. IL has maintained its financial and programmatic support for the Youth Ocean Explorers (YOE) summer program, and its STEM enrichment collaboration with the University Bound (UB) program. Both of which have seen the successful introduction of hybrid models of engagement. IL has also participated in STEM outreach that has taken place at local public schools and impacted over 100 k-12 students. Professional development opportunities for educators and students have also emerged through funding for SCUBA certifications, as well as the new Adopt a Classroom program, which aims to give STEM teachers the tools they need.

Product and Resource Development

IL continues to make advancements regarding co-created STEM education resources and products that can, and do, improve citizen science, public outreach, and youth engagement efforts. During Year 2, a multitude of at-home STEM learning kits was created and given to participants both in YOE and UB to ensure student engagement at home. In partnership with VIMAS, educator kits are also being prototyped. These kits will be given to STEM teachers for the purpose of supplementing and enhancing school curricula. IL has also continued to procure the technology necessary to maintain its efforts in the realms of 3D printing, and virtual/augmented reality tours and simulations. The creation of dynamic, engaging, and place-based tabletop displays and dioramas have also begun, with the goal of assembling more immersive booths at various community outreach events.

Major Accomplishments and Research Findings: Informal Learning

Goal IL1: *Increase and sustain the reach of the Informal Learning team throughout the Territory.*

IL has successfully begun increasing its size, and therefore reach, by bringing on both a Community Engagement Specialist for the district of St. Croix, as well as an outreach assistant for St. Thomas/St. John district. Due to this increase in capacity, IL has been able to reach a total of 1,085 community members through a combination of youth enrichment and community events (such as the 2022 Great Mangrove Cleanup, and 2021 Coastweeks Cleanup, and Earth Day Fair) in which IL co-coordinated or participated in the creation of a comprehensive "Everything Informal Learning" resource, to

be used both for partner engagement and training for future outreach personnel, has also begun. Currently, this resource exists as a Google Drive folder with smaller folders, each containing descriptions of each of IL's outreach partnerships and initiatives. Engagement with partners and stakeholders for the island of St. John has also increased. Conversations have begun with St. John educators from the Gifft Hill School, and National Park Service to discuss potential public and school outreach projects. While IL has not had the opportunity to carry out in-person outreach for the St. Thomas/STJ district to date, plans are being made to roll out and/or participate in upcoming community outreach events such as the St. John Earth Day Fair.

Goal IL2: *Diversify range of topics presented in informal education and outreach initiatives.*

IL has begun engaging R2R researchers for the purpose of diversifying the Geoscience topics presented to k-12 audiences. For example, researchers such as David Hensley, as well as student researchers within the Brandt lab, have worked with IL to present topics such as Watersheds and Agricultural Science, and Coral Disease research respectively. Other topics newly highlighted during Year 2 also include Food Security, Coastal Ecology, Fisheries, and Sustainability. That said, it is imperative that researcher engagement continues to improve to better reflect what is written in the SP. To that end, a "Outreach Menu" is being constructed, which summarizes ideas and concepts related to each R2R theme and relevant community outreach. Progress on this document has been slow due to limited capacity but should improve as the team has grown.

Regarding growing relationships with entities with similar goals and dissemination efforts to VI-EPSCoR, IL has built relationships with several organizations. These include 1) The Virgin Islands Conservation Society, and Virgin Islands Eco-Schools, which has led to the creation of the USVI Tiny Forests project, which aims to create forested spaces within public schools, and 2) St. Croix Environmental Association which will lead to the creation of a comprehensive Ridge to Reef flora and fauna guide.

Goal IL3: *Promote and guide k-12 URM students into the Geosciences and broader STEM pipeline to build a local STEM workforce.*

Through STEM/Geoscience-focused enrichment initiatives, IL has engaged a total of 702 URM k-12 students throughout Year 2. Specifically, this includes 98 University Bound (UB) students, 18 Youth Ocean Explorer (YOE) students, 25 Camp Storm Strong participants, with the remaining 588 being school groups and classes in public schools who IL engaged through classroom presentations and field trips hosted by partnering organizations like the St. Croix Environmental Association.

Collaborations with community partners, such as Junior Scientists in the Sea (JSIS) and Cane Bay Dive, have made it possible to provide opportunities for 5 UB students, and 15 YOE students, across both districts, to pursue their Open Water/Advanced Open Water SCUBA certifications. This has already begun leading to students participating in EPSCoR-funded research such as coral disease and restoration. Several YOE participants are now at institutions of higher learning, one of which being the University of the Virgin Islands, pursuing Geoscience degrees.

Goal IL4: *Work toward becoming a recognized Hub of information and resources for STEM and environmental education, awareness and sustainability in largely underserved communities.*

IL has been successful in the realms of creating new/strengthening existing partnerships both locally and abroad, for the purpose of sharing VI-EPSCoR's story. When it comes to presentations, Jarvon Stout (St. Thomas/St. John Community Engagement Specialist), Dr. Lawanda Cummings (Formal Learning Lead) and Mrs. Resa Berkely (Data Specialist) gave a virtual poster presentation at the Southeast ECO Conference, on the importance of culturally relevant practices for creating STEM literacy within island communities. Both Stout and Cummings, along with Dr. Nadia Monrose and Dr. Verleen McSween, presented at a town hall hosted by the National Academy of Sciences, Engineering, and Medicine. Stout has also given presentations to the St. Thomas Rotary II group on current k-12 STEM outreach projects that IL is leading with University Bound.

IL has also been able to maintain connections with other jurisdictions. Specifically, Jarvon Stout is a member of the National EPSCoR Education, Outreach, Diversity and Communications (EODC) Council, which connects outreach and communications personnel from EPSCoR jurisdictions across the US. This EODC council works to better connect and inform EPSCoR jurisdictions through co-created webinars and workshops often focused on topics like science communication, broadening participation, and professional development.

Goal IL5: *Build new, and improved-upon existing, connections and lines of communication to better reach and understand target audiences.*

Considerable progress has been made in the realm of reaching, expanding, and understanding target audience(s). The team has begun laying the groundwork for several projects that would not only allow better access to community members across different spaces, but also make it possible to craft targeted assessments that provide data on the efficacy of this work as it pertains to demographics, STEM attitudes, behaviors and literacy. The first of these initiatives involves working with community spaces such as the Territory's Children's Museums and the St. John National Park to curate immersive and educational exhibits that focus on R2R research. The second, which is being called "Adopt a Classroom" focuses on working with public school educators across the Territory to outfit their classrooms with STEM-themed materials, supplies, and props that further promote science literacy and affinity within their students. IL has also been in talks with entities such as Island Therapy Solutions which serves differently-abled individuals within the VI. The goal of this partnership is to develop STEM enrichment for special needs youth and young adults. That said, work still needs to be done as it pertains to finding connections with other underserved groups like non-English speakers, religious groups and ASL speakers, as outlined in the SP.

Goal IL6: *Build self-sufficiency and innovation within the IL team and its efforts.*

Great strides have been made regarding IL's capacity to create and/or procure innovative materials and resources for community engagement and accessing sources of community funding to support this critical work. When it comes to assets, IL has not only seen success in the way that 3D printing, and virtual reality are used but is now capable of creating its own locally relevant 3D models and virtual reality simulations of local ecosystems and the R2R research tied to them. In partnership with VIMAS, the production of several Geoscience-based kits, which will be made available to local educators, has started. These kits will cover topics such as Sea Floor Mapping, Marine Biology and Ecology, Food Security, and Water Quality Testing. When it comes to obtaining funding support, IL is in a position where community organizations are learning more about the work that is being done and are willing to support these efforts. Following a recent presentation to Rotary II of St. Thomas, IL has been awarded $10,000 to host a 3D modeling and printing workshop with University Bound students in both districts. IL and VIMAS wrote a funding request letter to the 34th Legislature's Committee on Finance, from which $20,000 was granted to aid in expanding and sustaining the YOE component for the St. Croix district.

Additional noteworthy updates not mentioned in the Strategic Plan

There are two highlights not mentioned in the SP that have the potential to greatly improve the efficacy of IL's work. One such highlight is the creation of a web-based academic platform. This platform, currently known as "STEM Family", will be hosted on the VI-EPSCoR Informal Learning page and consist of interactive videos, trivia and assessments all around the R2R research leads, their teams, their work, and will be a resource for the community. More importantly, it will also serve as a reliable tool for k-12 educators that will enrich student-focused curricula. IL will be working closely with Formal Learning to host regular educator focus groups to ensure the platform's cultural relevance going forward. Also worth noting is that IL and VIMAS are working together to lead in the creation and outfitting of a "Ridge to Reef: Community Engagement Center" that will be in the improved Center for Marine and Environmental Studies (CMES) building. This space will contain interactive activities, immersive displays, and educational exhibits that focus on locally relevant ecosystems and natural resources, as well as the R2R research connected to them. Both endeavors can increase the audiences that we reach and improve the means by which we reach them.

5. EMERGING AREAS AND SEED FUNDING

Project Outcomes Report Continued

Preface: The EA research component of the R2R project was derived from a call for white papers during the initial proposal development. The following three research areas were selected based on the merit and rigor of the research proposal. The selected emerging areas were aligned with original objectives of the emerging research for the current R2R project.

Seed funding is characterized in the R2R project as mini grants. Mini grants are managed by our Education and Workforce Development component. The mini grant update for Year 2 is detailed under Education and Workforce Developments' Major Accomplishments section.

SYNOPSIS: Emerging Areas - Seagrass & Sargassum
Research Lead: Dr. Edwin Cruz Rivera

The seagrass and *Sargassum* emerging areas research is led by Dr. Edwin Cruz-Rivera. It includes external collaborators D. Christopher Rogers (University of Kansas, KU) and Stacy Krueger-Hadfield (University of Alabama, Birmingham, UAB). During Year 2, the project lead accepted a tenured position at Morgan State University and will continue his engagement with the project through a courtesy appointment granted in 2021. Year 2 of the project supported graduate students Jendahye Antoine and Matthew Souza at UVI, and Alexis Oetterer at UAB. Alexis replaced the graduate student hired through UAB during Year 1. In the area of seagrass invasive ecology, the team has finished experiments on feeding behavior of Caribbean grazers, seagrass mechanical properties, and some of the nutritional quality assessments of the seagrass. Five sites have been sampled for invertebrate densities on different seagrass beds (bot linear and suction samplings). Samples from the latter are being presorted for shipment to Dr. Rogers, who will do the final taxonomic identification. In the area of *Sargassum* golden tides, replicate golden tides and benthic *Sargassum* of two species (for comparison) have been sampled, dried, and shipped to Dr. Krueger-Hadfield for genotyping and assessment of genetic diversity. We were able to obtain additional floating *Sargassum* samples from a French group doing cruises across the Sargasso Sea as an additional comparison. The Cruz-Rivera-Rogers efforts have produced one peer-reviewed publication. Two grant proposals were submitted, of which one was funded (NASA) to expand on the *Sargassum* research. Additional collaborations with Drs. Greg Guannel (UVI) and Bret Webb (University of South Alabama) are discussed by project lead Guannel elsewhere.

Major Accomplishments and Research Findings: Emerging Areas - Seagrass & Sargassum

Goal EA 3: Measure the spread of the invasive seagrass Halophila stipulacea in the territory and the mechanisms affecting its expansion.

Objective EA 3.3: *Assess the role of herbivores as top- down control of* H. stipulacea*.*

Fifteen experiments including 3-5 different Caribbean herbivores have been finished. The last set of data on nutritional quality and mechanical properties of seagrass to complete this section of the project is underway and will be concluded by August 2022.

Objective EA 3.4: *Quantify the effect of seagrass type on associated invertebrate communities.*

Five sites have been sampled with a combination of linear, circular, and suction sampling. A pilot tethering project with fighting conch has been included to assess the mechanisms leading to differences in invertebrate distribution among seagrass bed types. Samples for taxonomy are being presorted to ship to collaborator Rogers for final taxonomic elucidation. One article dealing with invertebrate diversity studies in the VI has been published: Cruz-Rivera, E. and D. C. Rogers. 2022. An unavoidably short history of inland aquatic animal diversity research in the US Virgin Islands. Aquatic Ecology. https://doi.org/10.1007/s10452-021-09933-7 (on-line first).

Goal EA 4: *Analyze the effects of Sargassum golden tides on Virgin Islands ecosystems.*

Objective EA 4.1: *Determine genetic diversity of golden tides.*

Two golden tide events were sampled in the VI, including well replicated inclusion of the two species and three morphotypes suspected to be involved in these events. Additionally, a common and a rare benthic *Sargassum* species were sampled for comparisons of genetic diversity. Offshore pelagic *Sargassum* samples were also obtained from other groups collaborating with Dr. Krueger-Hadfield to complement our genetic assessment. A new graduate student was hired to fill the position left by the previous graduate student in this project.

SYNOPSIS: Emerging Areas- Brewer's Bay Acoustic Array
Research Lead Dr. Paul Jobsis

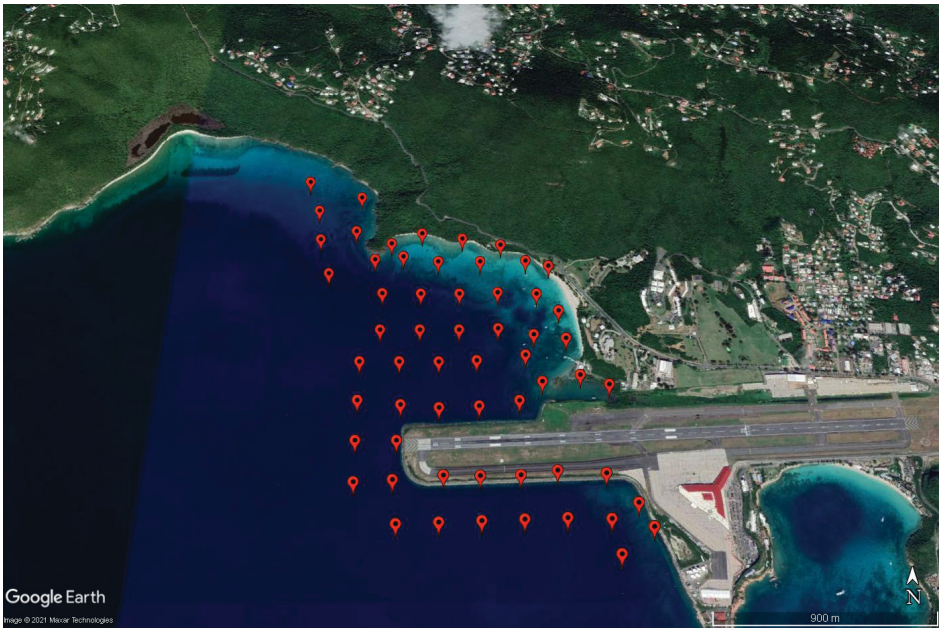
Great progress was made during the second year of research in the Brewers Bay animal movement in a changing marine environment study despite the start being slightly delayed. All of the goals and objectives, EA1.1 and EA1.2, were met with one small exception described below. Both the acoustic tracking post-doctoral fellow, Dr. Kayla Blincow-Israel, and the incoming masters' student research fellow, Taylor Brunson were not available in July as proposed, but assisted in the project that fall along with undergraduate students, Keedencia Harris and Nicholas Durgendeen (SP EA1.1c). Therefore Dr. Jobsis and MMES student Andrew McGregor worked together during July and early August of 2021 to install 59 receiv-

er bases, synchronous tags, reference tags, Hobo temperature loggers, and VR2x receivers in specific locations throughout Brewers Bay and Hawksbill Cove (Figure X) (R2R SP Objective EA1.1b). Earlier that year Dr. Jobsis was added to Dr. Kristin Hart's National Marine Fisheries permit (#20315, EA1.1a) which allowed his team of students and local volunteers to start collecting and tagging threatened Green and critically endangered Hawksbill sea turtles. Since starting on August 21st he and his team have caught, marked, and released 52 Green and 15 Hawksbill sea turtles. Of that total 16 green turtles, 11 hawksbill turtles, and 9 giant hermit crabs received Innovasea acoustic tags (Figure XX, SP objective EA1.2a and 1.2b). No fish were captured and acoustically tagged in Brewers Bay which was part of objective EA 1.2a, but this will be remedied in the summer of 2022 when we plan to acoustically tag stingrays that utilize the seagrass beds in Brewers Bay and Hawksbill Cove. Water quality measurements and seagrass monitoring have been started and will continue throughout the two years of this project (SP objectives 1.1e and 1.1f).

Emerging Area: Movement ecology of animals in a changing marine environment	
EA1.1a NMFS and DPNR permits completed and reported	Achieved: note DPNR permit was not required.
EA1.1b FPS acoustic array installed and data downloaded every six months per the manufacturer's recommendation.	Achieved: the Innovasea FPS array was installed by early August 2021 with a test download in September and the first data download in March 2022.
EA1.1c Post-doctoral fellow hired and 2 masters level and two undergraduate level students engaged in animal tracking	Achieved: Post-doctoral fellow Kayla Brunson, graduate students Andrew McGregor and Taylor Brunson, undergraduate students Keedencia Harris and Nicholas Durgendeen.
EA1.1d Randomly sample three seagrass type beds within the array and use DropCam to characterize the benthic habitat within the array	Achieved: We have started doing photo transects to characterize the benthic habitat in Brewers Bay.
EA1.1e Brewers Bay water quality sampling	Achieved: We have been collecting standard water quality and nutrient analysis six times per year in Brewers Bay and Hawksbill Cove
EA1.1f: Outreach and Education	Achieved but reduced due to COVID-19. We have conducted tagging events with a limited number of participants, sea turtle surveys with UVI undergraduates, and a group of 16yr old volunteers from the Virgin Islands Montessori School and International Academy
EA1.2a Acoustically tag sea turtles and fish	Achieved partially: 16 green turtles, 11 hawksbill turtles, and 9 giant hermit crabs have deployed with acoustic tags. Hermit crabs replaced the fish, but we will tag fish, likely stingrays in Year 3
EA1.2b Tag sea turtles and fish using non-acoustic methods for a mark and recapture study	Achieved: 52 greens 15 hawksbills, and 9 giant hermit crabs have been marked (non-acoustic tag) for a mark and recapture study to estimate population size. No fish were marked for such a study the estimation of the hermit crab population will replace this part of the objective.

Major Accomplishments and Research Findings: Emerging Areas - Brewers Bay Acoustic Array Emerging Areas-Movement Ecology of Animals in a Changing Marine Environment

The installation, testing and completion of the first data download of the fine-scale positioning system array in Brewers Bay and Hawksbill Cove was a major achievement. Dr. Jobsis and his team worked diligently at the July and August of the 2021 to complete this objective. Master Student Andrew McGregor received a student award from Innovasea and Dr. Jobsis received $80k in donations from the Baird Family Trust, the Lana Vento Charitable Trust, Leatherback Brewing Company, and the National Save the Sea Turtle Foundation to support students, expand the acoustic array, and purchase additional acoustic tags which as allowed this study provide a 24k/yr stipend to Andrew McGregor and to add hawksbill sea turtles to this project



Above left: Figure 1. The Innovasea Fine-scale Positioning System installed in Brewers Bay and Hawksbill Cove in July and August of 2021. The red markers indicate the position of the 59 acoustic receivers and synchronizing tags.

Above right: Figure 2. Green sea turtle with Innovasea V16 tag attached to its marginal scutes allowing the position of the animal to be determined by the FPS array.

SYNOPSIS: Emerging Areas - Seagrass and Beach
Research Lead: Dr. Gregory Guannel

This year, we developed a new dataset for the USVI. We compiled the location of all the beaches, and started to gather information about their physical characteristics: erosion or accretion rate, sediment size, profile, etc. Such a database does not currently exist for the territory. We also compiled information about offshore wave climate around the different islands by post-processing decades of model hindcast results. We are planning outreach and community events to share these data. These data will serve as model input in our studies. Finally, the PhD student, Ms. Deborah Fernandez, from Portugal, joined the University of South Alabama. She will conduct most of the research for this project, but needs to be at USA in order to get the proper academic training

Major Accomplishments and Research Findings: Emerging Areas - Seagrass and Beach

Beaches of the USVI have been mapped and rates of shoreline change has been computed for the major beaches, including the ones that will be included in the analysis of the relative role of seagrass offshore: Lindbergh Bay, Sapphire Beach and Abby Beach on St. Thomas. We have also started taking shoreline and sediment measurements at those beaches, along with beaches on other islands. This information is currently not available for any of the shorelines of the USVI. We're also working on a manuscript that is going to be submitted to Frontiers on April 19th titled "State of the Practice and Conceptual Guidelines for Integrating Emergent Vegetation with Existing Coastal Infrastructure for Engineering With Nature".

6. RESEARCH SUPPORT

Research Equipment / Infrastructure Investments

The reconstruction of the Marine Science Center and the CMES Annex is behind schedule. The completion and move-in dates are in the Fall of 2022 for the MacLean Marine Science Building and the Summer of 2022 for the CMES Annex. The completion of these buildings will be a huge step forward for UVI and many of its VI-EPSCoR supported researchers. However, we continue to be productive by working out of trailers, containers, and converted parking lots. Fortunately, much of the marine and terrestrial research conducted at UVI is field based. For many of our researchers, the work is focused on the environmental factors best measured in the field and therefore can continue their work outside of laboratories and offices.

Cyberinfrastructure

VI-EPSCoR's cyberinfrastructure component in collaboration with UVI's Information Services and Institutional Advancement (IS&IA) department has been building on past NSF funding support by

- Providing core network infrastructure upgrades from 1 Gbps to 10 Gbps to research facilities;
- Improving the research data server and storage topology;
- Configuring the current MS Azure environment to replicate with a newly proposed on-premises data server and storage solution; and
- Improving University Internet connectivity data transmission throughput and speed

Cyberinfrastructure met its Year 1 goal during Year 2 and successfully conducted network throughput and speed tests to determine Internet capacity bottlenecks for researchers. IS&IA also continues to ensure research network needs are met for new construction and existing research facilities.

All Year 2 goals have also been met. IS&IA collaborated with Florida International University to configure network speed and capacity according to research needs. They are also developing specifications for campus network cabling and fiber Request for Proposals for contractors.

We have also hired a New Data Manager, Travis Hamlin. Travis is a recent 2021 Marine Science undergraduate, who has experience working with the Oceanography team as a student researcher. He also earned his Data Management certification and is learning Microsoft Azure cloud services from a contracted cloud service professional.

And we were recently awarded a $500K Campus Cyberinfrastructure (CC*) grant from NSF to supplement funding for network infrastructure upgrades across both UVI campuses.

7. BROADENING PARTICIPATION

Our "Broadening Participation" efforts over the Year 2 reporting period were significantly impacted by the pandemic and its lingering impacts. UVI traditionally hosts several large public events such as "Day on the Green" which brings the community and alumni back to campus and here VI-EPSCoR has played a significant role in organizing and hosting well-attended events. We also have more targeted events such as "Reef Fest" that focus on environmental education regarding our coastal and marine ecosystems. These large events were not held, so our EWFD and IL team relied nearly exclusively on hosting virtual events such as the Summer Institute event. One exception to in-person engagement has been the Great Mangrove Cleanup events on each of the three main islands in the Territory led by Wilson Grimes and her team. Overall, our activities engaged nearly 4000 people (3979), with participation from 3 additional institutions (1 MSI); We hosted a class from Yale University (1 faculty and 16 students) and a small group from Iowa State University (1 faculty member and 4 students). We hosted several groups from within UVI which brought 13 faculty and 82 students out to our various research sites. Our EWFD team hosted several events for 203 k-12 teachers and 1000 students reached through Teacher Training. Our IL team hosted multiple events for 1889 members of the public through a mix of in-person and virtual events. We did not collect specific demographics (gender/race etc.) for the participants of our external engagement activities, however, 6% of the population of the Territory are Afro-Caribbean (black), while 15.6% are white, 1.4% are Asian and 2.1% are mixed or some other ethnicity. Hispanic or Latino of any race account for 17.4% of the population (10.3% Puerto Rican, 5.4% Dominican), so typically, we routinely reach a highly diverse audience that is historically underserved with most of our activities.

8. PARTNERSHIPS AND COLLABORATIONS

Our partners and collaborators are still extensive, despite the impacts of the pandemic. Additional details can be found with our data submission into research.gov, but in summary, the R2R team collaborated with 27 academic institutions, 10 federal and Territorial agencies, 4 private sector firms, 8 nonprofits or NGOs, and 7 other types of organizations. Some examples of our partnerships and collaboration include traditional research collaboration with Lousiana State University's (LSU) Dan Holstein who was a postdoc here under our previous Track 1 award and is now an assistant professor at LSU and is working closely with Tyler Smith in our Oceanography and Coral Reef Resilience themes. Our relationship with federal and Territorial agencies includes NOAA and VI-Department of Planning and Natural Resources- who both contribute funding for our coral monitoring program in local and federal waters. Because our research sites are in federal lands, we have a long-term relationship with the National Park Service on both St. John and St. Croix. We enjoy support from local foundations like the Community Foundation of the Virgin Islands (CFVI) who supports our IL team, just as environmental focused organizations like the Baird Family Foundation supports our sea turtle researchers and students. A final example

of other organizations includes companies like the Karen Peterman consulting company that provide program assessment of our Mangrove research team, just as our IL and watershed monitoring and land use teams engage the local farmers like the owners of Ridge to Reef Farm.

9. COMMUNICATION AND DISSEMINATION

SYNOPSIS: Communication and Dissemination
Led by Communication Specialist Elisa Bryan

The Communication team's efforts in Year 2 continue to focus on informing the community about the Ridge to Reef Project and its accomplishments. One of the ways that goal is being achieved is through continued refinements and updates to the website viepscor.org and a new video "VI-EPSCoR Ridge to Reef Grant Update" which was posted to the YouTube channel and shared widely on social media. The Spring 2022 Newsletter has also been published and shared on-line. Printed copies are currently being distributed.

MMES graduate Dan Mele and new hire has been brought on board on a part-time basis. In addition to filming and editing the EPSCoR Ridge to Reef Grant Update YouTube video, he is focusing efforts on photographing the activities of the R2R team for promotional and educational purposes. Mele is also being mentored in co-authoring his first blog post on the Oceanography work of the R2R project. We expect to publish that story by June 1. The Communication team is also in the process of creating a second video focused on the work of the Alien Seagrass Emerging Area.

Major Accomplishments: Communication and Dissemination

The video "VI-EPSCoR Ridge to Reef Grant Update" was created and shared on VI-EPSCoR's YouTube channel. The video, narrated by Dr. Kim Waddell and filmed by new hire Dan Mele, provides a compelling overview of the impacts VI-EPSCoR has had on the territory during its four grant cycles and an overview of the R2R project. This video, shared to social media, was the most engaging post with a reach of 10,211 and 2,448 link clicks. Overall, in Year 2 our Facebook page reached 47,933 members and Instagram reached 6,061.

The newest issue of our bi-annual newsletter was published in May. The title of the issue is called "Preparing A STEM Workforce For The USVI", this issue highlights the achievements of our Workforce Development team and spotlights two outstanding students. It also provides an update of the research teams' accomplishments. The newsletter is available digitally as well as in print format.

The USVI Marine Debris Action Plan has been published and is available for download from the website. Created by the Marine Debris Advisory Committee, it is a living document (updated every 5 years) developed from input of local and federal partners with the intent to guide marine debris management in the territory. Similarly, The USVI Marine Debris Curriculum, is also available for download from the website. This place-based curriculum, in partnership with the NOAA Marine Debris Program, was co-created with the input of 61 USVI educators and other partners. It offers downloadable lesson plans centered on marine debris education that are specifically relevant to the USVI. It is already being downloaded and used in the territory.

New additions to the website include Mangroves 360 , an immersive virtual tour of USVI mangroves, About EPSCoR , which summarizes areas of research, project highlights, a historical funding overview and archive link of the Mare Nostrum grant and Marine Debris in the USVI, a hub for all VI-EPSCoR marine debris-related content has been added to the website.

Additional accomplishments include creating all visuals for the 2021 Annual Conference "Connecting the Dots From Ridge to Reef" including social media posts. The publication of the first R2R newsletter entitled "Ridge to Reef" and the launch of the updated website was coordinated visually and timed to coincide with the annual conference.

The Communications team also worked behind the scenes to help prepare the slides and presentations for the virtual Reverse Site Visit this spring and to create the Annual Report document. Additionally, assistant Dan Mele applied for and received his commercial drone pilot certification in May 2022, an accomplishment that will lead to even greater opportunities to document via photo and video the work of R2R researchers.

10. SUSTAINABILITY

The sustainability of the VI-EPSCoR program and projects is strong with levels of overlapping and complimentary research efforts that have developed over the past decade or so with NSF, other federal, and local Territorial funders/ stakeholders. The USVI Territorial Government continues to rely on VI-EPSCoR-supported researchers and programs to advise on natural resource management decisions and provide science-based assessments. A multi-decadal example is the USVI Territorial Coral Reef Monitoring Program (TCRMP) under the direction of VI-EPSCoR co-PI Dr. T. Smith and the USVI Department of Planning and Natural Resources (DPNR). Together they are responsible for monitoring the condition and trajectory of coral reefs in territorial and federal waters of the USVI. These program goals are to understand the processes affecting coral reef ecosystems in the USVI and develop scientifically based management strategies. The funding support (over $500K/annum) for this work is extremely reliable and, more importantly, the data and analyses derived from this monitoring program will be used to test for the most important interacting sets of drivers with respect to supporting resilience in USVI coral ecosystems- all which are central themes to the R2R project.

K. Waddell and G. Guannel's award with FEMA and the Virgin Islands Territorial Emergency Management Agency (VITEMA) for developing the next USVI Hazard Mitigation and Resilience Plan (HMRP) is another example of the research sustainability that the Track 1 awards like our R2R cultivates. This 3-year, $5M project began in late 2018 and has developed a comprehensive plan that integrates principles and elements of resilience, sustainability, and climate adaptation into the plan for the Territory's built and natural environments. This project has led to new collaborations with climate adaptation colleagues in Puerto Rico that led to the recent announcement that our $5M National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Sciences and Assessments Program (RISA) proposal (GG and KW are co-PIs) was funded. The work from this project will complement our work to understand the environmental stressors and drivers of resilience affecting our natural resources and communities. The new award will provide support for out Informal Learning team in their efforts to engage underserved and underrepresented communities that want to understand the natural hazards and consequences of climate change that impact their communities and compromise the quality of their lives.

Among the various awards to our R2R researchers, two researchers warrant mention here as part of our effort to expand student training opportunities, which builds the sustainability of our jurisdiction's research enterprise. The first one is Marilyn Brandt's $2.5 million grant to study multi-species coral disease transmission by the NSF Ecology and Evolution of Infectious Disease Program. This award greatly expands her team's collaboration with marine disease researchers around the country and facilitates new opportunities for her students to engage other research faculty while developing new skills at partnering institutions. The other researcher is Kristin Wilson Grimes with her impressive assortment of capacity building grants. Grimes has had several students supported on her NSF NRT Strong Coasts (Award #1735222), her NSF INCLUDES SEAS Islands Alliance (Award #1930991), as well as on her NSF S-STEM (Award #2030713). Her funding success and productivity has led to her invitation to join the National Science Foundation's Advisory Committee for Geosciences (January 2022-December 2024).

Overall, the R2R team continues its success in securing additional grant funding that leverages NSF-EPSCoR's ongoing investment in the Virgin Islands. This year, there were 34 grant proposals submitted amounting to $18,716,155. 29 of the 34 proposals are pending and 5 were funded. The R2R team was awarded 21 proposals for this reporting year totaling $5,153,306.

11. MANAGEMENT, EVALUATION AND ASSESSMENT

See attached document entitled "*Virgin Islands NSF EPSCoR Evaluation Report- Year 2*".

12. EXPENDITURES AND UNOBLIGATED FUNDS

The VI-EPSCoR team has worked to improve our spending despite the constraints caused by COVID-19. The total award increment for Year 2 totalled $4,761,137 and the total Year 1 carry-forward totalled $1,275,246.49. To date, we have spent $3,343,334.77 in Year 2. Our total unspent funds are $2,693,048.72. Current obligated funds total $998,618.48 and the total unobligated funds total $1,694,430.24. Our unobligated funds are estimated to be 18%.

Cost Share and Cost Contributions

Cost share funds in the sum of $794,677.54 were received to help fulfill our year 2 goals and objectives and assist the VI-EPSCoR program. Cash contributions of $149,720.04 were provided from the U.S. Virgin Islands Legislature to support VI-EPSCoR's administrative staff salaries and fringe as well as a sub-award with the Louisiana State University to support

coral resilience research. Additionally, cash contributions of $150,000 were provided from Florida International University and $164,617.12 from the VI Next Generation Network to support the university's cyberinfrastructure. The University's Information Services & Institutional Assessment provided $52,740.02 in cash contributions to support salaries and fringe for cyberinfrastructure personnel. In kind contributions of $215,508 were provided from Broadband VI to also support the University's cyberinfrastructure. In addition, cash contributions of $28,888.11 were provided from National Sea Turtle Foundation Scholarship Fund, $24,777.81 from the Baird Sea Turtle Research Assistantship Fund, and $2,891.34 from Sea Turtle Reserve & Conservation, to support students and to purchase marine research supplies at the University of the Virgin Islands. Lastly, VI-EPSCoR received in kind contributions of $4,709.10 from Mangrove field work volunteers and $826.00 from VI-Ecotours for kayak rentals to support Mangrove research.

Cost contributions in the sum of $43,581.91 were also received from the University of the Virgin Islands to support a UVI grant Accountant personnel and other grant related supplies.

Non-EPSCoR Funding

There were 22 non-EPSCoR-related research proposals that were submitted during the reporting period, totalling the requested amount of $14,971,620. All of these proposal submissions remain pending.

13. SPECIAL CONDITIONS

A. Jurisdiction-Specific Programmatic Terms and Conditions (required for Years 1-5)

Year 2 Annual Report Update for R2R Project:

8.1. Hiring of Faculty and other Key Personnel: The following two tenure-track faculty hires will occur during the first two years of the project.

i. *A tenure-track restoration ecologist, to be hired in Year 1 or 2, who will contribute to Goal 3.*

We successfully hired Dr. Robin Smith for the restoration ecologist position in Year 1. Please also note that UVI does not offer a path toward tenure for any research faculty. We offer 1 and 2-year contracts to all our research faculty and following promotion to Associate Research Professor, longer-term contracts are typically offered.

ii. *A second tenure-track position that will contribute to the project will be hired by Year 3.*

We are preparing a job description for a hydrologist that will be posted in the summer of 2022 with the plan to complete the recruiting and hiring process by the end of the calendar year.

8.2. Within 90 days after the Strategic Planning meeting, VI EPSCoR will provide a plan describing how the educational activities of the project may be leveraged or modified so that they can prepare undergraduate students directly for the job market or graduate school post-graduation.

We have identified several activities in our Strategic Plan that address this and that focus on preparing our undergraduates for the workplace. In our Education and Workforce Development (WF) component, we detail two goals that target our undergraduates.

In our WF2 Goal, we articulate that we plan to increase recruitment, retention and persistence of URM undergraduates in the STEM and resilience-related majors, minors and certificate programs. We plan to do that by doubling (from 10% to 20%) the number of first year students participating in STEM and resilience-themed experiential learning opportunities that promote an interest and affinity in STEM. We also articulate that the VI-EPSCoR WF team will provide 10% of UVI's sophomore and junior students with a deeper resilience-themed experiential learning opportunities that we expect will promote retention and persistence in a STEM major, minor, or certificate program, as well as with any STEM-related career goals.

The interest in multi-disciplinary majors and internships here at UVI has grown substantially, and programs like VI-EPSCoR are creating service and experiential learning opportunities that evolve into new "science identities" for our students. Projects here at the University like the FEMA award to develop the next hazard mitigation and resilience plan for the Territory are leveraging VI-EPSCoR's investment by hiring recent UVI graduates and providing them with training in GIS mapping, computer skills and writing opportunities- all skills that help them connect their academic training with

applied technical skills essential for successful job placement here in the Territory. There are other emerging multidisciplinary projects and opportunities under development across the University, so the VI-EPSCoR leadership is tracking their emergence and will explore them for potential leveraging as they come on-line.

8.3. At the time of the strategic planning meeting, VI EPSCoR will provide a clear management plan and timeline of the project that shows integration of all activities with one another where applicable. In addition, this document will link investigator and staff to all activities listed in the proposal. This should also contain all responsible parties required for the completion of each activity.

Our Management Plan for the R2R project is detailed in our Strategic Plan. R2R project leadership has implemented a thorough and responsive management structure overseen by our Leadership and Management teams and assisted by two panels of authorities and experts. Project leaders expect to benefit from annual feedback, from our External Advisory Board which focuses on our project activities, and from our Governing Committee which reviews R2R progress and provides guidance to assure the program achieves the Territory's Science & Technology goals. We also get feedback from our External Evaluators (The Implementation Group) who will provide annual reports, including summaries of data, findings, and recommendations, which will be shared with the R2R Leadership Team and with NSF. R2R leadership will institute annual midcourse changes based on these evaluations as needed.

The R2R project has adopted a shared leadership model that has proven to be effective in large team science projects—such as our previous Track 1 awards—with five Management Team members providing day-to-day management and another eight providing science and outreach leadership. The Project Director (Kim Waddell) provides strategic guidance and leads synthesis discussions. The Project Administrator (Kelly Harrigan) oversees project coordination. Our Financial Manager (Latoya Matthew) provides financial oversight, a Communications Manager (Elisa Bryan) coordinates external engagement, and a Data Specialist (Resa Berkeley) leads our data collection and management activities. Science leadership comes from the co-PIs (Richard Nemeth and Tyler Smith), as well as from the research leads for Coastal Resilience and Oceanography (Tyler Smith), Marine Diseases (Marilyn Brandt), Mangrove Restoration (Kristin Wilson Grimes), Emerging Areas (Edwin Cruz Rivera, Paul Jobsis, and Gregory Guannel), Fish Ecology (Rick Nemeth), and EWFD areas (Lawanda Cummings and Michele Guannel). Each of these leads are responsible for the goals, objectives and outcomes detailed in our Strategic Plan's components.

The Leadership and Management Teams work to ensure that R2R meets the goals and objectives in the Strategic Plan. We also expect to respond to external evaluations and NSF Site Visit and Reverse Site Visit recommendations and implement appropriate changes and compile annual NSF reports—including creating an on-line database to facilitate annual reporting by participants. The Leadership and Management teams meet monthly to coordinate progress, and also meet with leadership teams of individual research areas monthly.

8.4. Within the first year of the project, VI EPSCoR will produce a plan that shows a clear protocol for the strategy behind building collaborations. This will include strategies for determining how a collaboration will fit into and benefit the project.

VI-EPSCoR has completed a collaboration agreement that was developed with input from the leads of each research component, as well input from postdocs, students, and technical staff. The purpose of the collaboration agreement is to establish processes and methods to ensure an open and collaborative atmosphere over the life of the VI-EPSCoR R2R project. The agreement is a living document and will be modified as necessary to reflect changing circumstances over the life of the project. The agreement establishes shared respect and collaboration amongst researchers through clearly stated guidelines on communication and conflict resolution procedures, authorship and citation guidance, data management protocols, and fiscal collaboration procedures, which includes an unspent funds policy. The collaboration agreement can be found on our website at https://static1.squarespace.com/static/57211eff59827e8a710f3c30/t/61ddd9edb737707f2971bd2e/1641929198750/VI-EPSCoR+Collaboration+Agreement.pdf

B. Recommendations of the Reverse Site Visit (Required for Years 3-5)

Not applicable for Year 2 reporting.

C. Recommendations of the Site Visit (Required for Years 4-5)

Not applicable for Year 2 reporting.

D. Other Required Actions (if any)

None.

14. TABULAR/GRAPHIC REPRESENTATION OF PROGRESS TO DATE

See following pages.

Watershed Monitoring and Land Use (WL)				
Goal WL1: Identify sediment flux sources via sediment fingerprinting, and nutrient flux and microbial flux monitoring to characterize the role of runoff in two Virgin Islands watersheds. · Objective WL1.1: Characterize upstream sedimentary runoff sources via UV-Vis spectroscopy. · Objective WL1.2: Characterize nutrient and bacteriological fluxes into the marine environment.				
	Specific milestones			
Objective WL1.1	Year 1	Progress	Year 2	Progress
WL1.1a: Provide training on sediment source tracking procedures to research teams.	Delivery of detailed procedures for sediment trap use and sample collection.	Completed; protocol is developed and in use		
WL1.1b: Scout locations for sampling and collect permits.	Locations of interest geo-tagged for permitting processes, permits acquired from government and private landowners.	Completed; all study site locations have been identified and geo-tagged, all necessary permits received	Yearly reporting requirements fulfilled.	Completed; annual reports submitted to NPS
WL1.1c: Purchase and install monitoring and sampling equipment: rain gauges, sediment traps, etc.	Sediment traps and weather stations installed in multiple locations within in each watershed.	Completed; sediment traps are in use	Maintain and monitor stations.	Completed; maintenance ongoing
WL1.1d:Collect and process samples from field research locations.	Sediment source samples collected and processed.	Completed; samples were collected and processed for storage	Samples collected and processed.	In progress; samples were collected and processed for storage, awaiting final processing for data extraction in lab
WL1.1e: Interface with other teams for sample collection.	Samples received + quarterly check-in.	Completed; samples were collected and processed for storage on STT, will be further processed	Samples received + quarterly check-in.	Completed; samples were collected and processed for storage on STT, will be further processed
WL1.1f: Interpret data and determine conclusions for dissemination in community and scientific literature.	Reporting requirements fulfilled.	Completed; preliminary geospatial data interpretation and site characterization data has been analyzed; all reporting requirements fulfilled for Year 1	Reporting requirements fulfilled.	Completed; preliminary analysis of rainy season 2021
Objective WL1.2	Specific milestones			
	Year 1	Progress	Year 2	
WL1.2a: Purchase necessary equipment for bacteria and nutrient analysis of water samples and install field equipment.	Equipment purchased and calibrated, installed in field.	In progress; equipment has been purchased but has not been deployed pending collection of samples due to dry weather	Equipment maintained.	Completed; maintenance ongoing
WL1.2b: Scout locations for sampling and collect permits.	Locations of interest geo-tagged for permitting processes.	Completed; streamflow sampling locations identified and geo-tagged	Yearly reporting requirements fulfilled.	Completed; annual reports submitted to NPS
WL1.2c: Collect and process water samples.	Samples collected and processed regularly and after runoff events.	Incomplete; no samples collected without sufficient rainfall.	Samples collected and processed regularly and after runoff events.	Incomplete; no samples collected without sufficient rainfall; alert system is in place to collect grab samples on St. Croix when water appears
WL1.2d: Interface with other teams for sample collection.	Raw data received + quarterly check-in.	Completed; samples were collected and processed for storage	Raw data received + quarterly check-in.	In progress; samples were collected and processed for storage, awaiting final processing for data extraction in lab
WL1.2e: Interpret data and determine conclusions for dissemination in community and scientific literature.	Reporting requirements fulfilled.	Completed; preliminary geospatial data interpretation and site characterization data has been analyzed; all reporting requirements fulfilled for Year 1	Reporting requirements fulfilled	Completed; preliminary analysis of rainy season 2021
Goal WL2: Estimate the downstream impact and ecosystem services rendered by conservation land use interventions. · Objective WL2.1: Before-After Control-Impact (BACI) analysis to provide quantitative estimate of downstream benefit of conservation land use and comparison with reference forest. · Objective WT2.2: Field-scale supporting experiment in agroforestry land uses compared to reference forest for nutrient cycling and water infiltration · Objective WL2.3: Plot-scale supporting experiment in living mulch ground covers in plantain system for nutrient cycling and water infiltration.				
	Specific milestones			
Objective WL2.1	Year 1	Progress	Year 2	

WL2.1a: Design/establishment.	Secure agreements with landowners, install monitoring equipment.	Completed; equipment installed and permission obtained	Equipment maintenance.	Completed; maintenance ongoing
WL21.b: Sample collection.	Random + post rainfall samplings.	Completed; samples were collected	Random + post rainfall samplings.	Completed; samples were collected
WL2.1c: Sample processing.	Soil samples processed by lab.	Completed; soil samples have been collected and processed for color and particle size analysis in profile	Soil samples processed by lab.	Completed; samples were collected and have been processed for volumetric flux
WL2.1d: Data analysis.	Prelim. analysis for reporting reqs.	Completed; preliminary analysis	Prelim. analysis for reporting reqs.	Completed; preliminary analysis
Objective WL2.2	Specific milestones.			
	Year 1	Progress	Year 2	
WL2.2a: Design/establishment.	Secure agreements with landowners and relevant agencies, install monitoring equipment.	Completed; permission received, initial equipment installed in all plots and surveys performed	Equipment maintenance, orchard maintenance.	In progress; equipment arrived and partially installed except in some plots where heterogeneity was identified - final installations expected by May 2022
WL2.2b: Sample collection.	Samples collected from all fields.	Completed; soil samples and site characterizations data has been collected from all fields	Samples collected from all fields.	In progress; soil bulk density samples expected in May 2022
WL2.2c: Sample processing.	Soil samples processed by lab.	Completed; soil samples have been collected and processed for color and particle size analysis in profile	Soil samples processed by lab.	In progress; soil bulk density samples expected in May 2022
WL2.2d: Data analysis.	Prelim. analysis for reporting reqs.	Completed; preliminary geospatial data interpretation and site characterization data has been analyzed; all reporting requirements fulfilled for Year 1	Prelim. analysis for reporting reqs.	Completed; analysis for reporting, and continuing scientific analysis of plot heterogeneity
Objective WL2.3	Specific milestones			
	Year 1	Progress	Year 2	
WL2.3a: Design/establishment.	Plantain planting and living mulch establishment.	Completed; plantain was planted in April 2021, living mulch has been collected and is being propagated for ground cover experiment	Plantain maintenance.	Completed; maintenance ongoing (though project will terminate before Year 3)
WL2.3b: Sample collection.	Samples collected from all plots.	Completed; soil samples and site characterizations data has been collected from all plots	Samples collected from all plots.	In progress; soil bulk density samples expected in May 2022
WL2.3c: Sample processing.	Soil samples processed by lab.	Completed; soil samples have been collected and processed for color and particle size analysis in profile	Soil samples processed by lab.	In progress; soil bulk density samples expected in May 2022
WL2.3d: Data analysis.	Prelim. analysis for reporting reqs.	Completed; preliminary analysis was performed on initial dataset	Prelim. analysis for reporting reqs.	Completed; prelim. analysis for reporting and conferences was done
Goal WL3: Share communication, community education, and integration activities to support public and stakeholder benefit of the land use research. · Objective WL3.1: Participation in integration activities for community engagement and education outreach. · Objective WL3.2: Provide students with educational and experiential opportunities in science. · Objective WL3.3: Compilation and presentation of results at conferences and in publication.				
Objective WL3.1	Specific milestones			
	Year 1	Progress	Year 2	
WL3.1a: Participate in service-learning/mentoring of SCI-100 and R2R Resilience Leaders students.		Incomplete; event did not take place as of May 2021	Engage and mentor 1 SL/ SCI-100/Resilience leader student.	Incomplete; no student engaged
WL3.1b: Contribution to R2R newsletter.	Photographs of project and essay produced.	Completed; photographs and essay produced for newsletter	Photographs of project and essay produced.	Completed; photographs and essay produced for newsletter
WL3.1c: Creation of lectures and presentations for EOD events.	One presentation or lecture at a sponsored event.	Completed; participated in informal learning event (University Bound student tour)	One presentation or lecture at a sponsored event.	Completed; presented a lecture at a sponsored event (PBL teacher meeting)

Objective WL3.2	Specific milestones			
	Year 1	Progress	Year 2	
WL3.2a: Participation of undergraduate students in research activities	Engagement of 1 undergraduate in paid participation.	Completed; one student was hired for paid research experience in March 2021 and will continue through the end of Year 1	Engagement of 1 undergraduate in paid participation.	Completed; one undergraduate student was engaged in paid participation
WL3.2b: Participation of graduate students in research activities.			Engagement of 1 graduate student in paid participation.	Completed; graduate student is engaged in paid research activity

Objective WL3.3	Specific milestones			
	Year 1	Progress	Year 2	
WL3.3a: Attendance and presentation at scientific conferences.	Attendance/present at one conference.	Completed; presented at 1 conference	Attendance/present at one conference.	Completed; presented at 1 conference
WL3.3b: Publication of results in peer reviewed literature.	Preliminary abstract completed for all research projects.	Completed; all projects have been summarized in the form of a PhD dissertation proposal (Hensley) for eventual publication, and literature review for each publication has also begun	Preliminary abstract completed for all research projects.	Completed; abstracts created for WL1 and WL2 projects

Mangroves and Mangrove Restoration (M)				
Goal M1: Investigate current and historic USVI mangrove distribution, recovery, and loss. · Objective M1.1: Years 1-3: Document historical and current mangrove extent and estimated species composition across the territory using archival information and the application of new technology. · Objective M1.2: Years 1-5: Document the current status and recovery of mangroves using aerial imagery and long-term field plots.				
Objective M1.1 Years 1-3: Document historical and current mangrove extent and estimated species composition across the territory.	Specific milestones Year 1	Progress	Year 2	Progress
M1.1a:Compile current and historical aerial imagery.	Compilation initiated: Open-source images complied. Private imagery prices identified. Gap analysis used to determine priority imagery for purchase, and purchases completed. Communications with collaborators regarding potential for shared imagery discussed.	Completed; compilation initiated.	Compilation completed.	In progress; we are still compiling images, but have been in communication with collaborators from the Smithsonian, Pennsylvania State University and The Nature Conservancy on methods and approaches.
M1.1b: Compile historical maps and charts.	Initiation of online and in-person searches for historical maps and charts containing mangrove distribution information. This will include communications with the Danish and US archives, local historical societies and organizations, territorial libraries and/or other resources as they arise.	Completed; compilation initiated.	Compilation completed.	In progress; searches and communications have begun but are not yet complete.
M1.1c: Take new drone imagery of mangroves across the territory.	Identification of priority USVI mangrove sites for drone imagery collection. Team becomes acquainted with drone flight operation & imagery processing software. Imagery collection begins.	In progress; sites are identified, team has become familiar with the steps needed to become legally authorized to fly in the USVI and has started those steps. We have investigated image processing options, but no acquisition of images have begun.	Drone flights completed over territorial mangroves for high resolution imagery of current mangrove extent. Images georeferenced and organized into Geodatabase.	Delayed; Durdall passed her FAA part 107 certification in March 2022 and the lab will participate in the acquisition of drone images in wetland habitats in May 2022 with The Nature Conservancy, but all images are not yet collected, georeferenced or organized.
M1.1d: Create atlas (map mangrove extent over time).	Creation of a Geodatabase where aerial imagery, historical maps and new drone footage is cataloged as it is acquired. Resources geo-referenced, as needed. Mangrove mapping methods established and mapping begins.	In progress; draft database started but we are delayed on establishing methods for mapping as we are still acquiring data sources and need to assess what will work best across those.	Completion of atlas of mangrove historical and current extent, with estimation of species composition areas, where possible.	In progress; still acquiring and processing images.
M1.1e: Atlas and historical narrative shared.				
Objective M1.2 Years 1-5: Document the current status and recovery of mangroves using aerial imagery and long-term field plots.	Specific milestones Year 1	Progress	Year 2	
M1.2a: Site selection.	Finalization of research sites coordinated with other research areas.	Completed; Fish Bay, St. John and Salt River, St. Croix were selected in coordination with other R2R research areas.		
M1.2b: Apply for permits.	Permits drafted, submitted, and approved.	Completed; all territorial and federal permits have been drafted, submitted and approved.		
M1.2c: Conduct repeat drone surveys of sample sites.	Drone surveys completed (2x per year)	In progress; additional licensure and accreditation needed to legally fly drone to collect these data. Process has been investigated and started.	Drone surveys completed (2x per year)	In progress; license to fly acquired in March 2022. Permits to fly acquired from CZM.
M1.2d: Document areas of existing canopy extent, damage, and dead trees at study sites.	Drone survey aerial imagery georeferenced, mapping completed for that year's imagery	Incomplete; unable to legally collect drone imagery.	Drone survey aerial imagery georeferenced, mapping completed for that year's imagery	In progress; license to fly acquired in March 2022. Permits to fly acquired from CZM.

M1.2e: Analyze mapping data to estimate percent mortality and percent recovery.	Completed analysis of year 1 data.	Incomplete; unable to legally collect drone imagery.	Completed analysis of year 2 data, including change over time analysis of years 1-2.	In progress; license to fly acquired in March 2022. Permits to fly acquired from CZM.
M1.2f: Assess new mangrove growth.	Develop and complete field methods for rapid assessment of new mangrove growth, to be completed at main sample sites and potentially at additional sites across the territory.	In progress; methods developed and materials ordered. Fieldwork to begin in May 2021.		Completed; survey of 19 mangrove forests completed.
M1.2g: Establish and re-survey long term mangrove plots within research sites.	Determined location of long term plots within each site, developed and finalized a long term monitoring methodology using pre-existing USGS methods, established and surveyed the plots.	In progress; locations TBD, but methods established. Fieldwork to begin in May 2021.	Completed re-survey of long term plots.	Completed; first survey of 19 mangrove forests completed. A subset of these will be re-surveyed annually starting in Year 3 (no Year 2 data, however).
M1.2h: Analyze long-term monitoring plot data.	Completed analysis of year 1 data.	In progress.	Completed analysis of year 2 data, including change over time analysis of years 1-2.	Incomplete; the first year of field data collection occurred in Year 2, so there is no change analysis.
M1.2i: Analyze cores for carbon storage.	Collected sediment cores at long-term monitoring site locations. Completed laboratory analysis of cores for organic matter (OM) as a proxy for carbon content. Initial analysis of year 1 cores completed.	In-progress; materials ordered, fieldwork to begin in May 2021.	Repeated collection of sediment cores at long-term monitoring site locations. Completed laboratory analysis of cores for OM. Analysis of year 2 cores completed, including comparisons to carbon storage from prior year.	Incomplete; cores for all permitted sites have been collected but not yet analyzed. Field data collection happened in Year 2 so there is no change analysis possible. Graduate student Julia Plotkin will analyze these cores as part of her thesis.
M1.2j: Share long-term monitoring results.				
Goal M2: Grow USVI Mangrove Restoration Opportunities. · Objective M2.1: Years 1-5: Examine where and how mangrove restoration can be implemented in the USVI · Objective M2.2: Years 3-5: Field test different mangrove restoration techniques to understand factors affecting resilience of seedlings. · Objective M2.3: Years 1-5: Grow the mangrove citizen science program. · Objective M2.4: Years 2-5: Evaluate the impacts of the mangrove citizen science program.				
Objective M2.1 Examine where and how mangrove restoration can be implemented in the USVI.	Specific milestones			
	Year 1	Progress	Year 2	
M2.1a: Apply for mangrove propagule collection permits.	Permits drafted, submitted, and approved.	Completed.		
M2.1b: Prepare, develop, and maintain a land-based nursery for mangrove seedling grow-out.	Researched mangrove nursery methods. Acquired materials and supplies needed for establishment of nursery infrastructure. Nursery established and fine-tuned to support sapling growth of all local mangrove species if possible.	Completed; methods researched, materials and supplies acquired, plumbed et nursery constructed (8 tables with 24, 45 gallon tanks).	Nursery maintained and fine-tuned.	Completed; nursery methods continue to be refined and number of tables expanded (25 tanks fully plumbed with fresh and salt-water on the flow-through system) and 9 unplumbed tanks.
M2.1c: Collect mangrove propagules for nursery stocking.	Propagule collection sites determined. Propagule tracking/tagging methodology established. Mangrove nursery database established. Initial propagules collected, tagged, added to the database and transferred to the nursery.	In progress; collection sites determined, initial propagules collected, database still under development.	Collection of additional propagules as needed for nursery grow-out and outplanting experiments.	Completed
M2.1d: Conduct water-table and field grow-out experiments.	Established experimental design for water-table and field grow out experiments for mangrove saplings. Experiments initiated and maintained. Results added to mangrove nursery database.	In progress; design almost completed, expect to begin in June 2021.	Experiments completed. Results added to mangrove nursery database. Nursery stocking techniques refined based on results.	In progress; one experiment examining the effects of container on red mangrove growth and survival was initiated in September 2021 and will run for 7 months. Graduate student Allison Hoelvoet will start her experiment looking at the effects of substrate and clumping on red mangrove growth and survival in late spring 2022.

M2.1e: Analyze mangrove nursery grow-out experiment results.	Analysis of year 1 nursery data initiated.	In progress; data collection to begin in June 2021.	Analysis of years 1-2 nursery data completed.	In-progress; most data have been entered, QA/QC process has begun, some preliminary results on survivorship have been completed.
M2.1f: Mangrove nursery grow-out methods, best practices, and results shared.			Graduate student thesis	In-progress; graduate student Allison Holevoet will begin her experiment in Spring 2022. Initial experimental infrastructure setup and material acquisition complete.
Objective M2.2 Field test different mangrove restoration techniques to understand factors affecting resilience of seedlings.	Specific milestones			
	Year 1	Progress	Year 2	
M2.2a: Determine mangrove restoration sites.				
M2.2b: Apply for mangrove outplanting permits.				
M2.2c: Conduct restoration experiments to investigate effects of spacing and bioturbator abundance on seedling resilience.				
M2.2d: Analysis of restoration experimental data.				
M2.2e: Mangrove restoration experimental outcomes shared.				
Objective M2.3 Grow the mangrove citizen science program.	Specific milestones			
	Year 1	Progress	Year 2	
M2.3a: Coordinate with existing partners and seek new partnership opportunities to support program development	Meet with partners to discuss program goals and strategies	Completed; met with VIMAS, NPS, H. Lavity Stoutt Community College, USGS, DPNR.		
M2.3b: Recruit program participants.	Develop recruitment materials. Advertise and begin participant recruitment	In progress; recruitment materials are being developed to align with program goals and strategies.	Recruit participants	In progress; application to UVI IRB submitted in March 2022 to conduct community listening sessions to inform program design.
M2.3c: Engage participants in mangrove restoration activities.	Engage participants in mangrove grow-out activities	Incomplete; we anticipate this will begin in July 2021 as the new post doc comes on board.	Engage participants in mangrove grow-out activities	Completed; 4 UVI undergraduates volunteered at the nursery this year.
Objective M2.4 Evaluate the impacts of the mangrove citizen science program.	Specific milestones			
	Year 1	Progress	Year 2	
M2.4a: Obtain UVI IRB approval.			Apply for and obtain IRB approval.	In progress; application to UVI IRB submitted in March 2022. We are awaiting a decision.
M2.4b: Develop and test assessment instruments.			Existing instruments tested for cultural relevance; embedded assessment activities identified and/or created	In progress; instruments have been developed but not yet tested. Pending UVI IRB approval.
M2.4c: Collect participant data.				
M2.4d: Analyze participant data.				
M2.4e: Communicate and build on research findings.				
Goal M3: Share USVI Mangrove Research with Stakeholders & Provide Opportunities for New Partnerships. · Objective M3.1: Years 1-5: Share mangrove research through Integration Activities (planned EOD and VI-ISERP activities, community events, and other opportunities). · Objective M3.2: Years 1-5: Provide opportunities for student training and enrichment. · Objective M3.3: Years 1-5: Participate in professional development opportunities that boost communication of research and strengthen partnerships.				
Objective M3.1 Share mangrove activities through Integration Activities (planned EOD and VI-ISERP activities, community events, and other opportunities).	Specific milestones			
	Year 1	Progress	Year 2	

M3.1a: Integration Activity: Share research through VI EPSCoR channels (e.g., promotions, announcements & blog posts).	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 2 products or events per year.	Completed; content provided for 6 social media posts on instagram.	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 2 products or events per year.	Completed; contributed content for 6 social media posts on instagram, newsletters (Summer 2021 and Spring 2022), and revised webpage content for the mangrove section.
M3.1b Share research through community outreach events (e.g., Reef Fest, Sip N' Science)	Participate in 1 event per year	Completed; 2021 St. Thomas Great Mangrove Cleanup.	Participate in 1 event per year	Completed; 2021 St. John Great Mangrove Cleanup, 2022 St. Thomas Great Mangrove Cleanup, 2022 Friends of the St. John National Park Earth Day Event. Infographics created and shared. One Science Saturday completed in July 2021.
M3.1c: Integration Activity: Participate in VI-ISERP activities.			Participate in summer institute	Completed; Grimes participated in Summer 2021.
M3.1d: Integration Activity: EPSCoR website development.	Review, advise & inform new content on viepscor.org website to accurately reflect R2R goals and achievements.	Completed; materials and revisions provided.		
M3.1e: Integration Activity: Annual EPSCoR Newsletter Development.	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Completed; materials and revisions provided for the newsletter.	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Completed; materials and revisions provided for the newsletter.
Objective M3.2 Provide opportunities for student training and enrichment.	Specific milestones			
	Year 1	Progress	Year 2	
M3.2a: Engage undergraduate students in mangrove research.	2 undergraduates engaged.	In progress; two UVI undergraduate students interviewed for summer research opportunities in the Grimes lab and will begin in June	2 undergraduates engaged.	Completed; 7 UVI undergraduate students have been engaged in mangrove research activities.
M3.2b: Engage graduate students in mangrove research.	2 graduate students engaged.	Completed; 4 UVI MMES students recruited to work on mangrove research and restoration goals.	2 graduate students engaged.	Completed; to-date, 6 UVI MMES students have been recruited to work on mangrove research and restoration goals.
M3.2c: Explore synergies for student training and enrichment with other partners and programs.	Opportunities explored as they arise.	Completed; opportunities leveraged with the SEAS Islands Alliance and NRT Strong Coasts.	Opportunities explored as they arise.	Completed; opportunities leveraged with the SEAS Islands Alliance and NRT Strong Coasts. Nursery tours for UVI clubs and classes and visiting classes (e.g., Yale).
Objective M3.3 Participate in professional development opportunities that boost communication of research and strengthen partnerships.	Specific milestones			
	Year 1	Progress	Year 2	
M3.3a: Participate in R2R writing workshops.	Workshop participation.	Incomplete; delayed to Year 2.	Workshop participation.	Completed though not as envisioned; Grimes, Durdall, and Stewart participated in VOWS writing workshops this year and the Grimes lab held a workshop for the lab in April 2022.
M3.3b: Attend and share research efforts at local, national and international conferences.	Participate in 1 conference per year.	Completed; 8 presentations at local, national, and international conferences.	Participate in 1 conference per year.	Completed; 11 presentations at local, national, and international conferences.
M3.3c: Integration Activity: Attend annual VI EPSCoR Conference.			Participate in VI-EPSCoR annual conference.	Completed; Grimes, Durdall, Stewart and graduate students participated in the Annual Conference in July 2021.

Emerging Areas: Brewers VPS Array, Beaches, Seagrass, *Sargassum* (EA)

Goal EA 1. Determine the impacts of invasive seagrasses that alter movement, habitat, and food resources for fish and sea turtle species and the growing effects of large volumes of *Sargassum*.
· Objective EA 1.1: Install Innovasea fine-scale positioning system to monitor the movement of tagged macrofauna (sea turtles, fish, and conch) in areas of changing seagrass communities.
· Objective EA 1.2: Acoustically tag an sea turtles and fish utilizing these areas susceptible to changes in seagrass communities and influxes of *Sargassum* to monitor their movement and relative population size.
· Considerations: local permits are expected to be accessed through VI-DPNR relatively easily, National Marine Fisheries Permits to handle turtles is under review. If the NMFS permit is declined Dr. Jobsis has been in discussion with Dr. K. Hart (USGS) for this project to be added to her current NMFS permit.

	Specific milestones			
Objective EA1.1	**Year 1**	**Progress**	**Year 2**	**Progress**
EA1.1a: Obtain permitting and equipment; ordering required for tagging sea turtles and fish.	Receive ten year NMFS permit, two year local permit, and equipment orders received.	UVI's IACUC board approved the research plan, The local Department of Fish and Wildlife permit for array installation and outreach with sea turtle project has been submitted. The national permit for inwater work with turtles was returned and will be resubmitted. The research can begin in July under the NOAA / NMFS permit of USGS researcher, Dr. Kristen Hart.	Annual NMFS and DPNR permit report completed.	DPNR permit was not required. New NMFS permit application was completed by Paul Jobsis on April 1st, 2022. The work remains covered under Dr. Hart's NMFS permit #20315
EA1.1b: Install acoustic receivers, Hobo temp loggers, DO2 Loggers.	Design and order additional Innovasea receivers, tags and batteries	The acoustic array has been designed and the appropriate tags, receivers and batteries have been ordered	Innovasea position system array installed. Download acoustic data and analyze every four months.	The FPS array was installed. A test download was completed after two week. The system is working well but two receivers needed to be and were moved. Per the manufacturers recommendation we will download the date every 6 months.
EA1.1c: Acoustic tracking student and postdoc engagement for turtle and fish tracking in changing seagrass beds, and *Sargassum* events.	Attract and enroll students interested in invasive seagrass and Movement Ecology/acoustic tracking. Advertise for Acoustic tracking Post-doc	MMES students Andrew McGregor and Taylor Brunson have been recruited to conduct research on movement ecology in Brewers Bay. Candidates for the Acoustic Tracking Post-doc have been interviewed.	Post doc hired, 2 MMES students engaged, 2 undergraduate students engaged	Post-doc Kayla Blincow-Israel was hired in Nov. of 2021. Graduate students Taylor Brunson and Andrew McGregor are engaged with the projects and their theses will be conducted using this data. Two undergraduate students, Keedencia Harris and Nicholas Durgendeen, have been helping with the project.
EA1.1d: Dropcam and sample seagrass beds quarterly randomly sampled in 100cm2 subplots quarterly		NA	Randomly sample 3 seagrass type beds within the array and use DropCam to characterize benthic habitat within the VPS array biannually.	Benthic sampling of seagrass beds with in the array has begun. It has not been focused on the species type. Instead they are focused on areas used by sea turtles.
EA1.1e: Brewers Bay Water quality sampling.	Collect water samples quarterly and test for standard water quality and nutrients.	Water samples were collected and analyzed by UVI's Environmental Analysis Laboratory	Collect water samples quarterly and test for standard water quality and nutrients.	Water samples are collected six times a year and processed by UVI Environmental Analysis Laboratory
EA1.1f: Outreach and Education.	1 blog post.	Research stories were submitted the VI-EPSCoR newsletter and website, which can be converted to a blog post. A news story was published about the (matching) funds from the National Save the Sea Turtle Foundation.	1 public sea turtle tagging event.	Two events were held but the size was limited due to COVID-19 and the current state of the marine center
Objective EA 1.2				
	Year 1	**Progress**	**Year 2**	
EA 1.2a: Acoustically tag sea turtles and fish.	Recruit students interested in movement ecology and acoustic tracking.	Completed	10 to 15 of each species tagged, engage/enroll students interested in acoustic tracking.	16 green turtles, 11 hawksbill turtles and 9 giant hermit crabs were tagged with V16p or V9 acoustic tags. Hermit crabs were used instead of fish. Fish will be tagged in year 3
EA 1.2b: Tag sea turtles (non-acoustic tags) for mark and recapture population estimates.	Recruit students interested in movement ecology and acoustic tracking.	Completed	Turtle and fish tagging (non acoustic) every four months to estimate population size in the affected areas.	Tagging was conducted on nearly a monthly basis. Giant hermit crabs were tagged instead of fish. Fish, likely stingrays, will be tagged in year 3
Research Team Cohesion: Integration Activity: List communication and collaboration activities developing within teams, across research sites and across disciplines.		Integration Activities: completed discussions with Dr Cruz-Rivera and his student Matt Souza about tagging conch in Brewers Bay; conch tags were purchased. Discussions with Dr. Nemeth (Fish Ecology) about duplication of Reef Bay parrotfish study in Brewers Bay. The two movement ecology studies (Reef Bay and Brewers Bay) personnel meet regularly and have tested equipment together.		

Goal EA 2: Quantify the role of seagrass type in short and long-term beach evolution.
· Objective EA 2.1: Quantify wave and water column velocities characteristics and difference between two species of seagrass under different conditions.
· Objective EA 2.2: Quantify sediment movement and shoreline evolution under different wave conditions, shoreward of different types of seagrass beds.

	Specific milestones			
Objective EA 2.1	**Year 1**	**Progress**	**Year 2**	
Activity EA 2.1a: Explore selected sites and acquire equipment and obtain permit(s).	Permit received for wave buoy, pressure transducer, and site; Registration and license to fly drones received, with appropriate exemptions for research when and where applicable.	Equipment received and tested. Planning extensive site work in the summer	Permits, licenses and registration from Year 1 renewed as appropriate.	Ongoing- Permits received for field work on beaches in St. Croix and St. John for shoreline change analysis. Permits not received for seagrass bed analysis due to delay in getting student and field work.
EA2.1b: Recruit student.	Identify graduate student at UVI or other EPSCoR jurisdiction to perform field work; identify and recruit undergraduate student at UVI to perform field work as appropriate.	Graduate student identified and recruited for Ph.D. position	Graduate student identified and recruited; identify new graduate student for following year as appropriate; recruit undergraduate student.	PhD student hired through University of South Alabama. The student is a foreign national, so she had to wait until Jan. 2022 to enter the United States, after Covid restrictions were lifted. An undergraduate student was recruited. Because of other commitment, she was replaced by another student who's continuing her work.
EA2.1c: Seagrass bed characteristics.			Measure characteristics of seagrass beds (density, stem diameter, stem height) for the two species in order to include them appropriately into the wave model.	Delayed due to delay in getting the student and field work started.
EA2.1d: Wave measurement and analysis.	Deploy and test wave buoy offshore of seagrass bed, in ~10 m water depth to establish offshore wave conditions outside of the shoaling and breaking region to model wave evolution; deploy and test pressure transducer in shallower water in regions with little or no seagrass for wave model calibration.	Equipment received and tested. Planning extensive site work in the summer	Deploy pressure transducers in various locations in and around seagrass fields and buoys offshore; calibrate wave model to identify appropriate friction coefficient associated with seagrass beds and wave attenuation caused by seagrass beds.	In progress - Field work has been delayed because of lack of graduate students. Work is now scheduled for Summer 2022
EA2.1e: Wave-induced current measurement and analysis.				
Activity EA2.1f: Align with Objective 1.2b				
	Specific milestones			
Objective EA 2.2	**Year 1**	**Progress**	**Year 2**	
EA 2.2a: Identify site(s), acquire equipment and obtain permits(s).	Permit received for wave buoy, pressure transducer, and site; Registration and license to fly drones received, with appropriate exemptions for research when and where applicable.	In progress- permits are in the process.	Permits, licenses and registration from Year 1 renewed as appropriate.	Ongoing- Permits received for field work on beaches in St. Croix and St. John for shoreline change analysis. Permits not received for seagrass bed analysis due to delay in getting student and field work.
EA 2.2b: Recruit student.	Identify graduate student at UVI or other EPSCoR jurisdiction to perform field work; identify and recruit undergraduate student at UVI to perform field work as appropriate.	Graduate student identified and recruited for Ph.D. position	Graduate student identified and recruited; identify new graduate student for following year as appropriate; recruit undergraduate student.	Graduate student has started working at University of South Alabama (USA) in January. Her arrival was delayed because she's European, and there was a COVID related travel ban for Europeans to enter the US. UVI submitted paperwork to NSF to provide a subaward to USA so they can support part of the graduate student studies. A site visit is being planned for the summer.
EA 2.2c: Sedimentation on seagrass beds.			Install sediment rods on seagrass meadows (two species) and outside the meadow to monitor sedimentation rates; get familiar with sedimentation monitoring and results reporting.	Delayed due to delay in getting the student and field work started.
EA 2.2d: Beach and bathymetric surveys.	Test and establish routine for beach survey and bathymetric survey with single beam sonar data measurement and post-processing.	Equipment received and tested. Planning extensive site work in the summer	Regularly survey beach and bathymetry.	We conducted surveys of 20 different beaches in the USVI, familiarizing ourselves with the instruments. These surveys are also baseline surveys that will be useful to later understand the periodic changes that they experience. More regular surveys at the sites chosen with the graduate student and collaborator at USA will follow.

Goal EA 3: Measure the spread of the invasive seagrass *Halophila stipulace*a in the territory and the mechanisms affecting its expansion.
- **Objective EA 3.1: Measure the distribution and expansion rate of the invasive seagrass.**
- **Objective EA 3.2: Determine the physiological tolerance of the invasive seagrass to environmental variation.**
- **Objective EA 3.3: Assess the role of herbivores as top- down control of *H. stipulacea.***
- **Objective EA 3.4: Quantify the effect of seagrass type on associated invertebrate communities.**

	Specific milestones			
Objective 3.1	**Year 1**	**Progress**	**Year 2**	**Progress**
EA 3.1a: Select sampling sites , apply for field permits and order tagging supplies.	Long term monitoring sites established; permits obtained; marking and measuring supplies purchased.	Sites have been determined in coordination, two permits have been obtained, some supplies have been obtained	Sampling permit renewal obtained; seagrass markers maintained or renewed, quadrats fixed or replaced.	Permit submitted

EA 3.1b: Marking seagrass beds and establishing long term transects.	Three *Halophila* beds at <5, ~15 and ~30 m marked and expansion rate measured 2 times a year.	Will begin summer 2021	Three *Halophila* beds at <5, ~15 and ~30 m marked and expansion rate measured 4 times a year.	Because of covid restrictions diving recertification was not possible. Transects will begin summer 2022
EA 3.1c: Monitoring of environmental conditions at expanding *Halophila* beds.	Measurements of temperature, salinity, PAR and photosynthesis at 2 times a year.	Will begin summer 2021	Measurements of temperature, salinity, PAR and photosynthesis at 4 times a year.	Linked directly to previous
EA 3.1d: Guidance of M.S. thesis on field.	Recruitment of interested graduate student, begin of student courses and research engagement.	Student Matthew Souza is being funded through this project	Student finishes required graduate courses and is engaged in research; student provides blog entry for EPSCoR site.	Accomplished. Souza's project well underway and projected to finish by summer 2022
Objective EA 3.2	Specific milestones			
	Year 1	**Progress**	**Year 2**	
EA 3.2a: Lab experiments on *Halophila* growth: light and salinity.		Delayed due to lack of research space	Purchase of growth lights, pots and filters; low-replication pilot experiment run.	Materials were purchased and received. Expected experiments begin summer 2022
EA 3.2b: Lab experiments on *Halophila* growth: light and temperature.		Delayed due to lack of research space	Purchase of heaters, pumps and reservoir tanks, trial run.	Delayed due to lack of research space.
EA 3.2c: Undergraduate student recruitment and training.		Student recruitment will not proceed until space issues	are resolved	Delayed due to lack of research space.
EA 3.2d: Proposal development.		A proposal with collaborators in FL and PR is in progress	Proposal submission based on preliminary data from trial runs.	Proposal was submitted but not funded
Objective EA 3.3	Specific milestones			
	Year 1	**Progress**	**Year 2**	
EA 3.3a: Feeding experiments with *Halophila* and native seagrasses.	Multiple choice laboratory experiments on relative palatability of *Halophila* vs. native seagrass	Will be conducted summer 2021	No-choice laboratory experiments on relative palatability of *Halophila* vs. native seagrass.	Completed - All experiments have been finished
EA 3.3b: Exploration of mechanism of deterrence.	Comparisons of nutrient profiles among studied seagrasses (protein, carbohydrates, lipids, C:N ratios).	Will begin summer 2021	Analysis of polyphenolics in seagrasses.	Samples have been collected and freeze-dried. Tests will be finished summer 2022
Activity EA 3.3c: Graduate student engagement.	Recruitment of interested graduate student, begin of student courses and research engagement.	M.S. student Jendahye Antoine is finishing her coursework to engage in this project; a thesis committee has been formed	Student finishes required graduate courses and is engaged in research; student provides blog entry for EPSCoR site.	Student Antoine is set to defend by the end of summer
Objective EA 3.4	Specific milestones			
	Year 1	**Progress**	**Year 2**	
EA 3.4a: Assessments of seagrass invertebrate diversity in *Halophila* and native meadows.	Long term monitoring sites established based on those of objective 3.1 to include native nearby beds; permits obtained; suction sampling begins twice a year.	To begin in June 2021	Sampling permit renewal obtained; supplies for sample preservation replenished, suction sampling continues twice a year.	In progress- Permit submitted
EA 3.4b: Description of new species.				
EA 3.4c: Proposal preparation.				
Goal EA 4: Analyze the effects of *Sargassum* golden tides on Virgin Islands ecosystems. **· Objective EA 4.1: Determine genetic diversity of golden tides.** **· Objective EA 4.2: Measure the effects of *Sargassum* accumulations of beach biota.** **· Objective EA 4.3: Measure the effects of decomposing algal accumulations on water quality.**				
Objective EA 4.1	Specific milestones			
	Year 1	**Progress**	**Year 2**	
Activity EA 4.1a: Establish sampling protocols; obtain permitting; purchase supplies.	Sampling protocols established; permits obtained; molecular genetics supplies purchased.	Sampling protocols have been determined; purchase of supplies is in progress	Molecular genetics supplies replenishment; collection permit renewed.	Supplies obtained; permit submitted
Activity EA 4.1b: Selecting UAB MS student.	Student identified and begins studies in Marine Biology at UAB.	Student Anna Smith has been recruited to begin studies Fall 2021	Student continues studies at UAB; student passes qualifying exam.	Student Alexis Oetterer has replaced previous student
Activity EA 4.1c: Collect samples; process samples.	Samples collected from min. 3 sites (~50 thalli per site); samples freeze-dried; DNA extracted.	Starting May 2021	Primers for HiPlex genotyping pipeline developed; year 1 bloom analyzed; year 2 bloom samples extracted.	Samples processes, shipped, and ready to analyze in July 2022
Activity EA 4.1d: Science communication via EPSCOR blog and The Molecular Ecologist/AGA blog	Krueger-Hadfield writes EPSCOR blog and one each for TIME and AGA.	Blog entries are pending on research conducted during travel to the VI. Due to covid restrictions, this will occur in September 2021	UAB student writes EPSCOR blog and TME and AGA about field work or recent papers on pop gen.	Blogs are dependent on research conducted during travel to the VI. Due to covid restrictions, this will occur in September 2022
Activity EA 4.1e: Capacity building.				A NASA proposal was funded.
Objective EA 4.2	Specific milestones			
	Year 1	**Progress**	**Year 2**	

Activity EA 4.2a: Select sampling sites , apply for field permits and order trapping and preservation supplies.				
Activity EA 4.2b: Measuring *Sargassum* effects on beach invertebrates with pitfall traps.				
Activity EA 4.2c: Identification and description of species.				
Activity EA 4.2d: Mentoring of a graduate student.				
Objective EA 4.3	Specific milestones			
	Year 1	**Progress**	**Year 2**	
Activity EA 4.3a: Permit application, election of sites with and without *Sargassum* and supplies purchase.				
Activity EA 4.3b: Measuring *Sargassum* decomposition effects on coastal nutrients.				
Activity EA 4.3c: Measuring *Sargassum* decomposition effects on coliform abundance.				
Activity EA 4.2d - Capacity building				

Fish Ecology (FE)				
Goal FE1: Advance our understanding of how natural and anthropogenic stressors on coral reefs change herbivore (i.e. parrotfish) assemblages. · Objective FE1.1: Determine if variability in resilience of coral reefs during 2005/2006 mortality event affected the composition of herbivore fish communities (greater shift from *Scarus* to *Sparisoma spp*. at low resilience sites). ·Objective FE1.2: Determine if variability in sedimentation rates onto coral reefs affected the composition of herbivore fish communities (negative relationship between sediment load and *Scarus spp*.).				
Objective FE1.1: Determine if variability in resilience of coral reefs during 2005/2006 mortality event affected the composition of herbivore fish communities	Specific milestones			
	Year 1	Progress	Year 2	Progress
Activity FE1.1a: Synthetic analysis of Territorial Coral Reef Monitoring data.	TCRMP fish and coral data compiled and organized from years before (2002-2005) and after (2006-2010) the 2005/2006 bleaching and disease mortality event.	MMES capstone project focused on data synthesis of coral resilience and herbivore communities and grazing rates. A second data synthesis initiated is focused on the response of herbivore community to coral reef decline.	Changes in herbivore fish and benthic communities compared statistically before (2002-2005) and after (2006-2010) the 2005/2006 mortality event. First draft of manuscript completed.	Data analysis completed and significant results obtained showing changes in parrotfish diversity, density and biomass following disturbance. First draft of manuscript in progress.
Objective FE1.2: Determine if variability in sedimentation rates onto coral reefs affected the composition of herbivore fish communities (negative relationship between sediment load and *Scarus spp*.).	Specific milestones			
Activity FE1.2a: Analyze historical data on terrestrial sedimentation rates and structure of herbivorous fish communities	Historical fish and sedimentation data compiled, QA/QC and preliminary statistical analysis completed	Sedimentation data has been compiled in form of manuscript by T. Smith (Henderson et al) and submitted.	Data of herbivore communities at sites with variability in sediment flux statistically analyzed. First draft of manuscript completed.	Data on parrotfish diversity, density and biomass and historical sedimentation rates over the past 20 years and across 23 sites were analysed. Significant effects of sedimentation on parrotfish biomass and composition were found. first draft of manuscript in progress.
Goal FE2: Advance our understanding of how benthic characteristics of impacted reefs affect feeding rates and reproduction (frequency of spawning, fecundity) of herbivorous parrotfishes. ·Objective FE2.1: Determine if feeding rates of *Sparisoma* and *Scarus spp* are affected differently by differences in benthic algal composition and sediment loads. ·Objective FE2.2: Determine if frequency of spawning and fecundity of *S. rubripinne* are affected by differences in benthic algal composition and sediment loads.				
Objective FE2.1: Determine if feeding rates of *Sparisoma* and *Scarus spp* are affected differently by differences in benthic algal composition and sediment loads	Specific milestones			
	Year 1	Progress	Year 2	
Activity FE2.1a: Measure differences in sediment flux among parrotfish feeding sites.	Undergraduate student recruited. Sediment trap locations identified and sediment collectors installed in Reef Bay (n=20 distributed within two target feeding areas). Sediment traps collected monthly, sediment flux measured and terrigenous component determined.	Undergraduate students recruited (Keedencia Harris, Samual Gittens). Sediment traps installed Sept 2021 following NPS permit approval. Graduate student Race Stryker recruited to work with marine sediments and watershed dynamics lead David Hensley	Sediment traps collected monthly, sediment flux measured and terrigenous component determined. Data from first 12 months analyzed.	Sediment from sediment cups collected monthly since October 2021. Sediment samples currently being analyzed by graduate students Jenna Cheramie and Race Stryker.

Activity FE2.1b: Measure differences in algal composition and height and sediment load in filamentous algae.	Benthic and algal composition data collection sites identified. Methods for algal composition, turf height and sediment load in filamentous algae initiated.	Data collection sites identified and tiles matrices installed Sept 2021 following NPS permit approval July 2021.	Data collected on algal composition, turf height and sediment load in filamentous algae using standardized benthic assessment methods in feeding areas (links to Reef Resilience). Standardized limestone tiles deployed in parrotfish feeding areas and sedimentation in filamentous algae measured.	Limestone tiles deployed Sept 2021. Benthic data collected monthly since October 2021 and currently being analyzed by graduate students Jenna Cheramie.
Activity FE2.1c: Measure feeding rates of a *Scarus* and *Sparisoma* species in areas that differ in algal cover and sedimentation	NPS research permit application submitted, feeding locations identified, graduate student recruited.	NPS research permit submitted and approved July 2021. MMES Graduate student Jenna Cheramie recruited. Two parrotfish spawning sites and feeding areas identified.	Feeding areas and feeding habitats quantified and feeding rates of 30 yellowtail parrotfish (*Sparisoma rubripinne*) measured from two sites that differ in benthic algal composition and sediment loads.	Feeding areas and feeding habitats quantified and feeding rates of 30 yellowtail parrotfish (*Sparisoma rubripinne*) measured from two sites that differ in benthic algal composition and sediment loads.
Activity FE2.1d: Measure differences in parrotfish diet among feeding sites that differ in algal composition and sediment load.		IACUC application approved.	Parrotfish collected (see 2.2.2) and digestive tract sent to UPR for diet analysis. Lab-based metabarcoding analysis conducted of stomach contents of yellowtail parrotfish feeding in areas that differ in benthic algal composition and sediment loads. One UVI undergraduate student hosted in Dr. Schizas lab.	Fish collections completed (April 11-15), fish guts dissected and DNA extracted and sent to lab for diet metabarcoding analysis. Gonads collected for fecundity analysis.
Objective FE2.2: Determine if frequency of spawning and fecundity of *S. rubripinne* are affected by differences in benthic algal composition and sediment loads.	Specific milestones Year 1	Progress	Year 2	
Activity FE2.2a: Measure frequency of spawning of *S. rubripinne* that feed in areas that differ in benthic algal composition and sediment loads.	NPS research permit application submitted, locations for acoustic array identified, equipment purchased. Acoustic receivers installed in Reefs Bay and range testing initiated. Recruiting process for post doc started. Graduate student recruited.	NPS permit submitted and approved July 2021. Receiver QA/ QC testing completed. Locations for receiver array identified. Movement ecology postdoc interviews in progress. MMES Graduate student Jenna Cheramie recruited.	Post-doc hired. Range testing completed. Acoustic data downloaded and receiver array maintained every 6 months. *S. rubripinne* tagged with acoustic transmitters from two feeding sites (n=15/ feeding site) and at two spawning sites (n=15/ site).	Post Doc Kayla Blincow-Israel hired Nov 2021. Receivers array (n=54) installed and range testing completed. Sixty yellowtail parrotfish tagged at 6 different feeding sites (n=10/site) in Sept 2021.first 6 mo acoustic data download completed Feb 2021. Preliminary data analysis done.

Activity FE2.2b: Measure fecundity of *S. rubripinne* that feed in areas that differ in benthic algal composition and sediment loads.			Ten (10) female *S. rubripinne* from two spawning aggregation sites collected every four months over two years to determine seasonal and site specific differences in fecundity, Lab based analysis conducted on fecundity (estimate number of eggs in ovaries), gonad-somatic index (ratio of body weight to gonad weight) and condition factor (ratio of length to weight) of female *S. rubripinne* from two spawning aggregation sites.	Fish collections completed (April 11-15) and fish dissected for diet metabarcoding analysis and gonads. These fish were collected from feeding grounds as fish migrated to spawning aggregation sites (not at spawning site) to ensure that fish have not yet spawned and had full ovaries.
Activity FE2.2c: Conduct direct and remote observations of spawning activity of *S. rubripinne*.	Methods (visual, auditory) developed for remotely recording spawning activity at two *S. rubripinne* spawning aggregation sites.	Remote camera/hydrophone used to collect preliminary data at primary *S. rubripinne* spawning aggregation site.	Direct observations conducted on a monthly basis of spawning activity at two *S. rubripinne* spawning aggregation sites.	Direct observations and counts of spawning adults at two sites completed multiple times monthly. First trial video/hydrophone deployment started Apr 2022.
Goal FE3: Improve our understanding of oceanographic and environmental variables that influence reproductive rates (frequency of spawning and fecundity) of coral reef fish that spawn in aggregations. · Objective FE3.1: Determine which oceanographic and environmental variables (current speed and direction, seawater temperature, wave height, salinity, turbidity, wind speed, rainfall) are most important for frequency of spawning at aggregation sites. ·Objective FE3.2: Determine which Oceanographic and environmental variables are most important for reproductive output of *S. rubripinne*.				
Objective FE3.1: Determine which oceanographic and environmental variables (current speed and direction, seawater temperature, wave height, salinity, turbidity, wind speed, rainfall) are most important for frequency of spawning at aggregati.	Specific milestones			
	Year 1	Progress	Year 2	Progress
Activity FE3.1a: Measure oceanographic features at spawning aggregation sites.			Suite of oceanographic and environmental sensors deployed and other sources of data from ocean buoys, thermistors, weather stations, etc. incorporated into analysis.	Signature AWAK with echosounder installed at both fish spawning sites in January 2022. First data download in March 2022. ADCP had technical issues which were resolved. A second trial deployment occured Apr 6-14, 2022 and data is being analyzed.
Objective FE3.2: Determine which Oceanographic and environmental variables are most important for reproductive output of S. rubripinne.	Specific milestones			
	Year 1	Progress	Year 2	Progress
Activity FE3.2a: Measure fecundity of *S. rubripinne* that feed in areas that differ in benthic algal composition and sediment loads.			On-site plankton collection methods developed using diver operated plankton nets and collection bags.	This work is scheduled to begin in May 2022. Delayed due to departure of Sennai Habtes. Currently in the process of recruiting a graduate student.
Activity FE3.2b: Examine egg and pre-flexion larvae dispersal patterns.				
Goal FE4: Share results of Fish Ecology Research with Stakeholders & Provide Opportunities for New Partnerships. · Objective FE4.1: Years 1-5: Share Fish Ecology research through Integration Activities (planned EOD and VI-ISERP activities, community events, and other opportunities). · Objective FE4.2: Years 1-5: Provide opportunities for student training and enrichment. · Objective FE4.3: Years 1-5: Participate in professional development opportunities that boost communication of research and strengthen partnerships.				

Objective FE4.1: Share fish ecology activities through Integration Activities (planned EOD and VI-ISERP activities, community events, and other opportunities).	Specific milestones			
	Year 1	Progress	Year 2	
Activity FE4.1a: Integration Activity: Share research through VI EPSCoR channels (Promotions, announcements & blog posts).	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 2 products or events per year.	Nemeth and Cheramie contributed article on parrotfish project to annual VI-EPSCoR newsletter.	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 2 products or events per year.	Provided text and photos for 1 blog post
Activity FE4.1b: Share research through community outreach events (e.g., Reef Fest, Sip N' Science).	Participate in 1 event per year.	Shared research on parrotfish herbivory project at informal gathering to generate interest in Sip N' Science at new venue. Nemeth and grad student Kayla Budd participated in Reef Fest mangrove cleanup activity and used opportunity to promote watershed management awareness through mobile app for reporting environmental issues.	Participate in 1 event per year.	Kayla Budd promoted sediment awareness with a virtual demonstration at a Science Saturday event. R. Nemeth solicited the diving community to report on rainbow parrotfish sightings. This citizen Science effort resulted in 27 sightings of 70 rainbow parrotfish.
Activity FE4.1c: Integration Activity: EPSCoR website development.	Review, advise & inform new content on viepscor.org website to accurately reflect R2R goals and achievements.	Updated VI-EPSCoR website with new information on parrotfish project.	Review, advise & inform new content on viepscor.org website to accurately reflect R2R goals and achievements.	Photos and text submitted to Elisa to update Fish Ecology website.
Activity FE4.1d: Integration Activity: Annual EPSCoR Newsletter Development.	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Nemeth and Cheramie contributed article on parrotfish project to annual VI-EPSCoR newsletter.	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Provided text and photos for 2 newsletters.
Objective FE4.2: Provide opportunities for student training and enrichment.	Specific milestones			
	Year 1	Progress	Year 2	
Activity FE4.2a Engage undergraduate students in fish ecology research.		Keedencia Harris participated in seagrass research along with R. Nemeth and graduate student Sophie Costa. She is completing her scuba certification and will begin to assist on parrotfish project his summer.	1 undergraduates engaged as intern with Univ. of Puerto Rico (N. Schizas lab - see FE2.1d).	Samuel Gittens (Fall 2021) and Gregory O'Neill (Spring 2022) completed directed independent research in Nemeth lab. Fifteen (15) undergraduates engaged in field methods for fish ecology in Fall 2021.

Activity FE4.2b Engage graduate students in fish ecology research.	1 graduate students engaged	Five graduate students engaged in a variety of fish ecology research (Sophie Costa, Kayla Budd, Danielle Olive, Jenna Cheramie and Maksym Cohen), including effects of invasive seagrass on juvenile snapper demographic rates, effects of coral disease on cleaning goby populations, life history characteristics of mutton snapper under different management, effects of sedimentation and benthic algae community on parrotfish life history characteristics and influence of oceanographic patterns on grouper spawning behavior, respectively.	2 graduate students engaged.	Seven (7) graduate students worked on thesis research in fish ecology including Sophie Costa, Kayla Budd, Danielle Olive, Macsym Cohen, Jenna Cheramire, Sierrah Mueller and Taylor Hobbs. Fourteen (14) graduate students engaged in field methods for research diving in Fall 2021.
Objective FE4.3: Participate in professional development opportunities that boost communication of research and strengthen partnerships.	Specific milestones Year 1	Progress	Year 2	
Activity FE4.3a:Participate in R2R writing workshops.	Workshop participation.	no progress	Workshop participation.	Workshop was not organized due to COVID
Activity FE4.3b: Attend and share research efforts at local, national and international conferences.	Participate in 1 conference per year.	no progress due to COVID	Participate in 1 conference per year.	Nemeth lab submitted 7 abstracts to ICRS for 2021 but in-person presentations were postponed to July 2022 due to COVID. One presentation was conducted virtually at ICRS in July 2021 by Danielle Olive: "Olive, Danielle A., Virginia Shervette, Molly Stevens, Jeremiah Blondeau, Richard S. Nemeth "An Evaluation of Life History Characteristics of Mutton Snapper, Lutjanus analis, in the U.S. Virgin Islands". Six (6) abstracts were submitted to ICRS for July 2022.
Activity FE4.3c: Integration Activity: Attend annual VI EPSCoR Conference.		Attended and presented at VI-EPSCoR annual conference 14-15 July, 2021.	Participate in VI-EPSCoR annual conference.	Provided two presentations at VI-EPSCoR annual conference in July 2021. Presentations were "Connecting the dots between watershed management, coral reefs, and parrotfish" and "Meet the Scientists: Tools and Technology to measure spawning frequency and reproductive output.

Research Team Cohesion: Integration Activity: List communication and collaboration activities developing within teams, across research sites and across disciplines.		Surveyed Fish Bay gut with David Hensley (Activity # WL1.1b, WL1.2b); Working with Tyler Smith on the coral resilience data synthesis (CR1.1d, CR1.2e,f:); Assisted Kristin Grimes with acquiring historical mangrove restoration data from St. John (M1.1b), working with Sennai Habtes on acquisition of oceanographic instrumentation (OC1.1a) and plankton sampling strategy (OC1.2a); Edwin Cruz-Rivera helping on plankton identification for seagrass project (E3.4a) and assisting his student on seagrass sample collections and expansion rates (EA3.1b)		Shared data with Edwin Cruz-Rivera on invertebrate collections in seagrass beds (E3.4a). Cruz-Rivera and Habtes assisted my graduate (Sophie costa) and undergraduate (Gregory O'Neill) students in plankton identification. Facilitated sediment data analysis with Hensley's graduate student (Race Stryker). Shared data analysis on coral reef disturbance and sedimentation on parrotfish diversity, density and biomass with Tyler Smith ((CR1.1d, CR1.2e,f). Shared observation of SCTLD coral disease prevalence in Reef Bay study sites with Marilyn Brandt (MD 1.1a).

Oceanography (OC)				
Goal OC1: Quantify the influence of oceanographic and environmental variables on the variability in reproductive rates (frequency of spawning and fecundity) of S. rubripinnis. · Objective OC1.1: Determine which oceanographic and environmental variables (current speed and direction, seawater temperature, wave height, salinity, turbidity, wind speed, rainfall) are relevant at spawning aggregation sites and other R2R research sites. · Objective OC1.2: Determine (quantify) the frequency of spawning of S. rubripinnis at Reef Bay, St. John. . Objective OC1.3: Determine fecundity (abundance of eggs and reflection larvae) of S. rubripinnis at Reef Bay, St. John during spawning periods;				
	Specific milestones			
Objective OC1.1	Year 1	Progress	Year 2	Progress
Activity OC1.1a: Deploy suite of oceanographic and environmental sensors and utilize other sources of data from ocean buoys, thermistors, weather stations, etc), including terrestrial R2R measurements if available.	Define desired parameters and spatial/ temporal scales of measurements required to address objective. - Plan and execute site surveys and develop deployment plans and oceanographic and environmental sensor requirements considering important habitat locations and model resolution. -Select the appropriate equipment for experiment sites and secure quotes. - Complete inventory and best use analysis of newly purchased and existing oceanographic sensors, identify appropriate sites, and develop deployment protocols. - Create detailed list of all measured parameters (Oceanographic, Environmental, and Terrestrial) at reef bay site and other sites relevant to Oceanography R2R research.	Full list of available oceanographic data in the US Caribbean is being compiled by Dr. Habtes in collaboration with researchers from the CFMC. A subset of the most suitable data for use in the reef bay study will be combined with UVI long term datasets appropriate for analysis. All data from UVI instrumentation (adcp's, CTD's, hobo loggers) have been QA/QC'd and archived. Current oceanography equipment has been surveyed, 6 new instruments have been purchased and existing equipment maintained and calibrated. Preliminary surveys have been completed at reef bay by R. Nemeth, and descriptions of the sites have been communicated to S. Habtes. Deployment and sampling protocols are in development.	Complete purchase of a Nortek aquadopp Acoustic Doppler Current Profiler (ADCP)/ Signature AWAC and SeaBird 19plus moored CTD for Reef Bay H&O site, these are suggested equipment but best available equipment will be determine based on site surveys and best use analysis conducted in year 1. - Complete purchase of between 2 and 4 AWAC's or 2 ADCP and 2 wave buoys for Reef Bay and other R2R sites. - Develop deployment, data management, and equipment maintenance plans for all listed equipment. - Complete Deployment of all oceanographic equipment at R2R research sites.	In progress: Deployment of moored thermistor string with real-time data transmission at Grammanik Bank to measure and monitor full water column T-S structure and variability at this important mesophotic coral reef and fish spawning location. (D. Wilson / T. Smith, Planned for May/June 2022) Signature AWAK with echosounder installed at both fish spawning sites in January 2022. First data download in March 2022. ADCP had technical issues which were resolved. A second trial deployment occured Apr 6-14, 2022 and data is being analyzed.
Activity OC1.1b: Examine statistical relationship between oceanic and environmental variables on reproductive output (using data from OCE1.2).	- Develop and organize time-series database,for all oceanographic, environmental, and terrestrial data collected at reef bay site and from other external sources (i.e. ocean buoys, thermistor string, weather stations) OCE1.1a. - Identify appropriate statistical model for examining the influence of oceanic and environmental variables on reproductive output.	Existing UVI time-series data has been QA/QC'd and archived, review of determining appropriate datasets is in progress, along with research to identify appropriate statistical methods for analysis. Further progress was delayed until the data from UVI instrumentation was archived and prepared for analysis, and research in conjunction with the CFMC has identified pertinent longterm datasets in the US Caribbean.	- Identify appropriate statistical data program, complete background research and begin compiling a model/analysis of the relationship between predictor variables (oce, env., ter.) on *S. rubripinne* reproductive output. - Run preliminary test of model/analysis using NOAA NMFS USVI CRER database of larval Scaridae and *Sparisoma* abundance.	In progress: PostdocKayla Blincow-Israel Israel is starting to work with Ocean technician Vanessa McKague on learning acoustic Doppler wave and current logger (AWAC) data output. We are still in the testing phase of the echosounder data and working with Nortek engineers to refine the sensor calibrations to detect parrotfish egg densities at spawning sites. We are also testing the ability of remote cameras to collect data on frequency of spawning rushes at two spawning sites. Lasly, with Dr. Habtes no longer an active participant, we are not able to run preliminary test of model/ analysis using NOAA NMFS USVI CRER database of larval *Scaridae* and *Sparisoma* abundance.
	Specific milestones			
Objective OC1.2	Year 1	Progress	Year 2	
Activity OC1.2a: Conduct plankton tows at spawning sit	- Complete site surveys at Reef Bay. - Conduct literature search on *Scarid* and *Sparisoma* pelagic larval duration and early life history. - Use information from surveys and literature search to design ichthyoplankton survey and collection protocols. -Identify meristic/phenotypic characteristics of larvae or eggs (if possible) to use in analysis. - Advertise for graduate and undergraduate Research Assistants for OCE1.2a/ OCE1.3a.	Site surveys at reef bay conducted by R. Nemeth, and site information communicated to S. Habtes during planning meetings. Literature search for *Scarid* and *Sparisoma* completed as part of completed MS research by K. Ewen. Survey design is in progress, delayed due to leave of absence requested by S. Habtes until determination of sampling abilities and priorities determined by R. Nemeth. Recruitment of undergraduate and graduate students within oceanography delayed until succession plan for lead researcher within the oceanographic research area is determined.	- Summarize data on *S. rubripinne*. - Recruit 1 MMES graduate student and 1 UVI undergraduate students for projects related to understanding the influence of appropriate R2R predictor variables on *S. rubripinne* reproductive output for OCE1.2a/OCE1.3a.	Completed: We have recruited 1 graduate student, Taylor Hobbs, to assist in field and lab work when egg collections begin. We have also recruited undergraduate Tara Thompson, who will start video analysis documenting number of yellowtail parrotfish present and spawning frequency at each spawning site.
	Specific milestones			

Objective OCE1.3	Year 1	Progress	Year 2	
Activity OC1.3a: Collect eggs at spawning sites to identify fecundity potential during spawning aggregations and understand the influence of oceanographic and anthropogenic	- Complete site surveys at Reef Bay, use information to design collection of egg clouds via SCUBA/ship. - Design SCUBA/ship net sampling egg collection apparatus. - Design survey and collection protocols for egg collection during spawning. - Advertise for graduate and undergraduate Research Assistants for OCE1.2a/OCE1.3a.	Site surveys at reef bay conducted by R. Nemeth, and site information communicated to S. Habtes during planning meetings. Literature search for *Scarid* and *Sparisoma* completed as part of completed MS research by K. Ewen. Survey design is in progress, delayed due to leave of absence requested by S. Habtes until determination of sampling abilities and priorities determined by R. Nemeth. Recruitment of undergraduate and graduate students within oceanography delayed until succession plan for lead researcher within the oceanographic research area is determined.	- Conduct sampling of *S. rubripinne* fecundity from egg clouds at Reef Bay. - Use NOAA NMFS CRER cruise to collect eggs/larvae at standard US Caribbean stations. - Summarize data on *Sparisoma spp.* from NOAA SEFSC CRER Database. - Recruit 1 MMES graduate student and 1 UVI undergraduate students for projects related to understanding the influence of appropriate R2R predictor variables on *S. rubripinne* reproductive output for OCE1.2a/OCE1.3a.	In progress: We have collected yellowtail parrotfish females from four parrotfish feeding areas to examine fecundity. Next month we will also attempt to collect egg clouds by hand, with nets or plastic bags, in lieu of plankton tows that Dr. Habtes was going to do.
Goal OC2: Determine larval dispersal pathways from point-source spawning aggregation sites of *S. rubripinne*. · Objective OC2.1: Use ichthyoplankton abundance data and regional ROMS model to model dispersal, and if possible retention, pathways. · Objective OC2.2: Increase the resiliency of the oceanographic research capacity (personnel and equipment) within UVI.				
	Specific milestones			
Objective OC2.1	Year 1	Progress	Year 2	
Activity OC2.1a: Develop realistic and accurate hydrodynamic outputs from the US Caribbean Regional Ocean Modelling System for use by the Connectivity and Biodiversity research component and a wider audience of US Caribbean stakeholders.	- Develop an US Caribbean coastal ocean model (USCCOM) based on the ROMS architecture with fine resolution nested grids for STX and STT/STJ (300 m) that cover the R2R research sites. - Iterative testing of the nested grid outputs compared to current and temperature measurements in the nearshore areas. - Develop LTRANS connectivity module to model larval dispersal of S. rubripinne, E. striatus, L. analis from spawning locations.	In progress- The US Caribbean Coastal Ocean Model (USCCOM), a primitive equation numerical modeling system for the US Caribbean coastal ocean based on the ROMS AGRIF (Regional Ocean Modeling System with Adaptive Grid Refinement in Fortran) architecture developed. Post-doc S. Mukherjee is familiarizing himself with the use of the LTRANS module for dispersal module with USCCOM outputs.	- Integrate the USCCOM with data assimilation for better prediction of ocean properties. - Develop computing infrastructure and protocols for data sharing between UVI and connectivity modeling researcher (D. Holsteing at LSU). - Secure 1 source of extramural funding to extend physical oceanographic research from Postdoc S. Mukherjee.	Completed - USCROMS model finalized and published (Mukherjee et al. 2022. J. Opr. Oceanogr.), 330 m over the entire US Caribbean, data produced for years 2019 and 2020, manuscript in prep. on oceanographic dynamics from model, model runs shared to Daniel Holstein who is incorporating into a connectivity modeling system, a proposal (Jobsis and Wilson) was submitted in March 2022 to the Office of Insular Affairs "***Development of Strategies for Sargassum Mitigation in the US Virgin Islands Using Oceanographic Methods and Modeling***" that would partially support Dr. Mukherjee if funded.
Activity OC2.1b: Integrate oceanographic variables, coral reef condition, parrotfish reproductive output, and connectivity models parameterized from regional ocean models and time series of synoptic remotely sensed data (Chlorophyll a, Sea Surface Temperatures, Sea Surface Height Anomalies, etc)	- Summarize all available oceanographic, environmental, and terrestrial R2R data for use in mixed statistical model. - Identify appropriate statistical model and parameterization.	Full list of available oceanographic data in the US Caribbean is being compiled by Dr. Habtes in collaboration with researchers from the CFMC. A subset of the most suitable data for use in the reef bay study will be combined with UVI long term datasets appropriate for analysis. All data from UVI instrumentation (adcp's, CTD's, hobo loggers) have been QA/QC'd and archived	- Historical data analysis and model testing using CRER database and larval abundance and R2R Reef Bay data.	In progress: We are in process of collecting data on oceanographic variables and coral reef condition. We will be able to estimate parrotfish reproductive output from fecundity and spawning visitation rates of females but other calibrating reproductive output using AWAC data and plankton tows are uncertain at this time due to equipment calibration issues and Dr. Habtes departure, respectively.
	Specific milestones			
Objective OC2.2	Year 1	Progress	Year 2	

OC2.2a: Develop more permanent physical and human infrastructure to conduct oceanographic research.	- Solicit quotes, and select contractors, and begin 55' Derecktor ANB oceanographic equipment upgrades. - Complete vessel stability testing and design of winch and frame for installation. - Secure at least 2 extramural funding sources (i.e. NSF MRI proposal or CariCOOS EOI) to supplement salary for oceanographic personnel and needed equipment upgrades for coastal research vessel. - Develop working group for vessel management, use, and associated infrastructure for vessel maintenance and development. - Review and approve Org chart for vessel management and operations (in development by VI-EPSCoR Admin and CMES director.	A list of available vendors and quotes for suite of necessary equipment and upgrades to the vessel required for development of an operational coastal oceanographic research vessel is under development by Dr. Habtes, and will be delivered to VI EPSCoR administration prior to his leave of absence. They can decide on how to proceed once a determination has been made on whether to continue a the vessel program without a lead oceanography researcher, or when one has been put in place. Drs. Habtes, Jobsis, and Wilson have identified at least 3 sources of funding and have been collaborating on developing the preliminary documents to use in submission of proposals. A working group of VI EPSCoR researchers and administration and at least 4 outside members which have vessel program experience has been developed. We are still awaiting an organizational chart of vessel management responsibilities from VI-EPSCoR Admin and CMES director.	- Installation of oceanographic winch and frame for ichthyoplankton sampling as part of OCE1.3. - Identify and secure extramural funding to hire coastal ocean vessel captain and engineer.	Completed - Given the lack of focused administration in the oceanography program and the lack of a clear stream of funding to support the medium sized RV Derektor it was decided to sell the vessel and use the proceeds to pursue a smaller research vessel with a faster cruising speed. This vessel would put the entire USVI waters in a days range, suport diving operations as the core of marine R2R activities, and other light oceanographic projects. Submitted a proposal (Wilson and Jobsis) to National Science Foundation Major Research Instrumentation Program in January 2021 ***MRI:Acquisition of Ocean Gliders for Marine Science Research Support at the University of the Virgin Islands***
Goal OC3: Share USVI Oceanography Research with Stakeholders & Provide Opportunities for New Partnerships · Objective OC3.1: Share oceanography research through Integration Activities (planned EOD and VI-ISERP activities, community events, and other opportunities). · Objective OC3.2: Provide opportunities for student training and enrichment. · Objective OC3.3: Participate in professional development opportunities that boost communication of research and strengthen partnerships.				
Objective OC3.1 Share oceanography research through Integration Activities (planned EOD and VI-ISERP activities, community events, and other opportunities)	Specific milestones Year 1	Progress	Year 2	
OC3.1a: Integration Activity: Share research through VI EPSCoR channels (Promotions, announcements & blog posts).	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 2 products or events per year.	Provided submissions to VI EPSCoR for annual newsletter and website.	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 2 products or events per year.	Completed - working on a blog post with EPSCoR to highlight the oceanographic program.
	Participate in 1 event per year.	co-authors on two published papers (Marine Ecology Progress Series & Aquatic Botany), and authors on one submitted paper under review (Journal of Operational Oceanography. Three presentations on our research at conferences, workshops, and online meetings. A presentation and panel discussion at the 2020 SACNAS, National Diversity in STEM Conference; a panel discussion for the GEO REU Workshop Series: Elements of an REU; and a panel discussion for #BlackinMarineScienceWeek.	Participate in 1 event per year.	Completed: Made presentation at annual VI-EPSCoR conference and introduced concept of using various technologies (remote video camera, AWAC) to document reproductive output at yellowtail parrotfish spawning aggregation sites.

OC3.1c: Integration Activity: Participate in STEM Faculty Support, Resilience Leaders, and Service Learning Program activities.	Coordinate with EOD to develop integration activities in STEM Faculty Support, Resilience Leaders, and Service Learning Program activities.	Participated in EOD surveys to identify interest for collaboration. Collaborations are planned for later years.	Participate in 1 event per year.	Due to leave of absence, S. Habtes did not participate in integration activity. However his MMES advisee, Naomi Scott, was TA for SCI 100 for two years including Fall 2021 and Spring 2022. This role encompassed teaching labs to approximately 40 students per semester and helping to explain the service learning option to students.
OC3.1d: Integration Activity: EPSCoR website development.	Review, advise & inform new content on viepscor.org website to accurately reflect R2R goals and achievements.	Website text was developed and published on the website in February 2021.		
OC3.1e: Integration Activity: Annual EPSCoR Newsletter Development.	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Developed newsletter article on the development of the USCCOM, March 2021	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Completed - Contributed to the April 2022 EPSCoR newsletter with a segment "Oceanography" written by Dr. T Smith.
	Specific milestones			
Objective OC3.2 Provide opportunities for student training and enrichment.	Year 1	Progress	Year 2	
OC3.2a: Engage undergraduate students in oceanography research.	Advertise and recruit.	Not completed due to leave of absence by S. Habtes	2 undergraduates engaged.	Completed: Two Undergraduate students recruited by Doug Wilson via lecturing in MSC 239 have participated in joint UVI-OCOVI-Rutgers University ocean glider field activities; both have applied to the Rutgers summer 2022 Glider Camp.
OC3.2b:Engage graduate students in oceanography research.			1 graduate student engaged (OCE1.2a/b).	Completed: We are recruiting graduate student Taylor Hobbs to assist on plankton collection at Reef Bay study site.
OC3.2c: Explore synergies for student training an enrichment with other partners and programs.	opportunities explored as they arise.	developed opportunities for collaborative research between R2R and NSF Strong Coasts NRT.	opportunities explored as they arise.	2 UVI Undergraduate students have applied to the Rutgers summer 2022 Glider Camp. (OC3,2a)
	Specific milestones			
Objective OC3.3 Participate in professional development opportunities that boost communication of research and strengthen partnerships.	Year 1	Progress	Year 2	
OC3.3a: Participate in R2R Coral Resilience workshop, R2R data working groups, and stakeholder meetings relevant to R2R (i.e. CFMC, DPNR, etc..)	Workshop and working group meeting participation.	S.Habtes chair of CFMC EBFM TAP, attended 2 EBFM TAP meetings and 4 CFMC meetings. R2R Coral Resilience workshop delayed until later in the year or during year 2, and are waiting for scheduled R2R working group meetings later in the year.	Workshop and working group meeting participation.	In Progress - Dr. Mukherjee working with Dr. T. Smith to provide oceanographic data outputs for the Marine Resilience analysis with a workshop to be held in Year 3.

OC3.3b: Attend and share research efforts at local, national and international conferences, meetings, or workshops.	Participate in 1 per year.	co-authors on two published papers (Marine Ecology Progress Series & Aquatic Botany), and authors on one submitted paper under review (Journal of Operational Oceanography. Three presentations on our research at conferences, workshops, and online meetings. A presentation and panel discussion at the 2020 SACNAS, National Diversity in STEM Conference; a panel discussion for the GEO REU Workshop Series: Elements of an REU; and a panel discussion for #BlackinMarineScienceWeek.	Participate in 1 per year.	Completed - USCROMS model presented: Mukherjee S, Wilson D, Habtes S, Jobsis P, Smith TB. "The impact of submesoscale turbulence and internal tides on the US Caribbean ocean circulation: A modeling study" 2022 Ocean Sciences Meeting, March 3. D. Wilson, Session Co-chair *Session OT17 Ocean Observation for the Small Island Developing State (SIDS)* and presenter *The Need for Innovative Ocean Observing Tools for Small Island Developing States*. Archived Presentation, 2022 Ocean Sciences Meeting.
OC3.3c: Integration Activity: Attend annual VI EPSCoR Conference.		Planned attendance in July of 2021	Participate in VI-EPSCoR annual conference.	Completed: Made presentation at annual VI-EPSCoR conference and introduced concept of using various technologies (remote video camera, Signature ADCP) to document reproductive output at yellowtail parrotfish spawning aggregation sites.

Marine Disease and Restoration (MD & MR)				
Goal MD1: Determine how species biodiversity affects the spread and impact of coral disease · Objective MD1.1: Test how variability in species assemblages affects disease prevalence across reef habitats · Objective MD1.2: Compare disease incidence among experimental species assemblages				
Objective MD1.1. Test how variability in species assemblages affects disease prevalence across reef habitats	Specific milestones			
	Year 1	Progress	Year 2	Progress
MD1.1a: Quantify disease across species assemblages using existing datasets	Datasets on disease and species composition identified and compiled.	Completed	Analysis of disease and species assemblages completed.	Completed
Objective MD1.2: Quantify disease incidence among experimental species assemblages	Specific milestones			
	Year 1	Progress	Year 2	
MD1.2a: Involve MMES student and undergraduates in experiment.			Recruitment of MMES student and undergraduate(s).	In progress
MD1.2b: Acquire necessary permits for experimentation.			Permits applied for/acquired.	Completed
MD1.2c: Experimentally test disease transmission in mesocosms with specific species compositions.			Experiment initiated.	In progress
Goal MD2: Determine how local stressors (e.g., nutrients, turbidity) and global stressors (e.g., temperature stress) drive temporal and spatial distributions of disease. · Objective MD2.1: Test effect of water quality and temperature stress on disease prevalence and transmission.				
	Specific milestones			

Objective MD2.1: Test effect of water quality and temperature stress on disease prevalence and transmissioned.	Year 1	Progress	Year 2	
MD2.1a: Use existing data sets to investigate disease prevalence in relationship to locally driven water quality parameters and temperature stress.			Data sets on local water quality parameters, thermal stress and disease prevalence compiled - output from Coral Resilience section.	In progress. Water quality sampling has occurred in 3 consecutive months in each of the wet and dry seasons. Data are in process of being analyzed and collated with existing data sets.
MD2.1b: Involve MMES student and undergraduate in experiments.				
MD2.1c: Acquire necessary permits for experimentation.				
Activity MD2.1d: Perform lab-based transmission experiment under different levels of temperature stress (levels: no stress, moderate, severe). These experiments will be disease transmission experiments among experimental corals. We will adapt the methods of Williams et al. 2020.				
MD2.1e: Perform lab-based transmission experiment under different levels of local water quality parameters determined to be important in Activity MD2.1a.				
Goal MD3: Predict the spread and impact of multi-species coral disease. · Objective MD3.1: Develop a connectivity-based disease spread model. · Objective MD3.2: Develop species assemblage map for region. · Objective MD3.3: Test effect of influential species assemblage parameters (identified under Goal 1.1) and influential water quality parameters (identified under Goal 1.2) on disease spread model accuracy.				
	Specific milestones			

Objective MD3.1: Develop connectivity-based disease spread model.	Year 1	Progress	Year 2	
MD3.1a: Use hydrodynamic model outputs to parameterize a connectivity model for the northern Virgin Islands.			Produce final metrics/model runs to assign network placement for long-term coral reef sites and spatially randomized sites (aligns with Coral Resilience)	Completed: Post-doc Sonaljit Mukherjee has provided ROMS simulations to D. Holstein for parameterization of connectivity model
	Specific milestones			
Objective D3.2: Develop coral species assemblage map for region	Year 1	Progress	Year 2	
MD3.2a: Identify and combine data sources for coral species assemblages from existing long-term and spatially randomized coral reef monitoring programs	Team assembled and working towards database production of stony coral diversity at long-term sites [links to Coral Resilience Objectives CR1.2a and 1.2b].	Completed	Database of diversity at long-term sites completed [links to Coral Resilience Objective 1.1.b].	Completed
MD3.2b: Produce basic species distribution grid.			Identify/develop spatial grid.	Species distribution data assembled. Grid in progress.
	Specific milestones			
Objective MD3.3: Test effect of influential species assemblage parameters (identified under Goal 1) and influential water quality parameters (identified under Goal 2) on disease spread model accuracy	Year 1	Progress	Year 2	
Activity D3.3a: Hire post-doc				
MD3.3b: Use model framework to determine how species diversity (Goal 1.1) and water quality (Goal 1.2) affect coral disease spread.				

Goal MD4: Share Disease Research with Stakeholders through participation in outreach and education activities. · Objective MD4.1: Share information through planned EOD and VI-ISERP activities. · Objective MD4.2: Participate in professional development activities.				
Objective MD4.1: Share information through planned EOD and VI-ISERP activities.	Specific milestones			
	Year 1	Progress	Year 2	
MD4.1a: Share research through VI EPSCoR channels (Promotions, announcements & blog posts).	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 1 product or event per year.	Completed	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 1 product or event per year.	Completed
MD4.1b: Share research through community outreach events (e.g., Reef Fest, Sip N' Science).	Participate in 1 event every other year.		Participate in 1 event every other year.	Presenting TEDx talk April 2022.
Activity D4.1c: Integration Activity: Participate in VI-ISERP activities	TDB		TDB	M. Brandt presented to and participated in STEM Institute PBL Certification Program as a presenter and mentor
MD4.1d: Integration Activity: EPSCoR website development.	Review, advise & inform new content on viepscor.org website to accurately reflect R2R goals and achievements.			M. Brandt provided information to communications team for website updates.
MD4.1e: Integration Activity: Annual EPSCoR Newsletter Development.	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Completed	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	M. Brandt provided information and photos for annual newsletter.
Goal MR1: Expand capacity for restoration ecology research in the US Virgin Islands. · Objective R1.1: Hire Restoration Ecologist Research faculty.				
	Specific milestones			

Objective MR1.1. Hire Restoration Ecology Research faculty.	Year 1	Progress	Year 2	
MR1.1a: Hire faculty	Develop request for proposal for Research faculty; advertise through UVI Human Resources; Assemble hiring committee; Review applicants.	Position description developed, Position advertised and committee formed for review. Top candidates interviewed and one top candidate invited for presentations. Top candidate selected and offered the position.	Restoration Ecologist position begins.	New Restoration Ecologist Dr. Robin Smith started in September 2021.
Goal MR2: Determine how diversity affects success of coral outplanting. · Objective MR2.1: Compare growth and survival of outplanted corals among different species configurations.				
	Specific milestones			
Objective MR2.1. Compare growth and survival of outplanted corals among different species configurations.	Year 1	Progress	Year 2	
MR2.1a: Involve MMES student and undergraduate in experiments.			Recruitment of MMES student and undergraduate(s).	Six graduate and 5 undergraduate student interns trained in coral restoration techniques. One MMES student (D. Strobel) recruited for thesis work on coral outplanting.
MR2.1b: Acquire necessary permits for experimentation.			Permits applied for/acquired.	Permits for coral outplanting acquired.
MR2.1c: Perform lab-based transmission experiment under different levels of temperature stress.			Permits required and experiment started.	Permits acquired. Multi-species outplanting experiment commenced in January 2022.
Goal MR3: Determine how gradients in water quality affect success of coral outplanting. · Objective MR3.1: Measure growth and survival of outplanted corals across range of water quality.				
	Specific milestones			

Objective MR3.1: Measure growth and survival of outplanted corals across range of water quality.	Year 1	Progress	Year 2	
MR3.1a: Involve MMES student and undergraduate in experiments.				
MR3.1b: Acquire necessary permits for experimentation				
MR3.1c: Outplanting at sites representing a range of water quality				
Goal MR4: Share Restoration Research with Stakeholders through participation in outreach and education activities. · Objective MR4.1: Share information through planned EOD and VI-ISERP activities.				
	Specific milestones			
Objective MR4.1: Share information through planned EOD and VI-ISERP activities	Year 1	Progress	Year 2	
MR4.1a: Share research through VI EPSCoR channels (Promotions, announcements & blog posts)	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 1 product or event per year.	Complete	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 1 product or event per year.	Contributed content for press releases and blog posts.

MR4.1b: Share research through community outreach events (e.g., Reef Fest, Sip N' Science).	Participate in 1 event every other year.		Participate in 1 event every other year.	Presenting a TEDx talk April 2022.
MR4.1c: Integration Activity: Participate in VI-ISERP activities.	TDB		TDB	M. Brandt presented to and participated in STEM Institute PBL Certification Program as a presenter and mentor
R4.1d: Integration Activity: EPSCoR website development.	Review, advise & inform new content on viepscor.org website to accurately reflect R2R goals and achievements.	Complete		M. Brandt provided information to communications team for website updates.
R4.1e: Integration Activity: Annual EPSCoR Newsletter Development.	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Complete	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	M. Brandt provided information and photos for annual newsletter.

Coral Resilience (CR)				
Goal CR1: 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. · Objective CR1.1: Create a comprehensive database of external drivers (biophysical regimes) at 42 long-term research sites, with emphasis on describing stressors, disturbance, and other processes that have a potential influence on reef resilience at each location. · Objective CR1.2: Create a comprehensive database of the internal drivers (biological characteristics and processes) at 42 long-term research sites, with an emphasis on factors that have a potential influence on coral reef resilience. · Objective CR1.3: Develop metrics describing biological resilience (resistance and recovery) at 42 long-term research sites, including trajectories of diversity and abundance of corals and associated biota · Objective CR1.4: Identify gaps in knowledge within databases of biophysical drivers and response variables at each location that need additional information. · Objective CR1.5: Conduct analysis of the influence of biophysical drivers on coral reef resilience across sites, identify most critical internal and external drivers on ecosystem resilience and targets for restoration of resilience.				
Objective CR1.1. External Drivers	Specific milestones			
	Year 1	Progress	Year 2	Progress
CR1.1a: Assemble and analyze temperature regimes at long-term coral reef monitoring sites by assembling an expert working group to identify metrics and gaps in knowledge.	Team assembled and working towards database production.	In progress	Database produced of thermal regimes. Characteristics of thermal regimes analyzed (long-term means, variability, thermal extremes/marine heat waves, drivers such as doldrums and Amazon/ Orinoco river plumes).	In progress - QA/QCed database assembled. Working with Sonaljit Mukherjee and Doug Wilson to analyze processes. Database needed for resilience study is complete. Need to determine which metrics (e.g., mean, thermal stress, variability) to include in the analysis
CR1.1b: Assemble and analyze wave and benthic orbital velocity regimes at long-term coral reef monitoring sites by assembling an expert working group to identify metrics and gaps in knowledge.	Team assembled and working towards database production.	In progress	Database produced of wave and benthic orbital velocity regimes. Characteristics of wave regimes analyzed (long-term means, variability, extremes and potential for disturbance, cumulative energy).	In progress - QA/QCed database assembled. Database needed for resilience study is partially completed. Need to verify model outputs and benthic orbital velocities accurately represent the wave climate at the monitoring sites. A manuscript is in preparation on storm wave impacts on coral reefs using outputs from the Simulation of Waves Nearshore Model.
CR1.1c: Assemble and analyze current regimes at long-term coral reef monitoring sites by assembling an expert working group to identify metrics and gaps in knowledge.	Team assembled and working towards database production.	Incomplete; Awaiting publication of finalized ocean current products	Produce a description of the benthic current regimes at each of the long-term monitoring sites based on the hydrodynamic model.	In progress - the USCROMS model completed and published (Mukherjee et al. 2022). Need to extract the current metrics at monitoring sites to be used in the resilience study.
CR1.1d: Assemble and analyze water quality regimes at long-term coral reef monitoring sites by assembling an expert working group to identify metrics and gaps in knowledge.	Team assembled and working towards database production.	In progress	Explore the use of the connectivity modeling system to develop a vulnerability index of each long-term monitoring site to land-based run off of sediments and pollutants.	In progress - Optical properties database based on remote sensing created for each site (partners: Joseph Ortiz, Kent State U. and K. Adem Ali, College of Charleston). A manuscript is in revision for water quality regimes (Adem K, *Flanagan D, Brandt ME, Ortiz J, Smith TB (in revision) Semi-analytical inversion modelling of Chlorophyll a variability in the U.S. Virgin Islands. PLoS ONE).
CR1.1e: Compile physical oceanography drivers into geographic surfaces to characterize the physical regimes around the USVI.			Georeferenced surface of physical oceanography regimes produced.	In progress - Outputs from the CR1.1 physical objectives are coming in.
Objective CR1.2. Internal Drivers	Specific milestones			
	Year 1	Progress	Year 2	
CR1.2a: Assemble data of coral species and attribute diversity at 42 long-term coral reef monitoring sites.	Team assembled and working towards database production of stony coral diversity at 42 long-term coral reef monitoring sites.		Database of diversity at 42 long-term coral reef monitoring sites completed. Analysis of site groupings using multivariate statistics to provide background material for understanding attributes of 42 long-term coral reef monitoring sites.	In progress - Database has been assembled. Multivariate analysis has not yet been started. However, metrics of diversity are ready for the resilience analysis.

CR1.2b: Assemble data and analyze internal drivers of marine disease at 42 long-term coral reef monitoring sites by assembling an expert working group to identify metrics and gaps in knowledge.	Team assembled and working towards database production of disease incidence and diversity at 42 long-term coral reef monitoring sites.	In progress	Database of marine disease incidence completed at 42 long-term coral reef monitoring sites.	In progress - Database has been assembled. Needs to be QA/QCed and alternate metrics need to be calculated for sites not with the coral health methodology of the Territorial Coral Reef Monitoring Program.
CR1.2c: Assemble data and analyze internal drivers of nuisance species (Ramicrusta, lionfish) at 42 long-term coral reef monitoring sites.	Team assembled and working towards database of the distribution of Ramicrusta textilis (encrusting red algae) and Pterois volitans (lionfish) at 42 long-term coral reef monitoring sites.	In progress	Database of invasive species completed. Manuscript on the spatio-temporal patterns of Ramicrusta and peyssonnelia algal crusts at 42 long-term coral reef monitoring sites.	In progress - Database has been assembled. Needs to be QA/QCed and alternate metrics need to be calculated for sites not with the coral health methodology of the Territorial Coral Reef Monitoring Program. Manuscript on Ramicrusta emergence in the USVI is in the writing phase (analyses completed). To be submitted by the end of 2022. Data on lionfish to be presented at the International Coral Reef Symposium.
CR1.2d: Other Invertebrate Diversity at 42 long-term coral reef monitoring sites.	Team assembled and working towards how to assemble a database of invertebrate biodiversity at 42 long-term coral reef monitoring sites.	In progress	Determination made of how to measure this level of diversity. Database of non-coral sessile and motile invertebrates at long-term sites potentially completed completed.	In progress - Database has been assembled. Needs to be QA/QCed and alternate metrics need to be calculated for sites not with the coral health methodology of the Territorial Coral Reef Monitoring Program.
CR1.2e: Fish Diversity at 42 long-term coral reef monitoring sites.	Team assembled and working towards database of fish diversity at 42 long-term coral reef monitoring sites.	In progress	Database of diversity at 42 long-term coral reef monitoring sites completed. Analysis of site groupings using multivariate statistics to provide background material for understanding attributes of 42 long-term coral reef monitoring sites.	In progress - Database has been assembled. Needs to be QA/QCed and alternate metrics need to be calculated for sites not with the fish survey methodology of the Territorial Coral Reef Monitoring Program.
CR1.2f: Herbivory at long-term coral reef monitoring sites.	Team assembled, metric of herbivore pressure agreed to, and working towards database of herbivore pressure at 42 long-term coral reef monitoring sites.	In progress	Produce final metrics, a model of herbivore pressure based on diversity, size, and biomass of herbivores, and database of herbivore pressure.	In progress - Masters of Marine and Environmental Science students (2020 Cohort) investigated herbivory as part of their year 1 capstone. Finalizing analysis to publish manuscript. Need to determine a final metric of herbivore pressure for use in the resilience analysis.
CR1.2g: Management Regimes at long-term coral reef monitoring sites.	Team assembled and working towards database production of management regimes across the 42 sites.	In progress	Estimate levels of protections and vulnerability to fishing and physical damage at each site. Produce final metrics, complete database of management effectiveness.	In progress - Working group needs to determine the best metrics for level of protection. Working on manuscript to determine the role that depth has a refuge of fishes from fishing pressure.
CR1.2h: Connectivity at long-term coral reef monitoring sites.	Team assembled and working towards modeling of connectivity among 42 long-term coral reef monitoring sites.	Incomplete; Awaiting publication of finalized ocean current products	Produce final metrics/model runs to assign network placement for 42 long-term coral reef monitoring sites and spatially randomized sites in Goal 2.	In progress - USCROMS has been finalized and outputs transferred to Dr. Daniel Holstein. Connectivity model is being created based on USCROMS and can then be parameterized to create a connectivity matrix for the long-term sites and to conduct other R2R analyses.
CR1.2i: Rugosity (proxy) at long-term coral reef monitoring sites.	Team assembled and working towards database production rugosity at 42 long-term coral reef monitoring sites	In progress	Produce final metrics and database at 42 long-term coral reef monitoring sites.	In progress - Database has been assembled. Needs to be QA/QCed and alternate metrics need to be calculated for sites not with the coral health methodology of the Territorial Coral Reef Monitoring Program.

CR1.2j: Coral Health (indicator) at long-term coral reef monitoring sites.	Team assembled and working towards database production of coral health (bleaching and partial mortality) at 42 long-term coral reef monitoring sites. Team to determine how to prepare metrics to be best used in the resilience analysis.	In progress	Produce final metrics and database at 42 long-term coral reef monitoring sites.	In progress - Database has been assembled. Needs to be QA/QCed and alternate metrics need to be calculated for sites not with the coral health methodology of the Territorial Coral Reef Monitoring Program.
CR1.2k: Coral Interactions at long-term coral reef monitoring sites.	Team assembled and working towards database production of coral interactions (algae, sponges, sediment, predation, territorial damselfish) at 42 long-term coral reef monitoring sites. Team to determine how to prepare metrics to be best used in the resilience analysis.	In progress	Produce final metrics and database at 42 long-term coral reef monitoring sites.	In progress - Database has been assembled. Alternate metrics need to be calculated for sites not with the coral health methodology of the Territorial Coral Reef Monitoring Program. Working with Masters student Erin Hollister to look at TCRMP interactions data as part of her thesis and as a stand-alone publication. She is analyzing data now.
	Specific milestones			
Objective CR1.3. Resilience Metrics	Year 1	Progress	Year 2	In progress
CR1.3a: Develop metrics describing biological resilience (resistance and recovery).	Team assembled and analyzing coral cover, abundance, and diversity trends at 42 long-term coral reef monitoring sites.	In progress	Produce final metrics (dependent variables, responses of coral community) to be used in the analyses of resilience.	In progress
	Specific milestones			In progress
Objective CR1.4. Gaps	Year 1	Progress	Year 2	Progress
CR1.4a: Identify gaps and seek additional information.	Collate gaps from working groups and identify gaps that might be important in understanding coral reef resilience.	Incomplete; Deliverables pushed back one year to allow for in-person meeting after COVID-19 restrictions	Collect information to address important gaps (if any).	Incomplete; Deliverables pushed back one year to allow for in-person meeting after COVID-19 restrictions
	Specific milestones			In progress
Objective CR1.5. Analyses	Year 1	Progress	Year 2	Progress
	Layout the framework for the statistical modeling, identify data		Finalize statistical modeling framework and finalize data sets for analyses	In progress
CR1.5b: Conduct analyses of resilience.	Prepare hiring documents for a resilience postdoctoral associate and advertise position.	In progress	Once components are assembled, conduct analysis of resilience drivers. Hire post-doc early in Y2.	In progress - Postdoc job announcement is in preparation. To be closed after the International Coral Reef Symposium, July 2022. Will use that event to recruit.
CR1.5c: Conduct workshop with participants to go over results of resilience analysis, identify and last tasks, and plan outputs and manuscripts.				
CR1.5d: Prepare synthesis manuscript (s) on drivers of coral reef resilience.				
Goal CR2: Understand the impact of regional larval connectivity patterns on biodiversity patterns. · Objective CR2.1: Develop regional connectivity model for coral reef organisms. · Objective CR2.2: Determine network and habitat connectivity metrics and corresponding estimates of biodiversity. · Objective CR2.3: Analyze the relationship between realized diversity and connectivity, stress, and past disturbances.				
	Specific milestones			
Objective CR2.1	Year 1	Progress	Year 2	

CR2.1.a: Develop model.	Develop connectivity model for the USVI using hydrodynamic model outputs. [Links to OC2.1a and MD3.1a]	Incomplete; Awaiting publication of finalized ocean current products	Use hydrodynamic model finalized in year one to parameterize a connectivity model.	In progress - USCROMS has been finalized and outputs transferred to Dr. Daniel Holstein. Connectivity model is being created based on USCROMS and can then be parameterized to create a connectivity matrix for the long-term sites and to conduct other R2R analyses.
Objective CR2.2	Specific milestones			
	Year 1	Progress	Year 2	
CR2.2.a: Determine network patterns.			Run model across sites with known biodiversity metrics.	Incomplete; Awaiting finalization of connectivity model; Biodiversity databases from the National Coral Reef Monitoring Program, Deep Coral Reef Monitoring Program, and others are ready for incorporation.
Objective CR2.3	Specific milestones			
	Year 1	Progress	Year 2	
CR2.3.a: Combine biophysical data sets and connectivity analysis to see if connectivity is related to diversity				
Goal CR3: Share Coral Reef Resilience Research with Stakeholders through participation in outreach and education activities. · Objective CR3.1: Share information through planned EOD and VI-ISERP activities. · Objective CR3.2: Participate in professional development activities.				
Objective CR3.1: Share information through planned EOD and VI-ISERP activities	Specific milestones			
	Year 1	Progress	Year 2	
CR3.1a: Share research through VI EPSCoR channels (Promotions, announcements & blog posts).	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 1 product or event per year.	In progress	Assist with information dissemination by advising communications department on achievements, activities and items of import. Provide photos when possible. Allow time for interviews and development of blog posts. Contribute 1 product or event per year.	In progress - Marine resilience material has been contributed to EPSCoR promotions.
CR3.1b: Share research through community outreach events (e.g., Reef Fest, Sip N' Science).	Participate in 1 event every other year.	In progress	Participate in 1 event every other year.	Incomplete - Pause of in person events during pandemic
CR3.1c: Integration Activity: Participate in VI-ISERP activities	TDB	Incomplete; Deliverables pushed back one year to allow for in-person meeting after COVID-19 restrictions	TDB	Incomplete; Deliverables pushed back one year to allow for in-person meeting after COVID-19 restrictions
CR3.1d: Integration Activity: EPSCoR website development.	Review, advise & inform new content on viepscor.org website to accurately reflect R2R goals and achievements.	Completed; Assisted with website content		In progress - Marine resilience material has been contributed to EPSCoR newsletters and website.
CR3.1e: Integration Activity: Annual EPSCoR Newsletter Development.	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	Completed; Assisted with newsletter content	Assist communication department with relevant content for annual VI-EPSCoR newsletter. This includes providing photographs, essays, quotes, etc.	In progress - Marine resilience material has been contributed to EPSCoR newsletters and website.

EWFD (WF)				
Goal WF1. To integrate resilience research themes (i.e. mangrove restoration, coral reef ecosystems, and land-sea interactions) into teacher professional development to improve K-12 student preparation. . Objective WF1.1: To build STEM community dedicated to developing and implementing research-based best practices in teacher development practices and in student learning using environmental resilience research within the local context. . Objective WF1.2: To build long-lasting STEM community partnerships for increase sustainability of the VI-ISERP center				
	Specific milestones			
Objective WF 1.1	Year 1	Progress	Year 2	Progress
WF 1.1a: Facilitate a series of annual Summer Teacher Workshops open to all K-12 educators in the Territory, intensive professional development on pedagogical best practices, ecosystem resilience curricula, STEM content knowledge, STEM career knowledge, and emergent needs.	One meeting held with VIDE to coordinate summer workshops, needs assessment completed with teachers and R2R faculty to identify workshop themes, summer workshops facilitated for 50 educators.	Met with VIDE and R2R researchers. Needs assessment completed for Summer Institute with R2R faculty inclusion in offerings.	One meeting held with VIDE to coordinate workshops, needs assessment completed with teachers and R2R faculty to identify workshop themes, summer workshops facilitated for 50 educators.	Met with VIDE and R2R researchers. Needs assessment completed for Summer Institute with R2R faculty inclusion in offerings. First summer event completed with 89 teacher and administrator participants.
WF 1.1b: Initiate SI PBL-Certificate program to serve as structure for developing and maintaining enhanced PLCs.	Curriculum designed for certificate program. Website created to host description of program and cohort information.	Website in process. Certificate program completed with a online/virtual communication plan.	Enroll first cohort (N=8) in the certificate program, secure two R2R/UVI faculty engaged in resilience research to mentor PLCs. Two R2R faculty present during Summer Workshops, and listed as mentors for PLCs during the academic year. R2R faculty review curriculum development, provide feedback, and organize one field experiential learning experience for teachers. Cohort teachers design two PBL curricula lesson plans.	Three R2R/UVI faculty recruited representing curricula development in mangrove restoration, coral restoration, and agriculture. Some attrition issues with recruited teachers due to increased responsibilities based on COVID-19 district requirements (N=3). Additional recruitment planned with curricula development and review scheduled for 2022 STEM Institute in June.
WF 1.1d: Conduct formative evaluation on PD Program Structure.	Six virtual workshops conducted during the academic year (pedagogy, online teaching, emergent themes), over 300 hours of PD certificates granted. Assessment and evaluation conducted with an internal report.	Completed.Directors for STEM Institute facilitated 10 Teacher Talk Fridays with local teachers to address identified needs from COVID-19 in technology and distance learning pedagogy.	Six virtual workshops conducted during the academic year (pedagogy, online teaching, emergent themes), over 300 hours of PD certificates granted. Assessment and evaluation conducted with an internal report.	Completed. Director for STEM Institute facilitated 10 Teacher Talk Fridays with local teachers to address identified needs from COVID-19 in technology and distance learning pedagogy. Team facilitated 6 pedagogy focused session for math, science, and art integration.
WF 1.1e: Hire two undergraduate student workers, one for each campus	Create contract, job description, outline expectations, advertise positions, hire two students for Year I Summer.	Completed. Hired 2 undergraduate research student workers. Hired a graduate student withtravels savings due to COVID-19 to facilitate student training	Hire new student workers as needed due to turnover (e.g. students graduating, etc).	Loss of 2 undergraduate student workers due to COVID-19 restrictions and international student HR requirements. Retained graduate student researcher. Hired undergraduate student for summer.
	Specific milestones			
Objective WF 1.2	Year 1	Progress	Year 2	
WF1.2a: Initiate SI PBL-Certificate program to serve as structure for developing and maintaining enhanced PLCs.	Create protocols for forming community partnerships/begin to foster relationships.	Protocol plans started with mentor teachers in alignment with PBL-Certificate program	Organize and facilitate training on securing and maintaining community partners, create two new community partnerships.	Team training facilitated, team registration with CAISE grant development informational sessions, team participation in CASL pre-conference NSF grant proposal development session (CREA Conference). Facilitated 4 training sessions in partnership with Microsoft, Subsume, Teacher Tech Knowledge, Code.org, and ARMS/ Micro:bit. Established CSTA-USVI through the Computer Science Teacher Association, the 100th Chapter to combat lack of CS-teachers in USVI.
WF1.2b: Hire two Master Teachers on four year contract to help mentor teachers in PBL certificate program and to help secure and maintain community partners.	Create contract, job description, outline expectations, advertise positions.	Completed. Created contract, job description, outline expectations and advertising for position	Hire two candidates, one on each island.	Two master teachers hired for STT and STX

WF1.2c: Facilitate culmination event with community partners	Design Culmination event.	Not started. The disruption of Covid-19 prevented planning.		Not started. The disruption of Covid-19 prevented planning.
WF1.2d: Establish a Stakeholder Network.	Research the relevant stakeholders within DOE, VIDE, local schools, community STEM organizations, and UVI faculty for inclusion in a VI-ISERP network.	Faculty and student offices have been identified and alerted of the stakeholder network. A meeting is planned for Fall 2021.	Annual dissemination of Center Newsletter and stakeholder meeting.	Newsletter template developed and articles for each component. Centralized based for center materials. Letters of invitation distributed to stakeholders with meeting requests for May 2022. Newsletter distribution will be done June 15th.
Goal WF2: Increase recruitment, retention, and persistence of URM undergraduates in STEM and resilience-related majors, minors, and certificate programs. . Objective WF2.1: Double the number of first year students participating in STEM and resilience-themed experiential learning opportunities that promote an interest and affinity for STEM, from currently 10% to at least 20%. . Objective WF2.2: Provide 10% of sophomore and junior students with deeper, resilience-themed experiential learning opportunities that promote retention and persistence in a STEM major, minor or certificate program; and STEM-related career goals.				
	Specific milestones			
Objective WF 2.1	Year 1	Progress	Year 2	
WF2.1a: Develop and implement service learning and resilience focused curricula within freshman-level courses (SCI 100 & SSC 100).	Analyze existing quant and qual data from SCI 100 (2018-2020); SSC 100 course development to incorporate service learning & overall social justice theme.	Qualitative data from SCI 100 yielded two publications; additional quant/qual analysis during summer of Year 1 identified tracks of resilience-themed experiential learning. SSC 100 course on STT has integrated new modules this year. Summer 2021 meetings identified common themes for projects across the two courses, including disaster preparedness, public health (COVID-19 and healthcare disparities), and climate change impacts and policy.	Establish complementary learning outcomes and assessments across SCI 100 / SSC 100.	Resilience-themed experiential learning was employed in both SCI 100 and SSC 100 during AY 2021-2022. The number of student participants nearly doubled, from 19 (2020-2021) to 33 (2021-2022), meeting Objective WF2.1. Existing and aspirational student learning outcomes were assessed in March 2022. Utilizing student feedback and analysis of projects during AY 2021-2022, updated learning outcomes will be identified during Summer 2022. One tool being utilized is the AAC&U VALUE rubric on critical thinking, to compare trademarks of this outcome across students who conducted experiential learning projects, versus students pursuing traditional research papers.
WF2.1b: Evaluate the impact of resilience-themed experiential learning on first year students' interest in and affinity for STEM.	Develop focus group methodology; recruit student & service partner participants; identify UVI sources of student tracking (Institutional Research).	Focus group methodology & recruitment plan was planned for the summer of Year 1 with social science faculty and was delayed due to the unavailability of one team member. Ideas for student tracking were explored during AAC&U Virtual Institute in June 2021. In Year 2, tracking mechanisms were identified in collaboration with UVI's Center for Student Success, using the institution's advising tracking system.	Run focus groups for students and partners to gather data on outcomes and impacts to date.	Focus group questions were drafted in Summer 2021. Implementation has been delayed by the halt on in-person human subjects research. This restriction was just lifted at UVI in March 2022. During Spring 2022, we are utilizing feedback surveys from SCI 100 and SSC 100 students in order to solicit information that will inform the finalization of focus group questions - this work and IRB updates (to include in-person focus groups) is slated for Summer 2022.
	Specific milestones			
Objective WF 2.2	Year 1	Progress	Year 2	

WF2.2a: Develop and implement a (sustainable) Resilience Leaders program .	Investigate structures for resilience leaders program (UVI Center for Resiliency and Sustainability, certificate program, Center for Student Success, internships/senior seminars); ID goals for job placement of RL program (% students placed after graduation; breadth of employers/schools).	Discussion has started regarding RL program structures and will be continued during summer of Year 1. Current focus is on new interdisciplinary degrees at UVI, within which the other components can be added. RL program goals will be drafted during summer of Year 1.	Recruit former SL participants for resilience-related internships as pilot approach for upper-level students; choose & pursue one of options to institutionalize RL program.	Four former SL participants recruited to co-author peer-reviewed book chapter due August 2022. Resilience Leaders pathways identified through new Physics concentration in Engineering (two courses on Islands Systems Resilience that Guannel will assess starting Spring 2023; focus of BCSER proposal submitted March 2022). Involvement of ten undergraduate student instructors and researchers identified as fulfilling Resilience Leader goals.
WF2.1b: Assess the impact of participation in the RL program on student retention, persistence, and career goals.				
Goal WF3: To support student/ faculty research infrastructure via support for pre and in-service STEM workforce, with the goal to increase STEM career interest, skills, and retention. .Objective WF3.1: To develop mechanisms of support and development for STEM students (undergraduate and graduate) for career skill development, research productivity, and retention. .Objective WF3.2: To develop mechanisms of support and development for early-career STEM faculty for career skill development, research productivity, and retention.				
	Specific Milestones			
Objective WF 3.1	Year 1	Progress	Year 2	
WF3.1a: Support Faculty Mentoring Training/Mentoring Workshops.	Completion of Professional Mentor Training by 2 UVI Faculty.	Two faculty have been recruited for training through the Center for the Improvement of Mentored Experiences in Research (CIMER) at the University of Wisconsin in Madison to be completed by Fall 2021.	- Completion of Professional Mentor Training by 2 UVI Faculty. -Facilitation of 1 Mentoring Workshop by Trained Facilitators.	Intra and inter institutional supports-Partnering in new grant to extend mentoring training to Mentors. Completed 2 faculty mentoring trainings with ECS and developed partnerships for faculty mentoring development for U-RISE proposal and the RII BEC proposal.
WF3.1b: Promote use of Undergraduate Student Mentoring Individual Development Plans (IDPs).	Completed review of student IDP/compact resources Adoption of IDP/ compact.	The IDP/compacts have been reviewed and will be adopted within the summer research program as pilot.	-STEM faculty trained on use and implementation of IDP/compact. -Initial launch of IDP/compact with STEM student mentees by mentors completed/ End-of-year assessment conducted. - Initial Launch of End-of Semester Surveys with STEM student mentees conducted	Training of faculty completed for IDP/ compact, Initial launch of IDP done with ECS student during summer training. No end of year assessments completed due to COVID-19 shift in academic offerings and format.
WF3.1c: Promote R2R research exposure and the use of STEM skills within an education context through an undergraduate practicum program.	-Establish partnership with local schools for practicum site development and develop student selection and supervision protocol. - Recruit VI-ISERP teachers with R2R focused PBLs for student integration.	The Covid-19 shifts limited schools capacity to engage in novel partnerships. VI-ISERP teachers will be approached during the STEM institute for participation in Spring 2022.	Fill 2 practicum slots with VI-ISERP teachers. Provide training to teachers on mentoring protocol for students.	The Covid-19 shifts limited schools capacity to engage in novel partnerships. VI-ISERP teachers will be approached during the STEM institute for participation in Spring 2022.
WF3.1d: Develop a Graduate Student Professional Development Plan (PDP)/ Listserv.	-Best practices in PDP development researched/ PDP form designed and launched in Spring 2022. -Increased STEM graduate student use of PDPs by 20%. -Listserv of Professional Development services and resources for Grad Students launched.	A PDP form was developed. Meetings are scheduled for Fall 2021 with graduate programs for support of adoption. A platform (group) has been developed to engage students and share resources.	-Increased STEM graduate student use of PDPs by 10%. -Listserv of Professional Development services and resources for Grad Students maintained	PEER Program, Slack Network Listserv, Instead of formal launch of PDP, focused on mentoring graduate students in educational research pursuits. Voices of Women in STEM (VOWS) maintained through 2 semesters with noted accomplishments in grant and publication development.
WF3.1e: Establish an Integrative Student Support Network.	Support network at UVI of services for STEM student retention and success identified.	Initial invitations have been issued to relevant offices on UVI Campus. A meeting is being organized in Fall 2021 to formalize partnerships and goals of the network.	Annual Stakeholder meeting for Integrative Student Support Network facilitated.	Sent out call to identified stakeholders for participation in Stakeholder network, Met with Dean of Innovation to collaborate on committee facilitation.
	Specific Milestones			
Objective WF 3.2	Year 1	Progress	Year 2	
WF3.2a: Support of Early Career STEM Faculty.	- Development of annual tracking plan for early career STEM faculty. - Listserv of Professional Development services and resources for STEM Faculty launched.	A platform (group) has been developed to engage early career faculty and share resources.	- Annual compilation of Tracking data completed. - Listserv of Professional Development services and resources for STEM Faculty maintained.	Launched Slack Network Listserv with opportunities and access to broader research community. Social media and slack network analytics shared in reverse site visit. Slack network actively maintained.Tracking structures reworked for students and professionals.

WF3.2b: Support Educational Research among Early Career STEM Faculty.	Mini-grant RFP for the initial mini-grant recipients released and formation of application review committee.	Partnering with the PEERS Schools our of Rochester Technical Institute, support has been established for application development for faculty doing Education Research. An initial RFP is being drafted now.	2 x $2000 mini-grant to faculty with focus on applied Educational Research funded/ Mini-grant RFP for Year 3 mini-grant recipients released.	Launched Mini-grants call for Proposals with a proposal due date for Feb 28th. Review committee formed with R2R researcher, UVI faculty and team members. Mini-grant reviewed and awarded to 1 graduate student and 1 faculty member.

Informal Learning (IL)				
Goal IL1: Increase and sustain the reach of the Informal Learning team throughout the Territory. · Objective IL1.1: Re-establish IL team on the island of St.Croix. · Objective IL1.2: Equal distribution of engagement between St. Thomas and St. John. Objective IL1.3: Increase support staff or personnel to aid in outreach and/or citizen science efforts.				
Objective IL1.1	Specific milestones			
	Year 1	Progress	Year 2	Progress
IL1.1a: Hire Community Engagement Specialist for St. Croix district.	Community Engagement Specialist (CES) will be hired for STX district. STX CES will be trained and familiarized with goals and objectives for Informal Learning.and R2R.	No progress made due to funding restrictions.	STX CES will coordinate and participate in 2 outreach initiatives in the STT/STJ district and coordinate a minimum of 2 outreach initiatives in STX district. They will also identify and meet with a minimum of 2 new, or existing, partners and/or stakeholders relevant to the STX district.	A STX Community Engagement Specialist was hired and has participated in 4 outreach events. This CES has also identified and met with at least 5 existing/new partners.
IL.1.1b: Creation of IL orientation and training resources.	Create a comprehensive orientation document detailing everything pertaining to Informal Learning.	Creation of this document has been started but it is not yet complete.	Add or change details to training guide as necessary.	This guide has been created and is updated regularly by IL staff to include all new partnerships/collaborations, resources and personnel.
Objective IL1.2	Specific milestones			
	Year 1	Progress	Year 2	
IL1.2a: Equal distribution of STT/STJ engagement.	Identify and engage partners, stakeholders who will support activities and initiatives of IL.	IL has begun identifying potential partners, but no engagement has occurred yet.	Coordinate a minimum of 3 outreach and/or citizen science initiatives across the territory, one on each island, STT, STX and STJ.	IL has coordinated/participated in more than 10 outreach and/or citizen science initiatives across the Territory.
Objective IL1.3	Specific milestones			
	Year 1		Year 2	
IL1.3a: Community Partner Recruitment.	Identify groups,organizations and funding sources necessary for hiring and/or recruitment of support personnel.	IL has identified 3 potential groups and/ or funding sources to support recruitment of support personnel.	Secure funding for 1 part-time graduate or undergraduate student in each district, in addition to recruiting 2 Volunteer groups for outreach and/or citizen science activities.	IL has hired one graduate student to serve as an outreach assistant for the STT/STJ district. An outreach assistant has not yet been identified and hired for the STX district. 2 volunteer groups have been recruited for outreach and/or citizen science events.
Goal IL2: Diversify range of topics presented in informal education and outreach initiatives. · Objective IL2. 1: Collaborate and communicate closely with R2R researchers. · Objective IL2.2: Partner with community-based groups and/or organizations whose goals and actions fall in line with, and can support/benefit from, R2R outreach and research.				
Objective IL2.1	Specific milestones			
	Year 1	Progress	Year 2	

IL2.1a: Researcher collaboration and communication.	Coordinate meetings with each R2R research theme. The meetings will help to: 1) Improve IL's understanding of R2R research goals and objectives, 2) Effectively align outreach and dissemination efforts with R2R research and secure researcher involvement and, 3) Improve communication/relationship between R2R research faculty and IL team.	IL has begun doing this with several R2R research components.	Collaborate with research team to coordinate 1 outreach and/or citizen science initiative for each R2R theme.	IL has collaborated with 4 R2R research leads to coordinate outreach and/or citizen initiatives in the realms of Watersheds and Land Use, Mangroves and Marine Debris, Coral Restoration, and Shoreline Erosion.
IL2.1b Outreach menu.	Create a comprehensive document that outlines outreach opportunities by type and date, to secure researcher involvement.	Creation of this document has begun but it is not yet complete.	At the beginning of each year, recirculate the document to give researchers a chance to secure their involvement for that academic year period.	This has not yet happened as creation of the document is still in progress.
Objective IL2.2	Specific milestones			
	Year 1	Progress	Year 2	
IL2.2a: Engage community groups.	Meet and form partnerships with, a minimum of 1 organization and/or community group(s) whose work aligns with R2R research and/or dissemination efforts.	We have formed one new partnership with World Oceans School, with the goal of further engaging University Bound students in the geosciences.	Meet and form partnerships with, a minimum of 2 organizations and/or community group(s) whose work aligns with R2R research and/or dissemination efforts.	IL has formed partnerships with 7 organizations and/or community groups. Each of these partnerships has led to the creation of several innovative STEM enrichment initiatives.
Goal IL3: Promote and guide k-12 URM students into the Geosciences and broader STEM pipeline to build a local STEM workforce. · Objective IL3.1: Increase and promote STEM enrichment and exposure opportunities for k-12 students. · Objective IL3.2: Support existing STEM enrichment and/or professional development initiatives through new and existing partnerships.				
Objective IL3.1	Specific milestones			
	Year 1	Progress	Year 2	
IL3.1a: Exposure and Engagement.	Conduct 2 STEM/environmental science-focused outreach activities. 50 k-12 students engaged.	We've participated in two virtual "Science Saturday" events focused on R2R research. We have also coordinated one Ag-based STEM activity for University Bound students. Both initiatives combined reached a total of approximately 1,300 residents with over 100 of these being k-12 students.	Conduct 4 STEM/environmental science-focused outreach activities. 100 k-12 students engaged.	IL has conducted/participated in 12 STEM/environmental science-focused outreach activities that engaged k-12 students. A total of 755 k-12 students have been engaged.
Objective IL3.2	Specific milestones			
	Year 1	Progress	Year 2	
IL3.2a: STEM Support.	Support 1 STEM enrichment or professional development initiative for k-12 students and/or educators.	IL provided funding support towards SCUBA certifications for 10 students of the Youth Ocean Explorers program.	Support 2 STEM enrichment or professional development initiatives for k-12 students and/or educators.	IL has provided funding support towards SCUBA certifications for 10 youth ocean explorer students, and 5 University Bound students. IL has also begun 1 STEM enrichment initiative geared towards public school STEM educators.
Goal IL4: Work toward becoming recognized Hub of information and resources for STEM and environmental education, awareness and sustainability in largely underserved communities. · Objective IL4.1: Become a resource locally and nationally for culturally relevant research that can benefit and assist other universities, stakeholder and partners. · Objective IL4.2 Identify avenues through which the IL team can effectively share the current and ongoing work that has been done ("share our story").				

Objective IL4.1	Specific milestones			
	Year 1	Progress	Year 2	
IL4.1a: Increase collaborations locally and nationally to share information.	Identify partnerships and collaborations with other Universities and organizations who can benefit from R2R research. These partnerships include existing relationships that UVI has regionally and nationally.	No progress made.	Working in conjunction with the communications coordinator, research updates will be disseminated to partners and collaborators One webinar will be held with partners to discuss ideas and shared resources.	IL has worked with the communications specialist to disseminate R2R newsletters to partners and collaborators throughout the Territory.

Objective IL4.2	Specific milestones			
	Year 1	Progress	Year 2	
IL4.2a: Share our story.	Multiple avenues (conference, workshop, webinar, publication) identified through which IL can share products/disseminate information on R2R research and outreach initiatives.	We have begun identifying workshops and/or conferences through which we can share our work.	Information/products will be shared via 1 workshop, webinar, conference or peer-reviewed publication.	IL gave two presentations on the role of informal learning in sustaining the STEM Pipeline, and University Bound STEM enrichment. These presentations were for Rotary, and the National Academy of Science, Engineering and Medicine, respectively.
IL4.2b: Cross-jurisdiction engagement.	Strengthen and increase communication and engagement with EOD and IL groups from other EPSCoR jurisdictions as well as EOD Council.	IL has participated in monthly EPSCoR-EOD council meetings.	Strengthen and increase communication and engagement with EOD and IL groups from other EPSCoR jurisdictions as well as EOD Council.	IL's STT/STJ Community Engagement Specialist has remained a member of the national EPSCoR EODC Council.

Goal IL5: Build new and improved-upon existing connections and lines of communication to better reach and understand target audiences. · Objective IL5.1: Creation and utilization of culturally responsive assessment tools and surveys.

Objective IL5.1	Specific milestones			
	Year 1	Progress	Year 2	
IL5.1a: Research and gain a better understanding of the different underserved community groups and what outreach initiatives would be best to reach them.	Identify and establish long-term relationships with community leaders or representatives for previously unengaged audiences (faith-based, non- English speaking, differently-abled etc.). Co-create culturally responsive survey disseminated via the identified community leaders.	We have met, and begun planning potential future collaborations with, an organization that serves the differently-abled and neuro-diverse community on the island of St. Thomas. A co-created culturally responsive survey has not yet been created.	Engage 2 underserved community groups through R2R-focused outreach. Disseminate surveys to gauge efficacy and impact of outreach methods with underserved audiences.	IL has begun working on initiatives geared towards both the neurodiverse/differently-abled and non-english speakers. Surveys have not yet been created.

Goal IL6: Build self-sufficiency and innovation within IL team and its efforts.
· Objective IL6.1: Pursue funding that puts IL team in a position to be more independent in building out and promoting its initiatives.
· Objective IL6.2: Through partnerships and collaborations, sourcing and/or developing tools that innovate both physical and virtual education and outreach efforts.

Objective IL6.1	Specific milestones			
	Year 1	Progress	Year 2	
IL6.1a: Funding.	Successfully submit for AISL grant. Identify and cultivate 1-2 funding sources.	IL, alongside FL successfully submitted an AISL proposal. IL has begun identifying outside funding sources for its initiatives. One of these potential funding sources has been engaged.	Identify and cultivate 2-3 funding sources.	IL has engaged, and received funding from 2 community and government funding sources.

Objective IL6.2	Specific milestones			
	Year 1	Progress	Year 2	
IL6.2a: Acquisition of tools and resources.	Conduct research on viable, innovative outreach tools and strategies.	We have begun looking into, and purchasing, resources that will allow us to incorporate kit-based and virtual outreach going forward.	Create or obtain 2 new outreach tools/ resources that can be adapted for the IL team's outreach initiatives/activities.	IL has purchased the tools necessary for, as well as made progress in, 3D printing, virtual reality and augmented reality. IL has also begun the creation of locally relevant outreach tools.

Communications and Dissemination (CD)				
Goal CD 1: Inform stakeholders and community of R2R Project research and educational goals and progress made toward achieving those goals · Objective CD1.1: Update website viepscor.org · Objective CD1.2: Generate social media content · Objective CD1.3: Write blog posts · Objective CD1.4: Create videos for YouTube Channel · Objective CD1.5: Photo essay series				
	Specific milestones			
Objective CD1.1	Year 1	Progress	Year 2	Progress
CD1.1a: Update website viepscor.org	Overhaul viepscor.org site to reflect new R2R Project team, goals and objectives.	Website is nearly complete and will soon be ready for final editing.	Review and update site with area leads twice per year.	Updates and additions have been made to the Mangrove and Informal Learning sections. For clarity, "About EPSCoR" and "About R2R" sections have been added/updated. In addition, the "Funding Overview" and "Mare Nostrum Archive" have been updated. Mangrove 360 has been added to the website. WFD trainings and activities are posted as needed. Researchers are encouraged at monthly meetings to use the website as a resource and contact Communications with updates.
	Specific milestones			
Objective CD1.2	Year 1	Progress	Year 2	
CD1.2a: Generate social media content	Post R2R research relevant content to social media outlets, a minimum of once per week.	Social media postings have been consistently generated. We expect to increase postings once the updated website is published.	Post R2R research relevant content to social media outlets, a minimum of once per week.	This goal is on track, and on most weeks is exceeded.
	Specific milestones			
Objective CD1.3	Year 1	Progress	Year 2	
CD1.3a: Write blog posts	Write 3 blog posts reflecting R2R Project activities and/or accomplishments.	Year 1 focus has been on writing the website and newsletter. Upon publishing of these items blog posts will follow to promote and expound upon the content found in those publications.	Write 3 blog posts reflecting R2R Project activities and/or accomplishments.	The blog posts have been delayed due to other communication work. One blog post will be completed by June 1, 2022.
	Specific milestones			
Objective CD1.4	Year 1	Progress	Year 2	
CD1.4a: Create informative videos for YouTube Channel			Work in partnership with videographer to create one video for YouTube channel.	This goal is on track and in development.
	Specific milestones			
Objective CD1.5	Year 1	Progress	Year 2	
CD1.5a: Write and work in partnership with photographer to create a photo essay series reflecting project goals.	Engage a photographer to co-create one photo essay reflecting R2R project goals. Publish the essays on the blog and promote on social media.	Discussions are underway with a photographer/videographer to accomplish this goal.		Dan Mele has been hired part-time to assist with photography and videography of R2R activities. With his partnership, progress is being made toward this goal.
Goal CD2: Produce a biannual VI EPSCoR Newsletter for broad audiences. · Objective 2.1: Produce two newsletters per year.				
	Specific milestones			
Objective CD2.1	Year 1	Progress	Year 2	

CD2.1a: Produce newsletter reflecting Project accomplishments, activities and goals	Write and publish a newsletter in Spring/Summer 2021.	Newsletter is written and in final review before publishing.	Write and publish two newsletters, one Fall/Winter and one Spring/ Summer.	Winter 2022 newsletter issue completed and posted on the VI-EPSCoR website. Printed copies are in the works.
Goal CD 3: Support R2R project team's promotional needs. · Objective CD3.1: Create flyers, social media posts and other promotional materials as needed to promote events and activities (i.e.: Reef Fest and Teacher Workshops). · Objective CD3.2: Create various branded support materials for VI-EPSCoR project as a whole (i.e.: project flyers, visual aids, signage, etc). · Objective CD3.3: Continued support of team researchers visual needs.				
	Specific milestones			
Objective CD3.1	Year 1	Progress	Year 2	
CD3.1a: Create flyers, social media posts and other promotional materials as needed to promote events and activities. VI-EPSCoR events are branded to ensure high-level, professional representation.	Create promotional materials (flyers, posters, cards, t-shirts, social media posts, etc.) as needed to advertise VI-EPSCoR events. Some (not all) of these events include Reef Fest, STEM Teacher Workshops and Annual Conference.	Flyers, and social media posts have been generated in Year 1. A logo for VI ISERP has been finalized.	Create promotional materials (flyers, posters, cards, t-shirts, social media posts, etc.) as needed to advertise VI-EPSCoR events. Some (not all) of these events include Reef Fest, STEM Teacher Workshops and Annual Conference.	Promotional materials have been created as needed and posted on the VI-EPSCoR website as well as shared through social media.
	Specific milestones			
Objective CD3.2	Year 1	Progress	Year 2	
CD3.2a : Create various support materials for VI-EPSCoR project as a whole. This includes Project flyers, presentations, visual aids, signage, etc.	Create visual support materials as needed.	Materials have been created as needed.	Create visual support materials as needed.	Visual materials have been created as needed. As an example, branded slide templates and zoom backgrounds for virtual meetings and presentations have been designed and made available to team leaders.
	Specific milestones			
Objective CD3.3	Year 1	Progress	Year 2	
CD3.3a : Support team researchers' design needs. This includes but is not limited to infographics, webinars, strategic project promotions and websites (usvistormstrong.org and vicoraldisease.org are examples).	Support team researcher's design needs.	Among the items created in Year 1 are: USVI Storm Strong website, cookbook promotion, summer camp and jobs opportunity promotions; a design and infographic class was taught to Dr. Smith's students, and the creation/design of the Marine Debris Advisory Plan document.	Support team researcher's design needs.	Ongoing updates have been made to the usvistormstrong.org website. In addition, promotional materials for the Storm Strong summer camp and mentorship opportunities have been designed. The Marine Debris Action Plan has been designed and published.

R2R Management (RM)

Goal RM1: Meeting the Data Management needs of the R2R team.
- Objective RM1.1: Improve University Internet connectivity data transmission throughput and speed.
- Objective RM1.2: Build upon core network infrastructure upgrades from 1 Gbps to 10 Gbps to research facilities.
- Objective RM1.3 Improve the research data server and storage topology.
- Objective RM1.4 Configure the current MS Azure environment to replicate with on-premises data server and storage solution.
- Objective RM1.5 Manage data collection and grant reporting data in ERCore.

Objective RM1.1	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM1.1a: Multi-home internet connection and increase bandwidth capacity as needed up to 10 Gbps on and between both campuses.	Conduct network throughput and speed test to determine Internet capacity bottlenecks for researchers.	Incomplete - This has been delayed due to Pandemic. The university plans returning to onsite operations in Fall 21.	Collaborate with Florida International University (FIU) and Network Engineer Consultant to configure network speed and capacity according to research capacity needs.	Completed - Both the network throughput and speed tests and collaboration with FIU engineers have been successfully completed. Results determined that commodity and research (Internet2) internet access capacity need to be increased on both campuses and network bottlenecks occur at student and research facility based buildings.

Objective RM1.2	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM1.2a: Upgrade research-related in-building wired and wireless services.	Identify research buildings on both campuses. Work with Contractor to ensure research network needs are met for new construction and existing research facilities.	In progress - Research buildings identified on both campuses, vendor quotes obtained and cabling contractor selected. Work continues with cabling contractor.	Develop specifications for and conduct RFP. Contract with cabling and wireless hardware vendors. Begin cabling work in STX research facility.	Completed - Cabling contractors selected and cabling work in the marine science and the annex buildings have begun.
RM1.2b: Upgrade fiber optic infrastructure and pathway system for research buildings from multimode to Singlemode fiber to support 10+ Gbps building uplink speeds.	Identify research buildings on both campuses. Work with Contractor to ensure research network needs are met for new construction and existing research facilities.	In progress - Research buildings identified on both campuses, vendor quotes obtained and fiber contractor selected. Work continues with fiber contractor.	Develop specifications for and conduct RFP. Contract with Fiber vendor. Begin fiber work on STT campus.	Completed - Fiber contractors selected and fiber cabling work to select research facilities have begun.

Objective RM1.3	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM1.3a: Expand public cloud services in support of research data needs.	Assessed regularly in partnership with Research/Project Leads and is ongoing throughout the project.	In progress - This is ongoing. Working with research leads to identify storage as needed.	Assessed regularly in partnership with Research/ Project Leads and is ongoing throughout the project.	In progress - Data Manager hired and he has begun configuring cloud application to house research data. Testing is in progress.

Objective RM1.4	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM1.4a: Deploy on-premises research virtual server and storage environment with replication to MS Azure, and possibly other public cloud environments.				

Objective RM1.5	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM1.5a: Collect data monthly from the researchers via CMES In-Class Report and the Provost Component report for the NSF Annual Report. Store the data in the ERCore module for security purposes and ease of access.	Collect data monthly via CMES In-Class Report and the Provost Component report for the NSF Annual Report and store the data in the ERCore module for security purposes and ease of access.	Complete - In class form developed and distributed to researchers. Researchers instructed on how to fill out report and how to write narrative for annual report. All data for this year have been input in to ERCore.	Collect data monthly via CMES In-Class Report and the Provost Component report for the NSF Annual Report and store the data in the ERCore module for security purposes and ease of access.	Complete - In class form developed and distributed to researchers. Researchers instructed on how to fill out report and how to write narrative for annual report. All data for this year has been input in to ERCore.

Goal RM2: Project Management
- Objective RM2.1: Implement project and collaborate with Research/Project Leads, UVI Administration, External Advisory Board, and Governing Committee
- Objective RM2.2: Workshop development, logistics, and coordination
- Objective RM2.3: Prepare the next USVI Science and Technology Plan

Objective RM2.1	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM2.1: Implement project and collaborate with Research/Project Leads, UVI Administration, External Advisory Board, and Governing Committee.	Conduct weekly team meetings. Conduct 2 per year External Advisory Board meetings. Conduct 2 per year Governing Committee meetings. Meetings are to assess, inform and obtain feedback on project implementation.	Completed- Weekly meetings established. Staff and Research Leads meeting occur bi-weekly. First External Advisory Board meeting occurred Nov 2020 and second is scheduled for July 2021. Governing Committee meeting scheduled in Fall 2021.	Conduct weekly team meetings. Conduct 2 per year External Advisory Board meetings. Conduct 2 per year Governing Committee meetings. Meetings are to assess, inform and obtain feedback on project implementation.	Completed - Team meetings moved to monthly. Staff meetings now held on the third Wednesday of the month and research project leads team meetings are held on the third Friday of the month. A Governing Committee meeting was held April 21st and a second meeting is scheduled for September 2022. External Advisory Board meeting was held in July and the next meeting is scheduled for July 2022. The External Advisory Board is also kept up to date via email and researchers are encouraged to engage board members for advice and mentorship. Lastly, a Collaboration Agreement, which outlines how we will work together on the project, was developed and is posted on the VI-EPSCoR website.

Objective RM2.2	Specific milestones			
	Year 1	Progress	Year 2	Progress

RM 2.2 Workshop and Annual Conference development, logistics, and coordination.	Host a conference to introduce research and researchers.	Completed: Annual conference held virtually June 2021	Host a conference to highlight research progress.	In progress: Annual Conference scheduled for June 2022.
Objective RM2.3 Prepare the next USVI Science and Technology Plan	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM2.3a: Assess, coordinate and create plan.		In progress - This will be worked on starting in yr. 2.	Identify internal and external stakeholders.	In progress - The Governing Committee has met to discuss and agree on an action plan. An action plan and timeline has been developed. Next steps are to create an Science and Technology Plan committee by September 2022.
Goal RM3: Collaborating with our External Evaluation and NSF EPSCoR Program teams to meet NSF's expectations for R2R Project Evaluation and Assessment. · Objective RM3.1: External Evaluation · Objective RM3.2: External Evaluation Communication/Attendance at VI EPS Meetings				
Objective RM3.1	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM3.1: External Evaluation	Initial planning and evaluation development/ Instruments designed/ Leadership interviews held, faculty surveyed.	Completed- Initial evaluation plan created and submitted with annual report.	Leadership and student interviews held, faculty and students surveyed, proposals and awards analyzed	Completed - External evaluators attended R2R meetings as requested by PD/ PA. A site visit was conducted in January/February 2022 where R2R faculty, postdocs, students, staff, and select UVI administrators were interviewed or focus groups were held. Undergraduates and graduate students were surveyed. Proposals and awards were analyzed as part of the Year 2 Evaluation Report.
Objective RM3.2	Specific milestones			
	Year 1	Progress	Year 2	Progress
RM3.2 External Evaluation Communication/Attendance at VI EPS Meetings	R2R Meeting attendance; regular/as-needed communication with PI.	Completed - Attended strategic planning meeting along with two project weekly meetings. Scheduled to attend next project meeting on May 14, 2021.	R2R Meeting attendance; regular/as-needed communication with PI.	Completed - Attended Annual Conference in June of 2021 and randomly attend both the monthly staff and research project leads team meetings. Scheduled to attend next Annual Conference in June 2022.