P894 **NOAA COLLABORATION IN THE FLORIDA KEYS**

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1. INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) is part of the daily fabric of life in the Florida Keys and across the adjoining coastal waters. This is because the NOAA vision of resilient communities, ecosystems, and economies requires a daily commitment from NOAA scientists, technicians, administrators, and other staffers working in the Florida Keys. This commitment derives from the NOAA mission of "science, service, and stewardship", which entails a three-pronged approach: 1) understand and predict changes in climate, weather, oceans, and coasts; 2) share that knowledge and information with others; and 3) conserve and manage coastal and marine ecosystems and resources. All three mission approaches are active daily in the Florida Keys and across the adjoining coastal waters, which constitute a unique subtropical environment, characterized by a complex mosaic of marine ecosystems, a climate with numerous continental, maritime, tropical, and extratropical influences, and a thriving and diverse human population vulnerable to both natural and anthropogenic hazards. Figure 1 illustrates the complex geomorphology of the Florida Keys and adjacent waters.

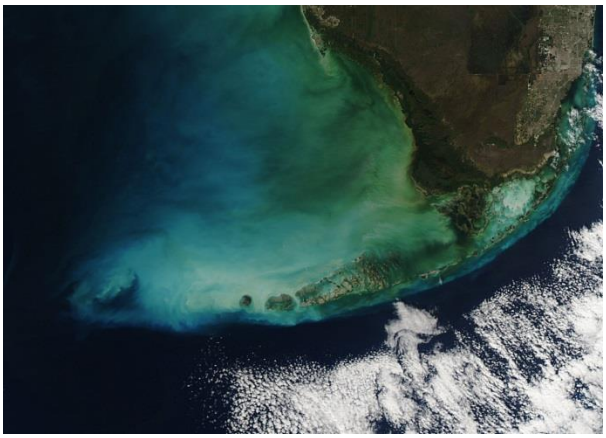

Fig. 1. MODIS image from the NASA Aqua satellite at 1830 UTC, 4 January 2012, showing the Florida Keys and adjacent coastal waters. Cumulus clouds are evident over the Straits of Florida, south of the Florida Keys. Lighter ocean colors along and north of the Florida Keys are associated with shallow, turbid water, while the darker colors south of the Keys are associated with deeper water in the Straits of Florida. Image courtesy of MODIS Rapid Response Project at NASA/GSFC.

NOAA operations in the Florida Keys range from environmental monitoring to weather forecasting, and from marine and cultural resource protection to fisheries management. The relationships among NOAA line offices in the Florida Keys have become increasingly collaborative during the last several years. Staffers with the National Weather Service (NWS) and National Ocean Service (NOS), in particular, have developed a close and fruitful collaboration involving teamwork, mutual learning, leveraging of resources, consistent messaging, and a focus on safety. We assert that this collaboration has improved overall NOAA mission effectiveness and efficiency in the Florida Keys.

The NOAA/NWS vision of a "Weather-Ready Nation" aligns closely with the theme of "resiliency" in the NOAA vision. In addition, the NWS mission (provide weather, water, and climate data, forecasts, and warnings for the protection of life and property and enhancement of the national economy) supports the overarching NOAA mission of science, service, and stewardship. The NWS issues *marine* warnings and forecasts for the coastal areas of the United States, along the coasts of U.S. territories, across ocean areas specified by international agreement, and on the Great Lakes. The NWS Marine, Tropical, and Tsunami Services Program provides, in cooperation with governmental and private sector partners, meteorological support for the protection of life and property, to promote economic benefits, and to enhance the quality of life for governmental, commercial, and recreational maritime operations including the nearshore coastal strip (NWS, 2010). The latest NWS Strategic Plan (NWS, 2011) highlights an operational paradigm that "reflects the NWS vision of the future which focuses on delivering decision-relevant data and information and interpretive services for high-impact events." This vision is the "Weather-Ready Nation", a society that is prepared for and responds to weather-dependent events. Strategic goals include: 1) improve weather decision services for events that threaten lives and livelihoods; 2) enhance climate services to help communities, businesses and governments understand and adapt to climate-related risks; 3) improve sector-relevant information in support of economic productivity; 4) enable integrated environmental forecast services supporting healthy communities and ecosystems; and 5) sustain a highly-skilled, professional workforce equipped with the training, tools, and infrastructure to accomplish our mission.

The fundamental goal of this work has been the realization of a "Marine Weather-Ready Nation" in the Florida Keys. Efforts to this end have focused first toward NOAA line offices, U.S. Coast Guard, Florida Fish and Wildlife Conservation Commission, Port of Key West interests, and other marine agencies. This paper

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will highlight numerous cases of NOAA collaboration in the Florida Keys, especially between the Florida Keys NWS Weather Forecast Office (WFO) and the Florida Keys National Marine Sanctuary (FKNMS). Section 2 will explain the importance of collaborative relationships among NOAA line offices. Sections 3 through 7 will include examples of NOAA collaboration activities in the areas of environmental monitoring, impact-based decision support services (IDSS), training and exercises, ecosystems, and public outreach and education, respectively.

2. NOAA IN THE KEYS: "DEEP" PARTNERSHIPS

The diverse mission of NOAA is carried out in nine key focus areas: 1) weather; 2) climate; 3) oceans and coasts; 4) fisheries; 5) satellites; 6) research; 7) marine and aviation; 8) charting; and 9) sanctuaries. Much of the work in these nine focus areas is administered and executed by six NOAA "line offices" (National Environmental Satellite, Data, and Information Service (NESDIS), National Marine Fisheries Service, NOS, NWS, Office of Marine and Aviation Operations, and Office of Oceanic and Atmospheric Research). The NOAA "staff offices" and "corporate services" also are essential for carrying out the NOAA mission. All six NOAA line offices conduct work in the Florida Keys. The main premise of this exposition is that collaborative work resulting from collaborative relationships, built by NOAA staffers at the local level, will engender not only increased trust and confidence between and among line offices, but also will yield more effective and efficient operations, and ultimately, success in the realization of resilient communities, ecosystems, and economies, including achievement of a Marine Weather-Ready Nation in the Florida Keys.

The partnerships evolving between the NWS and other NOAA line offices in the Florida Keys are those that satisfy the requisite provisions for a "deep relationship core partner", as described in NWS (2017).

3. ENVIRONMENTAL MONITORING

Observations made and data collected through NOAA environmental monitoring activities directly support the NOAA mission of science, service, and stewardship. Atmospheric and oceanic data are especially valuable for weather and ocean forecasting, as well as climate and ecosystem monitoring, atmospheric and oceanic research, search and rescue operations, and fisheries assessments. These data also are used directly by the Florida Keys marine community to support safe and efficient commerce.

The Florida Keys NWS WFO has collaborated with other NOAA line offices, as well as the private sector to increase the number and quality of atmospheric and oceanic observations in the Florida Keys and across the adjoining coastal waters. For example, in 2016, NOAA staffers from the NWS and NOS worked together in the identification of a more properly exposed location for the KYWF1 anemometer (see Fig. 2), the design of the instrument housing, the installation of the instruments, and subsequent quality review of data. Between 2008 and 2016, Florida Keys NWS WFO meteorologists trained dozens of FKNMS staffers to be "marine weather spotters". The Florida Keys NWS WFO Marine Weather Spotter Network is auxiliary to the SKYWARN spotter program, and more focused on the identification and communication of hazardous marine weather phenomena. Finally, between 2011 and 2016, Florida Keys NWS WFO meteorologists shared recommendations for several potential new automated weather stations at marine exposures with meteorologists from Weatherflow, Inc. Subsequently, staffers from both the Florida Keys NWS WFO and FKNMS worked collaboratively with Weatherflow, Inc. meteorologists and technicians to identify three appropriate locations, safely install equipment, and quality review subsequent data (see Fig. 3 for a photograph of two Florida Keys NWS staffers scouting a location for a potential new observing station).

Fig. 2. The re-located NOAA/NOS Key West Harbor Water Level Observation Network anemometers, atop the NOAA/FKNMS administration building, Key West, Florida.

4. IMPACT-BASED DECISION SUPPORT SERVICES

According to the NWS IDSS Philosophy (NWS, 2017), IDSS is "the provision of relevant information and interpretative services to enable core partners' decisions when weather, water, or climate has a direct impact on the protection of lives and livelihoods". NOAA line

offices are not only core partners to the NWS (by definition), but many of their operations involve work on aircraft and watercraft, as well as in hazardous environments (i.e., the sea). As such, the NWS has an obligation to provide IDSS to these line offices. Florida Keys NWS WFO personnel have been proactive with the provision of IDSS to other NOAA line offices (e.g, crews, divers, and scientists aboard NOAA ships, boats, and aircraft) in the Florida Keys during the last several years.

Fig. 3. Florida Keys NWS WFO Warning Coordination Meteorologist, Jon Rizzo (left) and Meteorologist Intern, Brandon Fling (right) on a NOAA/FKNMS vessel, participating on a familiarization float while scouting a potential location for a new automated observing station near Alligator Reef Light.

Events for which IDSS was provided to other NOAA line offices in the Florida Keys include:

- Several NOAA/NOS/FKNMS Buoy Team voyages along the Florida Reef tract.
- Joint U.S. Coast Guard-NOAA Shipwreck survey of the *Joseph M. Cudahy* (see Fig. 4 for a briefing example).
- Several aerial overflights of the FKNMS using NOAA Office of Marine and Aviation Operations aircraft.
- Marine Debris Removal Project.
- Two-week Florida Keys NWS meteorologist deployment to the NOAA Ship *Nancy Foster* (see Fig. 5 for a photograph of an in-person briefing during this deployment).

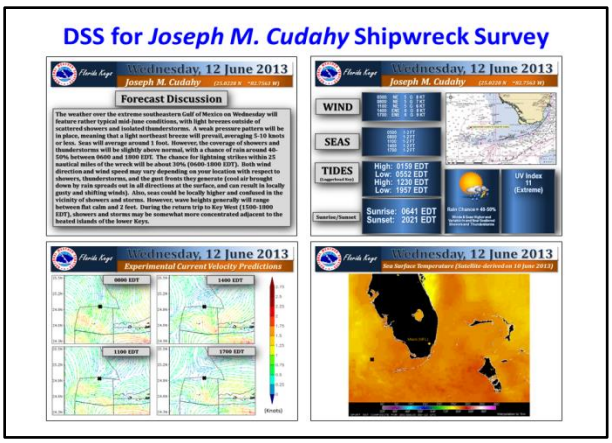

Fig. 4. An excerpt from an e-mail briefing on 12 June 2013, in support of the *Joseph M. Cudahy* Shipwreck Survey.

5. TRAINING AND EXERCISES

Joint, or "bilateral", learning activities provide a great opportunity for knowledge sharing, and advancement of multiple collaborative efforts between and among agencies. Florida Keys NWS WFO staffers have joined staffers from other NOAA line offices operating in the Florida Keys at many different training sessions, conferences, and tabletop exercises. These exchanges have fostered relationship building and associated trust and confidence, and information sharing concerning capacities, capabilities, needs, and operational thresholds. Examples of such meetings include:

- Florida Keys Area Committee quarterly meetings.
- Incident Command System (ICS) classes and exercises.
- Scientific seminars.
- Civic and industry meetings (e.g., Rotary Club, Propeller Club meetings).

Fig. 5. Florida Keys NWS WFO General Forecaster, Chris Rothwell, on the bridge of the NOAA Ship *Nancy Foster*, in August 2016, participating in the morning safety briefing during a research expedition in the Straits of Florida.

6. ECOSYSTEMS

Ecosystem-based management is an integrated adaptive management approach to help us consider tradeoffs in resource uses and protect and sustain diverse and productive ecosystems and the services they provide. Informed by science, it incorporates the entire ecosystem, including humans, into resource management decisions (NOAA, 2010). The NOAA/FKNMS (see Fig. 6) is one of 15 marine protected areas that make up the National Marine Sanctuary System. Administered by NOAA, and jointly managed with the State of Florida, the FKNMS protects 2900 square n mi of waters surrounding the Florida Keys, from south of Miami westward to encompass the Dry Tortugas, excluding Dry Tortugas National Park. The shoreward boundary of the sanctuary is the mean high-water mark. Within the boundaries of the sanctuary lie spectacular, unique, and nationally significant marine resources, from the world's third largest barrier reef, extensive seagrass beds, mangrove-fringed islands, and more than 6000 species of marine life. The sanctuary also protects pieces of our nation's history such as shipwrecks and other archeological treasures.

One of the objectives in NOAA (2010) is *an improved understanding of ecosystems in order to inform resource management decisions*. Consistent with this objective is research underway by the Florida Keys NWS and NOAA/NESDIS to predict coral bleaching "weather" along the Florida Reef tract a week in advance (see, e.g., Christensen et al., 2010).

Future efforts in the realm of ecosystem-based management and healthy and resilient ecosystems will include prediction of sea-level rise and climate change impacts.

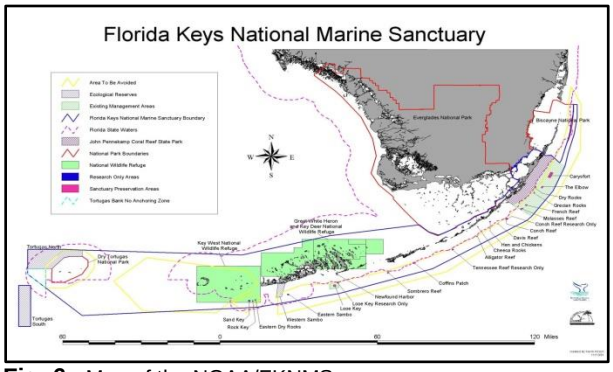

Fig. 6. Map of the NOAA/FKNMS.

7. PUBLIC OUTREACH AND EDUCATION

Communication to and education of the American public are essential to successfully fulfilling the mission of NOAA and the NWS. This is true for meteorology and weather forecasting, as well as ocean science, marine biology, ecosystem-based management, and coast surveys. NOAA line offices in the Florida Keys have been especially cooperative in this area, joining forces at public outreach events (seafood festivals, nautical markets, boating safety fairs), messaging (television, radio, social media, and the Internet), and education (community seminars, college courses, and safe boating and seamanship classes). One of the highlights of the NOAA outreach season in the Florida Keys is the quasi-annual "NOAA Science Saturday", held at the Florida Keys NWS WFO compound in Key West, Florida (Fig. 7).

Fig. 7. Photographs from the 2016 "NOAA Science Saturday", held at the Florida Keys NWS facility in Key West, Florida. Upper left: visitors lined up to enter facility for tour and presentations; upper right: visitors meeting with NOAA Florida Keys scientists; lower left: Senior Forecaster Alan Albanese leading a tour of the Florida Keys NWS Operations Floor; lower right: NOAA/FKNMS staff (Todd Hitchens, Sean Morton, and Patrick Vandenabeele) at their "Science Saturday" table.

8. CONCLUDING REMARKS

NOAA collaboration on a local scale is a reality in the Florida Keys. This collaboration has created many new opportunities for NOAA line offices to work together more effectively and efficiently, especially in the areas of environmental monitoring, IDSS, training and exercise, ecosystems, and public outreach and education.

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