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Virgin Islands Experimental Program to Stimulate Competitive Research

MARE NOSTRUM CARIBBEAN:

Stewardship through Strategic Research and Workforce Development

STRATEGIC PLAN 2014-2019

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EXECUTIVE SUMMARY

The Virgin Islands Experimental Program to Stimulate Competitive Research was awarded $20,000,000 by the National Science Foundation to implement the project *Mare Nostrum Caribbean: Stewardship through Strategic Research and Workforce Development*. The project period is August 1, 2014 through July 31, 2019. This document summarizes the strategic plan for implementation of the project through its expected five-year duration.

Mare Nostrum Caribbean will support coral reef research that will integrate physical, biological and human factors to elucidate mechanisms of ecosystem dynamics, disease, and demographics along natural and anthropogenic gradients of multiple stressors from shallow nearshore to deeper offshore reefs, and along longitudinal and latitudinal gradients. Emerging research areas include oceanography, watershed dynamics and human dimensions. Results will lead to better predictions of coral reef responses to changing climate conditions and anthropogenic impacts, and allow systematic and informed formulation and implementation of interventions.

For these mitigation strategies to work, however, the local population must be informed and have the skills to actively respond to these challenges faced by the United States Virgin Islands (USVI). The Territory has a need for, and a severe shortage of, a highly qualified STEM (science, technology, engineering, mathematics) workforce and scientifically literate public. A critical priority is the development of an educated and skilled workforce. This is especially important on these small, relatively isolated islands that are faced with dire economic conditions.

High unemployment and poverty in the USVI are coupled with low high school and college graduation rates and the lowest SAT scores in the nation. Thus, an equally significant aspect of this research infrastructure improvement grant is that UVI will work collaboratively with the VI Department of Education and other collaborators to develop a highly qualified STEM workforce, building on existing strengths. The Virgin Islands Institute for STEM Education Research and Practice will be established with primary goals of developing and implementing structured mentoring programs, integrating strategic research experiences for students, assisting in the transformation of the science curriculum, and expanding research into STEM teaching and learning at the K-12 and university levels, as well as in outreach.

The strategic planning process for *Mare Nostrum Caribbean* began with a workshop on October 24, 2014 that assembled participants from across the USVI to inform them of the award and to seek their input on further involvement of the USVI community in the project's implementation. This was followed by a more formal workshop, required by the National Science Foundation, on November 6-7, 2014 in which the project's principal investigators, NSF officials, members of the VI-EPSCoR Governing Committee and External Advisory Board, the project's external evaluator, research area leaders and others participated. The workshop, led by an external facilitator, explored areas that included VI-EPSCoR's vision and mission, goals, management, challenges of the project, reporting requirements, and evaluation. A list of the workshop's participants and its agenda are found in the appendix to this *Mare Nostrum Caribbean* strategic plan.

The University of the Virgin Islands is the only institution of higher learning in the U. S. Virgin Islands and hosts the VI-EPSCoR program on behalf of the people of the Virgin Islands. VI-EPSCoR receives policy guidance from a Governing Committee composed of university and

government officials, private sector representatives and others. The President of UVI currently chairs the committee. Technical guidance to the project is provided by an External Advisory Board composed of internationally recognized leaders in subject areas addressed by *Mare Nostrum Caribbean*. An external evaluator works closely with the VI-EPSCoR management team to ensure that the project's goals and objectives are met and that arising issues are addressed. Great effort has been invested to make certain that *Mare Nostrum Caribbean* addresses the needs of the USVI and is in harmony with other ongoing efforts. Much of this is achieved through close association with both the Virgin Islands Comprehensive Economic Development Strategy which serves as the USVI's science and technology plan and the USVI STEM initiative of the Virgin Islands Department of Education. This *Mare Nostrum Caribbean* strategic plan will serve as a roadmap by which VI-EPSCoR, the NSF, the VI-EPSCoR Governing Committee and External Advisory Board, UVI, project participants and others can guide and assess the project's progress.

The plan begins with a section describing the general administration of the project and a succession plan for the project's overall leadership. Included are an organizational chart, a table of project management actions, an implementation table that identifies critical activities that must take place during the project's duration and their impact/outcomes, and a table of principal project risks and strategies for their mitigation.

For each of the principal areas of the project – coral reef research; emerging research areas; workforce development; cyberinfrastructure improvement; and outreach, education and diversity, the strategic plan provides a brief overview. It summarizes the critical activities (e.g., hires, facilities development), and discusses the leadership of the unit and its succession plans in the event that leadership interruptions occur. Main risks specific to each area are identified and mitigation strategies are outlined. A strategic planning table that lists action items with quantitative goals is included in each section.

Coral reef research area is led by experienced UVI scientists, who will be assisted by three post-docs to be hired, along with graduate and undergraduate students as research assistants. Two new vessels, one each for St. Croix and St. John, will be purchased and renovations to the Virgin Islands Environmental Resource Station will be completed in Year 1. The coral reef research team will work with other project areas in translating research findings to formal and informal education. A principal risk for the coral reef and other field work is the disruption of activities and the destruction to vessels and equipment caused by hurricanes. Mitigation plans are in place to address these.

For emerging research areas, there will be two new faculty hires to support work in coastal oceanography and watershed dynamics. Graduate students and undergraduates will assist in these research areas as well as in human dimensions research, which is led by experienced faculty.

Workforce development will result in the establishment of the Virgin Islands Institute for STEM Education Research and Practice (VI-ISERP). A new STEM education faculty will be hired in Year 1 and will contribute to the administration of this institute, and post-docs will be hired in Years 2, 3 and 4. This institute will: oversee STEM education research; the development of additional training pathways at UVI; the integration of research to transform the undergraduate curriculum; the development and implementation of mentoring for all *Mare Nostrum Caribbean* researchers; and the transformation of K12 Education in the territory. This latter will be a cooperative effort with UVI and the Virgin Islands Department of Education. It will result in mentor teachers in model classrooms, supplied by materials based on research

activities in *Mare Nostrum Caribbean*. Professional Learning Communities will be established, beginning in Year 2, consisting of mentor teachers, UVI STEM faculty and other STEM researchers, and these will meet regularly. Lastly, the Center for Marine and Environmental Sciences and the VI Department of Planning and Natural Resources will develop a Cooperative Fisheries Institute with a laboratory on St. Croix, for fisheries biology training and research. In execution of workforce development, close and meaningful relationships are critical to its success, and they must be established and maintained within the university, with territorial departments, and with other partners. Workforce development is a relatively new focus area for VI-EPSCoR and the strategic plan sets out critical partnerships and collaborations that will be formed.

Cyberinfrastructure development is critical to the success of all phases of this project. This area has recently completed a major assessment, and the strategic plan outlines major actions.

Outreach, education and diversity will continue established successful activities (e.g., Science Cafes, annual symposia), but will also launch a major new initiative, Citizen Science, to actively engage underrepresented minorities of all ages in local relevant science. There are four new hires in this area, Citizen Science Coordinator, Outreach and Education Coordinator, Internet Communications Specialist, and a Data Manager; all are scheduled to be hired in Year 1. To complement the focus on citizen science, a new interpretive center will be established on the St. Thomas campus of UVI, and will be operational by Year 3. Findings of VI-EPSCoR's coral reef research activities will be shared and experienced by the general public. Plans to mitigate the impact that hiring delays and interruptions might have on the project are developed.

Lastly, the strategic plan addresses evaluation of the project. This will be done by engagement of an external evaluator over the life of the project. Strategic actions that will be taken by the evaluator in assessing and monitoring the projects progress are set out in the strategic plan.

INTRODUCTION

The Virgin Islands Experimental Program to Stimulate Competitive Research (VI-EPSCoR), *Mare Nostrum Caribbean,* was awarded funding by the National Science Foundation (NSF) in August 2014. It presents a unique opportunity to address the implications of climate change for insular social-ecological systems. This document presents the strategic plan for *Mare Nostrum Caribbean* for the period August 2014 to July 2019.

Small island communities suffer from a suite of similar problems: limited natural resources, narrow economic base, emigration of young professionals seeking better economic opportunities, heavy reliance on outside entities for goods and services, and the ever-increasing threat of global climate change. In the United States Virgin Islands (USVI), similar to many Caribbean island nations, nearshore marine ecosystems, especially coral reefs, are key to its economic viability, but they are also especially vulnerable to both land and water-based human activities and oceanographic-climatic perturbations. The USVI is in a prime position to conduct coral reef research that will synthesize knowledge about the various factors (including those affected by climate change) that control degradation, tolerance, and resilience of Caribbean coral reef ecosystems, so that the best management strategies can be identified.

The success of these management strategies, however, will ultimately be determined by the ability and capacity of the local communities, stakeholders and citizens to actively participate and self-organize in stewardship of these marine and environmental ecosystems. Improving the quantitative, scientific, and educational skills levels of the Virgin Islands' workforce will be key to sustainability for insular communities reliant on natural resources. To achieve this goal, *Mare Nostrum Caribbean* will also (1) invest in building capacity for cutting edge research, (2) implement workforce development strategies, (3) foster emerging areas of research (human dimensions, oceanography and watershed studies), and (4) engage the public in outreach. ***Our research will serve as a central focal point to strengthen both formal and informal science, technology, engineering, and mathematics education; increase the level of environmental stewardship; and lead to better informed decision making in management of our marine and other natural resources.*** A more aware and highly educated citizenry will lead to more diversified and sustainable economic development options for the territory. Lessons learned and models that will be developed through our research can be utilized by other insular communities.

Strategic Planning Process: On October 24, 2014 VI-EPSCoR convened an open strategic planning workshop on the St. Thomas campus of the University of the Virgin Islands (UVI). Among the 31 participants in the all-day session were people who contributed to the development of the proposal as well as other interested parties from throughout the USVI. Attendees included representatives from the UVI community, government agencies and non-governmental organizations. Discussions focused on implementation of all aspects of the *Mare Nostrum Caribbean* project with emphasis on ensuring broad participation in the project. Following the workshop, faculty and others involved directly in the project met in area meetings to plan the details of the project's implementation.

A formal externally facilitated strategic planning workshop, required by the National Science Foundation (NSF), was held on the UVI St. Thomas campus on November 6-7, 2014. Participants included UVI personnel responsible for implementing aspects of the grant, representatives from NSF, the VI-EPSCoR Governing Committee, the VI-EPSCoR External Advisory Board, VI Department of Education (VIDoE) and the UVI administration . Presentations were made on NSF expectations for the strategic planning process, the approaches

and expectations for the project's external evaluation, overviews of the content highlights for the various project areas, succession and risk mitigation planning and the organizational structure for the project. After the formal workshop, area leaders worked with their teams to develop narratives to describe their area and partners, to summarize risk mitigation and succession plans, and very importantly, to develop detailed log timelines specifying strategic actions and goals. Each area produced a very detailed timeline (but only the summary tables are presented herein) along with a narrative briefly describing the area, key personnel, a succession plan and a brief description of primary risks. The summary tables list action items with quantitative goals (e.g., 1 post-doc, Mentor teachers (10), 3 presentations). The products from each area were merged and vetted, an overall risk table was produced, and these form the core of **VI-EPSCoR's *Mare Nostrum Caribbean* Strategic Plan**.

Alignment with Territorial Science and Technology Plan and Science, Technology, Engineering and Mathematics Plan: The *Mare Nostrum Caribbean* project is in harmony with the USVI Comprehensive Economic Development Strategy (CEDS) which serves to guide science and technology development in the territory. CEDS references VI-EPSCoR and the Chair of the VI-EPSCoR Governing Committee is a member of the Comprehensive Development Committee that developed and monitors the strategy. In addition, the project's development was coordinated with the Virgin Islands Department of Education particularly through its Science, Technology, Engineering and Mathematics (STEM) initiative. The VI-EPSCoR Assistant Director is a member of the STEM Plan Task Force. The project proposal repeatedly points to adherence with both CEDS and the territory's STEM Education Plan. Representatives from both the Governor's Office, which coordinates CEDS, and the Department of Education, home of the STEM plan, participate in meetings of the VI-EPSCoR Governing Committee.

VISION: The Virgin Islands Experimental Program to Stimulate Competitive Research will be a regional, national and international leader in providing solutions to mitigate the effects of changing environmental conditions in insular social–ecological systems.

MISSION: The Virgin Islands Experimental Program to Stimulate Competitive Research promotes the development of the Territory's science and technology resources:

- by conducting research on areas of scientific inquiry linked to the Territory's economic development;
- by improving research infrastructure to strengthen competitiveness;
- by increasing participation of students in science and technology in order to build a skilled workforce; and,
- by building partnerships between government, non-governmental organizations, and the private sector to create a foundation of research and development for economic growth.

OVERALL PROJECT MANAGEMENT

Management of *Mare Nostrum Caribbean* is structured to insure that the project effectively and efficiently implements the approved project, not only as approved by NSF and in adherence with NSF requirements, but also that the best interest of the jurisdiction is always at the forefront. Policy guidance for VI-EPSCoR is provided by its Governing Committee. The committee consists of representatives the host university (the University of the Virgin Islands), the principal governmental bodies that VI-EPSCoR interacts closely with, non-governmental organizations and the private sector. The committee provides the overarching vision, aligns the research with the territory's overall science and technology plans, and makes broad policy decisions. It meets quarterly.

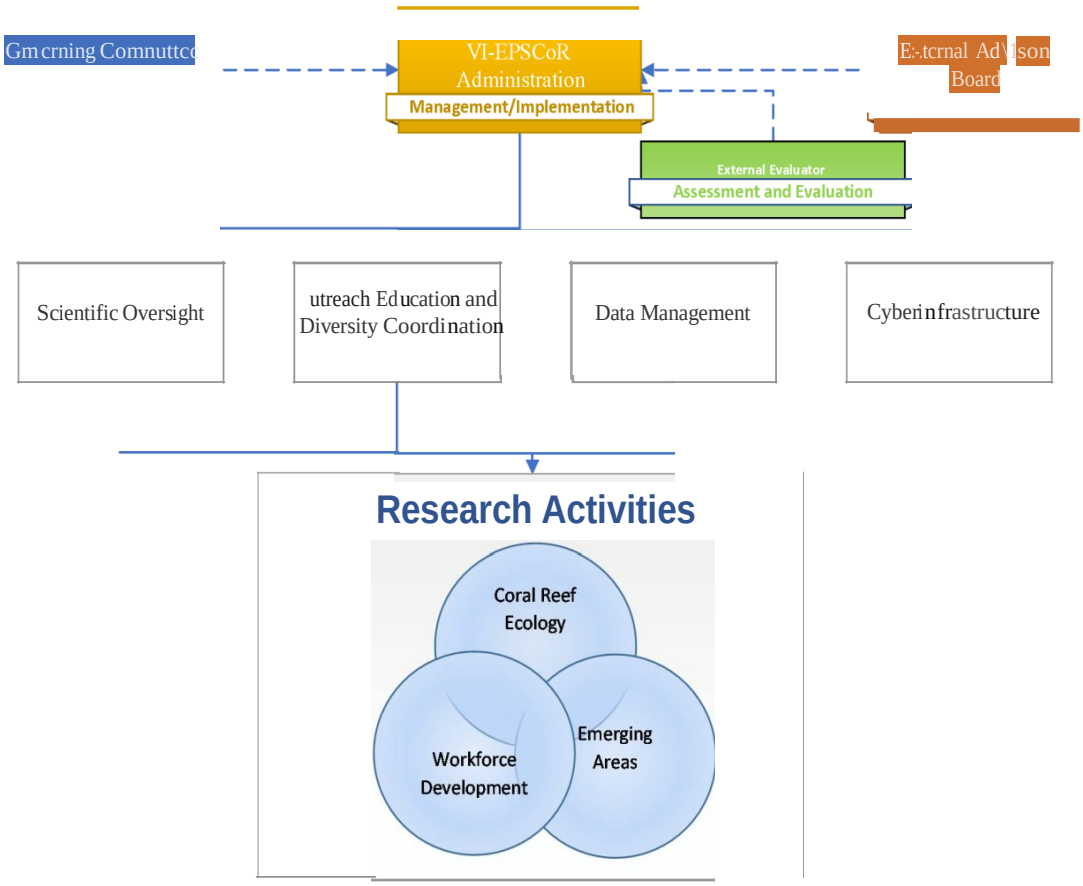
The External Advisory Board, composed of internationally recognized scientists, provides scientific and technical expertise to the project. The Board assists VI-EPSCoR in keeping aware of and responding to new opportunities. It meets semi-annually and produces an annual report with findings and recommendations for improving the project. An external evaluator also provides direct input to the VI-EPSCoR Director and his management team. This external project evaluator coordinates, implements and monitors the overall project evaluation process.

The above entities provide input to the VI-EPSCoR Director and his management team, the core of VI-EPSCoR's administration. The team is responsible for management and implementation of the project and consists of the Director, Assistant Director, Senior Scientist and a fiscal manager (a program specialist). This team oversees functions essential to the proper implementation of the main research activities including scientific oversight, outreach, education and diversity coordination, data management and cyberinfrastructure development and management. The research activities are coordinated by area leaders who meet on a regular basis with the management team. The project is organized into several areas (Coral Reef Research; Emerging Areas; Workforce Development; Cyberinfrastructure; and Outreach, Education, Diversity and Communication) as outlined in the sections below. Cyberinfrastructure provides IT support for all other areas. The other four areas are closely interlinked because the scientific results from the research programs not only lead to a more nationally competitive research program at the University, but also form the core of integration into STEM activities at the K12 though graduate level programs in the territory, as well as with outreach to all sections of the Virgins Islands population.

Principal annual responsibilities of the VI-EPSCoR Director are shown in the VI-EPSCoR Program Organization chart, and the critical activities of the VI-EPSCoR administrative office having to do with coordinating overall program execution are found in the Project Management and Project Execution tables.

Succession plan: Overall management of *Mare Nostrum Caribbean* is organized in such a way that no one person is critical to its functioning. The relevant core senior management team consists of the Director, the Assistant Director (Program Administrator) and the Senior Scientist, all co-PIs on the project. In the absence of the Director for a prolonged period, the University's Provost, also a co-PI on the project, will assume overall responsibility to NSF for the project, and the Assistant Director and the Senior Scientist will manage the day to day affairs of the project.

VI-EPSCoR Program Organization



Project Management						
		YEAR 1	YEAR 2	YEAR 3	YEAR 4:	YEAR 5:
	LEAD RESPONSIBILITY	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS
Action Item						
Conduct annual VI-EPSCoR management activities	H. Smith	Prepare and submit annual and project outcomes report to NSF	same	same	same	same, Final Report and Project Outcomes Report
	H. Smith	Adhere to NSF project oversight activitie	same	same	same	same
	H. Smith	NSF Reverse site visits (Yrs 2&4)	X		X	
	H. Smith	Respond to External Evaluator recommendations, incl. in annual report	same	same	same	same
	H. Smith	Convern Governing Committee 4 times	same	same	same	same
	H. Smith	Convene Ext. Advisory Bd. 2 times	same	same	same	same
	H. Smith	Convene Annual EPSCoR Conference	same	same	same	same
	H. Smith	Attend Annual EPSCoR Conference	same	same	same	same
	H. Smith	Attend PD/PA/OED meetings 2 times	same	same	same	same
	VI EPSCoR Admin Project Area Leaders Other key personnel	Convene Strategic Planning Meetings 2 times	same	same	same	same

PROJECT EXECUTION (integration and partnerships)						
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	
ACTION ITEM	RESPONSIBLE PARTY	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	IMPACT/ METRICS
New Hires - Faculty	WD EA/CR	STEM Ed (WD) Coastal Oceanographer (EA), Watershed Dynamics (EA)				3 new faculty
New Hires - Post-docs	CR, WD	Post-doc (CR)	Post-doc (CR) Post-doc (WD, STEM Ed)	Post-doc (CR) Post-doc (WD, STEM Ed)	Post-doc (WD, STEM Ed)	6 post-docs
New Hires- Technical Support	OED	Outreach & Diversity Coordinator; Citizen Science Coordinator; Data Manager; Internet Communications Specialist (all OED)				4 new technical support
New Units	CSM, SoE, VIDoE, CR, EA	VI-ISERP (WD)				VI-ISERP
	OED, CR, EA, community partners	Citizen Science (OED/CR)				Citizen Science program
	CR, DPNR	Collaborative Fisheries Institute				Collaborative Fisheries Institute
Major expenditures		Research vessels				Research Vessels
Major renovations	Interpretive Center (OED, CR)	Design plans	Engineering plans,permitting, begin construction	Final construction		Interpretive Center
		VIERS				updated VIERS

OVERALL PROGRAM RISKS				
RISK	**CONSEQUENCE**	**IMPACT**	**LIKELIHOOD**	**MITIGATION**
Hiring Delays	Delay implementation of a phase of the project	High	High	Make recruitment activities a high priority
Unsuitable hires	Program disruption	High	Medium	Utilize probation and termination options
Failure of participants or partners to be active in any phase of project	Project delays	Medium (could result in data gaps)	Medium	Develop and communicate clear responsibilities and monitor progress; if necessary remove offender from project and reprogram funds
Disruption of administrative or area leadership stability	Implementation of program disrupted due to guidance void	High	Medium	Maintain a current succession plan; maintain good communication throughout all parts of project
Budget reduction	Inability to met objectives	High (NSF and/or local sources)	Medium	Incorporate scalabilty and set priorities; reduce scope if necessary; address quickly to focus on identified
Delays in procurement of goods; internal bureaucratic issues or shipping/customs	Delay in project progress	Medium to High	High	Anticipate delays; build redundancy when possible; keep operations and maintenance plans current and functioning
Major storms or other natural catastrophe	Disruption of field research and other programs; damage to boats, field equipment and key infrastructure	High	Medium	Maintain and update hurricane plans; prepare contigency plans for work disruption
Coordination and management overwhelm science component	Decrease in intellectual merit; science, inspiration and morale suffer	Medium	Medium	Clearly define and assign leadership responsibilities; document admin time and effort; obtain dedicated institutional support and recognition
Research activities and decisions hindered by timeline and budget	Activities and measurements unproductive for capacity building	High	High	Use yrs 1-2 as "incubation" with max. flexibility to adjust for yrs 3-5; :red flag" vulnerble activities and design alternatives
Lack of institutional support for VI-EPSCoR funded research infrastructure	Lack of maintenance will result in non-functional instrumentation and equipment	High	High	Work with UVI Admin to support a Laboratory staff position
Lack of institutional improvements for post-awards grant management	Slow and cumbersome post-awards process (hiring; purchasing)	High	Medium	Work with UVI Admin to streamline post-award admin processes
Continued lack of institutional funding for CMES director position	Significant reduction in sustainability of program	High	High	Work with UVI Admin to refund CMES Director position
Poor external engagement at VI-EPSCoR events	Low attendance at events	High	Medium	Increase marketing efforts; engage more well known presenters; timely advertising; make calendar of events available on-line
External Advisory Board or Governing Committee does not meet on a regular basis	Significant reduction of constructive advice	Medium	Low/ Medium	Set up a specific schedule for future meetings, so members have on calendars well in advance

If the Assistant Director or the Senior Scientist leaves the project, the Director will assume that person's responsibility until a replacement occurs. In the absence of an area leader if there is no ready substitute, the VI-EPSCoR Senior Scientist or the Assistant Director, will provide oversight.

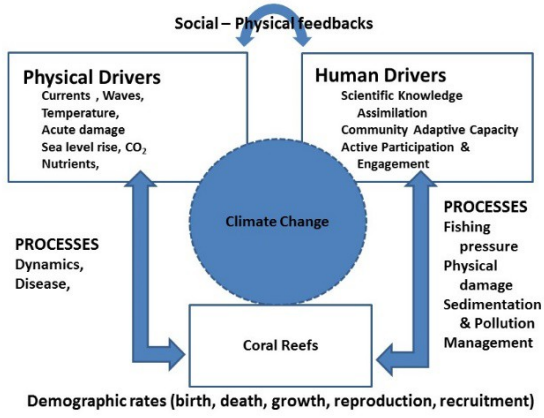
Risks: The principal potential risks of the VI-EPSCoR program are found in the Overall Program Risks table, while risks specific to each program area are discussed in area narratives.

RESEARCH AND EDUCATION

CORAL REEF RESEARCH

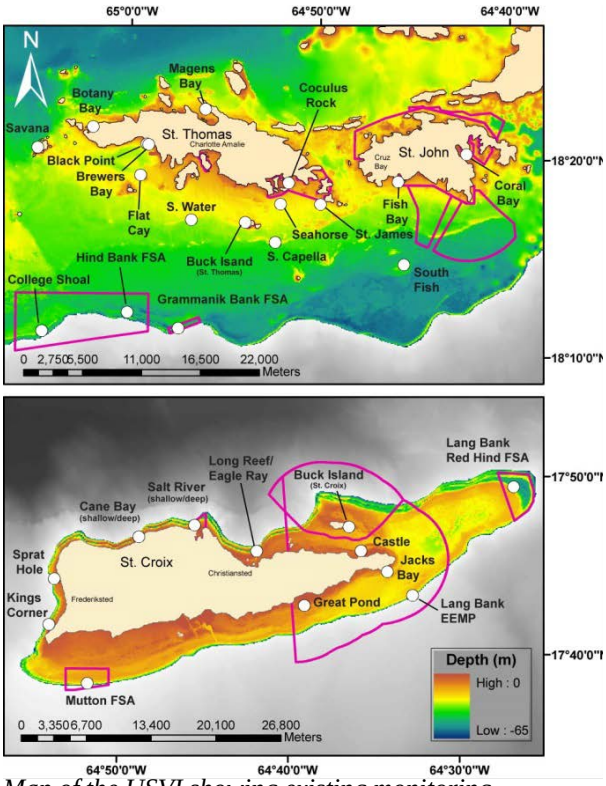
The USVI has had a long history of local stress to coral reefs, including the escalating use of land and sea resources with little planning and regulation. Concurrently, rapid land development for the tourism industry increased soil erosion and subsequent sedimentation in the marine environment to levels orders of magnitude above the natural background, increasing the susceptibility of coral colonies to bleaching, disease and mortality. In the USVI, coral reef degradation due to local drivers has been important historically, but recently external drivers are becoming more important and are threatening to overwhelm much of the intrinsic capacity for resilience in these systems. The most recent external biological threat is the invasive Indo-Pacific lionfish (*Pterois volitans*), which is now fully established throughout most of the greater Caribbean region. The rapid increase in lionfish populations and their voracious diet of juvenile reef fish has the potential to negatively impact small island economies through the decline of commercial fisheries and loss of ecologically important species that will further exacerbate stressors on coral reefs.

The challenge to reduce impacts on tropical coastal ecosystems and reverse declining ecological trends seems daunting. However, new evidence suggests that key human interventions can stimulate rapid ecological recovery. For example, establishment of marine reserves produces rapid increases in fish biomass and diversity, rebuilds spawning populations and protects critical habitats that support juvenile nurseries and spawning sites. Recovery of fishes can benefit corals through a trophic cascade that ultimately leads to the reduction of macroalgal abundance and the promotion of coral recruitment. Likewise, to limit the run-off of terrestrial soils, simple erosion control measures at land development sites are easily installed and enforceable, but these strategies require the social and political will to ensure compliance and effectiveness.



Coral Reef Research. Conceptual model of linkages among drivers and processes that affect demographic rates on coral reefs.

The USVI is in a unique position to test the core hypotheses concerning the drivers and processes that impact Caribbean coral reef degradation, tolerance, and resilience. The USVI's assets include more than 40 years of physical and ecological research, unsurpassed access to a wide diversity of coral reef habitats and other marine ecosystems, a strong human and physical



Map of the USVI showing existing monitoring locations of the Territorial Coral Reef Monitoring Program and protected areas (pink lines).

infrastructure to engage in and support marine ecological investigations, and a growing international network of researchers with interest in collaborating with the USVI or conducting research in the USVI.

The coral reef research program will integrate physical, biological and human factors to elucidate mechanisms of coral reef and associated ecosystems along natural and anthropogenic gradients of multiple stressors from shallow nearshore to deeper offshore reefs. Using key coral reef taxa we will (1) identify the dynamics of the drivers that control the major processes impacting demographic rates; (2) examine what properties lead to susceptibility to disease; and (3) measure and model the impacts of ecosystem changes on demographic rates of coral reef species and, conversely, the impacts of changes to these rates on maintaining ecosystem processes. Identifying the relative importance of forcing functions controlling coral, macroalgal, and fish communities is key to understanding why coral reef habitats appear as they do today. More importantly, a multi-scale comparative approach will allow us to better predict coral reef responses to changing climate and identify potential interventions.

Dynamics Research Area: Thermal stress and herbivory are emerging as factors central to the degradation of coral reefs. Depending on their depth and distance from shore, corals may experience temperature differences as great as 3°C, and have order of magnitude differences in daily variability. This suggests that spatially distinct coral reef habitats may also respond differently to increasing temperatures caused by climate change. *We will test the general hypothesis that heat content in the ocean's surface, as a result of climate warming, will change the temperature profiles experienced by corals at different depths and positions along the insular shelf.* To test this hypothesis we will synthesize and analyze our existing annual temperature measurements from over 30 locations from 1-65m depth. These data will be supplemented with a new array of temperature probes to depths up to 100 m and current profilers located specifically in areas that show different oceanographic processes. These data will allow us to identify the physical drivers that control bottom temperatures. Modeling scenarios of thermal distribution will examine if moderated thermal environments continue to be moderate in the future and, thus, have the potential to serve as refuges for sensitive reef taxa.

Herbivory is another important dynamic process within coral reef ecosystems, but the loss of major grazers to fishing and disease has increased coral and macroalgal interactions. *We will test the general hypothesis that herbivore communities of varying diversity and functional redundancy control the variability of algal productivity and biomass across the seascape.* Current research is examining the grazing rates of herbivorous parrotfishes on benthic

composition of shallow water reefs that are open to fishing. We will expand this work to conduct comparative herbivory studies with marine protected areas, mesophotic reefs, identified coral refuges and across latitudinal (and temperature) gradients. Anticipated results will be to understand how the coral reef community maintains core processes across the nearshore-offshore, shallow-deep and north-south gradients of biological and environmental variability.

Disease Research Area*:* This focal area will investigate how biophysical processes affect the susceptibility of coral reef ecosystems to disease and the impact of disease on coral reef demographics. Coral disease outbreaks on Caribbean coral reefs have caused some of the worst regional declines of living coral in recent times and have had significant effects on the diversity and structure of reef systems. The susceptibility of corals to disease and bleaching may be linked to and magnified by the exposure to terrestrial pollutants and sediments and an imbalance in nutrients from human sources. Understanding how physical processes affect the incidence and transmissibility of diseases and ultimately coral demographics is key to determining long-term trajectories of coral reef communities. *We will test the general hypothesis that environmental stress, population-specific susceptibility and scale dependent mechanisms of transmission combine to determine disease spread and distribution among diverse coral reef communities.* We will be testing important disease related variables across natural and anthropogenic stress gradients using both manipulative field experimentation and controlled laboratory conditions. Our testable model assumes that physiological stress increases susceptibility regardless of scale, but that transmission mechanisms of disease differ across scales. It therefore predicts that disease transmissibility is scale dependent. Anticipated results will be to define how factors promoting or inhibiting transmissibility determine coral disease dynamics at multiple scales, and thereby understanding which factors are most important in promoting the spread and impact of diseases in the Caribbean.

Demographics Research Area: This research theme will focus on three key elements of coral reef ecosystems that affect the demographic rates and distribution of important species groups, including reef fishes, marine algae, and corals.

1) The timing of reproduction and settlement of many coral reef organisms is highly synchronized to seasonal physical oceanographic processes such as temperature and currents. *We will test the general hypothesis that increasing sea temperatures will disrupt the temporal coupling of sensitive biological processes like reproduction*. We will establish a regional collaborative network of researchers that focus on the reproduction of reef fishes that form spawning aggregations.
2) Fishing mortality and now the invasive lionfish have the potential to greatly alter community dynamics through trophic cascades, particularly by targeting herbivorous species. The role of fish demographics is vital to understanding reef resilience, and has strong ties to human-ecological elements. *We will test the general hypothesis that changes in fish demographics have direct and indirect effects on coral reef community structure, coral demographics and reef resilience.* We will examine fish population assemblages across various gradients including management (i.e., fished and protected areas), environmental stress (nearshore to offshore), invasive lionfish (high vs. low density) and social-economic conditions (St. Thomas vs. St. Croix).
3) Certain marine algae inhibit coral communities by overtaking space, limiting coral growth and settlement, or increasing mortality. Conversely, others promote coral communities by

CORAL REEF DEMOGRAPHICS, DISEASE AND DYNAMICS (Includes research on spawning aggregations, reef fish demographics, lionfish, mesophotic reefs, disease, herbivory, refugia and connectivity)							
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
ACTION ITEM	RESPONSIBLE PARTY	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	IMPACT/ METRICS
Develop research program	Coral Reef Research Team (R. Nemeth, T. Smith, M. Brandt, B. Castillo)	Analyze existing biophysical data, select study sites for comparative studies; Clean existing HYCOM model. Establish experimental design for field studies. Submit 1 research grant proposal	Enter and analyze new data: Develop models; Conduct surveys of new sites and locations. Implement field experiments. Submit 1 research grant proposal	Analyse data and refine model outputs; Submit 2 research grant proposals	Analyze and validate new data; Conduct comparative analysis; Strengthen collaborative research through 2 joint proposals	Synthesize new data; Strengthen collaborative research through 2 joint proposals	Infrastructure in place to address research objectives. Increase number of external awards supporting research. Metrics: 2 new interdisciplinary awards each year for a total of 8 awards
Build multidisciplinary research team	Coral Reef Research Team (R. Nemeth, T. Smith, M. Brandt, B. Castillo)	Support startup funds and travel to regional and international study sites; recruit postdocs; provide training in technical diving	Conduct reciprocal site visits. Invite partners to participate in annual science conference. Hire post doc; Integrate new hires into research	Invite partners to participate in annual science conference. Hire post doc; Provide training in technical diving	Strengthen collaborative research through reciprocal site visits and joint conferences	Strengthen collaborative research through reciprocal site visits and joint conferences	Increase opportunites for collaborative research. Metric: Post-docs (n=3) hired on schedule.
Support student researchers	Coral Reef Research Team (R. Nemeth, T. Smith, M. Brandt, B. Castillo)	Recruit 4 graduate student and 4 undergraduate student.	Recruit 4 undergraduate student.	Recruit 4 graduate student and 4 undergraduate student.	Recruit 4 undergraduate student.	Recruit 4 graduate student and 4 undergraduate student.	Research opportunities for students support for faculty. Metrics: student assistantships awarded on schedule for graduate (n=12) and undergraduate students (n=20).
Acquire and deploy equipment and instruments	Coral Reef Research Team (R. Nemeth, T. Smith, M. Brandt, B. Castillo), Admin support Team	Deploy thermistors, conduct CTD casts, deploy time-lapse cameras and acoustic hydrophones. Upgrade technical diving equipment	Deploy instrumentation (passive acoustics) at control and experimental sites; Conduct calibration experiments	Expand instrument array to new study sites. Upgrade technical diving equipment;	Monitor and maintain instruments.	Monitor and maintain instruments. Upgrade all diving facilities	Collection of biophysical data. Metric: successful access to data streams on schedule
Engage stakeholders	Outreach and Education Team (Drayton, new hires for outreach, web master, Citizen Science)	Assist in development of website to promote global database.	Contribute new information to global database.	Highlight new research findings.	Highlight new research findings.	Highlight new research findings.	Increase global awareness by increasing number of persons who visit selected websites. Metric: 50% increase in "web hits" per year.
Disseminate data	Coral Reef Research Team (R. Nemeth, T. Smith, M. Brandt, B. Castillo)	Give 1 presentation at scientific conference and local venue.	Give 2 presentations at scientific conference and local venue.	Give 3 presentations at scientific conference and local venue.	Give 4 presentations at scientific conference and local venue.	Give 5 presentations at scientific conference and local venue.	Communication of findings to science community and public. Metric: at least 15 public presentations
Submit results for publication	Coral Reef Research Team (R. Nemeth, T. Smith, M. Brandt, B. Castillo)	submit 1 article for publication	submit 2 articles for publication	submit 3 articles for publication	submit 4 articles for publication	submit 5 articles for publication	Communication of findings to science community and public. Metric: at least 15 articles submitted

providing cues for larval settlement. Algal communities are, in turn, controlled by bottom-up forces of nutrient supply and top-down forces of herbivory and disturbance.

Management Structure: Key leading senior research personnel are Dr. T. Smith, dynamics lead, who studies ecological effects of climate change, and land based sources of pollution and algae-herbivory processes on coral reefs; Dr. M. Brandt, disease lead, specializes in coral disease ecology; Dr. R. Nemeth, demographics lead, is an expert in reef fish ecology and has experience in a broad set of related disciplines. Drs. Smith, Nemeth and Brandt are experienced in working in mesophotic (deep coral) ecosystems. The research team will be assisted by and mentor 3 post-doctoral scholars including Dr. Dan Holstein, and 15 graduate and 10 undergraduate students. Other USVI scientists involved in this research include UVI faculty Drs. T. Turner (phycology), S. Ratchford (symbiosis), B. Castillo (lionfish), and Dr. C. Rogers of the U. S. Geological Survey (coral ecology).

Succession Plan: Loss of M. Brandt, T. Smith or R. Nemeth could be temporarily covered by one of the other two remaining faculty or post docs or possibly a senior staff member but would require new hire in their area of expertise.

Specific risks for this area include high vulnerability to disruption of research activities, and potential damage to or loss of vessels and other equipment, due to effects of major storms. The impact is “High” and likelihood “Medium”. For mitigation, a hurricane plan and a contingency plan are in place.

EMERGING RESEARCH AREAS

The University of the Virgin Islands offers great potential for cutting edge competitive research that is related to our strength in coral reef research. Specific emerging research areas will enhance our strengths and lead to collaborative research that will also help us better understand Caribbean communities’ social and economic resilience in the face of climate change. VI-EPSCoR will support three emerging research areas: Coastal Oceanography, Watershed Dynamics and Human Dimensions. They will complement our current expertise, expand our ability to conduct high impact, multi-disciplinary research in the territory, and lead to an increase in competitively funded research at UVI. *Coastal oceanography* will provide interdisciplinary research opportunities on coral reefs, complement current collaborations, and facilitate our understanding of ocean and coastal processes under changing climatic conditions. *Watershed dynamics* will focus on the key ecological, hydrological and spatial factors that influence ecosystem health under changing climatic conditions and anthropogenic regimes, as well as determine how these factors function in an integrated land-ocean system. *Human dimensions* will provide a unique social-ecological approach to sustainable ecosystem management and contribute to our understanding of how cultural perspectives, attitudes and behaviors contribute to small island social-ecological systems’ ability to adapt to environmental change. By broadening our research expertise we are building for a future of active high impact research that will shed light on multiple factors affecting small island nations and tropical environments.

These emerging research areas will add to the previously established research core at UVI in marine sciences, help implement the teacher-scholar model throughout the university, and provide graduate and undergraduate students with additional research opportunities. We expect that developing these areas will lead to production of key publications that will stimulate

successful grant awards advancing multi-disciplinary research, and increase the engagement by UVI students, post-doctoral scholars, faculty and community members in meaningful science in the Territory. By integrating these activities into the VI-EPSCoR workforce development and citizen science programs we will strengthen these areas and compound the effect felt throughout the community.

Coastal Oceanography: Coastal oceanography is expected to most quickly augment the marine science research strengths at UVI. The need for a better understanding of the oceanographic processes that affects nearly all aspects marine ecosystems has become evident, especially processes that affect the dispersal fish, coral larvae and sediments, as well as those that influence the vulnerability of ecosystems to storms, concentrations of nutrients, and the accumulation of thermal stress. Hiring a coastal oceanographer will be a high priority in year one. The oceanographer will be integrated into the coral reef research team at UVI and build on collaborations with Caribbean Coastal Ocean Observing System (CariCOOS) at University of Puerto Rico Mayaguez and University of Miami. Working with CariCOOS will add responsibilities for overseeing Territorial weather stations and oceanographic buoy deployed and maintained by CariCOOS. This new position will be primarily housed in the UVI Center for Marine and Environmental Studies (CMES), with limited teaching responsibilities within the College of Science and Mathematics (CSM), which will allow for better integration in to activities for the workforce development and citizen science programs. The infrastructure is in place for the addition of an oceanographer to have maximum effect in the near term. It is expected that the collaboration with the coral research team will quickly result in joint publications and at least two interdisciplinary funded awards in years four and five.

Watershed Dynamics: Small island ecosystems depend critically on the interactions between land and sea. The compact nature of island watersheds leads to a wide range in the level of natural and anthropogenic impacts. Pristine and heavily impacted watersheds may be within a few miles of each other, thereby making research on these areas manageable and clearly relevant to island stakeholders. In addition, watersheds and alterations to watersheds are major determinants of biophysical properties of associated nearshore marine waters and thereby linking watershed use to marine sedimentation, water quality and ecosystem health.

UVI has personnel with interest and expertise related to watershed dynamics including Dr. R. Platenberg and Dr. A. Primack, but a faculty member dedicated to watershed dynamics research is needed to grow this area of research. A new hire in this field will build our research capacity and provide opportunities for integration and expansion of coral reef research group as well as the Environmental Analysis Laboratory (EAL) and the Institute for Geocomputational Analysis and Statistics (GeoCAS). S/he could have experience in a range of related topics including hydrology, stream ecology, or land management, but will need to work well with UVI students and current research faculty. Natural collaborations with local agencies, such as Coastal Zone Management, Division of Fish and Wildlife and other units of the Department of Planning and Natural Resources are expected to develop. The joint research and teaching position will allow for increased interactions with graduate and undergraduate students and integration into the workforce development and citizen scientist initiatives of VI-EPSCoR. The new hire will be housed primarily in CMES and will be expected to integrate his/her research into the goals of *Mare Nostrum Caribbean*.

EMERGING AREAS							
Coastal Oceanography		**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	
ACTION ITEM	**RESPONSIBLE PARTY**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**IMPACT/ METRICS**
Initiate Coastal Oceanography Research	Paul Jobsis with assistance from Coral Reef 3D team (R. Nemeth, T. Smith, M. Brandt, B. Castillo)	Hire Coastal Oceanographer; Integrate oceanographer into multidisciplinary research team	Provide start-up research support. Consolidate data and modelling needs, purchase equipment. Designate collaborative working groups at UVI. Develop oceanography research goals for UVI	Form collaborative working groups beyond the University; submit grant proposals to support collaborative research	Synthesize collected data and submit grant proposals to support collaborative research	Synthesize new data; Strengthen collaborative research incorporating oceangraphy through 2 joint proposals	Oceangrapher hired; Infrastructure in place to support research objectives. Active Oceanographic Research that compliments Coral Reef research. Metrics: 2 new interdisciplinary awards in years 4 and 5. 2 publications
	P. Jobsis, Oceanographic Technician and New Oceanographer		Recruit 1 grad student and 2 ug students.	Recruit 2 ug students.	Recruit 1 grad students and 2 ug students.	Recruit 2 ug students.	Metrics: MMES student research projects (2) and undergraduate research posters (8).
Watershed Dynamics		**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	
ACTION ITEM	**RESPONSIBLE PARTY**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**IMPACT/ METRICS**
Initiate Watershed Dynamics Research	P. Jobsis, R. Platenberg, A. Primack, new hire	Hire Watershed Researcher (CMES and CSM) to support research team including MMSC, EAL and GeoCAS;Integrate Watershed Dynamics researcher into multidisciplinary research team	Consolidate hydrology, meteorology and survey data; purchase related equipment. Designate collaborative working groups at UVI;	Provide research, administrative and teaching support and form collaborative working groups beyond the University ; Develop Watershed research goals for UVI;	Synthesize collected data, submit grant proposals to support collaborative watershed related research; 1 publication, 1 presentation;	Synthesize new data; Strengthen collaborative research through 2 joint proposals; 1 publication, 1 presentation;	Watershed Dynamics faculty hired; Infrastructure in place to address research objectives. Active Watershed Dynamics Research that compliments Coral Reef research. Metrics: 2 new interdisciplinary awards in years 4 and 5 awards; 2 publications, 2 presentations
	P. Jobsis, R. Platenberg, A. Primack, new hire		Recruit 1 grad student and 2 ug students.	Recruit 2 ug students.	Recruit 1 grad students and 2 ug students.	Recruit 2 ug students.	Metrics: MMES student research projects (2) and undergraduate research posters (8).
Human Dimensions		**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	
ACTION ITEM	**RESPONSIBLE PARTY**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**IMPACT/ METRICS**
Develop Human Dimensions Research Program	K. Alexandridis, R. Nemeth, K. Engerman	Integrate Human Dimensions research into multidisciplinary research team; Collate existing data and identify questions; Identify and engage strategic partners at local, regional, national	Field work on chosen projects; Submit 1 interdisciplinary proposal related to climate change adaptation	Continue Field data collection, conduct preliminary analyzes, presentation; Submit 1 manuscript on environmental knowledge dynamics; presentation ILEK partnership meetings	Synthesize and analyze collected data; submit 2 grant proposal; 2 publication; 2 presentations	Synthesize and analyze collected data; submit grant proposals; 2 publication; 2 presentations; Strengthen collaborative research through 1 joint proposal	Infrastructure in place to address research objectives. Metrics: 2 new interdisciplinary awards in years 4 and 5 awards; Number of manuscripts, number of presentations, number of successful proposals
Mentor student researchers	K. Alexandridis, K. Engerman, M. Brandt	Recruit both undergraduate and graduate research assistants	Recruit both undergraduate and graduate research assistants	Recruit both undergraduate and graduate research assistants	Recruit both undergraduate and graduate research assistants	Recruit both undergraduate and graduate research assistants	Number of student theses (3), publications (3) and presentations (6)

Human Dimensions: A primary difficulty in understanding and managing for environmental sustainability is the uncertainty inherent in social-ecological systems. The attitude and perceptions of different stakeholder groups affect their ability to assimilate new knowledge. Potential solutions and related decisions to the challenges faced by communities because of climate change have less to do with the scientific understanding of the problem then how such challenges are perceived by the community. This raises the significance of community, stakeholder and citizen participation in managing our environment and natural resources. The broad question we will address is: *What are the perspectives of specific community stakeholder and institutional groups regarding the drivers, thresholds, critical variables and feedbacks that influence environmental sustainability?* We will explore, investigate and identify the key constituent factors that promote knowledge assimilation, facilitate adaptive governance and enable or inhibit the emergence of social-ecological stewardship. Key leading senior personnel include Dr. K. Alexandridis and Dr. K. Engerman. Dr. Alexandridis, a joint CMES and CSM faculty member located on St Thomas, will continue to manage GeoCAS which will become a hub of human dimensions research activities. Dr. Engerman from UVI's College of Liberal Arts and Social Science will pursue related research on St Croix.

Both will develop local and regional partnerships and collate available data related to human dimensions research and explore key human dimensions related to climate change adaptation in the US Virgin Islands and broader Caribbean. International partnerships will aid in understanding integrated local environmental knowledge dynamics. Undergraduate and graduate researchers will serve to increase the manpower of this area of research. Such partnerships between UVI researchers and students, and regional and international research groups is expected to double the number of presentations, publications and research funding to study human dimension issues in the Virgin Islands.

WORKFORCE DEVELOPMENT

VI-EPSCoR's workforce development area will support the development of the Virgin Islands Institute for STEM Education Research and Practice (VI-ISERP). The Institute will foster a cohesive research-based strategy for continued improvement in STEM education in the Territory. The long-term goal of the workforce development area is to improve the quantitative and scientific skills in the USVI workforce to strengthen economic competitiveness in STEM fields. The short-term goal for this grant is to significantly improve STEM education in the Territory, at both the K12 and the University levels. Improved STEM education will lead to a workforce that is better prepared to train for and work in STEM related careers. VI-ISERP will provide a collaborative infrastructure for research in STEM Education in the Territory, supporting the development of a cohesive center for grant writing, and coordinating activities in STEM Education research and practice.

The vulnerability of the USVI is tied to the tremendous need to develop a large, diverse, highly qualified scientific workforce. Nationally, the competitiveness of American industry is tied to the quality of American universities and educational systems. The same is true for the USVI. SAT scores of graduating high school students are lower than those of any state (2012 US average math SAT = 496, VI math SAT average = 384) and the proportion of USVI residents who have earned bachelor's degrees (12%) is far lower than the US national average (27%). According to the No Child Left Behind Report Card published by the VI Department of

Education, highly qualified teachers are rare for the STEM fields in the USVI, with only 32.6%

of students having a highly qualified teacher in math and only 29.3% for core science classes. Because tourism is the dominant industry, economic diversity is low. Attracting employers and developing local entrepreneurs depends on carefully planned workforce development. Improving the quantitative and scientific skills as well as the educational levels of the workforce will be the key to sustainability for this community. UVI has had success helping students to overcome deficiencies and to excel in highly competitive doctoral programs, and our current goal is to scale up this effort. Our vision for transformative workforce development inextricably links our research themes and educational research. We will focus on transforming STEM education in the Territory as the first step in increasing competitiveness in the STEM workforce.

The Virgin Islands Institute for STEM Education Research and Practice (VI-ISERP) will coordinate the workforce development efforts; provide a cohesive center for grant writing; and bring together a group of skilled researchers to support research-based change that will have an impact across the field. This Institute will be a center of excellence within UVI's College of Science and Mathematics with strong connections to UVI's School of Education. New hires may have joint appointments with both units. The Institute will coordinate the five strategies of our workforce development plan focusing on STEM Education at the University level and in the Territorial middle and high schools:

1. Implementation of an effective program of STEM Education research: VI-EPSCoR funding will support UVI faculty and their collaborators in implementing educational research, in collaboration with activities at both the University and in Territorial public middle and high schools. This research will be infused with VI-EPSCoR related research on coral reef demography, disease, and diversity. University scientists working in these areas will be active participants in these projects. A faculty member with expertise in STEM Education research will be hired to start working with existing faculty in Year Two. Post-doctoral researchers will be hired for years 2-5 to work with faculty on STEM Education research projects. External funding for new projects will be actively sought. Project results will be presented at national meetings and submitted for publication in peer reviewed journals.

2. Development of additional training pathways at UVI to improve STEM education in the Territory: VI-ISERP Directors will initiate the evaluation of the graduate programs developed with the support of previous VI-EPSCoR funding (MMES and MMAT), and will also evaluate the greatest need for other post-graduate training. The Institute will also facilitate the establishment of undergraduate certification paths (STEM minor) for STEM teaching which is already in process at UVI with NSF Noyce funding.

   In addition to the curricular changes above, there will also be a training program to increase the expertise of people doing fisheries research in the USVI. A Cooperative Fisheries Research lab will be developed in collaboration with the VI Department of Planning and Natural Resources (DPNR) and CMES. The newly equipped lab will provide opportunities for more research to be conducted in-house and consolidate management and dissemination of data. VI-EPSCoR and other grants will provide graduate research assistantships for MMES students to work on research that is relevant to the DPNR Division of Fish and Wildlife, provide expertise to develop a fisheries database at Geo-CAS, and provide funding to help build territorial capacity in fisheries

data collection. CMES will coordinate experts in various fields to provide training

workshops for staff in fisheries stock assessment, GIS, and fisheries statistics. These activities will facilitate collection and analysis of critical life history data gaps for the majority of commercial species.

3. Integration of research to transform the undergraduate curriculum: A third goal for VI-ISERP will be to facilitate integration of authentic research and active learning in the undergraduate STEM curriculum at UVI. Teams of researchers and teaching faculty will work together to bring specific research projects into the curriculum using successful programs as models to implement research-based courses and modules in stages while integrating well-designed assessment plans measuring students' abilities to think scientifically, formulate hypotheses, and design experiments. Introductory Chemistry labs will be used as the focus for this work involving Chemistry faculty (Dr. B. Castillo) who will also be working with *Mare Nostrum Caribbean* researchers. The outcome will be engaging classrooms and laboratory experiences that will increase STEM retention and scholarly papers. The partnerships of research-active faculty with faculty members who may not actively be conducting research will thus have an added benefit of developing the scholarship of all faculty and expand the research capacity of UVI and the Territory.

4. Development and implementation of mentoring training for all faculty members, post-docs, and graduate students involved in *Mare Nostrum Caribbean* projects : Undergraduates, graduate students, and postdoctoral fellows will conduct research along with UVI faculty engaged in coral reef research, educational research, and other areas. All faculty members, postdoctoral fellows, and graduate students involved in VI-EPSCoR-funded mentoring will complete mentor training annually.

5. Transformation of K12 STEM Education in the Territory: The Virgin Islands Department of Education (VIDoE) has adopted the Common Core State Standards (CCSS) and is in the process of integrating Next Generation Science Standards (NGSS) into the curriculum, and VI-ISERP will help catalyze the process. It will support VIDoE's efforts so that all ten middle and high schools in the Territory will have inquiry and project-based learning practices, infused with VI-EPSCoR research, aligned with NGSS and CCSS, and established as the model for STEM instruction. At the heart of this effort will be Professional Learning Communities (PLCs), which will be developed to support implementation of research based pedagogical approaches and techniques emphasizing inquiry-based learning in support of NGSS and CCSS. PLCs will be developed and supported through Summer Institutes, academic year activities, and research experiences for In-Service teachers. Each PLC is focused on a subject area (e.g., mathematics) for a set of grade bands. The members of each PLC will form a network for supporting teachers as they develop and implement inquiry and project-based learning practices, infused with VI-EPSCoR research, in implementing NGSS and CCSSM with effective technology integration. Mentor Teachers will be the core members of a PLC. The Mentor Teachers will be trained from in-service math and science teachers to lead the implementation of the inquiry- and project-based activities (developed in coordination with Mare Nostrum researchers) within STEM classrooms in all ten middle and high

schools in the Territory. This core of Mentor Teachers will be supported by UVI STEM faculty as well as at least one additional STEM expert. The STEM expert will be a UVI researcher or faculty member, or someone working in a content related discipline in the Territory. VIDoE Instructional Technologists will also be a member of each PLC. Pre-service teachers will participate in PLC activities as part of their training. Core PLC members will meet regularly and hold discussions via social networking, with meetings of all PLC
members occurring four times per year. PLCs will provide teachers local and sustained support towards improving their transformed teaching practice while they design and implement inquiry- and project-based learning activities in their own classrooms.
Local STEM experts in PLCs will support teachers to design inquiry- and project-based learning units with locally relevant interdisciplinary STEM content including VI- EPSCoR related research on marine environments. As PLCs will serve as a platform for
reflection on practices as a professional development strategy, videos of Mentor Teachers in the classroom will be used for a reflective study of local practices and for collaborative action research towards developing local exemplary practices. PLCs will disseminate best practices in inquiry and project-based teaching.

6. Investigating the impact of a hybrid problem-based online learning environment on the development of students' laboratory and problem solving skills using real case scenarios

Research Plan
This research is designed to study students' development of chemistry laboratory and problem solving skills in a hybrid problem-based distance learning environment. This study allows researchers to use eye-tracking hardware and software, retrospective think alouds, and a distance learning platform to explore cognitive processes and cognitive effort that students use to develop laboratory skills and solve problem scenarios. The goal of the study is to answer the following overarching research question: What is the impact of a hybrid problem-based distance learning environment on the development of students' laboratory and problem solving skills using real case scenarios?

Sub-level research questions are:

What is the impact of problem-based learning and virtual laboratory experiences on students' self-regulatory skills?
Does the hybrid learning environment increase engagement in chemistry instruction?

In numerous cases, chemistry laboratory activities are implemented using a recipe format where the outcomes are already pre-determined. Recipe format chemistry labs do little to foster critical thinking and problem solving. Further, these activities do not prepare

students to work using investigative skills like the scientists they one day plan to become.

Further, chemistry laboratories can be time consuming and expensive without providing students with investigative and discovery scientific experiences. Chemistry educators are increasingly incorporating online virtual chemistry laboratories, as would be used in a distance learning environment, to increase students' understanding of chemistry concepts and expose them to science laboratory techniques when science equipment and apparatus are not readily available. These virtual laboratories rely on the ability to provide students' with the opportunity to visualize chemical reactions and experiments, for example, to increase their understanding of chemical concepts and lab skills. The desire is to produce enhanced conceptual understanding but to use online technologies to do so. However, many of these online learning chemistry visualization platforms are not designed using problem based learning strategies.

Researchers have not specifically studied increases in students' laboratory or cognitive skill development and engagement in real time by combining problem based and online learning. Understanding the experiential nature of problem based labs from students' perspectives creates an opportunity to improve the chemistry lab experience in a distance learning environment, particularly for students who do not experience problem-based learning or learning in a virtual setting.

The experimental environment will be the introductory chemistry laboratory course, CHE 151-152, at UVI. The lab that will be studied begins in week 11 of the Fall 2015 semester where students learn to determine calcium hardness and alkalinity using titrimetric methods.

As a result of completing the laboratory activity, students will:
Develop precise and accurate measurement skills using volumetric and titrimetric analysis;
Recognize the necessity for careful observation and accurate measurement in problem solving; and
Engage in quantitative problem solving.

After performing basic laboratory titration activities, students will be presented with a problem scenario. They will be informed that a surrounding marine environment has successfully treated fish through the maintenance of the appropriate pH level. However, fish are increasingly showing up with diseases. Students will be asked to develop a strategy to determine the cause of the disease and an effective water treatment and testing plan to restore the original pH of the water to sustain the health of the fish.

Eye-tracking hardware and software, retrospective think alouds (RTAs), and online surveys will be used to collect data from students while learning to use chemistry apparatus in a problem-based learning environment. Eye-tracking methodology has been recently used to assess student engagement in problem solving (Tang & Pienta 2012) and in garnering information about student comprehension of visualizations in chemistry (Williamson et al. 2013). Researchers used eye-tracking to investigate why and how

complexity factors within the problem influenced student ability to solve gas law problems and to understand students' problem solving strategies. In the Tang and Pienta study, eye movement patterns revealed cognitive efforts of students successful and unsuccessful in solving problems related to gas laws.

People obtain and process visual information during eye fixations. Fixations are defined as eye gaze points that remain in one location for a period of time. Rapid eye movements occurring between fixations are called saccades. Eye movements are typically the result of cognitive activities; that is, when humans are exposed to text, pictures, or movies, eye movements are direct and objective indicators of attention, which is linked to cognitive processing. Specifically, the duration of an eye fixation indicates the cognitive complexity of the material. The total number of fixations on a region can be considered an indicator of how important the information in that region is and how effectively it was transferred to long-term memory. The sequence of fixations implies the strategies of processing information or solving problems and, thus, the final organization in long-term memory.

Eye-tracking data typically includes the location, duration, and sequence of students' fixations on the visual representations. Such information is not usually discovered using conventional assessment methods (e.g., written examinations and scores) when measurements of cognitive performance or task difficulty are needed. The UVI proposed eye-tracking study extends the Tang and Pienta study to explore the development of students' laboratory and problem solving skills in a hybrid problem-based distance learning environment.

This research involves the use of an eye-tracking system with a connected audio device. The use of the eye-tracking system is the basis of the study to determine qualitatively how students use lab equipment and apparatus to solve real world problem scenarios. The use of this qualitative data will allow researchers to develop enhanced learning environments that support students in enhancing their problem solving and critical thinking skills. Some studies found that novices and experts showed different patterns of eye movements when they solved science problems. Compared to traditional assessment methods such as examination scores and times to accomplish tasks, eye tracking can provide more subtle and accurate data related to learners' attention and cognitive processing. It can also be used to differentiate novices and experts more distinctly. The information obtained from eye-tracking data may provide educators with additional insight into students' levels of expertise, thereby enabling more effective curricula and assessments.

In this study, UVI researchers will measure online and real-world engagement using eye-tracking software, eye-tracking glasses and RTAs. Research has shown that incorporating eye-tracking in usability and engagement research can provide certain benefits compared with traditional data collection strategies. The basic idea behind eye-tracking is that our eye movements can be used to make inferences about cognitive processes. A Tobii T120 eye tracker with Tobii Studio 2.0.4 software will be used to collect eye movement data while students are performing laboratory activities. The eye tracker follows the user's eye movement by reflecting infrared light onto the eye and then, using a geometrical model,

determines the exact gaze point of the user. Most eye tracking studies aim at analyzing patterns of visual attention of individuals when performing specific tasks (e.g. reading, searching, scanning an image, driving, etc). In these studies eye movements are typically analyzed in terms of fixations-a pause of the eye movement on a specific area of the visual field, and saccades—rapid movements between fixations. This data is usually illustrated using gaze plots (or scan paths) which show saccades and fixations or aggregated heat maps which show the amount of or length of fixations.

Although eye-tracking can provide a wealth of data, it should be combined with additional qualitative data because eye movement cannot always be clearly interpreted without the participant providing context to the data. For instance, longer fixations can mean a user found a particular area interesting, but it can also mean that they found the area difficult to interpret. Hence, it is important to attempt to supplement eye tracking data with additional information gained from the participants about their experience, RTAs. During RTAs, participants are asked to articulate a description of their experience after completing a specific task.

Few studies, if any, currently exist on the use of eye tracking devices that include RTA strategies to determine the impact of hybrid learning in chemistry laboratories.

Data will be collected from experimental and control groups. The experimental hypothesis is that students in the experimental group (within the hybrid learning environment) will have higher cognitive effort, as indicated by eye-movement patterns, and higher self-regulatory skills when engaged in solving problem scenarios than students not in the hybrid learning environment. The null hypothesis is that the hybrid learning environment will have no effect on students' problem solving and self-regulatory skills.

Course design features: One objective for this research is to influence students' capacity for solving problems and self-regulated learning—learning strategies necessary for becoming more ready to undertake advanced STEM courses. Developing the capacity for self-regulated learning early on in college is expected to lead to better success in classes and persistence with college curriculum.

As the first step to students becoming more self-regulated in their learning, we propose to invite them to take a chemistry lab with an embedded online learning component as would be used in distance learning. The online class will be designed with all the key features that lead to students becoming self-regulated learners. Towle and Cottrell (1996) listed the following as features that made an online course successful at creating self-regulated learners:

Clear, advance information about tasks
Specific performance goals for assignments
Intrinsic rewards for task completion
Timetabling that allows sufficient time for task completion
Expectation that learners will remain on task
Support for student learning, such as encouraging discourse

Formative assessment and feedback that enables students to monitor and modify their own learning
Appropriate summative assessment, that is, that tests problem solving rather than rote repetition of fact
Appropriate staff development/faculty training
We will incorporate these features in the online segment of the hybrid learning environment. Since self-regulated learning is also affected by the presence of and interactions with peers and instructors, we will be careful to include this aspect as a key feature of the online segment of the chemistry lab.

Based on this model and our ability to provide the optimal context for students, we argue that the online course in combination with access to an online learning community with mentors, a distance learning environment, will increase student capacity for self-regulated learning. To be specific, the learning context we build will include:

Significant presence of near peer mentors and faculty mentors accessible through distance learning technologies;
Prompt feedback and interaction;
Problem based modules that test not just for content but also for increases in self-regulation and efficacy; and
A structure allowing students to have significant freedom to go at their own pace.

The introductory chemistry lab will be designed with key features that promote students towards becoming self-regulated learners. Course features include the following:

Development of higher order thinking skills;
Development of self-regulated and self-directed learners;
Pre-post assessments which measure cognitive (laboratory skills) and non-cognitive skills (self-regulation);
Visually appealing content to include pictures and videos;
Videos that students can pause and rewind and text students can comment on;
Activities that engage students with interesting but doable problem sets and case scenarios;
Problem based learning and case based instructional strategies.

This research project will use innovative technologies to collect qualitative and quantitative real-time data from students as they experience problem based activities in a chemistry laboratory and have those concepts reinforced through virtual laboratories that include web-resources, video-lectures, animated demonstrations, self-evaluation, online discussions and interactive textbooks.

The Tobii glasses and data analysis software will be used to collect eye tracking data from students while participating in labs. The Morae software will be used to determine the usability (e.g. engagement) of students during online sessions. The eye-tracking system in a real-world setting along with the RTAs will allow researchers to capture data that measures cognition and engagement in this designed hybrid learning environment.

Variables that will be analyzed include:
Point of gaze
Gaze angle (for online eye-track monitoring)
Gaze direction
Saccades (fast eye movement)
Fixation
Total time spent solving problem scenarios
Average time spent in each problem solving phase
Comparisons will be made in the problem solving strategies of students in the experimental and control group. Interaction effects will be determined. A within and between groups comparison will be made using analysis of variance for fixation, saccades, and time during problem solving sessions. Data will be analyzed for statistical significance. Researchers will conduct statistical analysis on eye-tracking data (e.g. fixation, gaze, saccades) to assess the correlation between various constructs.

Researchers will use the RTA process to analyze students' comments for general themes and pattern codes to determine where they are experiencing success or frustration during the online or in-class laboratory experience.

Additional data analysis
Analysis of variance numerous engagement constructs across experimental and control groups
Correlation between area of interest and content knowledge;
Correlation between fixation and execution of chemistry laboratory techniques
Correlation between fixation and engagement
Correlation between fixation and perceptions of self-regulatory skills
Analysis of themes and patterns of retrospective think aloud data
Data Analysis: A multilevel analysis of the longitudinal data will be performed to investigate the influence of online learning on cognitive (academic) and non-academic skills—to include self-regulation. Students who take hybrid problem-based chemistry laboratory course augmented by the online virtual laboratory course will serve as the experimental group (entering 2015 cohort). This introductory chemistry course, CHE 151-152, will be taught by Dr. Bernard Castillo at the University of Virgin Islands. Students in the same introductory chemistry course without the virtual laboratory and online features will serve as the control group (entering 2015 cohort).

These results will inform decisions about teaching instrumentation within the chemistry classrooms at UVI and within USVI high schools, and advance educational research knowledge. Distance learning technologies informed by pedagogical research, as described above, have the potential to enable the small islands of the USVI to share resources, e.g., modern instrumentation.
Once data analyses are underway, we will work with middle and high school teachers in the Territory to develop appropriate lessons. This work will serve as the basis for preparing additional proposals for further investigation of the efficacy of distance learning in chemistry education.

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WORKFORCE DEVELOPMENT **Improve the quantitative and scientific skills as well as the educational levels of the USVI workforce**

		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
ACTION ITEM	**RESPONSIBLE PARTY**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**IMPACT/ METRICS**
Implement an effective program of STEM Education research	STEM Institute (VI-ISERP)Directors	Hire STEM Ed faculty; Develop collaborations; Start collaborative project	Hire 1 STEM Ed postdoc; Start a STEM Ed project; present at national meeting; submit 1 manuscript (ms); submit 2 proposals for external funding.	Hire 1 STEM Ed postdoc; Start a STEM Ed project; 4 presentions at national meeting; submit 4 manuscript (ms); submit 3 proposals for external funding.	Hire 1 STEM Ed postdoc; Start 3 STEM Ed projects; 8 presentions at national meeting; submit 3 manuscript (ms); submit 4 proposals for external funding.	Start 3 STEM Ed projects; 10 presentions at national meeting; submit 4 manuscript (ms); submit 4 proposals for external funding.	Number hires, number research projects; number presentations; number publications; number proposals submitted (and number awarded); number teachers involved, number collaborators; number UGs
Establish a research program investigating distance learning	STEM Institute (VI-ISERP)Directors	Develop detailed research plan: purchase eye tracking glasses and software; set up and prepare eye tracking glasses and software	Collect baseline data on distance learning; design 3 lessons for online teaching; design 3 lessons using inquiry pedagogy; informational session on informed consent; collect eye tracking data from students participating in online lessons; data analysis	Prepare and submit ms concerning distance learning work; at least one presentation at a national meeting on distance learning work; prepare proposal for continued work on distance learning; work with VIDE high school teachers to develop distance learning modules	At least one presentation at a national meeting on distance learning work; prepare proposal for continued work on distance learning; work with VIDE high school teachers to develop distance learning modules	At least one presentation at a national meeting on distance learning work; prepare proposal for continued work on distance learning; work with VIDE high school teachers to develop distance learning modules	
Develop and revise UVI STEM curricula *a)Develop STEM*	STEM Institute (VI-ISERP) Directors	STEM teaching minor developed and courses scheduled	1 course in new minor offered; recruit students for the minor	All courses in new minor offered; continue recruiting			Minor in STEM teaching established; number of students enrolled in courses and in minor
Develop and revise UVI STEM curricula *b)Review MMES and MMAT*	STEM Institute (VI-ISERP) and Graduate Program Directors	Initiate program reviews for MMES and MMAT; Identify external evaluator(s)	Self- study for MMES, MMAT; visit and report by external review team	Curricula, format are updated	New Curricula, format implemented	Self- study for MMES, MMAT; visit and report by external review team	New curricula and format for MMES, MMAT implemented
Develop the Cooperative Fisheries Institute	Rick Nemeth, CMES, DPNR	Plan for Cooperative Institute, planning for workshops	Design and equip fisheries lab (DPNR, STX); hold workshop; begin research	hold workshop; continue research	hold workshop; continue research; 1 presentation	hold workshop; continue research; 2 presentation; 2 manuscripts	Cooperative Fisheries Lab; Number of projects; number of grad students; No. of undergrads;no. of presentations; no. of
Integrate Research to Transform CHE 151L and 152L in the Albert A. Sheen campus.	B. Castillo	Develop 1 experiment for courses; develop assessment plans; Prepare pre- and post- class survey on experiments.	Implement 1 research experiment for CHE 151L (Fall) and CHE 152L (Spring); Assess student learning on new experiments	Develop 1 additional experiment ; Assess student learning; Present findings at local conference	Implement 2nd experiment ;Assess and evaluate learning; 1 manuscript for publication	Continue experiments in courses, assessment & evaluation; submit ms for publication; 2 presentions (local and national meetings)	Number of research experiments implemented; number of students involved; published articles; number of presentations
Mentor training for all faculty members, post-docs, and grad students involved in Mare Nostrum projects	Bauman	Mentoring training and assessment plan developed; workshop in mentoring held (external consultant); Mentee-Mentor partnerships established	Revision of mentor training plan based on Year 1 assessments; Workshop held and success evaluated; Mentee-Mentor partnerships assessed and evaluated	Revision of mentor training plan based on Year 2 assessments; Workshop held and success evaluated; Mentee-Mentor partnerships assessed and evaluated	Revision of mentor training plan based on Year 3 assessments; Workshop held and success evaluated; Mentee-Mentor partnerships assessed and evaluated	Revision of mentor training plan based on Year 4 assessments; Workshop held and success evaluated; Mentee-Mentor partnerships assessed and evaluated	Mentoring effectiveness of all involved in Mare Nostrum projects increased by 30% over baseline measures CTSA Post- Mentor Training Survey and the Mentoring Competency Assessment

WORKFORCE DEVELOPMENT **Improve the quantitative and scientific skills as well as the educational levels of the USVI workforce**

		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
ACTION ITEM	**RESPONSIBLE PARTY**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**IMPACT/ METRICS**
Training for Mentor Teachers and Development of Professional Learning Communities (PLCs)	STEM Institute Directors, VIDoE	Coordinate all activities with VIDoE; Recruit 10 Mentor teachers & UVI Mare Nostrum faculty; 3 in service trainings; 2 summer workshops (STT and STX); design Inquiry/Project based learningmodules (VIDoE); create model classroom; develop materials to supply 6 model classrooms; establish baseline data on use of practice; develop plan for PLCs in all 10 VI HS and JrHS;	Coordinate all activities with VIDoE; Recruit for Mentor teacher (10); Summer Workshops for In-Service Teachers (STX, STT); 4 in-service teacher training activities during the school year; supply materials for min. 6 model classrooms taught by mentor teachers; assess, analyze STEM teaching practices, modify as needed; establish 2 PLCs (math at the middle school)	Coordinate all activities with VIDoE; Recruit for Mentor teacher (10); Summer Workshops for In-Service Teachers (STX, STT); 4 in-service teacher training activities during the school year; supply materials for min. 6 model classrooms taught by mentor teachers; Assess, analyze STEM teaching practices, modify as needed; establish 2 PLCs (science at middle school)	Coordinate all activities with VIDoE; Recruit for Mentor teacher (10); Summer Workshops for In-Service Teachers (STX, STT); 4 in-service teacher training activities during the school year; supply materials for min. 6 model classrooms taught by mentor teachers; assess, analyze STEM teaching practices, modify as needed; establish 2 PLCs (science at HS)	Coordinate all activities with VIDoE; Recruit for Mentor teacher (10); Summer Workshops for In-Service Teachers in STX, STT; 4 in-service teacher training activities during the school year; supply materials for min. 6 model classrooms taught by mentor teachers; assess, analyze STEM teaching practices, modify as needed; establish 2 PLCs (math at HS)	number Mentor teachers; number students taught; number PLCs; effectiveness of teaching methods; teacher proficiency and student learning; number EPSCoR researchers involved;

Succession Plan: Initially, Dr. S. Romano, Dean of the College of Science and Mathematics (CSM), will have overall responsibility for the management of the workforce development area. She will work closely with Dr. C. Ekici (CSM) and Dr. R. Howard (School of Education), who will oversee the day to day activities of VI-ISERP. Each of these leaders will be able to assume responsibility for any of the STEM Institute activities. The STEM Education Research faculty member (to be hired), will become integrated into the management team. Once the new faculty member has joined the team at the beginning of Year 2, the management structure of the Institute will be revisited. In Years 2, 3, 4, and 5, teaching post-doctoral scholars will work with faculty. The work of the Institute will be supported by an Administrative Assistant, a Data Manager, and a Web Specialist. In the absence of the area leader, Provost Camille McKayle, the Co-PI on the *Mare Nostrum Caribbean* project, would provide oversight in this area.

Risks specific to this area are the need to coordinate with the VIDoE (recruiting for Mentor teachers, designating model classrooms, forming PLCs) and the commitment of teachers/principals to the project. The impact of delays in these actions is "High", but likelihood "Medium" if there is a commitment on both parties (VIDoE and VI-ISERP) to make this work.

CYBERINFRASTRUCTURE

Information and Technology Services (ITS) provides technology support for the Virgin Islands Experimental Program to Stimulate Competitive Research (VI-EPSCoR), as well as to support the University of the Virgin Islands' (UVI) mission and to provide leadership to accomplish UVI's strategic plan. ITS has the accountability for managing UVI's academic and administrative systems and the information technology infrastructure that supports them.

Information Technology Services will support *Mare Nostrum Caribbean* by carrying out the four actions listed in the cyberinfrastructure strategic planning table. ITS will coordinate with project area leaders to assure that requisite technology needs are met.

Succession Plan: The Vice President, Information Services and Institutional Assessment (Ms. T. Koopmans) will have overall responsibility for the management of the

CYBERINFRASTRUCTURE (provides technology support for VI-EPSCoR's activities)						
	YEAR 1	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	
ACTION ITEM	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**IMPACT/ METRICS**
Upgrade of the Wide Area Network (WAN)	Develop Cyberinfrastructure 5 year plan; Increase the inter-island bandwidth from 300 to 600 mbps					Bandwidth increased; Five year plan in place
Upgrade of the Local Area Network (LAN) infrastructure	Increase network closet environmentals and security	Upgrade aged bldg. cabling; Upgrade UPS in network closets	Upgrade core, distribution and access layer switches			All upgrades complete
Design cloud-based disaster recovery				Implement cloud-based solution for applications		Cloud based solutions implemented
Provide technical guidance and coordination for the integration of a web services	Upgrade Hycom servers; Implement web service servers for project area outcomes; coordinate needs with all areas of Mare Nostrum	coordinate needs with all areas of Mare Nostrum	coordinate needs with all areas of Mare Nostrum	coordinate needs with all areas of Mare Nostrum	coordinate needs with all areas of Mare Nostrum	Technology needs met

cyberinfrastructure area, working closely with the IT Engineer, Project Manager (Ms. K. Harrigan) who will oversee the day to day activities of the cyberinfrastructure projects as well as provide project management and reporting of project activities. The Assistant CIO (Ms. S. Harris) is named as a successor, in the interim, to either the Vice President, Information Services and Institutional Assessment or the IT Engineer, Project Manager should either individual no longer be able to serve in their role.

Risks especially critical to ITS are equipment procurement delays, either due to slow purchasing or shipping and customs issues. The impact and likelihood are "Medium". For mitigation the intent is to plan for potential delays (order early) and build some redundancy.

OUTREACH, EDUCATION, DIVERSITY AND COMMUNICATION

The goal of VI-EPSCoR's Outreach, Education, and Diversity (OED) program is to see a U.S. Virgin Islands community that is demonstrably more science literate and engaged in issues that are scientific and environmental in nature. This will be accomplished through strong collaborations with both governmental and non-governmental partners in the community, which identify the strengthening of the Science, Technology, Engineering and Mathematics (STEM) capabilities within the Territory as part of their mission. The OED strategic plan has been developed with consultation with such partners and identification of potential partners, e.g., the VI Department of Planning and Natural Resources, the Virgin Islands Department of Education, the Virgin Islands Marine Advisory Service, Mathematics and Environmental Science Academy (MESA) Coordinators, St. Croix Environmental Association, 4-H, the Virgin Islands Caribbean Cultural Center, and of course our *Mare Nostrum Caribbean* colleagues. Our outreach and education strategies are carefully designed to embrace the rich diversity that makes up the Virgin Islands community. We will optimize on opportunities to embrace the various groups and sub-groups represented here, and provide an inclusive environment for STEM information sharing and learning for students and non-students alike. Within this context, we will place particular emphasis on underrepresented groups in STEM, such as African American males specifically and Latinos in general. Our informal education efforts involving the wider USVI community through our initiatives like our Citizen Science and Science Café programs will contribute significantly to our mandate of comprehensive inclusion of Virgin Islands residents. What has become clear through the consultation process, is that there is the need for further deliberations and careful planning if our collective OED efforts are to be successful and transformative in the U.S. Virgin islands. It is against this backdrop that VI-EPSCoR's OED Strategic Plan is presented.

Many of our OED programs have been developed, improved and stood the test of time, but in *Mare Nostrum Caribbean,* we will develop a new comprehensive program in *citizen science*. The activities planned will engage USVI residents in research, outreach and education with terrestrial and marine programs. Benefits include richer data sets resulting from larger sample sizes; enhanced citizen awareness and concern; cost savings; improved science literacy in the community; strengthening of the local workforce's capacity; and the introduction of innovative questions and thinking to local research mindsets. However, in the U.S., citizen science initiatives have not connected as well with groups that have been historically underrepresented in science. The introduction of *Citizen Science in the Virgin Islands* provides a unique opportunity to innovate and assess models for engaging underrepresented minorities in locally relevant science. A full time Citizen Science coordinator will develop the program in

partnership with local agencies and organizations. We will renovate a hurricane damaged building, a short distance along the shore from UVI in St. Thomas, to create the Citizen Science Interpretive Center. It will serve as a meeting and training facility where outreach coordinators will engage the public and visitors, researchers will make presentations and develop interactive kiosks and students will explore STEM disciplines through creative hand-on environmental activities.

In the first year of the Mare Nostrum program, we will hire an Outreach, Education and Diversity (OED) Coordinator, a Data Manager, an Internet Communications Specialist, and a Citizen Science Coordinator. The outreach coordinator and internet communication specialist will work closely with researchers and educators involved with Mare Nostrum core research and emerging areas and the STEM institute to develop a strong media presence within the community.

The Citizen Science Coordinator will initiate a detailed 4-year Citizen Scientist Initiative Plan in Year 1 and a Citizen Science Advisory Team will be established to provide technical and other advisory support. The citizen science program will be developed to educate and engage the broader public, and enhance community ownership of, and pride in, the territory's resources. The projects will be designed to increase public understanding of the potential consequences of climate change and strategies for small island communities to adapt. Our citizen science program will focus on the land-sea interface by examining how human activities in watersheds affect freshwater resources and nearshore marine environments. The success of this program will rely upon a continuous feed-back loop of information from Citizen Science Coordinator to Community Participants to UVI's GeoCAS database to the jurisdictions Department of Planning and Natural Resources (Figure 1). The Citizen Science Coordinator will engage the public to help monitor biological and physical parameters including rates of erosion and transport sediments and pollutants to the sea using simple tools and equipment. Development of a mobile phone app will allow citizens to document real-time erosion during heavy rain events and the results displayed on an interactive website. To build community involvement the Citizen Science Coordinator will work with our Outreach and Education Coordinator Carrie Jo Boyce (new hire) to strengthen local partnership to develop a territory-wide Adopt-a-Watershed campaign. The campaign will target four specific age groups (grades 4-6, 7-12, college students and resident adults) with specific activities designed for each group. Interaction with the public will in collaboration with the planned St. Thomas Brewer's Bay and St. Croix East End Marine Park ecosystem research initiatives. The goal will be for citizen scientists to identify sites that have high potential for erosion and the positive feedback loop will help manage these sites before heavy rainfall washes the soil into the sea, creating a brown mud plume that severely damages coral reefs and the marine environment. The citizen-science education and training program will take place in an interpretive center, a seaside building on UVI's campus. Conceptual plans will be developed for the interpretive center which will include renovation of the abandoned building, an outdoor amphitheatre, a classroom and interactive kiosks to display Mare Nostrum research.

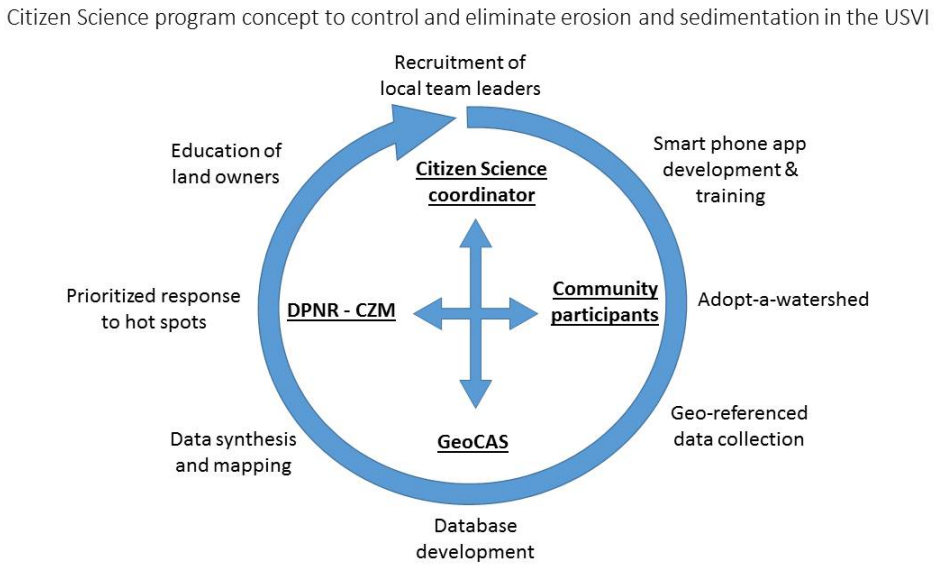

Figure 1. Diagram of information flow among partners (inside circle) and the strategic activities (outside circle) to reduce and eliminate erosion and sedimentation in the Virgin Islands.

We will invite existing and potential new partners to our 2015 Annual Conference on St. Croix to expose them to detailed aspects of the Mare Nostrum program in order to continue to build our partnership base. At the K-12 levels, we will continue to strengthen our partnerships by identifying a minimum of one school or inter-school program per island for adoption and support in STEM-related activities.

We recognize the importance of effectively communicating our work to our constituents. While some of our VI-EPSCoR staff and partners have been trained in the past in effective messaging, we will continue to build on this initiative by hiring appropriate consultants to collaboratively develop a *Science, Becoming the Messenger* workshop that will offer training to a wider range of professionals and graduate students in the Territory. In this vein, we will also develop a 15 – 20 minute presentation to capture 8-12th graders' interest in STEM, and prepare a minimum of 5 media releases on Mare Nostrum program in year 1.

We will support the Virgin Islands Marine Advisory Service (VIMAS) in the strengthening of its data collection and assessment tools for Reef Fest and other outreach activities. Our outreach activities in collaboration with VIMAS and other partners in Year 1 will include: 3 Science Cafés; 5 Brown bag sessions (STX, STJ, STT) focusing on Mare Nostrum themes. Additionally, we will continue to capitalize on the large public assemblies associated with the St. Croix and St. Thomas Agricultural Fairs, and have our outreach and education displays and interactions with the community at these events.

The above Year 1 activities will form the foundation of our Outreach and Education goals and objectives over the five years of this strategic plan. These goals and objectives include the completion and development of the detailed 4-year Citizen Scientist Initiative Plan and a training handbook to serve as a model, improvement of OED data collection tools, expanding the number, quality and diversity of distributed media announcements, the establishment of a cadre of trained citizen scientists along with established and fully functioning citizen science projects, and the successful establishment and full operation of the interpretive center on St.

Thomas, and a similar facility on St. Croix. A successful Mare Nostrum OED program will be marked by our hosting and co-hosting of a range of conferences, workshops and public presentations to advance the mission and goals of the Mare Nostrum program. Other indicators of our success will be the strengthened partnerships and the enhanced partner expertise that will lend themselves to strengthening the STEM capabilities in the Territory, and result in more students becoming engaged in STEM, and utilizing the resources made available to them through the Mare Nostrum Program. All of this of course will be documented through the development and use of more elegant data collection and assessment, and communications tools.

BUDGET

A total of $60,000.00 in Year 1, and $80,000.00 in Years 2 - 5 of the project is reserved for these activities.

OUTREACH, EDUCATION, DIVERSITY and COMMUNICATION							
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
ACTION ITEM	RESPONSIBLE PARTY	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	STRATEGIC ACTIONS	IMPACT/ METRICS
Make NEW Hires to support OED and VI-EPSCoR activities	Nick Drayton, Rick Nemeth	Make these hires: O & E Coordinator;Data Manager; Internet Communications Specialist; Citizen Science Coordinator					Jobs filled
Establish Citizen Science Program	Nick Drayton, Citizen Science Coordinator (in collaboration with Coral Reef Research Team)	Conceptual plan for a citizen science program developed	Preliminary fieldwork and teaching tools developed; Outreach to potential participents	Data collected	Data collected, analyzed; presentation at Annual Conferences	Data collected, analyzed; presentation at Annual Conferences	Number of participants; number of hours participated; number of products (presentations, contributions to publications or outreach)
Development of Interpretive Center	Richard Nemeth, Nick Drayton, Paul Jobsis Coral Reef Research Team and Citizen Science Coordinator	Conceptual plans for renovation of building dveloped	Engineering plans completed; necessary permits obtained	Construction and rennovation completed	Center in full operation; Development of a self supporting model	Upgrade facility to include kiosks to display UVI research. Promote "Friends of" concept	Interpretive Center built; business plan developed;number of/type of visitors and Mare Nostrum researchers involved
Annual Citizen Science Conf	Nick Drayton, Citizen Science Coordinator, and Coral Reef Research Team		Organize conference	Organize conference	Organize conference	Organize conference	Number presenters; number visitors
Establish new outreach partnerships	Nick Drayton, O&E Coordinator and Citizen Science Coordinator	Identify and contact potential partners	Develop cooperative programs	Develop cooperative programs	Develop cooperative programs	Develop cooperative programs	Number of new partnerships (min. 5) and description of what role they play in OED
Adopt-A School	Nick Drayton, O&E Coordinator	Schedule programs	Schedule programs	Schedule programs	Schedule programs	Schedule programs	
Science become a Messenger Training	Nick Drayton, O&E Coordinator	Design a workshop, hire appropriate consultants	Hold a workshop for faculty, media associates, grads, ugs	Hold a workshop for faculty, grads, ugs	Hold a workshop for faculty, grads, ugs	Hold a workshop for faculty, grads, ugs	Number in workshops; number of presentations given by workshop participants in 3 years
Develop assessment tool for ReefFest (VIMAS)	Nick Drayton, VIMAS and Reef Fest Coordinator	Assessment tool developed and used	Assessment tool developed and used	Assessment tool developed and used	Assessment tool developed and used	Assessment tool developed and used	Assessment tool; Report on results of assessment tool
Community subgroup events: Science Café, "brown bags" (incl. 1st Friday and lunchtime)	Nick Drayton, O&E Coordinator	Events scheduled and conducted: 3 Science Café; 15 Brown bag (STX, STJ, STT)	Events scheduled and conducted: 6 Science Café; 15 Brown bag (STX, STJ, STT)	Events scheduled and conducted: 6 Science Café; 15 Brown bag (STX, STJ, STT)	Events scheduled and conducted: 6 Science Café; 15 Brown bag (STX, STJ, STT)	Events scheduled and conducted: 6 Science Café; 15 Brown bag (STX, STJ, STT)	Number of events; number of people reached; diversity of communities reached; number of Mare Nostrum researchers involved
VI AgFairs (STT, STX),	Nick Drayton, O&E Coordinator	Develop display	Develop display	Develop display	Develop display	Develop display	Number of visitors
Man Up Initiative	Nick Drayton, O&E Coordinator	Develop program	Develop program	Develop program	Develop program	Develop program	Number of students attending
VI EPSCoR Annual Conference, UVI Fall & Spring Symposia	Nick Drayton, O&E Coordinator	Plan conferences	Plan conferences	Plan conferences	Plan conferences	Plan conferences	Number presenters; number visitors
Promote MareNostrum research	Nick Drayton, O&E Coordinator, Internet Communications Specialist	Prepare media releases on Mare Nostrum research	Prepare media releases on Mare Nostrum research	Prepare media releases on Mare Nostrum research	Prepare media releases on Mare Nostrum research	Prepare media releases on Mare Nostrum research	Number of releases (min. 2/yr); number of types of media: local, regional, national, international

Succession Plan: The Outreach, Education and Diversity (OED) program of VI-EPSCoR will be administered by an OED Coordinator. The position is currently being advertised and is to be filled in Year 1. In the absence of this individual, the Assistant Director (formerly the OED Coordinator) will perform the duties of the position until a replacement is found. Similarly, the Assistant Director will acquaint himself with the fundamentals of the newly emerging Outreach and Education areas (Citizen Science, Science cafés and multimedia messaging) to ensure continuity during any potential loss of key personnel.

Risks of particular concern in this area are four key hires (OED Coordinator, Citizen Science Coordinator, Data Manager, and Internet Communications Specialist). These people are critical personnel for the success of the overall VI-EPSCoR, thus this risk has "High" impact and "Medium" likelihood. Mitigation is to make these hires a priority. There is also a medium risk and likelihood of turnover in key individuals in partner organizations or the possibility that a partner has a funding shortfall, but the mitigation is to maintain frequent contact with all involved, and the flexibility to re-allocate resources if one partner cannot continue.

PROJECT EVALUATION

An external evaluator will provide annual guidance to the program administration and participants through visits, other communications and annual reports. The annual evaluation report includes reports from the External Advisory Board, and external (e.g., feedback from NSF, including from reverse site visits; outside reviews of the VI-EPSCoR developed Master's programs, MMES and MMAT) as well as internal reviews. The report will also highlight and discuss conflicting views. A summary of action items is found in the chart of the Evaluation Strategic Planning table.

Succession and risk: Should the current external evaluator not be able to continue in this capacity, a successor would be hired. Impact is "High", but likelihood is "Low".

VI-EPSCoR External Evaluation Strategic Plan						
ACTION ITEM	**LEAD RESPONSIBILITY**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**	**STRATEGIC ACTIONS**
Adherence to Strategic Plan	Kimbell	Help develop Strategic Plan; Develop Evaluation component	Annual Evaluation Report (reality check on strategic plans)	Annual Evaluation Report (reality check on strategic plans)	Annual Evaluation Report (reality check on strategic plans)	Annual Evaluation Report (reality check on strategic plans)
	Kimbell, Admin team, faculty	Evaluation plan submitted to PI 30 days after strategic plan approved by NSF	compare&revise evaluation plan to needs of program and strategic plan fidelity	compare&revise evaluation plan to needs of program and strategic plan fidelity	compare&revise evaluation plan to needs of program and strategic plan fidelity	collect and analyze program data required for NSF
Summative Evaluation	Kimbell, admin team, area leads	Collect and analyze program data required for NSF, Evaluation Rept submitted Mar 1, response rec'd Apr 1	Collect and analyze program data required for NSF, Evaluation Rept submitted Mar 1, response rec'd Apr 1	Collect and analyze program data required for NSF, Evaluation Rept submitted Mar 1, response rec'd Apr 1	Collect and analyze program data required for NSF, Evaluation Rept submitted Mar 1, response rec'd Apr 1	Collect and analyze program data required for NSF, Evaluation Rept submitted Mar 1, response rec'd Apr 1
Formative evaluation	Kimbell, admin team, area leads	share programmatic summative and formative data with admin team, with recommendations for improvement	share programmatic summative and formative data with admin team, with recommendations for improvement	share programmatic summative and formative data with admin team, with recommendations for improvement	share programmatic summative and formative data with admin team, with recommendations for improvement	share programmatic summative and formative data with admin team
	Kimbell	site visits 2 - 3 times per year	site visits 2 - 3 times per year	site visits 2 - 3 times per year	site visits 2 - 3 times per year	site visits 2 - 3 times per year
		monitor progress via phone, email and on-line data	monitor progress via phone, email and on-line data	monitor progress via phone, email and on-line data	monitor progress via phone, email and on-line data	monitor progress via phone, email and on-line data
compile all sources of reviews	Kimbell, Admin team	attend advisory meetings and/or obtain reports from all external and internal reviews	attend advisory meetings and/or obtain reports from all external and internal reviews	attend advisory meetings and/or obtain reports from all external and internal reviews	attend advisory meetings and/or obtain reports from all external and internal reviews	attend advisory meetings and/or obtain reports from all external and internal reviews
social network analysis	Kimbell	Implement social network analysis of collaborations and citations	Collaboration networks included in evaluation report.	Preliminary networks for citations for internal review	Collaboration and citation networks included in evaluation report.	Collaboration and citation networks included in evaluation report.

Appendices

Appendix A

Participant List
VI-EPSCoR Strategic Planning Workshop
November 6-7, 2014

VI-EPSCoR Project Director's Office

H. Smith (PI)
N. Drayton (co-PI)
C. McKayle (co-PI)
R. Nemeth (co-PI)
K. Prentice
T. Otto
H. Forbes

External Facilitator – J. Riordan

Area Representatives

Coral Reef and Emer. Areas: P. Jobsis, T. Smith, M. Brandt, R. Platenberg
Workforce Development: S. Romano, C. Ekici, R. Howard
Cyberinfrastructure: T. Koopmans, K. Harrigan

Evaluator – B. Kimbell

Governing Committee

M. Okolo
R. Evangelista

External Council – E. Gladfelter

National Science Foundation

D. Barnes
S. Kennan

V.I. Dept. of Education – K. Poszywak

UVI Administration

D. Hall (President)
F. Mills (Interim Vice Provost, RPS)

VI EPSCoR Strategic Planning Workshop

November 6-7, 2014

Location: West Hall, UVI, St. Thomas

Day 1 – Thursday, November 6, 2014

8:30am **Breakfast**

9:00am

Welcome and General Overview: Welcome by UVI officials (**Hall**/McKayle/Mills?) then Dr. Henry Smith welcomes the group, introduces participants, briefly reviews purpose and outcomes for the workshop, and provides a brief overview of the project.

- *What is the driving purpose behind the Project? What is all of this ultimately aiming to achieve?*
- *How do the various elements of this project "fit together" as a whole?*
- *What has been our approach to the strategic planning effort thus far, leading up to this meeting?*

9:15am-9:45am (20 min presentation; 10 min discussion = 30 min)

NSF Perspective: Greetings by Dr. Denise Barnes, NSF-EPSCoR Head. Slide presentation by NSF-EPSCoR Program Director, Dr. Sean Kennan who will explain NSF's expectations for the strategic planning process and product, reporting requirements, in the context of NSF-EPSCoR's programmatic goals.

9:45am-10:15am (20 min presentation; 10 min discussion = 30 min)

Project Evaluation Overview: Barbara Kimbell, External Evaluator for the project, outlines the approach and expectations for external evaluation of the Project.

- *Role of external evaluation*
- *Data collection processes, purposes, and schedule*
- *What data will we be collecting and measuring for the project?*

10:15am-10:30am (15 min)

Strategic Planning Introduction: John Riordan (facilitator) briefly reviews the agenda, and process, and offers a set of ground rules to guide the workshop.

10:30am – 10:45am **Break**

10:45am-11:15am (20 min presentation; 10 min discussion = 30 min)

Introduction: Henry Smith review proposed content for these Project-related elements:

- *Is our Vision statement compelling and inspiring?*
- *Is our Mission statement meaningful and powerful?*
- *Have we clearly communicated our alignment with the USVI Comprehensive Economic Development Strategy, UVI Strategic Plan 2017 and other guiding documents?*

Project Area Presentations: Project Area leads provide an overview of the content highlights for their respective areas, to include the following:

1. Brief description, assumptions, and key partners
2. Strategic Planning Table
3. Baseline measures (measures at Project start)
4. Risk Assessment

5. *Note: Highlight new information and responses to NSF Reviewers*

Discussion *(following each presentation)*
- *What are our reactions to what we've heard from this Project Area?*
- *What strengths do we see in what they've presented?*
- *Where would we offer suggestions to strengthen their content?*
- *Have they responded clearly to the NSF Reviewers' comments?*
- *What key integration points do we see for discussion later?*

11:15am -12:00pm (25 min presentation + 20 min discussion)
Coral Reef Research – Dynamics (Dr. Tyler Smith)

12:00pm – 12:45pm **Lunch**

12:45pm - 1:30pm (25 min presentation + 20 min discussion)
Coral Reef Research – Disease (Dr. Marilyn Brandt)

1:30pm – 2:15pm (25 min presentation + 20 min discussion)
Coral Reef Research – Demographics (Dr. Richard Nemeth)

2:15pm – 2:30pm **Break**

2:30pm – 3:15 pm (25 min presentation + 20 min discussion)
Workforce Development (STEM Education Research and Practice) (Dr. Sandra Romano)
- *In addition to the above, are we clear on how each research area is involved with and supports workforce development efforts?*

3:15pm – 3:45pm (15 min presentation + 15 min discussion)
Cyberinfrastructure (Tina Koopmans and Kelly Harrigan)
- *Are we clear on how cyberinfrastructure integrates with all other project areas?*

3:45 pm-4:15pm (15 min presentation + 15 min discussion)
Outreach, Education and Diversity (Nick Drayton)
- *Are we clear on how each research area is involved with and supports OED?*

4:15 pm – 4:30 pm
Review, Prep and Wrap Up
- *What take-away's have we come away with from Day 1?*
- *What can we do to ensure we make the most of Day 2?*

Day 2 – Friday, November 7, 2014

8:30am **Breakfast**

9:00am-9:15am
Reflections & Insights: Participants share any overnight reflections and insights from Day 1.

9:15am – 9: 45 am (30 min presentation + 15 min discussion)
Seed Funding and Emerging Areas (Dr. Paul Jobsis)
- *How will the emerging areas be integrated into the existing science and education focus areas?*

9:45am-10:30am
Project Milestones: Henry Smith leads discussion as participants develop Project Milestones to ensure they are useful 'check points', showing integration and coordination, such that "accomplishing all stated milestones should achieve the vision and mission of the project".

- *What are the right milestones for the Project as a whole?*
- *How will we track and hold ourselves accountable to these milestones?*

10:30am – 10:45am **Break**

10:45am - 11:15am
Succession Plan: Henry Smith presents a succession plan for the overall project detailing "how the project would continue should any key member be unable to fulfill his/her role in the project."

11:15am - 11:45am
Risk Mitigation Plan: Henry Smith presents the Project Risk Mitigation plan for the overall project. Participants ask questions, offer additional input and discuss implications and mitigation strategies.

11:45am – 12:45 pm **Lunch**

12:45pm-1:15pm
Organizational structure and relationships: *Henry Smith leads review of the project organizational chart to show respective roles and responsibilities. Participants work to fine tune the integration of all research areas and integrative areas (OED, Cyber, etc.) to ensure over-all coordination of effort.*

1:15pm-1:45pm
Communications Plan: Nick Drayton leads the discussion regarding communications plan. Participants ask questions, offer input and discuss implications.

- *Who are our various stakeholders, and how will we ensure they are aware of the impacts and importance of this project?*

1:45pm – 2:00pm **Break**

2:00pm - 3:00pm
Strategic Plan Outline Section Review and Refinement: John Riordan start walkthrough of the strategic plan outline section by section.

- *Clarify every section to where are all clear on what content should be included, and who will finalize that content.*

3:00pm-4:15pm
Next Steps and Action Items

- *What are the specific next steps we need to take, and timeline we need to adhere to, to ensure we achieve our Strategic Plan in a timely manner?*
- *Who will do what, by when, to make this happen?*
- *How will we hold ourselves accountable to getting this done in a high-quality, timely fashion?*

4:15 - 4:30pm **Closing Remarks:** Dr. Sean Kennan and Barbara Kimbell, and participants offer any final remarks. Henry Smith closes out the workshop.

4:30pm **Adjourn**

Appendix B

List of Acronyms and Abbreviations used in text and tables

CariCOOS	Caribbean Coastal Ocean Observing System
CCSS	Environmental Analysis Laboratory
CEDS	USVI Comprehensive Economic Development Strategy
CMES	Center for Marine and Environmental Studies
CR	Coral Reef
CSM	College of Science and Mathematics
DPNR	(VI) Department of Planning and Natural Resources
EA	Emergic Research Areas
EAL	Environmental Analysis Laboratory
GeoCAS	Institute for Geo-computational Analysis and Statistics
ITS	Information and Technology Services
MESA	Mathematics and Environmental Science Academy
MMAT	Master of Arts in Mathematics for Secondary Teachers
MMES	Masters in Marine and Environmental Science
NGSS	Next Generation Science Standards
NSF	National Science Foundation
OED	Outreach, Education and Diversity
PLC	Professional Learning Community
SoE	(UVI) School of Education
STEM	Science, Technology, Engineering, Mathematics
STJ	St. John
STT	St. Thomas
STX	St. Croix
USGS	U.S. Geological Survey
USVI	U.S. Virgin Islands
UVI	University of the Virgin Islands
VI	Virgin Islands
VIDoE	Virgin Islands Department of Education
VI-EPSCoR	Virgin Islands Experimental Program to Stimulate Competitive Research
VI-ISERP	Virgin Islands Institute for STEM Education Research and Practice
WD	Workforce Development