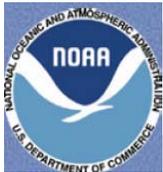


Project Work Plan

Integrated Marine Protected Area Climate Tools (IMPACT): Demonstration in the Florida Keys National Marine Sanctuary to develop climate- ecosystem decision- support tools for management

A partnership between NOAA, DOI/USGS, NPS, and the USFWS



February 2010

About this document

This draft document was created to inform project partners and other interested groups and individuals about the planned activities for the Florida Keys National Marine Sanctuaries climate impacts project. The document is intended to serve as a road-map for project activities and lay the groundwork for inputs/outputs resulting from this effort. For more information on this study please contact the Office of National Marine Sanctuaries (ONMS) at 301-713-3125, the Center for Coastal Monitoring and Assessment's (CCMA) Coastal Oceanographic Assessments, Status and Trends (COAST) Branch at 301-713-3028, the National Climatic Data Center at 828-271-4223, or visit: <http://IMPACTwebsite.html>

Project Summary

The proposed collaborative project will provide multi-scaled climate-ecosystem decision support tools and information for the regional science and management constituency of South Florida, including the Florida Keys National Marine Sanctuary (FKNMS) office. The project will include a multiagency, multidisciplinary partnership group to compile, assess, and evaluate regional to local climate information, and to integrate this information with ongoing coastal ocean observing, and monitoring programs in the Florida Keys. The project will also directly support management priorities involving climate impact evaluations, risk and vulnerability assessments relevant to the Florida Coral Reef Tract. The planned MPA site evaluation will provide critical science elements for sanctuary management plan reviews, and will serve as a prototype for evaluations in other networked MPAs. Planned products include a comprehensive set of climatologies (as input and guidance for climate change projections), an integrated summary to understand system-wide responses to climate, and a framework for integrating global climate model projections into the network of marine protected areas.

Background

Climate change is arguably the greatest and most challenging natural threat facing the planet today. In the last decade, progress has been made in refining global climate models; however uncertainty remains about climate changes at a finer geographic scale.

Entrusted with the stewardship of many of the most ecologically, economically and socially important marine resources in U.S. waters, managers at NOAA's Office of National Marine Sanctuaries need accurate and timely decision tools to take proactive steps in facing the threat of climate change to the sanctuaries. While the sanctuary system is developing a "Climate-Smart Sanctuary Initiative" (an effort to certify sanctuary sites that have taken proactive steps to address potential climate change impact at their sites), basic climate information must be readily available to inform managers of current and expected climatic conditions in their specific region. Like their MPA colleagues at the local, state and regional level, sanctuary managers are ill-equipped to analyze raw climate data on their own. Sanctuary managers require tailored products at the appropriate scale that will inform them of the status and trends of resources and what changes they should expect both locally and regionally as a result of a changed climate.

Climatologies form the basis for a better understanding of the linkages between climate and its impacts on coastal ecosystem processes, species, and habitats of the protected site, and when integrated with expert system inputs, can be used to form management tools in prioritizing and implementing adaptation actions. In addition, these climatologies are necessary to form the scientific underpinnings of the climate scenarios used by sanctuaries to be certified as part of the new "climate smart" initiative.

Historically, climatologists, oceanographers, and marine ecologists had little opportunity to work together to inform managers of present and potential future climate scenarios and impacts on a specific ecosystem. The challenge is to initiate a discussion between these communities and investigate what it would take to develop a merged suite of climate products that can prove useful in adaptive management planning and decision support.

The Proposed Study

In FY10, NOAA's Office of National Marine Sanctuaries (ONMS) in association with the National Center for Coastal Ocean Science (NCCOS) are partnering with the National Climatic Data Center (NCDC), the National Oceanic Data Center (NODC), the Office of Oceanographic and Atmospheric Research (OAR), and other science and data

management offices to implement a pilot project for creating decision-making tools for managers of marine protected areas and their resources at the local, state, regional, and federal level. This multi-year pilot project will involve 1) creating climatologies of conditions and trends, in averages and extremes, for the FKNMS, 2) integrating this information to develop a local-scale understanding of the timing, magnitude and spatial variability of changes in ecosystem-critical environmental elements as a response to climatic factors, and 3) defining outputs in a format for rapid assessment of climate impacts on ecosystem conditions, resources and habitats. Through this effort, the collective NOAA partnership will create prototype decision making tools and information for application in the FKNMS.

General Approach

The project will consist of 3 interrelated components: **Climate Analyses, Data Integration, and Interim Products Development.** Each component will be addressed through the collective partnership as shown in the project flow chart below (Figure 1). **Climate Analyses** will involve establishing a baseline of climatic conditions, patterns, and processes governing variability in the region of the MPA. The **Climate Analyses** will provide spatially explicit outputs for **Data Integration**, testing, and development of **Interim Products** and guidance documents. These 3 components represent the primary focus of the partnership.

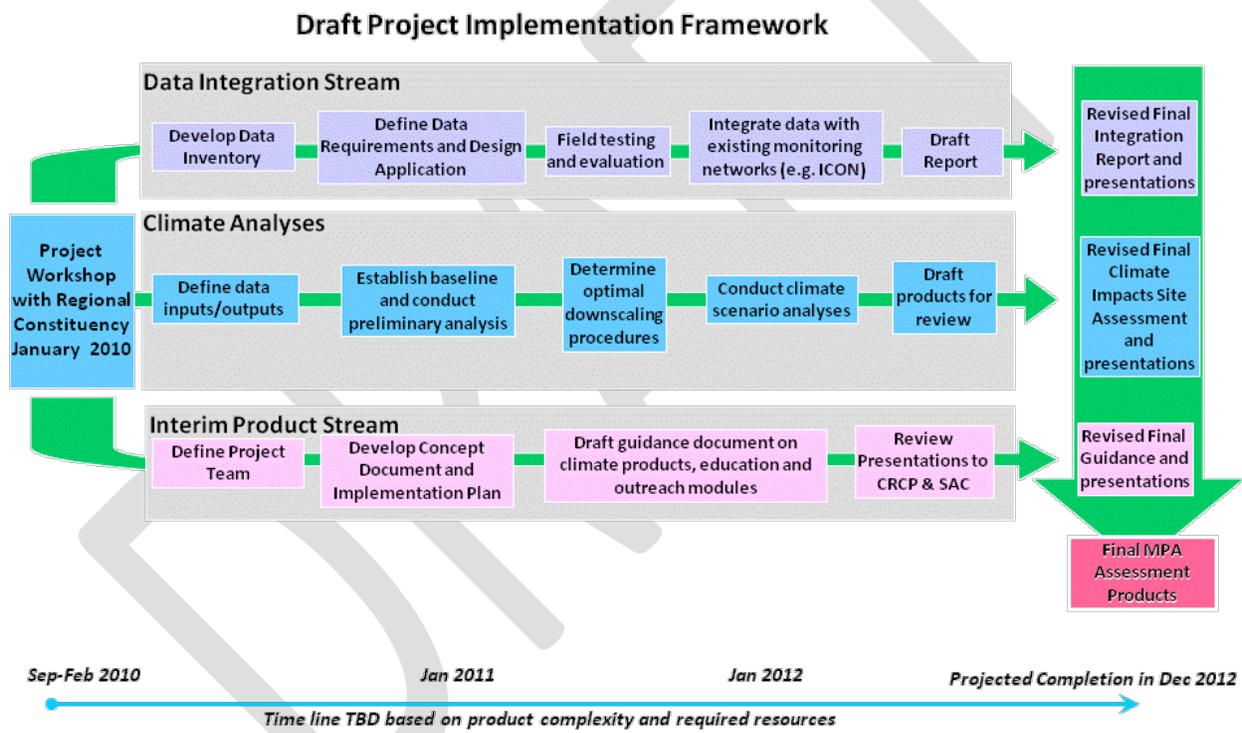


Figure 1- Project flowchart and approximate timeline.

Integrating Diverse Data Sources

Project implementation requires access to a vast array of data sources and platforms available via national and world-wide data centers and local observing networks. Platforms including satellite observational, modeled, *in situ* sensor, moored buoy, C-MAN, and shipboard monitoring will be used to build relevant data climatologies. Since relevant formats and scales must also be identified and defined prior to project implementation, a working inventory will be established to track existing and update new sources of data.

Data Integration will involve organizing inputs into a conceptual model for analysis with expert system input and guidance. Important climate variable inputs will be used in combination to characterize variable inter-

relationships, discernable trends, and habitat-species linkages across decreasing spatial and temporal scales of resolution (Figure 2). Numerous studies have linked large-scale climate variability and change to meteorological, oceanographic and biological responses at finer MPA- scales. Focus of climate analyses will be on the use of “descriptive” downscaling techniques to evaluate and assess overall effects of large scale climate variability, dominant weather types, and extreme events in the region of the FKNMS. Ecosystem responses will be based on general climate scenarios using established state-of-the-art global climate projections and coupling this information with known ecosystem stimulus- response indices, biogeographic information, and sentinel species indicators.

Data Integration for MPA climate tools development

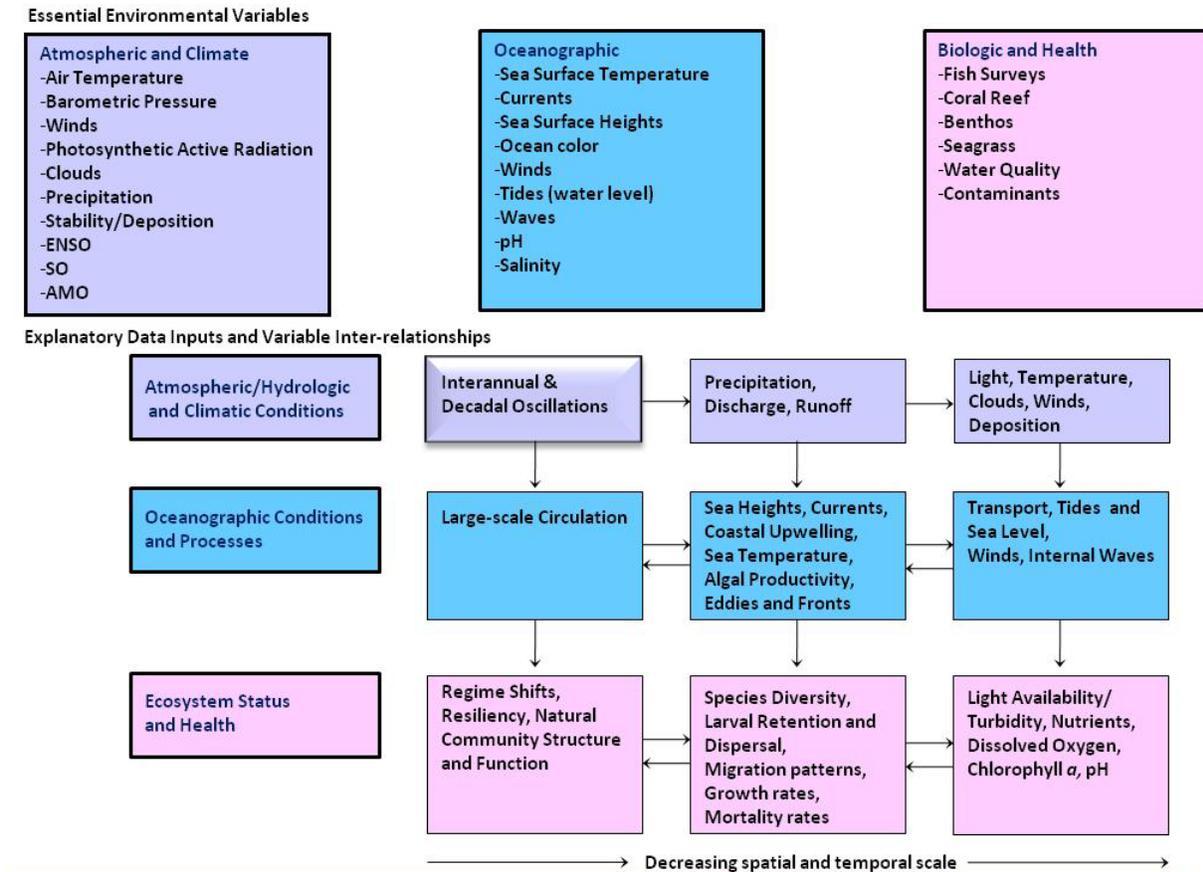


Figure 2- Conceptual framework for integrating diverse datasets across multiple spatial and temporal scales.

To facilitate information exchange among project partners, a website will be established. The website will be used to share documents, data files, draft products, and other information in electronic formats.

Objectives

- 1) Identify and synthesize relevant archival datasets to establish a climatological baseline for the Florida Keys NMS and surrounding region, addressing long term behavior (e.g., averages, variability, extremes, thresholds), using available data source providers, existing integration frameworks, and data sharing principles supported by NOAA.
- 2) Provide a climate analysis integrating various data sources, platforms, and inputs to develop a local-scale understanding of ecosystem-critical responses to climate change.

- 3) Define relevant outputs in a format for rapid assessment of climate impacts on ecosystem conditions, resources and habitats that will help automate the interpretation of both large-scale climate signals and real-time observational data in the field.
- 4) Provide critical climate information to support the development of skilled climate change predictions, risk and vulnerability assessments and management actions for regional marine natural resources in South Florida.

Project Activities including Products

Phase 1: Initial Project Planning— Initial meetings will be held to scope out the specific project goals, objectives, and relevant participation. Decisions were made to define the demonstration study area and determine the relevant datasets on which to focus. These discussions were integrated into the project prospectus and draft work plan. A webpage will be created to aid in communication of this effort to partner agencies and the public. The work plan will be updated as the project evolves and will be available in PDF format on the webpage for interested parties.

Kickoff meeting (Sept. 10, 2009: Location Silver Spring, MD, SSMC4).

Activities:

1. Establish goals and objectives. Layout all data available for the study. Invite new partners. Establish working groups.

Products:

- *One- pager and two-page Prospectus (October, 2009)*
- *Preliminary Data inventory (December, 2009)*
- *Stakeholder output/requirements document*

Climate and Sanctuaries Workshop (Jan. 10-14, 2010: Location AOML, Miami FL)

Activities:

1. Identify other key stakeholders within and outside NOAA with expertise to contribute to the subject. Revise output/requirements based on input/feedback received.
2. Discuss critical needs/requirements, data inventories and gaps, monitoring activities, and issues related to the development and deployment of a climate analysis and monitoring tool for the Florida Keys NMS (the pilot sanctuary).
3. Define project deliverables, action items, and target dates and milestones.

Products:

- *Inventory of Data Products and Sources (February, 2010)*
- *Draft Work Plan (February, 2010)*
- *Preliminary web page (February, 2010)*

Phase 2: Baseline climatology for the FKNMS— Climatological baselines of merged *in situ*, satellite, moored buoy, and modeled data will be established for the region of the MPA using available data source providers, existing integration frameworks, and data sharing principles supported by NOAA's Integrated Ocean Observing System (IOOS). Insights will be established on ecosystem variability, seasonal cycles, and governing processes affecting the FKNMS. This information will be matched with local knowledge of the ecosystem, and will serve as the backbone for climate analyses, data integration and climate product streams. Specified climate products will include tractable raw and derived data, designed to meet end user requirements and IOOS data integration standards for scientists. (Collaborators: NOS/NCCOS, ONMS, FKNMS; NESDIS/NCDC, NODC, STAR; OAR/AOML; FIU/SERC; NWS/NBDC; IOOS)

Activities:

1. Determine historical climate conditions at both regional and local scales based on a merged suite of available and unrestricted data archives from National and global data centers (see Table 1 for preliminary list of data and sources).
2. Extract spatially explicit time series information on atmospheric/meteorologic, oceanographic, and ecosystem variability, focusing on selected sub-regions of the MPA (lower, middle, and upper Keys).
3. Analyze data for seasonal, annual, inter-annual, event-driven patterns and governing processes.
4. Format satellite, gridded, in situ and modeled outputs to meet data IOOS integration standards, fully ingestible within a geographic information system (GIS).
5. Design data integration framework for decision support involving climate change impacts on MPA's.
6. Coordinate with regional sanctuary constituency on findings.

Products:

- *Comprehensive set of data climatologies and statistical summaries (January 2011)*
- *Web-based discovery prototype (March 2011)*
- *Presentation of process and initial results (January 2011)*
- *Updated data and integration framework of source and derived data products (January 2011)*

Table 1- Project Data and Sources

Product Platform	Product Type	Data Source	Spatial Resolution	Temporal Summary
In situ- Atmospheric	Temperature, Precipitation, Barometric Pressure, Humidity, Winds	NCDC, NBDC, CO-OPS	Point	Daily- Monthly
Modeled- Atmospheric	Sea Level Pressure, Temperature	NCEP Reanalysis 2	1° grids	Daily- Monthly
Satellite- Atmospheric	Clouds, surface Temperature	UWISC/CIMSS	9km	Daily/ Monthly
In situ- Meteorologic	Precipitation	GPCC, NCDC	1° grids	Daily- Monthly
Satellite- Meteorologic	Precipitation	NASA	0.25° grids	Daily- Monthly
Satellite- Atmospheric	PAR	NASA, NESDIS/STAR	1km	Weekly/ Monthly
Satellite- Atmospheric	Sea Surface Winds	RSS	25km	Weekly/ Monthly

Table 1- Cont.

Product Platform	Product Type	Data Source	Spatial Resolution	Temporal Summary
Modeled-Climatic	Southern Oscillation, North Atlantic Oscillation	CPC	Index	Daily/ Monthly
In situ-Oceanographic	Tides, sea level, temperature, salinity, currents	NBDC, CO-OPS, UHSLC,	Point	Weekly/ Monthly
Satellite-Oceanographic	SST	NODC	4km, 1km	Monthly
Satellite-Oceanographic	Ocean Color	NASA	1km	Monthly
Satellite-Oceanographic	Sea Level Anomalies, Currents	AVISO	1/4°, 1/3° grids	Weekly/ Monthly
Statistical-Derived Oceanographic	El Nino/Southern Oscillation, Atlantic Multidecadal Oscillation	CPC, ESRL	Index	Weekly/ Monthly
In situ-water quality monitoring	Nutrients, chlorophyll, light availability, turbidity,	AOML, FIO, FIU	Point	Weekly/ Monthly
Shipboard-Derived Biologic	Benthos, Pelagics	FIU, SEFSC	Point/Indices	Monthly
Image-Derived Habitats	Benthic Habitat Maps	ONMS, CCMA	high resolution	One time only

Phase 3: Climate Analyses and Data Integration— Rescaling of climate information to suit a regional to local scale analysis and assessment will be established. This will include a gap analysis to identify what additional physical, biological, and water quality data are needed to increase accuracy and robustness of regional- to *local*-scale climatologies, and a climate analyses to construct statistically significant linkages in the baseline climatologies, through “descriptive” downscaling techniques. Factors such as large- scale climate oscillations (e.g. ENSO), circulation patterns, dominant weather types, and extreme weather events will be used to assess key variable inter-relationships for the upper, middle and lower Keys. Integration of local knowledge, data and expertise to formulate customized climate outputs relevant to FKNMS ecosystem health and monitoring networks (e.g. ICON, SEAKEYS) will be performed. Existing and new data platforms and sources may need to be upgraded or adapted to meet Phase 3 requirements.

Concurrent with Phases 2 and 3 will be the continued development of an interactive web page to highlight project details, inputs/outputs, key raw and derived data and sources (including source metadata), and intentions on data management, sharing, and science integration. (Collaborators: NOS/NCCOS, ONMS, FKNMS; OAR/AOML/Coral Health and Monitoring Program; NESDIS/NCDC; FIO/KML/SEAKEYS; FIU/SERC; NWS/NBDC; IOOS)

Activities:

1. Conduct gap analysis to identify additional data inputs needed to increase accuracy and robustness of existing climatologies and update climatologies as needed.
2. Prioritize and define specific climatological attributes (means, deviations, and thresholds) of key variables for integration into ecosystem health monitoring networks.
3. Identify downscaling procedures that adequately represent spatial and temporal variances from local-scale conditions and processes, and large-scale climate forcing mechanisms.
4. Ensure downscaling procedures yield physically interpretable and defensible outputs.
5. Coordinate with regional sanctuary constituency on findings.

Products:

- *Presentation of gap analysis results (January 2012)*
- *Presentation of climate analysis preliminary results (January 2012)*
- *Updated web-based discovery prototype (March 2012)*
- *Presentation of data integration results (March 2012)*
- *Updated data integration and management framework (March 2012)*

Phase 4: Climate Products Development: Defining outputs for rapid assessment of climate impacts on ecosystem conditions, resources and habitats will be established for the FKNMS based on available real-time observational data and partner participation. Climate scenario projections addressing expected changes in ocean properties, water quality variables, sentinel species, and biogeographical habitats will be produced through expert system input, known ecological stimulus-response indices, and accepted global- regional climate models of projected change. Expected changes in coral reef resiliency and risk indicators (e.g. coral reef habitat, coverage, and bleaching stress) will be produced using established thresholds and forecasting systems. Development of NOAA educational and outreach modules on regional climate change impacts in the Florida Keys NMS will also be produced during this phase. (Collaborators: NOS/NCCOS, ONMS, FKNMS; OAR/AOML/Coral Health and Monitoring Program; NMFS/SEFSC; NESDIS/NCDC, STAR; FIO/KML/SEAKEYS; NWS/NBDC; IOOS)

Activities:

- 1) Prioritize key variable outputs that reveal significant and measurable response to external climate forcing.
- 2) Integrate expert system input on stimulus- response variable thresholds.
- 3) Utilize state-of-the-art global climate models of projected change to drive expected changes in key variables and ecosystem risk indicators at the MPA-scale.
- 4) Evaluate expected changes and shifts in sentinel species, biogeographic habitats, and seasonal cycles due to variability in climate.

Products:

- *Presentation of climate scenario analyses and results (December 2012)*
- *Site data integration draft report (December 2012)*
- *Site guidance document on climate products (December 2012)*
- *Site climate impact assessment draft report (December 2012)*
- *Outreach and Education modules on MPA climate impacts (December 2012)*

Projected Costs

FY10 Budget needs: \$60K

- Software and IT Support: \$6K
- Hardware and IT Support: \$28K

- IOOS Part Time Contractual Support: \$25K (covered through FY10)
- Web IT Support: \$6K
- Annual workshops and meetings for PI's and Collaborators (mostly travel for attendees): \$20K

FY11 Budget needs: \$K

- Software and IT Support: \$30K
- Full Time Contractual Support: \$36K (covered through FY11)
- Web IT Support: \$6K
- Annual workshop for PI's and Collaborators (mostly travel for attendees): \$20K

FY12 Budget needs: \$72K

- Software and IT Support: \$6K
- IOOS Part Time Contractual Support: \$36K (covered through FY12)
- Web IT Support: \$6K
- Annual workshop for PI's and Collaborators (mostly travel for attendees): \$20K
- Local Stakeholder training workshops on Education modules: \$20K
- Report Printing Costs: \$20K

Principal Investigators

Catherine Marzin- (ONMS contact) NOS/ONMS, 1305 East West Hwy. Silver Spring, MD 20910-3278, Phone: 301.713.3125 x 257. Email: catherine.marzin@noaa.gov

Karsten Shein, (NCDC contact), NESDIS/NCDC, 151 Patton Ave. Asheville, NC 28801-5001, Phone: 828.271.4223. Email: karsten.shein@noaa.gov

Douglas Pirhalla- (NCCOS contact)- 1305 East West Hwy. N/SCI-1 Silver Spring, MD 20910-3278 Phone: 301-713-3028 x 167. Email: doug.pirhalla@noaa.gov

Jim Hendee- (OAR Contact)- 4301 Rickenbacker Causeway, Miami, FL 33149-1026 Phone: 305.361.4396. Email: jim.hendee@noaa.gov

Tess Brandon (NESDIS Contact)- 1315 East West Hwy , SSMC3, E/OC1, Silver Spring, MD 20910-3282. Phone: 301-713-3272 x 181. Email: tess.brandon@noaa.gov.

Brian Keller (Florida Keys Contact)- 33 East Quay Road, N/NMS5, Key West, FL 33040. Phone: 727-553-1201. Email: brian.keller@noaa.gov