NOAA CORAL REEF CONSERVATION PROGRAM

NOAA Coral Reef Conservation Program Ecosystem Science Evaluation

Topical Area: Water Quality Data

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James Hendee, and Lew Gramer

Projects Surveyed for this Presentation

Project Title	Project Manager
Ocean Color Product for Monitoring the Threat of Land-Based Sources of Pollution to Coral Reefs	Alan Strong
Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI	James Hendee
Assessing Land Based Sources of Pollution in Tinian (CNMI)	Dave Whitall
Baseline Assessment of Guánica Bay, Puerto Rico in Support of Watershed Restoration	Dave Whitall
Characterization of Land-Based Sources of Pollution and Effects in the St. Thomas East End Reserves (STEER)	Tony Pait
Establish baseline optical conditions in the Florida Keys coral reefs, and quantify spatial and temporal variability	Libby Johns
Nutrient fluxes from coastal inlets into the SE Florida shelf	Thomas Carsey
Inter-disciplinary study of flow dynamics and sedimentation effects on coral colonies in Faga'alu Bay, American Samoa	Oliver Vetter
Technical Support of Inception of FDEP Coral Reef Nutrient Monitoring Program	Dave Whitall
Preliminary Investigation of Groundwater and Surface Water Impacts on Near Shore Biological Communities in Saipan Lagoon	Dana Okano
Enhancing Management Tools: Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs	Christopher Sinigalliano
Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed	Lew Gramer

Introduction, Overview, and Objectives of Work

Introduction, Overview, and Objectives of Work

NOAA CORAL REEF CONSERVATION PROGRAM

Ocean Color Product for LBSP to Coral Reefs

•Development of near real-time tools using data from NOAA's Visible Infrared Imaging Radiometer Suite (VIIRS), to provide managers with oceanic turbidity and chlorophyll levels in coastal waters surrounding each USCRTF priority watershed and adjacent coral reefs following large rainfall events

Baseline Optical Conditions in Florida Keys Coral Reefs

•Bio-optical shipboard profiling and optical measurements designed to characterize the underwater optical properties over the Florida Keys reef tract in space and time (baseline and time-varying water quality attributes)

•Objective is to assess water quality attributes such as chlorophyll *a*, bottom reflectance, and turbidity, to help refine and validate satellite ocean color imagery and algorithms

FDEP Coral Reef Nutrient Monitoring Program

•Working with Florida Department of Environmental Protection (FDEP) and Southeast Florida Coral Reef Initiative (SEFCRI) partners, develop coral reef nutrient monitoring plan to meet the management needs of the north Florida reef tract

Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

•Pilot study on microbial source tracking of microbial contaminants from LBSP, and on metagenomics (study of genetic material recovered directly from environmental samples) of coral community microbiome biodiversity for SE Florida Reefs

Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed

•Determine how frequently oceanic upwelling reaches the northern Florida reef tract, how much it contributes seasonally to the nutrient budget of the reef, and physical mechanisms that drive that contribution

Introduction, Overview, and Objectives of Work

Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Use satellite data to provide historical and near real-time maps and automated email alerts of enhanced turbidity at key coral reef sites in American Samoa, South Florida, and the Commonwealth of the Northern Mariana Islands

Surface and Groundwater Impacts in Saipan Lagoon

- Preliminary investigation of the health of the near shore biological communities in Garapan, Saipan, CNMI, (i.e., seagrass, algae, macroinvertebrates, and fish), and analysis of water quality parameters in surface and groundwater samples, to provide resource agencies in CNMI on the impacts on the nearshore marine environment

LBSP in Tinian

- Quantification of a broad suite of contaminants (metals, PAHs, PCBs, pesticides) in coral tissues, and provide snapshot of water column nutrient concentrations in and around the Tinian Marine Reserve

Baseline Assessment of Guánica Bay, Puerto Rico

- Baseline assessment of the biological resources of coral reefs off the coast of Guánica Bay, Puerto Rico, as well as the magnitude and spatial distribution of pollutant stressors (sediments, nutrients, contaminants) to this system

Integrated Assessment for St. Thomas East End Reserves (STEER)

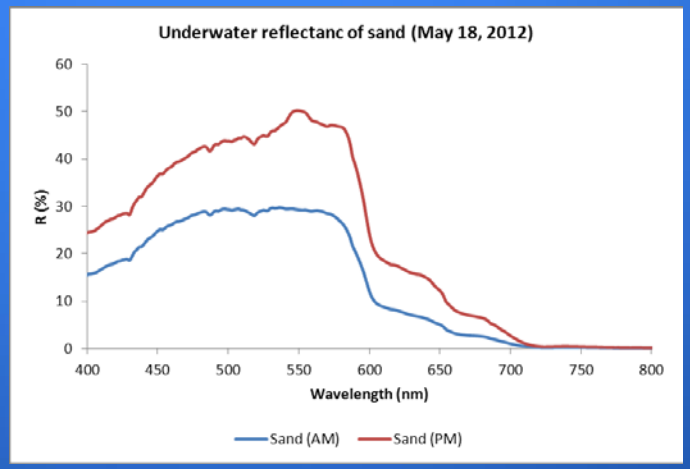
- Integrated environmental assessment for the St. Thomas East End Reserves (STEER) in St. Thomas, USVI that characterized chemical contaminants present and bioeffects, sedimentation and nutrients, along with an assessment of the biological community throughout the STEER

Establish baseline optical conditions in the Florida Keys coral reefs, and quantify spatial and temporal variability

Project delivers bio-optical profiling measurements to:

- Assess baseline and time-varying water quality attributes such as chlorophyll *a,* spectral light attenuation and turbidity
- Better understanding of baseline optical water quality attributes such as chlorophyll *a*, bottom reflectance, and turbidity
- More finely tuned algorithms for interpreting satellite ocean color imagery in the shallow Keys coastal waters
- Goal is improved science-based decision making capabilities for south Florida regional resource managers

Recovery of a Profiling Reflectance Radiometer. Image courtesy of Libby Johns, NOAA



Underwater reflectance of sand. Image courtesy of Libby Johns, NOAA

Funding Support

Funding Support

Ocean Color Product for LBSP to Coral Reefs

- Project funding from CRCP: $80K
- Internal - National Environmental Satellite, Data, and Information Service/Center for Satellite Applications and Research/Ocean Remote Sensing (NESDIS/STAR/ORS) support (FY12-16) ~ $800K
- NOAA Cooperative REmote Sensing Science & Technology Center/Educational Partnership Program (CREST/EPP) Support [Post Doc, etc.] FY14-16 ~ $150K

Baseline Optical Conditions in Florida Keys Coral Reefs

- Project funding from CRCP: $86K
- Leveraged resources included ship time aboard the University of Miami's vessel and AOML-funded lab based resources and federal salaries

Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

- Project funding from CRCP: $120K
- Leveraged resources from the Coral Health and Monitoring Program (CHAMP) and FKNMS Marine Biodiversity Observation Network (MBON)

FDEP Coral Reef Nutrient Monitoring Program

- Project funding from CRCP: $150K

Surface and Groundwater Impacts in Saipan Lagoon

- Project funding from CRCP: $45K
- Leveraged CNMI Bureau of Environmental and Coastal Quality (BECQ) agency partners ($21K) for equipment, sample analysis and staff time

Funding Support

LBSP in Tinian

- Project funding from CRCP: $129K
- Leveraged support from NOAA's National Centers for Coastal Ocean Science (NCCOS, FTE staff) and CNMI Division of Environmental Quality (DEQ, field logistics support)

Baseline Assessment of Guánica Bay, Puerto Rico

- Project funding from CRCP: $125K
- Leveraged staff and IT resources from NCCOS
- Leveraged boat and lab support at the University of Puerto Rico

Integrated Assessment for St. Thomas East End Reserves (STEER)

- Project funding from CRCP: $369K over 3.5 years
- Leveraged boat support, and in-kind contributions of time in the planning and field work for the project (~$50K)

Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed

- Project funding from CRCP: $160K
- In-kind federal contributions; state and local partners: scientific instruments; fuel, diver time

Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Project funding from CRCP: $170K
- In-kind federal contributions; state and territorial partners: personnel time

Information, Products, and or Tools Produced

Information, Products, and or Tools are Produced

Information and Products: Across Projects

- Technical reports
- CoRIS (online data and metadata)
- Online data and maps, some in near-real time
- Journal articles
- Public outreach materials

Ocean Color Product for LBSP to Coral Reefs

- Puerto Rico/Hawaii/American Samoa - VIIRS Coastal Ocean Color Products to accurately portray local turbidity and chlorophyll distributions following large rainfall events

Baseline Optical Conditions in Florida Keys Coral Reefs

- Ongoing monitoring of the optical properties in the Florida Keys National Marine Sanctuary

Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

- Development of a NOAA Marine 'Omics Bioinformatics Computing Center at AOML, for in-house capacity to analyze coral community and other marine environmental sequencing data

FDEP Coral Reef Nutrient Monitoring Program

- Monitoring plan document for the region, water quality data for the reef tract and an institutionalized/operational monitoring program operated by state and local partners

Information, Products, and or Tools are Produced

Surface and Groundwater Impacts in Saipan Lagoon

- Data on the spatial pattern of water quality and benthic community health throughout Saipan lagoon

Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed

- New data set of upwelling event dates 1999-2016 in the northern Florida reef tract, by four sub-regions, month, end-member watermass temperature, and furthest-inshore spatial extent
- Estimate of annual contribution of upwelling to nitrogen and phosphorus budgets for each of four sub-regions, and each of two major reef lines in southeast Florida

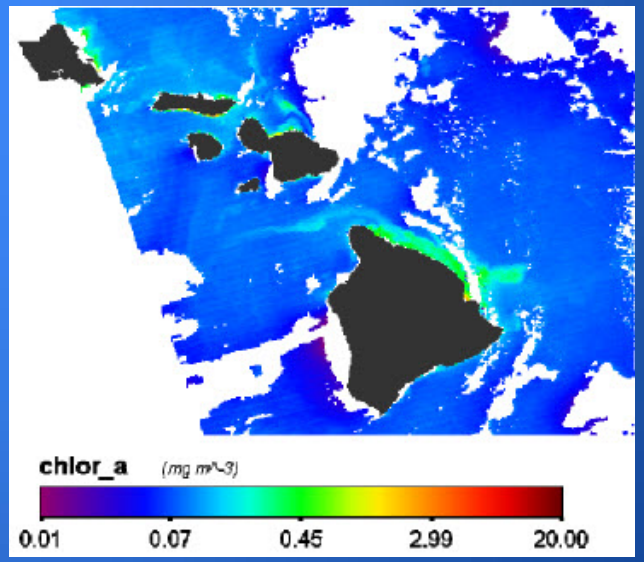
Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Daily ocean color and 'relative turbidity' maps with web interface for target regions, 2002-2016
- Ecological forecast system for generating email alerts of enhanced turbidity by sub-region

Ocean Color Product for Monitoring the Threat of Land-Based Sources of Pollution to Coral Reefs

- Data from NOAA's Visible Infrared Imaging Radiometer Suite (VIIRS) instrument
- Employs NOAA's newest operational color algorithm
- Output - VIIRS Coastal Ocean Color Products designed to accurately (locally calibrated & validated) portray local turbidity and chlorophyll distributions following large rainfall events in near real-time
- Imagery resolution:
  - 750m (2012 operationally ongoing by
  - 2016)
  - 350m (2012 operationally ongoing late-2016)
  - Near real-time: late 2016
- Managers/coordinators will have access to near real-time satellite data through the internet

West Maui (north) runoff example. Image courtesy of Alan Strong



Following Tropical Storm Darby – 25 July 2016; VIIRS Chl-a. Image courtesy of Alan Strong

Key Contributions and Strengths

Key Contributions and Strengths

Key Contributions: Across Projects

- Provide assessments of the status (baseline) of the stressors (nutrients, chemical contaminants, turbidity, etc.) in reef ecosystems that can be used to evaluate the efficacy of management activities, or potential changes in land use activities

Ocean Color Product for LBSP to Coral Reefs

- Jurisdictions have access to near-real time satellite data to show immediate results following large precipitation events carrying LBSP onto their respective near-shore coral reefs

Baseline Optical Conditions in Florida Keys Coral Reefs

- Bio-optical ship-based data collected and used to calculate the remote sensing reflectance to characterize the optically distinctive (shallow, turbid) water masses in the Florida Reef Track and the southwest Florida shallow water coastal region

Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

- Improved understanding of coral community exposure and response to land-based sources of pollution

FDEP Coral Reef Nutrient Monitoring Program

- Key water quality data that does not currently exist for the north Florida Reef tract
- Ambient (i.e., on the reefs) water quality and the condition around point sources (i.e., inlets and outfalls)
- Backbone around which other scientists can plan additional monitoring efforts for biological impacts or emerging techniques (e.g. omics) to leverage the water quality data

Key Contributions and Strengths

Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Turbidity events associated with major projects in southeast Florida were monitored via satellite, and alerts generated with daily resolution
- In situ turbidity data considered in decision regarding potential enforcement actions

Baseline Assessment of Guánica Bay, Puerto Rico

- Projects provide an assessment of the status of the stressors in reef ecosystems
- Data can be used as a "before" time point

Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed

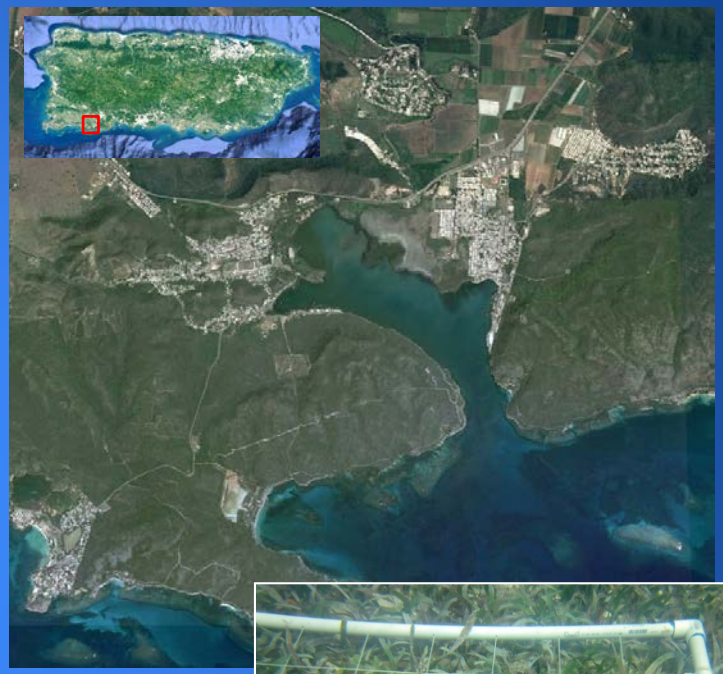
- Estimated oceanic upwelling to the nutrient mass budget of the northern Florida reef tract
- Shows that oceanic upwelling is a major source of nutrients to the reefs

Baseline Assessment of Guánica Bay, Puerto Rico in Support of Watershed Restoration

- Provides an important assessment of the status of stressors (sedimentation, nutrients, toxics) and ecological health of Guánica Bay and surrounding reef ecosystem

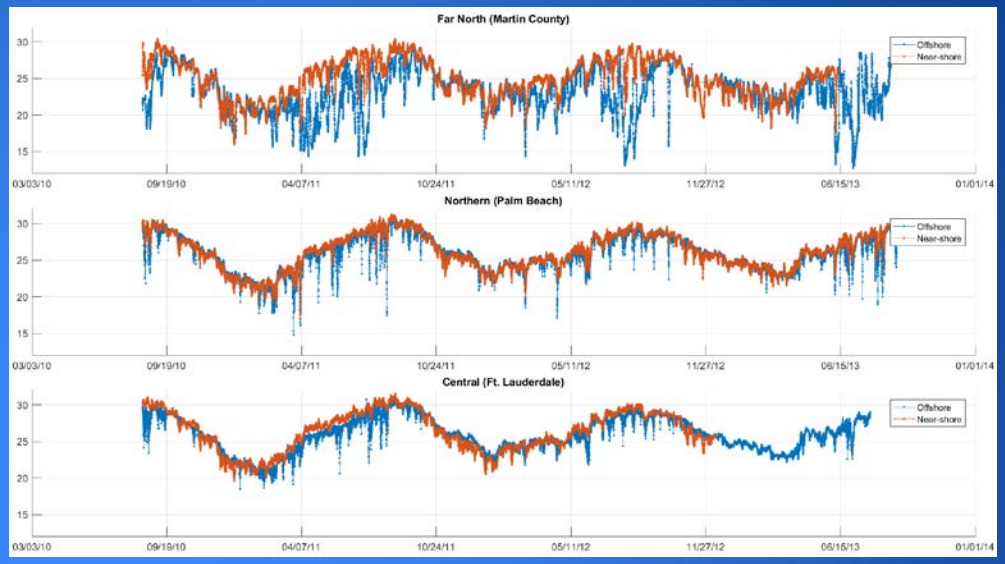
- Data will be used as a "before" time point in order to evaluate the efficacy of management activities or land use changes

- Assessment is part of the Guánica Bay Watershed Management Plan developed to address LBSP, and propose methods to reduce the loss of coral reefs through implementing effective watershed management planning

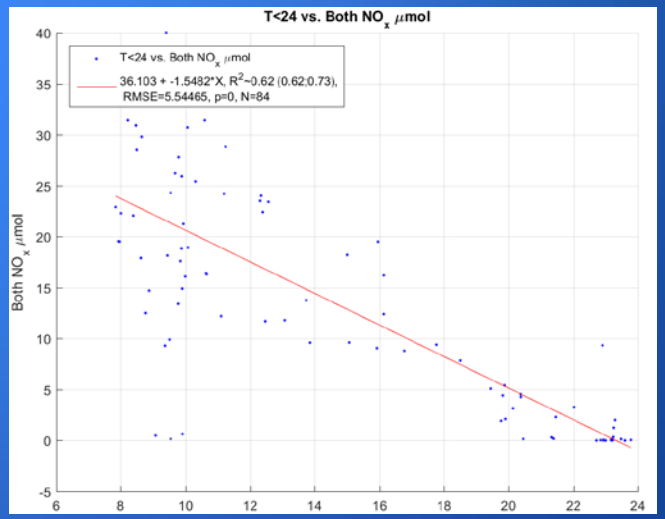


Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed

- Upwelling is a major source of nutrients to the reefs; a natural constraint on nutrient monitoring criteria in FL reefs
- Nutrients from upwelling not under influence of local sources or direct influence of human management decisions
- Oceanic upwelling significantly cools the summer waters of SE Florida shelf every year, and appears to contribute on the order 1,000-3,000 kg/m^3/year to total nitrogen and total silicates, 60-180 kg/m^3/year to total phosphorus



Events by sub-region, temperature, and inshore extent. Graph courtesy Lew Gramer.



Relationship between nitrogen and temperature on SE Florida shelf. Graph courtesy Lew Gramer.

How is the Information Being Disseminated?

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Information Dissemination: Across Projects

- Publications (e.g., technical reports and journal articles) distributed to management agencies and NGOs
- Science briefings conducted for relevant management agencies
- Publications and data available on websites (e.g., CoRIS and NCCOS data portal)
- Public meetings held to discuss the results of projects as requested (e.g., STEER Public Meeting Dec. 2012)
- Online portals for data and mapping
- One-page project summaries

Ocean Color Product for LBSP to Coral Reefs

- NOAA's CRCP, Coral Reef Watch and local managers will have access in near real-time via the internet to new satellite tools to quickly show them both when and where local reefs are being impacted following large precipitation events

Baseline Optical Conditions in Florida Keys Coral Reefs

- Data shared with USF's Optical Oceanography Laboratory and Institute for Marine Remote Sensing (IMaRS)
- All shipboard data can be accessed on the AOML South Florida Program (SFP) web site

FDEP Coral Reef Nutrient Monitoring Program

- Raw data will be served by Florida DEP
- Monitoring plan will be served on both FDEP and NOAA (NCCOS and CoRIS websites)

How is the Information Being Disseminated?

Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

- All Sequencing data deposited at the National Center for Biotechnology Information (NCBI) in the United States, the European Nucleotide Archive (ENA), and DNA Data Bank of Japan (DDBJ) with public access

Surface and Groundwater Impacts in Saipan Lagoon

- Presentation of findings to CNMI agencies at quarterly Watershed Working Group Meeting

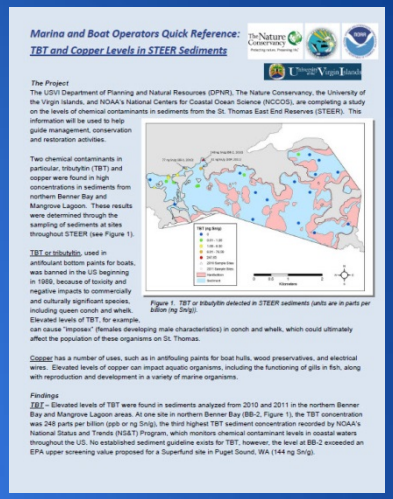
Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Historical and near real-time relative turbidity maps available on the Web
- Manager 'manual' is under review, detailing the interpretation and use of map and alerts

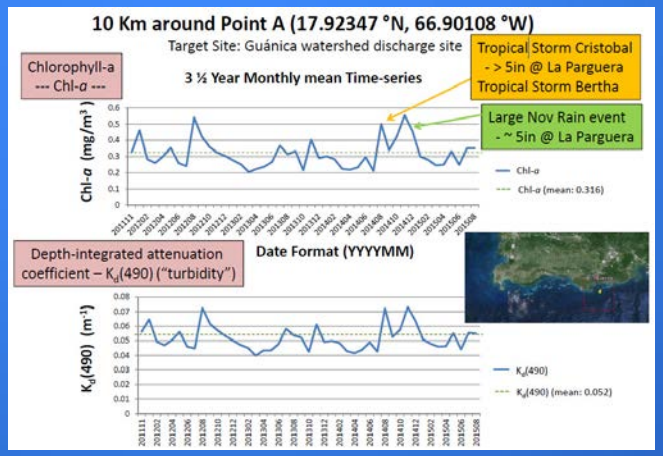
Information Dissemination

Technical reports and journal articles

Public meeting, for STEER management plan. Courtesy Sandra Romano, UVI

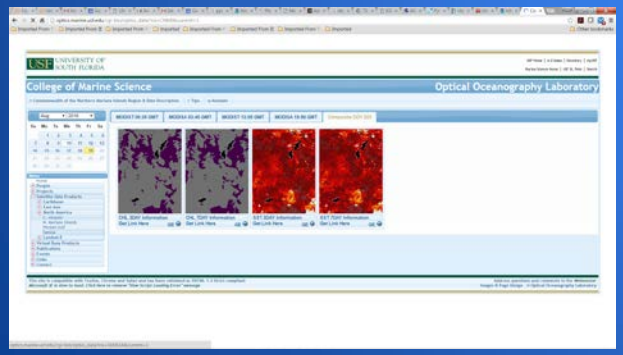


Marina and boat operators quick reference



Turbidity and chlorophyll a, Guánica watershed discharge site. Image courtesy Alan Strong

Presentation at ICRS 2016. Image courtesy ICRS



Historical and near real-time turbidity maps on the Web. Image courtesy Lew Gramer.

http://www.coris.noaa.gov/
https://coastalscience.noaa.gov/

How is the Information Intended to be Used?

How is the Information Intended to be Used?

Intended Use of Information: Across Projects

- Managers will have access to information, some in near real-time, to make better decisions
- Data is useful for identifying the magnitude and spatial distribution of potential problems
- Data can also be used as a "before" time point in order to evaluate the efficacy of management activities, or potential changes in land use activities

Baseline Optical Conditions in Florida Keys Coral Reefs

- Data generated is important for assessing productivity (phytoplankton biomass) in shallow water systems where water quality, benthos, sediments, and bottom reflection can result in errors using satellite ocean color measurements

FDEP Coral Reef Nutrient Monitoring Program

- Data will be useful to DEP and other coastal managers in assessing the role of water quality in reef health, and tracking the water quality response to management actions (e.g. decommissioning of offshore sewage outfalls)

Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

- Better understanding of coral health status, contaminant exposure, response to stress, and sources of contaminants for improved targeting of mitigation efforts

How is the Information Intended to be Used?

Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed

- Key component in an overall nutrient mass budget for southeast Florida reefs

Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Satellite turbidity plume alerts to be used to initiate in-the-water monitoring; historical relative turbidity maps to be used to track sources and fates of in-water material during key events

Surface and Groundwater Impacts in Saipan Lagoon

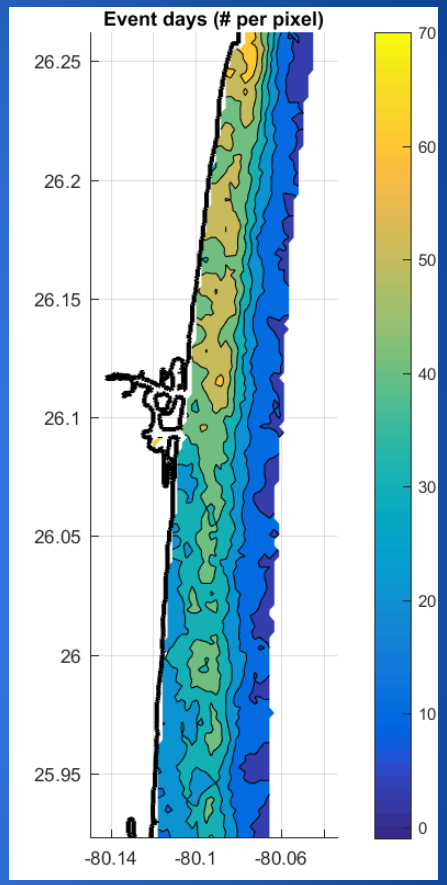
- Results will inform updates to the Conservation Action Plan for Garapan area of Saipan Lagoon, and guide current priority funding decisions for reducing nutrient inputs to the near shore lagoon areas

Integrated Assessment for the St. Thomas East End Reserves (STEER)

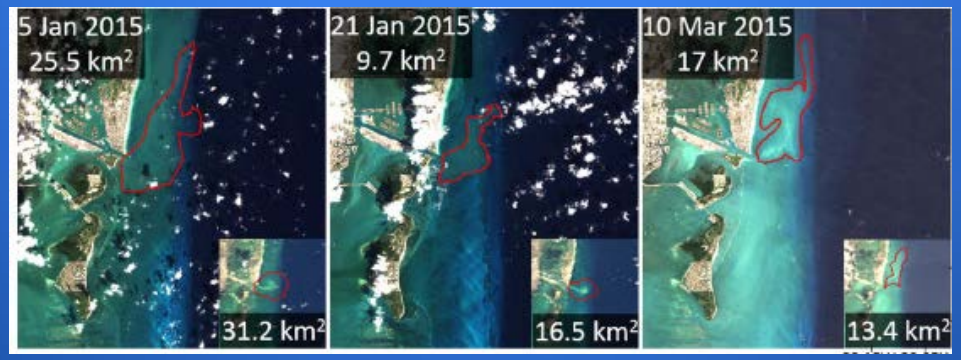
- Information being used by the USVI Department of Planning and Natural Resources (DPNR)

Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Web interface for manager review of near real-time daily maps
- Online record of daily email alerts
- Turbidity events associated with major projects in southeast Florida
- <u>Example</u>: Dredging associated with the multi-billion dollar expansion projects at both Port of Miami and Port Everglades
- Monitored via satellite, and alerts generated with daily time and 1 km space-resolution
- In situ turbidity data to be considered in potential enforcement actions



Daily ocean color and relative turbidity. Image courtesy of Lew Gramer.



Sediment plumes associated with dredging of Port of Miami. From Barnes et al., 2015.

Characterization of Land-Based Sources of Pollution and Effects in the St. Thomas East End Reserves (STEER)

Three year integrated environmental assessment project funded by CRCP beginning in 2011; requested by partners

- Chemical contaminants
  - Sediments (surface and cores)
  - Biota (coral, conch and fish)
- Coral histology
- Sediment toxicity
- Benthic infaunal assessment
- Characterization of fish and benthic communities
- Benthic habitat mapping
- Monthly nutrient monitoring
- Monthly sedimentation monitoring
- Monthly TSS measurements
- Passive (POCIS) water samplers

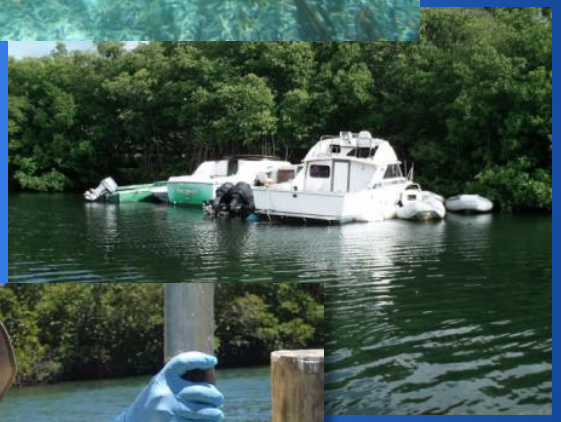
Characterization of Land-Based Sources of Pollution and Effects in the St. Thomas East End Reserves (STEER)

- Assessment of current status (baseline) of stressors, and biological condition throughout the STEER, as requested by project partners

- Example: Data and information from the integrated assessment in the STEER incorporated directly into the STEER Watershed Management Plan

- Example: Information (e.g., sediment core contaminant data) being used by the USVI Department of Planning and Natural Resources (DPNR) to respond to a request by marina/boatyard owners to dredge navigation channels into the marina/boatyard area in the STEER

- DPNR has the information needed (contaminant levels and bioeffects data) to require that any dredging that may occur, do so to minimize the release of toxic contaminants to sensitive nursery areas in the adjacent mangroves



What Are Your Challenges?

What Are Your Challenges?

<u>*Challenges: Across Projects*</u>

- Individuals producing the data that informs management decisions are not the same people who are making management decisions
- While every effort can be made to communicate the meaning and importance of science finding to those making management implementation decisions, there is no way to guarantee these results will be used or acted upon
  - <u>Example</u>: Unusually high PCB concentrations in sediments in Guánica Bay, but no management actions have been taken based on this information
  - Challenges sometimes tied to local capacity (both knowledge and fiscal/time ability), constantly changing priorities (exacerbated by high staff turn over), and weak goals or direction from local program leadership
  - In the STEER, efforts by The Nature Conservancy in STEER (work with boat yard owners)
- When possible, production of baseline information on LBSP prior to the development of watershed management plans would be helpful; baseline information can then inform the development of the watershed management plan (e.g., STEER)

<u>Ocean Color Product for LBSP to Coral Reefs</u>

- Assessing VIIRS satellite imagery for accuracy
- Requires local calibrations for water quality parameters sought by local managers
- Local calibrations can vary locally and needs to be assessed using in-situ data (cal/val) for potential VIIRS local algorithm refinements due to CDOM [e.g.], etc.

What Are Your Challenges?

Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

- Training of NOAA workforce in meta-omics
- Extremely large sequencing datasets to store, transfer, and analyze
- NOAA data repositories are not familiar with use of such molecular data
- Challenges with delays in turn-around time and cost for sequencing

Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed

- In-water measurement of nutrient concentrations is therefore expensive and requires logistical planning
- Sampling of nutrient concentrations in the water during major upwelling events which are unpredictable on the southeast Florida continental shelf is challenging

Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Limitations of satellite visible light
- Distinguishing between sediment resuspension vs. anthropogenic sources

Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Near real-time maps and automated email alerts of enhanced turbidity
- Limitations of satellite visible and near-infrared for ocean monitoring: both "cloud contamination" and land adjacency require careful reprocessing to provide useful pixels during critical events. In-water calibration helps, but is limited by logistics and cost.
- Sediment resuspension vs. anthropogenic sources: distinguishing these using current satellite products is challenging
- Combine these products with existing meteorological (CFS) and wave (NOAA WaveWatch III) model outputs for alerts

What Are the Potential Future Directions for this Work?

What are the Potential Future Directions for this Work?

Potential Future Directions: Across Projects

- Under current funding scenarios, no future work in planned for the immediate future
- Tracking change over time, to ensure that environmental degradation is not occurring is valuable
- Projects transferred to partners
- Reassessment of metrics now that management actions have occurred would be extremely valuable (e.g., Guánica Bay)

Ocean Color Product for LBSP to Coral Reefs

- Addition (2016/2017) of much higher resolution satellite data coming on-line, local assessments should become much more robust for coral reef monitoring

Baseline Optical Conditions in Florida Keys Coral Reefs

- Project transferred to the University of South Florida (USF) and work is ongoing
- Incorporated into the 5-year observational program associated with the multi-institutional Marine Biodiversity Observations Network (MBON) program
- Project funded by NASA and NOAA, with no additional support from the CRCP

FDEP Coral Reef Nutrient Monitoring Program

- Plan is to fully transition the monitoring program to FDEP after FY17
- Program will continue for the foreseeable future using FDEP funds with no additional CRCP funding

What Are the Potential Future Directions for this Work

Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

- Expanding 'omics technologies for other regions, more ecosystem types, and wider range of coral species

Identifying LBSP management options: Quantifying the contribution of upwelling to LBSP on SE Florida reefs by sub-watershed

- Development of automated in-water sensors that can continually (e.g., hourly) measure concentration of nutrients in the water column at very low (nanomolar) levels
- Upwelling events change sea-surface temperature (SST) in a measurable way, which could possibly be monitored using high-resolution satellite infra-red and microwave-based SST products

Surface and Groundwater Impacts in Saipan Lagoon

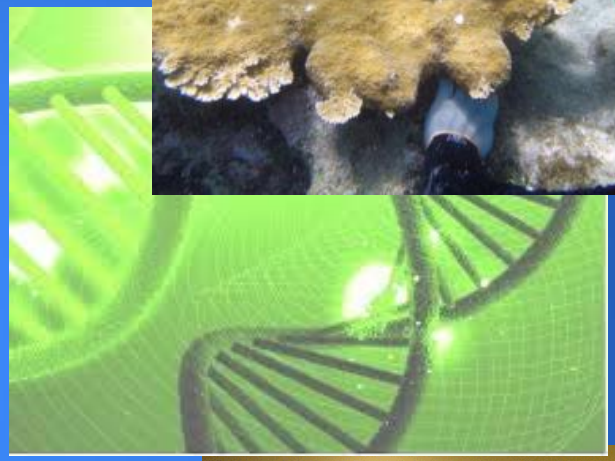
- Conduct source-tracking studies to identify the source of the nitrogen coming out of the groundwater
- Would lead to development of more accurate management plans to mitigate the nutrient input

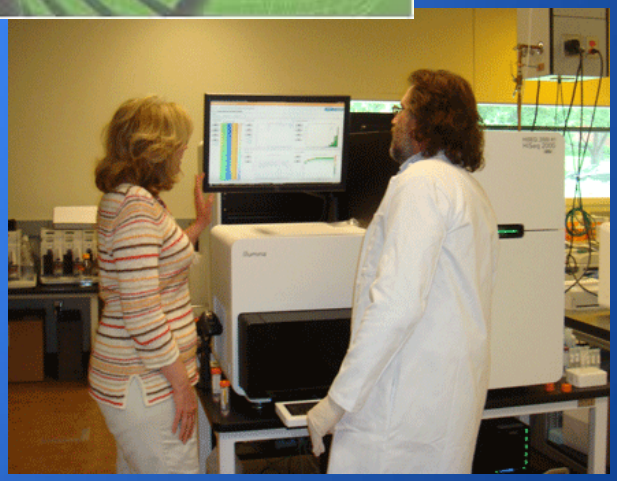
Sediment on reefs and adjacent coastal areas: information tools for managers in American Samoa, South Florida, CNMI

- Ongoing daily production of maps, and alerts highlighting enhanced turbidity, on the Web
- Enhanced automation of ocean color filtering algorithms for cloud contamination and land adjacency, and enhancement of daily alerts to control for wind- and wave-related resuspension

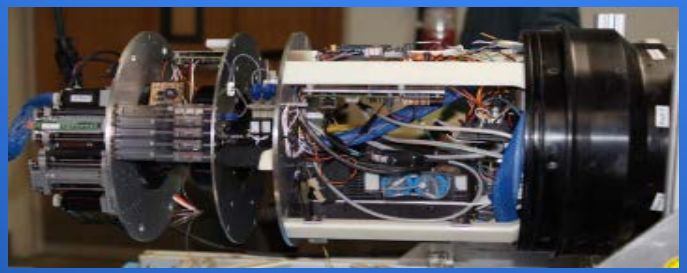
Molecular Genetic Tracking to Target Microbial Pollution Sources in South Florida Coral Reefs

- Continue source tracking of microbial contaminants from LBSP
- Expanding 'omics technologies for other regions, more ecosystem types, and wider range of coral species
- Develop a better understanding of ecosystem function and resiliency across trophic levels and environmental stressors (i.e. combining with eDNA assessment of genetic biomarkers for fisheries, larvae, pathogens, HABs, coral genotypes, etc.)
- Developing and testing 'omic methods for use in-situ and on ROV platforms





Images courtesy of Chris Sinigalliano, NOAA



Prototype DNA sequencer for deployment on ROV. Image courtesy of Chris Sinigalliano, NOAA

Surface and Groundwater Impacts in Saipan Lagoon

- CNMI agency staff now have a better understanding of relative (groundwater versus surface water) inputs of nutrients into the lagoon
- Conduct source-tracking studies to identify the source of the nitrogen coming out of the groundwater
- Assess the influence of season on nutrients in surface and groundwater
- Use of N-isotope, QPCR, or other means of tracing sources of total nitrogen and nitrate/nitrite
- Influence of groundwater on other factors should be assessed (seagrass growth rate, fish counts, etc.)
- Greater attention to groundwater for management action

Collecting water samples, and algal mats in nearshore areas in Saipan Lagoon. Images courtesy of Dana Okano, NOAA

Publications

Apeti, D.A., A.L. Mason, S.I. Hartwell, A.S. Pait, L.J. Bauer, C.F.G. Jeffrey, A.M. Hoffman, F.R. Galdo Jr, and S.J. Pittman. 2014. An assessment of contaminant body burdens in the coral (Porites astreoides) and queen conch (Strombus gigas) from the St. Thomas East End Reserves (STEER). NOAA Technical Memorandum NOS/NCCOS 177. Silver Spring, MD. 37pp.

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Bauer, L.J., J. Vander Pluym, C.F.G. Jeffrey, C. Caldow, A.M. Hoffman, and A.V. Uhrin. 2014. Characterization of fish communities and associated benthic habitats in the St. Thomas East End Reserves (STEER). NOAA Technical Memorandum 185. Silver Spring, MD. 67 pp.

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Pait, A.S., S.I. Hartwell, A.L Mason, R.A. Warner, C.F.G. Jeffrey, A.M. Hoffman, D.A. Apeti, and S.J. Pittman. 2014. An assessment of chemical contaminants in sediments from the St. Thomas East End Reserves, St. Thomas, USVI. Environmental Monitoring and Assessment. 186:4793–4806

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Zhao, J., B. Barnes, N. Melo, D. English, B. Lapointe, F. Muller-Karger, B. Schaeffer, and C. Hu (2012). Assessment of satellite-derived diffuse attenuation coefficients and euphotic depths in south Florida coastal waters. Remote Sensing of Environment 131, 38–50.

Zhao, J., C. Hu, B. Lapointe, N. Melo, E. M. Johns, and R. H. Smith (2013). Satellite-Observed Black Water Events off Southwest Florida: Implications for Coral Reef Health in the Florida Keys National Marine Sanctuary. Remote Sensing 5, 415-431; doi:10.3390/rs5010415.

Report for Florida Dept. of Environmental Protection on upwelling event details 1999-2016 and annual nutrient mass contribution estimates is under review