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National Parks and Caribbean Marine Reserves Research and Monitoring Workshop

St. John, U. S. Virgin Islands, July 11-13, 2006

Technical Report NPS/NRPC/WRD/NRTR-2007/015

On the cover: USGS divers Erinn Muller and Tony Spitzack monitor coral disease on Newfound Reef, St. John, US Virgin Islands.

Above: NPS biologists Jeff Miller and Rob Waara monitor coral cover at Tektite Reef, Virgin Islands National Park, St. John, USVI.
Photographs by Caroline Rogers.

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INTRODUCTION

Oceans are in serious trouble for several reasons, not the least of which is unsustainable fishing (Hutchings 2000, Jackson et al. 2001, Pauly et al. 2002, USCOP 2004, Worm et al. 2006). Separating the effects of pollution, invasive species, diseases, and ocean warming from fishing is critical, if resource managers are to move beyond reactively treating symptoms of stress to addressing the underlying causes of degradation. Places where scientists can study ocean ecosystems without influences of fishing are extremely rare in the United States. Fishing occurs in more than 99% of U. S. waters, including units of the National Park System (parks). Recently, marine reserves (reserves), i.e., marine protected areas (MPAs) in which extractive uses are prohibited entirely or restricted to take of a few pelagic or other species, were established in and around five national parks (Buck Island Reef National Monument, Channel Islands National Park, Dry Tortugas National Park, Glacier Bay National Park and Preserve, Virgin Islands Coral Reef National Monument). These reserves provide an unparalleled opportunity to study the effects of fishing in tropical, temperate, and sub-arctic ecosystems at scales ranging from thousands to hundreds of thousands of hectares. National Park Service policy allows recreational fishing and commercial fishing authorized by statute or regulation. Park managers need to ensure that fishing does not cause unacceptable impacts to natural resources and processes.

In July 2006, the National Park Service (NPS) and U. S. Geological Survey (USGS) held an international workshop on St. John, U. S. Virgin Islands (USVI), to discuss research, monitoring, and management experiences with MPAs in Florida and the Caribbean in order to identify opportunities for future research and monitoring in the new reserves in Buck Island Reef National Monument (BUIS), Dry Tortugas National Park (DRTO), Virgin Islands Coral Reef National Monument (VICR), and in nearby Virgin Islands National Park (VIIS). The emphasis of this workshop was on evaluation of reserve performance, not on reserve design or establishment processes. A primary objective of the workshop was to assist NPS in making science-based management decisions on marine reserves. Specifically, NPS needs to know the consequences, both social and ecological, of changing fishing practices in these parks. An experiment was begun with reserve establishment. Now we need to take advantage of this unique opportunity and directly measure the effects of removing fishing from these ecosystems.

Workshop participants included thirty scientists and managers from the United States (including Puerto Rico and the U. S. Virgin Islands), Mexico, the Bahamas, Belize, St. Lucia, Barbados, Colombia, and the British Virgin Islands (see Appendix A for List of Participants).

Purpose of This Synthesis

The purpose of this document is to synthesize the highlights of the ideas that emerged from the workshop discussions, particularly those relevant to the NPS marine reserves, not to summarize the presentations and discussion group reports. The workshop presentations are listed in Appendix B and are available at the following website: www1.nature.nps.gov/im/units/sfcn/viismtg.cfm.

Workshop Structure

Workshop participants explored four themes: 1) Expectations and Goals of Marine Reserves, 2) Connectivity, 3) Research and Monitoring, and 4) Next Steps. Connectivity here is used in a very broad sense to include ecological, social, and management connectivity. A particular effort was made to integrate socioeconomic aspects of marine reserves into the workshop. The objective was for participants to learn from each other about the performance of marine reserves in the western Atlantic and Caribbean and to apply the "lessons learned" specifically to the three National Park Service marine reserves in this region.

In his keynote address, Rafe Boulon, Chief of Resource Management for Virgin Islands National Park, framed the issues and opportunities for research and monitoring with an overview of MPAs in the USVI and introductions to VICR, BUIS, and VIIS.

While we focused on the USVI and Dry Tortugas, Florida, in this workshop, we recognize that the ideas and concepts could have application to other regions as well. We also recognize that "connectivity" has many meanings and applications, both social and ecological. We explored this core concept for ocean stewardship in the widest possible context of multiple scales of time and space, and in its many manifestations including: Ecological—food web, competition; Geographical—ocean currents; Natural history—larval dispersal, settlement habitats; Social—people to nature, within human communities; and Economic—fisheries, tourism.

BACKGROUND

Ocean and coastal resources have been included in the National Park System since the establishment of Acadia National Park in 1916, with a total of 74 units established for their beauty, national significance and educational value. The National Park Service is charged with conserving the cultural and natural resources of ocean parks unimpaired for current and future generations. However, as people move to the coasts (56% U. S. population now, 75% projected in 25 years), the National Park Service must contend with recreational demands, consumptive uses of coastal resources, and increased development of coastal watersheds adjacent to and within park units. Major park stewardship issues include the same issues that concern other coastal managers: fishing, habitat fragmentation and destruction, pollution, unsustainable uses, disturbance, and invasive species. In the National Park System, resource managers and scientists are hindered in many cases by a poor understanding of marine resource conditions and undocumented human impacts. Park managers also must contend with inadequate understanding of the underlying causes of ecological degradation, which in turn hinders their ability to effectively mitigate impacts. This lack of capacity hinders efforts to restore degraded marine ecosystems, maintain populations of targeted fish species and sustain fishing opportunities.

National Park managers and scientists must also consider the problem of "shifting baselines". In 1995, Daniel Pauly noted that each generation of fisheries scientists thinks of the baseline for fish species composition and abundance as the level existing when they first started their studies, and as stocks decline further, each successive generation accepts the new level as the new baseline against which to measure changes (Pauly 1995, Pauly et al. 2002). This "shifting baseline" syndrome is also applicable to evaluation of changes in coral reefs. It can result in a failure to recognize just how dramatic the changes have been and how urgent the need is for greater resource protection.

In recent years, marine reserves were created in four parks (Dry Tortugas NP, Buck Island NM, Virgin Islands Coral Reef NM, and Channel Islands NP) and parts of Glacier Bay NP were closed to provide increased protection for marine life and habitats. The new reserves are essentially a series of landscape-scale trials in Alaska, California, Florida, and the U. S. Virgin Islands. No-take reserves in parks of the 1950s and 1960s (i.e., areas with no fishing or other extractive uses) were on the order of 10s of hectares in extent. The National Park System now presents opportunities to examine reserves that range in size from 2,000 ha to 140,000 ha in diverse systems with multiple scales of treatments. Time is passing, the trials are underway, and ecosystems are changing in response to the treatments. As yet, NPS does not have enough research and monitoring in place to learn how to effectively advance the science for understanding ecosystem dynamics and to improve conservation strategies. Research and monitoring together support the cornerstone of area-based stewardship and adaptive management—knowledge and understanding of ecosystems, including people. Other key elements of stewardship include restoration ecology and connecting people to these special places.

Marine Reserve Establishment

In January 2001, President Clinton established 5,145 ha Virgin Islands Coral Reef National Monument off St. John and expanded Buck Island Reef National Monument off St. Croix to 7,627 ha. All fishing is prohibited in BUIS and only blue runner (pelagic jacks) and baitfish in Hurricane Hole may be taken in VICR. The National Park Service, which also manages Virgin Island National Park off St. John and Salt River Bay National Historic Park and Ecological Reserve off St. Croix, administers these new national monuments.

At Dry Tortugas National Park, NPS is currently promulgating regulations that will allow fishing to continue in just over half of the park, and create a 15,700 ha marine reserve called a Research Natural Area (RNA) that complements two reserves adjacent to the park established in the National Oceanic and Atmospheric Administration's (NOAA) Florida Keys National Marine Sanctuary. The three Dry Tortugas reserves together will total 67,235 ha. Recreational fishing and other resource consumptive activities will not be allowed in the DRTO-RNA. Commercial tour providers and private boaters will be required to use mooring buoys, and anchoring will be prohibited in the reserve to prevent damage to corals and other delicate organisms.

Marine reserves have been established throughout the world with a variety of goals, most often conservation of biodiversity and enhancement of fisheries (Sobel and Dahlgren 2005). The national monument proclamations for VICR and BUIS did not explicitly cite these objectives or use these phrases, but their terminology is largely

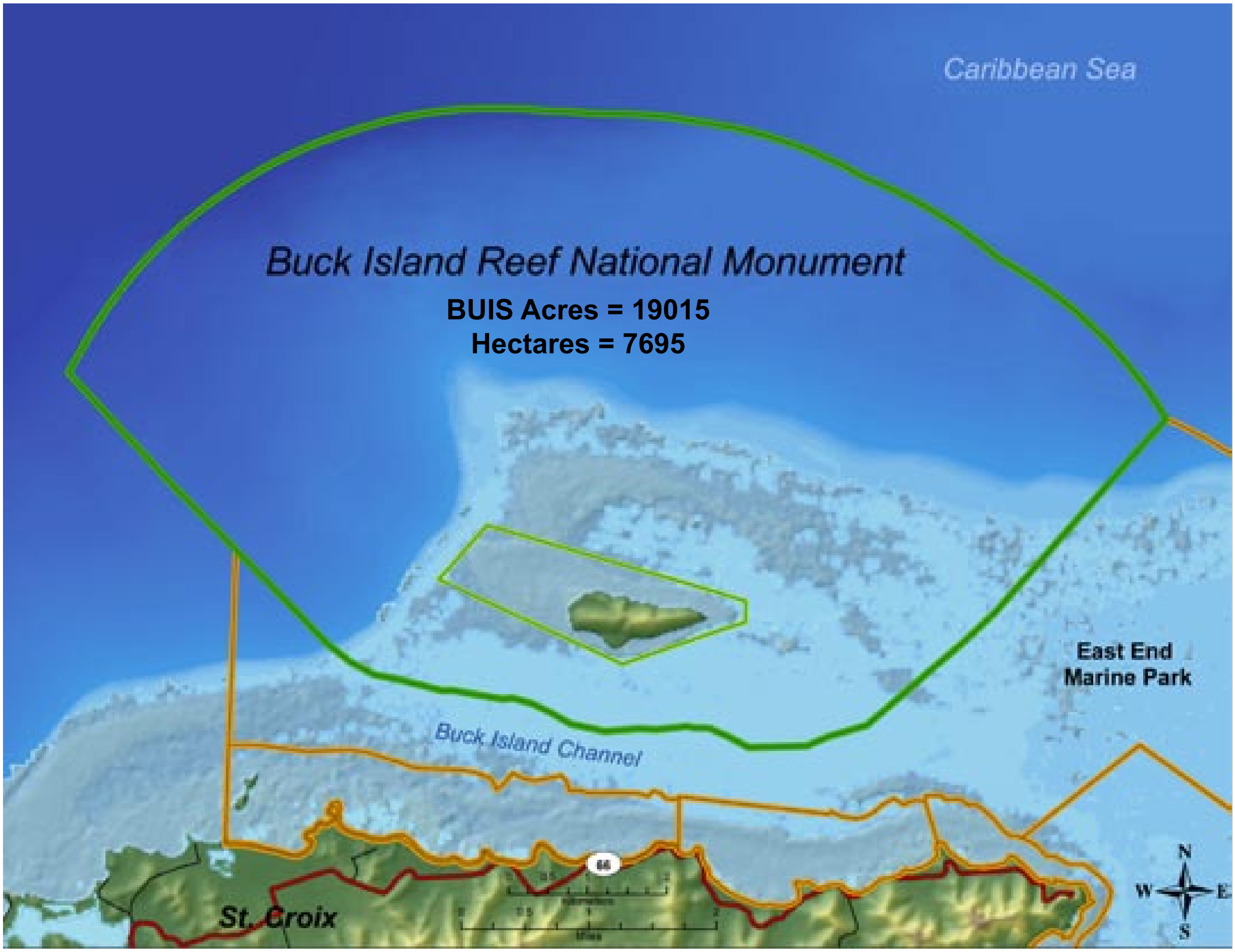

Figure 1. Map of Buck Island Reef National Monument.

ecological, and the goal is clearly to increase the protection for coral reefs, sea grass beds, and other interdependent habitats and species. Both proclamations specifically mention the objective of sustaining "the tropical marine ecosystem". Likewise, both proclamations specifically refer to protection of spawning aggregations and the whole range of habitats needed to support the different life stages of reef-associated organisms, many of which settle as larvae in shallow near-shore habitats and then move to deeper water as they mature. The concept of ecological connectivity is implied in the BUIS Proclamation with its reference to oceanic currents transporting planktonic larvae of reef organisms. The VICR Proclamation refers to the extensive mangrove habitat within Hurricane Hole as a nursery area "essential to the overall functioning and productivity of regional fisheries."

In the 1960s, when Buck Island Reef National Monument and the marine area of Virgin Islands National Park were established, very small areas less than 50 ha each (the Marine Garden and Trunk Bay) were set aside as "no take" zones. These proved to be insufficient to sustain resources. Now NPS has a few areas over 5,000 ha to test. How effective will these be in restoring or sustaining ecosystem integrity, stability, and capacity for self-renewal in the face of extreme natural events, ocean warming, coral diseases, increasing acidity of the ocean, and pollution?

Dr. Alan Friedlander pointed out some of the shortcomings of other fishery management tools. For example, rotational closures in Hawaii have not been effective (Williams et al. 2006). In addition, while quotas and size limits can be helpful, some gear types, such as gill nets that kill all species they catch, are especially destructive.

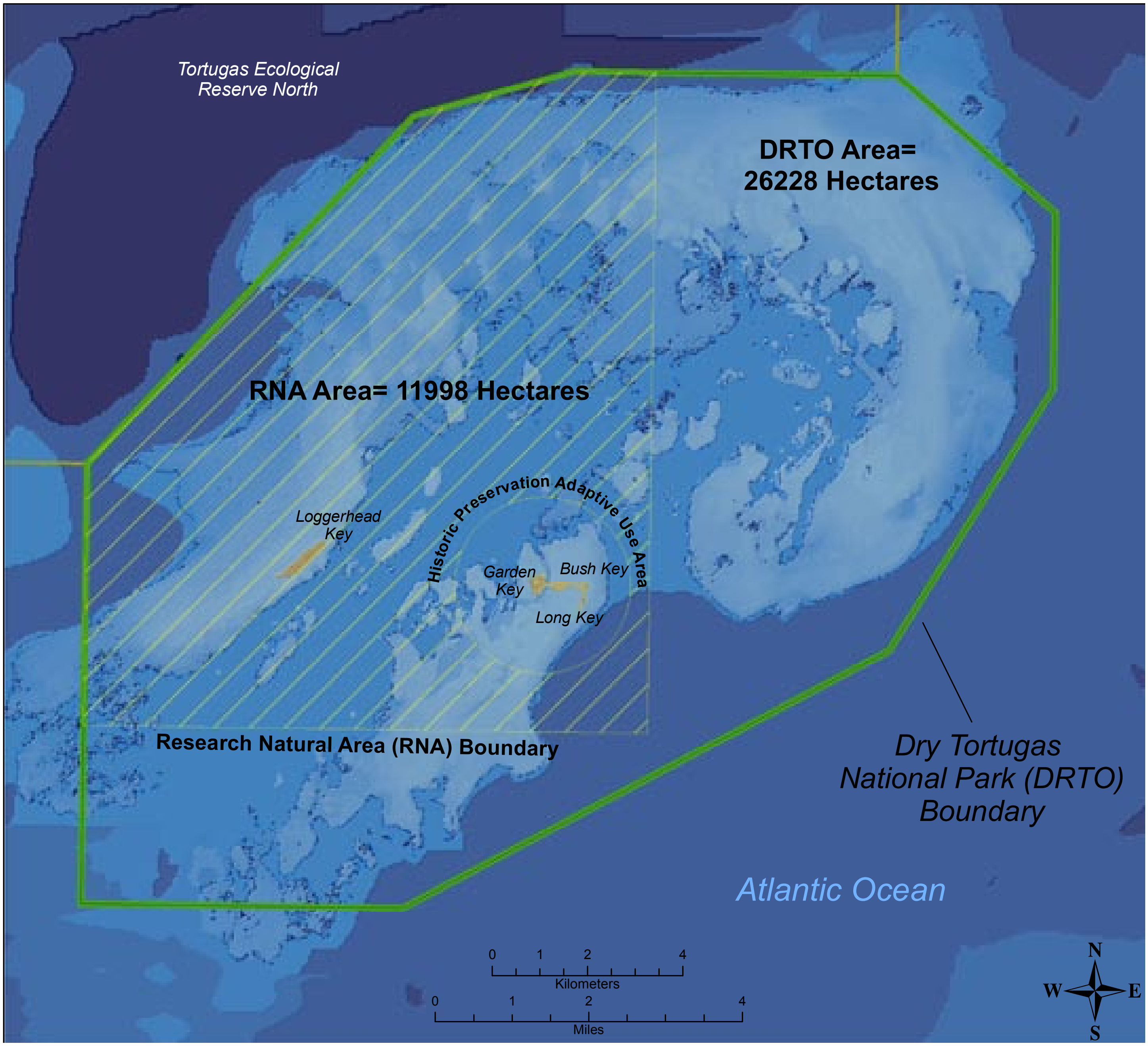

Figure 2. Map of Dry Tortugas National Park showing Research Natural Area.

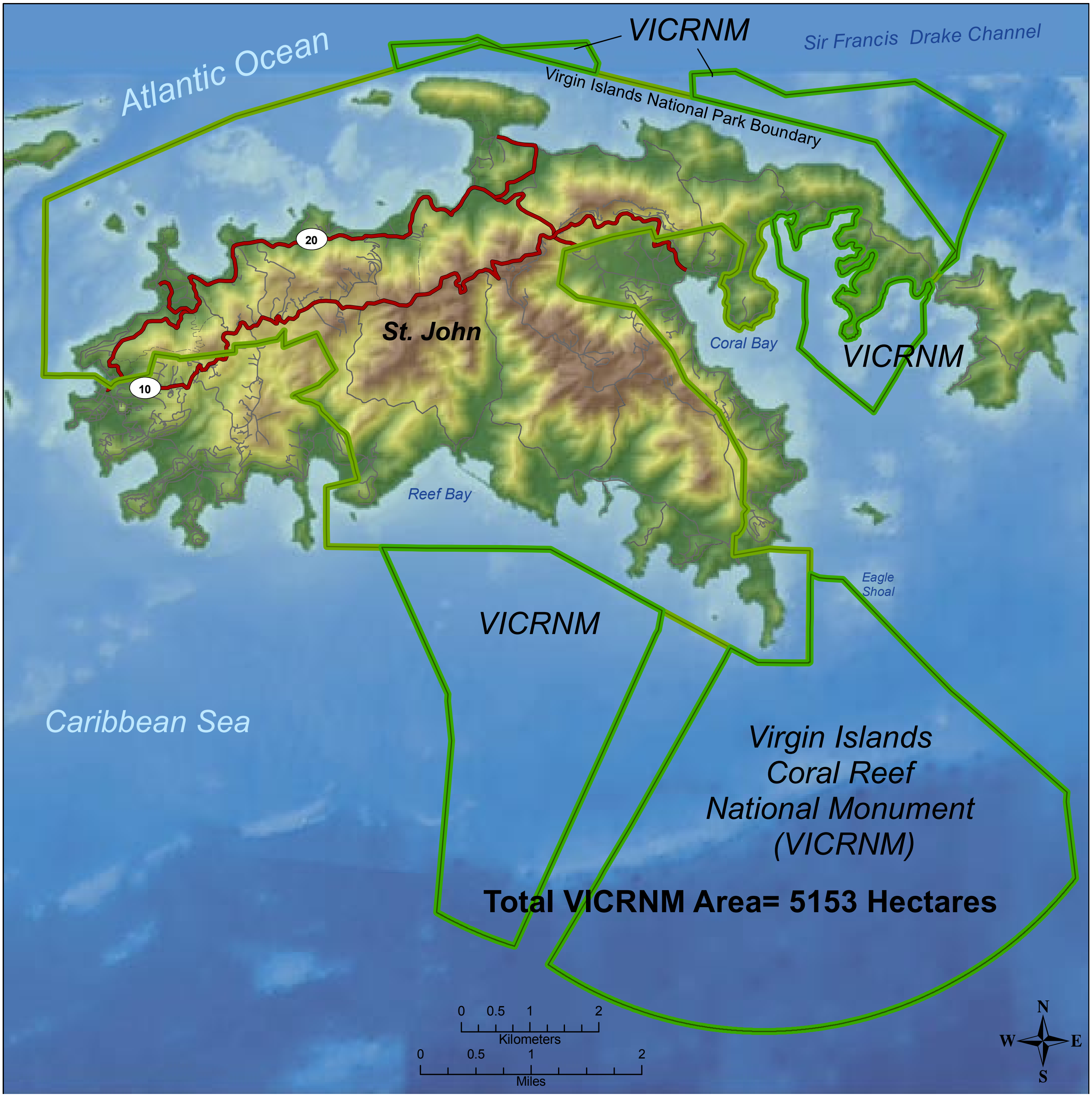

Figure 3. Map of Virgin Islands Coral Reef National Monument, Virgin Islands National Park.

KEY WORKSHOP FINDINGS

Ocean resources in all three NPS reserves in Florida and the Caribbean have been degraded, and greater protection clearly was warranted. One overarching question is whether or not the marine reserves will help reverse the declines and restore ecosystem structure and function. Fishing is just one of many stressors. Will removing it improve ecosystem integrity, stability, beauty, and capacity for selfrenewal? Will it improve the capacity for ecosystems to better endure or mitigate effects of other stressors? Marine reserves offer the opportunity to separate the effects of fishing from those of other factors and thereby improve understanding of ecosystem functioning.

Reserve Goals and Expectations

Biodiversity has some inherent limitations as a reserve goal because existing reserves may not contain the full range of habitats needed for sustainability—a gap analysis may be needed to determine if they are 'complete.' Also, since not all habitats have equal value there is a need to identify limiting factors, such as critical habitats for recruitment and reproduction.

Persistence is required to restore and ensure resilience of coral reefs. Like treating accident victims, other reserves in the region have gone through three phases of development: 1) establishment—"stop the bleeding," 2) enhance conditions within the reserve—"start the breathing," and 3) enhance conditions adjacent to the reserve—"get in shape."

Compliance and effective enforcement are based on education and outreach, not only on surveillance and authority. Education and outreach are critical. People need to have realistic expectations or they may lose faith in civic institutions. For example, real benefits of reserves are more likely to increase reproductive capacity and system capacity for self-renewal, not spillover and growth of fish for people to catch.

Reserve Locations and Contents

Baseline information is needed to evaluate changes in reserves. In particular, deep-water areas in VICR and BUIS need better habitat characterizations, movement patterns of juvenile and adult organisms need to be discovered, and larval movements need to be documented to improve and calibrate population replenishment models. NPS needs more high resolution, near-shore, ocean current and bathymetry data. NPS needs to help NOAA and USGS harmonize habitat mapping and site characterizations so the products are useful for park managers.

Relative to earlier reserves in this region, these new reserves may seem large. However, they may not work as well as people expect or would like as they may not be ecologically complete and/or large enough. Although in total the three Dry Tortugas reserves [the existing ones and the new RNA (approved in November 2006)] are three times the size of the USVI reserves, they still may not be large enough to contain all of the components, including sufficient juvenile recruitment and spawning habitat, necessary to sustain the resources they encompass. For example, DRTO has very little mangrove habitat and BUIS contains no mangrove communities or shallow seagrass beds that are important nurseries for many fishes and lobster.

When the proclamations for the NPS reserves in the USVI were made in 2001, very little information on the resources within the new boundaries existed, particularly in deep water. BUIS extends to depths of 1,500 m, and VICR reaches depths greater than 50 m. Within the last few years, fish surveys by NOAA and NPS, and cruises on the NOAA ships Nancy Foster and Ron Brown have added to the information for these deeper sites, revealing new species. Nevertheless, NPS managers still lack detailed information on resources within the monuments. Recent surveys revealed that the swath separating the eastern and western portions of the south side of VICR actually contains better-developed coral reefs on the midshelf than those inside the monument (Monaco et al. 2007). NPS and the USVI government are working with the Delegate to Congress to swap this area for an area of equivalent size just west of the eastern boundary. NPS resource managers expressed an interest in identification of "hot spots" i.e., areas of particularly high biodiversity, within and near the reserves.

Community Compliance and Effective Enforcement

Demarcation of the boundaries for the VI monuments is particularly difficult because of the expense of installing and maintaining boundary markers (buoys) in deep water. In fact, it is not possible to mark much of the boundary of the BUIS because depths exceed 1,000 meters. Establishing clear and identifiable boundaries is critical for compliance and effective enforcement. In one recent case, a fisher from St. Croix was cited for fishing within the reserve but was not charged because he claimed he would need a GPS to locate the reserve boundary and the regulations do not require fishers to own GPS units.

Enforcing reserve regulations that prohibit fishing is critically important for a number of reasons. Even a relatively small level of fishing effort can have substantial negative consequences. If reserves do not effectively reduce fishing mortality to near zero, scientific endeavors to measure reserve effects will be futile. Also, fishers want to see consistent enforcement. Lack of sufficient enforcement staff is a universal problem. Some of the most effective reserves are those that have the broadest public support. If fishers and others support the reserves, less enforcement is necessary. To build trust and support, fishers can be enlisted to help with management of reserves. For example, in Banco Chinchorro, Mexico, fishers are provided with radios to help patrol reserve waters and report violations. In the USVI, federal and territorial fishing regulations need to be updated and harmonized.

Connectivity within the Caribbean and Western Atlantic

The degree of connectivity among marine reserves and other MPAs has very significant management implications for the region. Dr. Bob Cowen presented a model of current patterns and potential dispersal of reef fish larvae within the Caribbean (see Cowen et al. 2000, Cowen et al. 2006). The model is based on the number of days that larvae remain viable and on current direction and velocity. It is possible to show the size and shape of the area ("dispersal kernel") that larvae can potentially reach from a particular source and to identify areas of suitable habitat. Dr. Cowen demonstrated that incorporation into the model of vertical transport of larvae, rather than just passive transport in the currents, substantially changed the "dispersal kernel". Jamaica and possibly St. Croix appear to be more isolated than many other land masses. Dr. Cowen identified a need for more shallow water bathymetry and current data, and a finer resolution model for the U. S. Virgin Islands.

Significantly, although most marine organisms have planktonic larvae that can be dispersed over large distances, evidence to date suggests that most larvae of reef-associated animals come from within 10s of kilometers rather than 100s of kilometers away. This finding suggests the need for more closely-linked reserves throughout the region. Dr. Cowen's model focused on fish larvae. A similar model of the transport of elkhorn coral larvae throughout the Caribbean has been presented by Dr. Iliana Baums and co-workers (Baums et al. 2005). It suggests some separation of elkhorn populations in eastern and western regions of the Caribbean, with mixing near Puerto Rico.

If the reserves are largely dependent on local habitats and fish assemblages for larvae for replenishment, local management becomes even more critical. More research, such as that done off St. Croix on bluehead wrasse showing that fish larvae are locally retained, is necessary (Warner et al. 2000, Hamilton et al. 2006). In addition, further research on movement of adult fishes and how they use habitats in time and space is needed for a better understanding of connectivity among reefs, reserves, and adjacent exploited areas. NOAA has just begun a tagging and telemetry study of several species of fishes within VIIS and VICR.

Dr. Chuck Birkeland noted that when investigating connectivity, it is not always clear just which species to select for study. He also highlighted the need to consider not only dispersal of larvae but also their survivability—in other words, larvae must settle in habitat that is suitable for their growth and survival.

Future research should focus on the role of the VICR, BUIS, and DRTO reserves in the overall region (Western Atlantic and Caribbean); the possible links between St. Croix and St. John (i.e., BUIS, VICR, and VIIS), between VIIS and VICR, and between BUIS and the East End Marine Park.

Reserve Effects on Humans

Basic information is needed to identify and characterize demographics of local reserve stakeholders, to describe changes in human use of ocean resources, and measure attitudes, beliefs, and values related to reserves. Regional fishery data, e.g., geo-referenced landings and effort, are needed to evaluate effects of reserves on fishers and fisheries, as well as to evaluate resource conditions. It is important to learn how reserves have affected local or regional markets for fishery products or other facets of fishing (gear purchases, social communities). Currently, most available socio-economic data are gathered at too coarse a scale to detect or describe marine reserve effects. Potential partners in addressing these issues include NOAA Sanctuaries, the National Marine Protected Area Center, international fishery management councils, and academics.

The frequency, extent, and nature of management agency interactions with the public can be good measures of effectiveness. Dr. Manuel Valdez-Pizzini and Dr. Daniel Suman noted that there are tools that provide guidance for gaining the support of the people who use the reserves or who were affected by their establishment, and involving them in the management of the reserves. Examples of these tools are the surveys described in the Socioeconomic Manual for Coral Reef Management (Bunce et al. 2000) and the IUCN booklet "How is your MPA doing?" (Pomeroy et al. 2004). There is a need for widespread public support and knowledge of how people use the marine reserves and nearby areas. It is also very important that people have realistic expectations about the benefits that may or may not accrue from the greater protection of resources.

Communication and education about the purposes of the reserve and ongoing research and monitoring ideally will be a continuing activity. One major goal is the acceptance of the reserves. The Soufriere Marine Management Area in St. Lucia now enjoys widespread support, but this required about a decade of concerted effort and involvement of local people.

Reserve Effects on Fish and Other Harvested Species

Basic fisheries monitoring—geo-referenced landings, fishing effort, characteristics of human communities engaged in fisheries—is needed in the U. S. Virgin Islands. Fisheries-independent information—population dynamics of targeted species—is needed for all of the reserve areas. Research is needed to test hypotheses such as "reserves cause more big fish, which have higher fecundities, which produce more little fish, that grow into more big fish" and "fish recruitment is better (higher, more frequent, more successful) in reserves than outside in similar habitat."

Experience from elsewhere in the region, such as the Florida Keys National Marine Sanctuary reserves, revealed that when fishing was eliminated some fishes became more abundant and increased in average length within a few years. However, when fishing stopped, responses of prey species for groupers and other species targeted by fisheries were unpredictable. Likewise, the effects on non-targeted and non-prey species are not known. Recent work in the Bahamas Exuma Cays Land and Sea Park (where fishing stopped in 1986) showed that increases in groupers did not lead to overall decreases in herbivorous parrotfishes because larger parrotfishes were able to escape predation (Mumby et al. 2006).

Early protection of lobsters in DRTO also produced benefits (Davis 2004). Lobsters are important predators that strongly influence the structure and functioning of many tropical marine ecosystems, from sea grass meadows to coral reefs. They prey on other invertebrate carnivores and grazers in reef systems. Removing large lobsters reduces the biodiversity and resilience of the entire system. It became clear that the potential reproductive contribution of a large population of big lobsters at Dry Tortugas, upstream from the Florida Keys, could greatly benefit lobster fisheries near and far. In 1974, NPS, with concurrence of the State of Florida, created a 26,000 ha lobster sanctuary, protecting lobsters in both juvenile and adult habitats. Nearly 30 years later, when male lobsters finally grew large enough to mate with large females, the large females at Dry Tortugas began producing huge quantities of eggs. Soon they were pouring millions of larvae into the ocean currents that swirl around the Florida Keys, before they settled into juvenile habitats in Florida Bay and Biscayne Bay and eventually entered the Florida Keys fisheries.

The lobster fishery's success appears to be based on a network of reserves that protects significant portions of lobster populations throughout their life cycle in adult and juvenile habitats. The reserves complement traditional socio-economic measures that control fishing effort and allocate resources among diverse interest groups with gear restrictions, fishing seasons, and bag limits.

The cascading effects of fishing, that is, the effects of fishing on other components of the ecosystem, are not well understood (see Newman et al. 2006). Likewise, the effects of removing fishing pressure are not well comprehended. Within VICR, fishing of the pelagic blue runners (*Caranx crysos*) is permitted at a few locations, and fishing of baitfish in Hurricane Hole is allowed. The possible effects of allowing fishing of these species and their roles in both pelagic and benthic ecosystems are not well enough known to predict impacts.

Another "unknown" is the likelihood of an increase in the number of apex predators, including sharks, as a result of reserve establishment (Friedlander and DeMartini 2002). This particular topic might be of special interest to visitors and residents.

Reserve Effects on Coral Reefs and Other Benthic Habitats

An underlying theme for this workshop was the need to better understand the response of benthic habitats to the cessation of fishing and the effects of benthic degradation on fishes. When fishing stops, the effects on targeted fish species are relatively predictable and can occur quickly. However, the effects on the coral reefs and associated sea grass beds, mangroves, and algal plains are not predictable and improvement could take decades or longer. As a specific example, coral reef habitats within the no take zones within the Florida Keys National Marine Sanctuary have not shown clear improvement since 1997 for undetermined reasons. It is not clear how changes in fish trophic groups after reserve establishment affect benthic resources.

A key concern is that regional and global stressors could undermine the benefits of the marine reserves. The 2005 bleaching event, followed by severe disease outbreaks, resulted in about 50% mortality of the living coral at long-term monitoring sites in BUIS and VIIS (Miller et al. 2006). The bleaching, which was especially severe in the USVI and Puerto Rico, was associated with the highest sea water temperatures ever recorded in the Caribbean. The response of fishes to this extensive coral mortality is not known. Monitoring of fishes associated with long-term transects could help reveal this fish/habitat relationship. Fish diversity and abundance often seem more correlated with the complexity of the physical structure than the amount of living coral. Hurricanes have also caused destruction in the USVI. Dry Tortugas was affected by four hurricanes in 2005 alone. There has also been growing concern over increasing acidity of the oceans and possible disastrous effects on corals and other calcium carbonate producing organisms (Kleypas et al. 2006).

Of course stressors associated with more tractable human activities, such as land-based sources of pollution and careless coastal development, can lead to decline in coral cover and other habitat changes particularly for reefs that are near shore. NPS has jurisdiction over upland and adjacent terrestrial areas and is therefore in a position to prevent or mitigate detrimental coastal development, such as sedimentation carried by storm runoff and other land-based stressors.

To add to the complexity, the synergy among the array of natural and human-related stressors is not understood. For example, what is the interaction of overfishing and global climate change? Also, the past history of an area will have an important influence on its ability to recover once fishing has been removed (Hughes et al. 2003, 2005).

Are there thresholds beyond which recovery or improvement will not occur? Dr. Chuck Birkeland noted that about 20 years after Crown of Thorns sea stars in Palau decimated live coral leaving only unconsolidated rubble, the reef had not recovered in spite of abundant coral recruitment. However, apparently after the substrate became more stable, coral grew back rapidly within about 6 years. The links between fishes and physical structure, and fishes and living coral cover, are not well understood. However, reduction of topographical complexity is thought to contribute to an imbalance in the system and losses in herbivory that can hinder coral recruitment (Szmant 1997). If topographical complexity is reduced because of hurricanes, anchor damage, bioerosion, and eventual disintegration of dead corals, fish may not come back.

Research, Monitoring, and Information Management

Monitoring needs to include regional-scale factors as well as local ones. Community engagement needs to be monitored and better understood. A goal of reserve management is to engage the public in monitoring through programs such as Reef Check, REEF and the Great Annual Fish Count. Budget and decision support tools, such as geographically explicit models that allow groups of people to play out and discuss "what if…" scenarios, are needed to help guide research and monitoring efforts.

Indications of reserve health should include demographics of once common species that are now rare, because they have great potential for change and are well known by human communities, e.g., Nassau grouper. Expectations include trajectories of change in trophic and size structures. Sizes of dispersal kernels are key measurements. For highly mobile species, reproductive and recruitment habitats may be all that can be studied in reserves.

A substantial amount of research and monitoring has taken place in the USVI and at Dry Tortugas. Federal and territorial agencies have provided significant amounts of support over many years. Data on fishes, corals, and other organisms from some of the longest monitoring programs in the Caribbean come from the USVI. Benthic habitat maps provide the foundation for future research and monitoring.

These long-term programs provide opportunities to take advantage of and build on historical information as well as more recent data. Many MPAs in the region lack baseline data, but NPS, USGS, and NOAA have invested significant financial and human resources to collect high quality data. There is a need to sustain the current monitoring that is occurring in the parks and monuments and to explore the possibility and feasibility of additional monitoring and experimental research to measure the effects of removing fishing pressure from these ecosystems. The effective collaboration among these and other agencies provides many opportunities for advances in understanding of marine ecosystems within parks. Management and synthesis of existing information is an ongoing need. Research and monitoring must be done over appropriate spatial and temporal scales.

Research and monitoring to evaluate marine reserve performance is scientifically challenging. There is no simple way to measure the ability of coral reef ecosystems to recover or to know whether they can possibly recover to their initial, intact condition. Ideally, research would have begun before and continued after reserve establishment at a number of sites with comparable habitat ranging from well-developed, high coral cover reefs, to sea grass beds, and other benthic habitats inside and outside each NPS reserve. Also, the most powerful comparisons would depend on the complete absence of any fishing. While much can be learned from the ongoing monitoring programs, further discussion is needed to develop the most appropriate experimental approach to evaluating reserve performance. Specifically the identification of comparable sites inside and outside reserves needs be determined and used consistently among various investigators. Some workshop participants suggested that the effects of banning fishing could be so substantial that much could be learned from comparison of numerous sites inside and outside reserve boundaries even if the sites are not strictly comparable. In other words, the consistency of treatment (= no fishing) could potentially override inherent site variability.

Other related research and monitoring activities were discussed in addition to those designed to directly measure reserve effectiveness. For example, as noted above, monitoring of fishes associated with long-term transects that NPS maintains around St. John and Buck Island could help reveal effects of the severe bleaching/disease event in 2005. It is not known how long it might take these effects to become apparent if they do occur. Monitoring of elkhorn coral during the bleaching event suggested that some genotypes were more susceptible to bleaching as some colonies bleached while others adjacent to them did not. Further research on susceptibility of major reef-building corals to disease is a critical need.

Ecological processes such as herbivory and recruitment (both fish and coral) have not received much attention. Additional information is needed on the appropriate level of parrotfish biomass and the changes in herbivory as fishes increase in size. Also, what are the linkages among fish and mobile invertebrates (lobster, conch, urchins) and benthic sessile communities (corals and algae)? As fish and mobile invertebrates grow larger in reserves, how do their feeding habits change and what effects does that have on benthic communities? Does improvement of benthic habitats within marine reserves eventually lead to an increase in the size of dispersal kernels for coral and fish larvae?

Another research focus is the testing of the hypothesis that corals in areas with very high current velocities are less susceptible to bleaching and disease. A pilot study on this between scientists from the University of the Virgin Islands and USGS has begun. These scientists also plan to evaluate the use of ADCPs (Acoustic Doppler Current Profilers) to document coral spawning and potential links between coral reefs in St. John and St. Thomas.

USGS and NPS will continue to collaborate on coral disease research. Although it would be very difficult to test, it is possible that the restoration of a more balanced ecosystem within and even adjacent to the NPS reserves could lead to a reduction in disease. For example, recent work suggests that macroscopic algae (seaweeds), which have increased substantially in the last 2-3 decades, could be releasing dissolved organic carbon that promotes growth of disease-causing organisms (Smith et al. 2006). Reduction of macroalgae following increases in herbivory could therefore be very beneficial.

The NPS monitoring program has developed a list of "vital signs," key indicators of ecosystem and population condition, to guide monitoring of parks in the Dry Tortugas and the USVI, including the reserves (see www1.nature.nps.gov/im/units/sfcn. Existing monitoring under this program will be expanding. There is also a need for monitoring the effectiveness of enforcement and education. Knowing more about how people use these areas, how markets and fisheries change, and if visitation (tourism) has increased as a result of marine reserve establishment are important, as well.

Marine Reserves Alone Are Not Sufficient

Although marine reserves are very promising tools and have the potential to reverse degradation, they will not resolve all issues confronting parks, and reserves can not be the only form of resource management (see Lubchenco et al. 2003). It is theoretically possible for fish populations in reserves to increase in number and mean size, while nearby populations outside the reserves collapse. Some fish and other species that move quickly through marine reserves will not be protected by the reserves for sufficient time to improve their contributions to subsequent generations. Stressors other than fishing, e.g., runoff from upland development and pollution from upstream sources, can degrade water quality in marine reserves. NPS has jurisdiction over adjacent and upland areas and is well-positioned to control detrimental human activities. But stressors from outside the marine reserve boundaries can diminish benefits of reserve designation. When marine reserves are established, fishing activity may shift to other areas and displace, not reduce, pressure on resources. This has apparently happened off St. Croix, as fishers have shifted from BUIS to adjacent Lang Bank.

North American Network of Marine Protected Areas

The North American Tri-national Commission for Environmental Cooperation has initiated development of a North American Network of Marine Protected Areas with a shared resources monitoring project among sister park sites along the west coast in the Baja to Bering region. This effort may provide a model for the Caribbean region. Agreement to shared goals and expectations of the monitoring program were the foundation of the project, followed by selection of a few indicators of interest to the selected 'sister park' sites. Currently, monitoring protocols for those selected factors are being developed (www.cec.org).

CONCLUSIONS

Workshop Outcomes

The workshop was successful in bringing together professionals from the U. S. and many Caribbean nations and islands to improve a shared understanding of experiences in many MPAs and marine reserves, and to provide additional guidance to the National Park Service in beginning to create a broader framework for monitoring and research in the USVI and Dry Tortugas, Florida. What connections should be explored further in these reserves to advance knowledge in social science, economics, ecology, oceanography, and fisheries science? Development of relationships among other parks in the region may offer opportunities for comparative studies and collaboration, e.g., the British Virgin Islands share a boundary with VICR—and similar resources and threats. Products of this workshop will include the presentations on web-sites (NPS and USGS), and this summary document to support requests for grants, and other funds, and to identify research and monitoring priorities in NPS and USGS.

Goals of Reserve Research and Monitoring:

- Understand and document changes in biodiversity and fisheries in and around reserves
- Measure and project trajectories of changes in trophic and population size structures in biological communities ("vital signs")
- Measure changes in dispersal kernel size
- Engage human communities (local, regional and larger) in reserve monitoring
- Measure and monitor social acceptability of reserves
- Measure and monitor reproductive output of reserves (spillover is secondary)
- Measure use of critical habitats
- Monitor human use
- Monitor efficacy of enforcement (compliance) and education (outreach)

Case studies, i.e., stories with messages, can be useful tools for communicating results of science and scholarship. What kinds of stories and messages will we be able to communicate from the experiences in and around these three reserves? The answers to this question will help guide and set priorities for reserve research and monitoring.

To make these reserves attractive for long-term investments in research and monitoring, the no-take provisions need to be effectively enforced and the enforcement efficacy documented. Global influences need to be differentiated from local factors and direct fishing effects. Fishers need to be convinced that research can be extended beyond reserves to other sites. The group expressed optimism that a partnership of NPS, USGS, NOAA and academic scientists could move forward on these issues. Many bright, dedicated people are engaged already, both managers and scientists, and they are looking for ways to leverage funds and find creative ways to work together for maximum results. We have engaged a diversity of professions, including social sciences, and look forward to productive collaborations. U. S. programs are relatively well funded, compared to many in the Caribbean. Nevertheless, funds and personnel are still quite limited and need to be deployed carefully. We believe basing decisions about research and monitoring on the experiences from others in the region discussed at this workshop will pay dividends, as will involving communications experts early in the study designs and reporting processes.

Recent coral bleaching and disease events and associated mortality demonstrate the crisis nature of this research. Complexity of benthic communities masks reserve effects and reduces the ability to detect changes related to changes in fishing activities. Reserve effects on complex benthic communities are neither as linear nor direct as they appear to be with fished species. The uncertainty associated with identifying and measuring the linkages among various parts of the system over time makes it challenging to determine cause-consequence relationships. Time lags introduced by these complex linkages complicate civic engagement—it's hard to convince the public to be patient and wait for the results, e.g., the Dry Tortugas lobster reserve took 25 years to realize what appear to be its full effects. Many factors other than fishing affect benthic communities and confound the measurements of reserve effects.

It will continue to be important to focus on the effects of eliminating fishing, other stressors, and the relationships among them to help tease out the effects of fishing and the consequent cascading effects. Fishes and other exploited resources contribute critically to coral reef ecosystems. We need to document the expected changes and plan for the unexpected by remaining flexible in experimental design and goal setting. Investigators of these reserves start with multiple historic data bases, e.g., Rafe Boulon's mangrove fish surveys, Jim Beets's and Alan Friedlander's 18-year fixed station evaluations of fish changes, NPS and USGS coral reef monitoring transects, and

NOAA benthic habitat maps, and should be able to progress quickly. Both short and long-term perspectives are important and needed, and it is critical to recognize and acknowledge our collective ignorance, because it is important to know what we don't understand.

SUMMARY FINDINGS, RESEARCH QUESTIONS, AND RECOMMENDATIONS

Reserve Goals and Expectations

Findings

- The goals and expectations of marine reserves in the Caribbean and Western Atlantic region are diverse, but most focus on biodiversity, ecological integrity, and fishery benefits in attempts to balance needs for sustainable uses and heritage values for future generations.
- Meaningful ecological changes resulting from reserve establishment likely will take decades, not years, to manifest themselves.

Research Questions

- Are reefs in reserves more stable and do they recover more quickly from stressors than exploited reefs?

Reserve Locations and Contents

Findings

- More basic information, especially from deep-water habitats, is needed to characterize the reserves and to evaluate changes in the future.
- NPS needs more technical capacity for exploring deep portions of the NPS reserves.

Research Questions

- Are the new reserves large enough to create measurable responses?
- Do the new reserves contain sufficient examples of various habitats to sustain communities and viable populations?
- Are the new reserves in the right locations?
- How much do adult fishes and invertebrates move in relation to reserve size?

Community Compliance and Effective Enforcement

Findings

- Reserves need to be effectively enforced and demarcated to be useful and attractive for research investments.
- Reserves are more effective when local communities support them and believe the rules and regulations to be fair and equitable.

Connectivity within the Caribbean and Western Atlantic

Findings

- Oceanographic conditions combine in various ways with natural history and behavior of organisms to determine larval connections among patches of suitable habitat. As reserves increase reproductive output, the ability to discover how these factors interact will be enhanced.
- Relationships with local constituencies are often damaged during reserve establishment; research and monitoring can help heal these wounds if partnerships and traditional ecological knowledge are sought and information shared widely and soon.
- The new reserves in the U. S. Virgin Islands and Dry Tortugas National Park will likely influence ocean and human communities throughout the Western Atlantic and Caribbean regions.

Research Questions

Note: these questions refer to reserves in the USVI and DRTO but all are relevant to other reserves as well

- How will various kinds and scales of connectivity influence research and monitoring of reserve performance?
- What can be learned about connectivity from these reserves?
- What connections should be explored further in these reserves to advance knowledge in social science, economics, ecology, oceanography, and fisheries science?
- What connections should be explored further to evaluate reserve performance?
- How are herbivory and algal cover related?
- How do reserves affect larval dispersal and recruitment?
- How can 'small-scale' detailed models for local applications directly in and around reserves best contribute to understanding and evaluating reserve performance?
- How do episodic events (rare, natural, extreme events) differentially affect reserves and surrounding exploited areas, i.e., are reserves more resilient?
- How are coral recruitment and settlement different in and around reserves?
- How is water quality at a micro scale on and around individual reefs different in and around reserves?
- What are the sources and fates for larvae of key organisms in the reserves and VIIS?
- How effective are enforcement efforts, including education and outreach?
- How do regional fishery data, e.g., georeferenced landings and effort, reflect effects on fishers, fishing opportunities, and fisheries?
- Will larger apex predators in reserves reduce tourism by threatening visitors and frightening others away?
- What defines human (public) perceptions of healthy coral reefs? Are rugosity and other structural elements part of it?
- What happened to fishers displaced from the NPS reserves in the USVI and how were re-

gional fisheries affected?
- How have the NPS reserves affected local or regional markets for fishery products or other facets of fishing, e.g., gear purchases, social communities?
- What other economic activities have changed in or near the reserves, e.g., have the reserves become destinations that attract visitors thereby increasing tourism-based economies?
- What are reserve visitor expectations and satisfaction levels and do they change with resource conditions?
- How could comparative studies with other reserves inform research and monitoring in these reserves and surrounding areas?

Reserve Effects on Humans

Findings

- Older reserves in the Caribbean and Western Atlantic tend to enjoy more public support than more recently established reserves
- The MesoAmerican Reef Project and the book "How is your MPA Doing?" (Pomeroy et al. 2004) offer models for measuring and monitoring reserve effects on human communities.

Research Questions

- How can social-economic monitoring best be integrated with ecological monitoring?
- How can user groups provide advice to NPS regarding reserve management?
- Who are the reserve users, what are their characteristic ages, education, and demographics, and how do their views of the reserves and NPS change over time?
- How do human uses, attitudes, beliefs, and values related to displacement from reserves change over time?
- How do people's satisfaction, attitudes, and expectations with reserves change over time?
- How do the economic impacts of reserves and new uses compare among local, regional, and distant human communities?
- How does NPS interact with the public and what is the efficacy of law enforcement in reserves?

Reserve Effects on Fish and Other Harvested Species

Findings

- Time lags of various lengths, up to decades, should be expected between cessation of fishing and marine-life population or ecosystem responses.
- So called "spill-over" effects are poorly documented and uncertain; the NPS reserves offer a good opportunity to measure and evaluate this process.

Research Questions

- How will continued fishing for pelagic blue runners or baitfish in VICR affect the performance of the reserve?
- Will reserves increase apex predator populations (sharks) to the point they may threaten visitor safety?
- How do population demographics of exploited species change in reserves and in adjacent areas?

Reserve Effects on Coral Reefs and Other Benthic Habitats

Findings

- Effects of fishing on non-targeted components of ecosystems are poorly understood; these reserves offer opportunities to measure and evaluate these processes.
- Linkages among fishery-targeted species, especially fishes, and benthic communities are poorly known; these reserves offer opportunities to explore potential linkages.

Research Questions

- Will effects of other stressors, e.g., ocean warming, coral diseases, pollution, or acidification, obscure or alter the effects of eliminating fishing?
- Will interactions among stressors or history of individual sites obscure fishing effects?
- Are there thresholds of change beyond which coral reefs can not recover, even with intervention?
- What are the linkages among fish and mobile invertebrates (lobster, conch, urchins) and benthic sessile communities (corals and algae)?
- As fish and mobile invertebrates grow larger in reserves, how do their feeding habits change and what effects does that have on benthic communities?
- How is habitat structure related to fish population dynamics?
- What are the effects of recent coral losses on fish populations?
- What is the relative resilience of reserve reefs vs. non-reserve reefs?
- What is the relationship of parrotfish biomass and reef health?
- Are there significant genetic variations among corals, within species, that affect thermal tolerances or disease resistance?
- Are coral pathogens alien invasives or endemic?
- Was coral mortality lower in areas with higher currents?
- What proportion of bleached corals recovered without disease; are they genetically different or in different microhabitats?

Research, Monitoring, and Information Management

Findings

- Integrated socioeconomic and ecological monitoring is more effective than either alone for determining reserve performance.
- The highest priorities for monitoring and research are to document changes at population levels, to determine how much replenishment is occurring, and to determine social and ecological 'hot spots' critical for spawning, nursery habitats, migration, and fishing.
- Existing and planned monitoring and surveys should be continued or implemented.

Research Questions

- How do populations, communities, and ecosystems change in and around reserves?
- How do coral reefs, particularly benthic cover, structural features, and diversity change in and around reserves?
- How do fish community trophic structures change in and around reserves?
- What roles do Cyanobacteria blooms play in reef health?
- How are watershed features and conditions linked to nearby coral reefs?
- What factors control or limit coral recruitment in and around reserves?
- What knowledge of coral diseases is needed to develop reef recovery and mitigation strategies?
- How permeable are reserve boundaries to fish and mobile invertebrates?
- How much critical habitat is in the reserves?
- How are populations of fishery-targeted species and other species changing?
- VICR is really a 'network' of three small reserves, how are they linked or do they influence each other?
- Where are the ecological and social 'hot spots' (spawning, migratory, nursery, fishing) in and around the reserves?
- How important are blue runner and baitfish to pelagic and benthic communities?
- How are reserves connected ecologically, socially, and oceanographically to near and distant areas?
- What are the relative effects of fishing and other stressors on ecosystems and human communities within and near reserves?
- How can coral and fish recruitment habitats be defined at micro scales?
- How has human use of areas changed following the inclusion of these areas within reserves?
- How is the natural history of key species likely to influence reserve effects?
- What molecular tools for coral genetics and diseases are needed to identify outcomes of stress and to separate anthropogenic factors from nature?

Recommendations

- Document reserve managers' interactions with local residents and other users, and record outcomes
- Engage local and distant communities in monitoring reserve condition
- Develop formal civic engagement processes, e.g., advisory councils
- Inventory and characterize deep-water habitats, including Lang Bank.
- Fishing effort and landings need to be measured and monitored in VICR and around other reserves with sufficient geographical scale to evaluate reserve influence and potential spillover effects

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APPENDIX B. Presentations

All of these Powerpoint presentations are available at the following website: www1.nature.nps.gov/im/units/sfcn/viismtg.cfm

Workshop Introduction Marine Reserves Research & Monitoring
Gary E. Davis
U.S. National Park Service
Washington, District of Columbia

Virgin Island Marine Protected Areas: Our Hope for the Future?
Rafe Boulon,
Virgin Islands National Park and Coral Reef National Monument
St. John, Virgin Islands

Marine Reserves: Goals & Expectations – A Case Study Buck Island Reef National Monument
Zandy Hillis-Starr
Christiansted National Historic Park, Buck Island Reef National Monument, and Salt River Bay National Historic Park and Ecological Preserve
St. Croix, U.S. Virgin Islands

Marine Reserve Goals and Expectations
Jim Bohnsack
NOAA Fisheries
Miami, Florida

Efficacy of Marine Protected Areas in the Hawaiian Archipelago
Alan Friedlander, Eric Brown, and Mark Monaco
NOAA
Waimanalo, Hawaii

Research & Monitoring in the Soufriere Marine Management Area, Saint Lucia
Kai Wulf
Soufriere Marine Management Area
Saint Lucia

Research And Monitoring In The Proposed And Existing Marine Protected Areas Of The British Virgin Islands
Nancy Woodfield
British Virgin Islands National Park Trust
Tortola, British Virgin Islands

Modeling The Scale Of Population Connectivity
Robert K. Cowen, Claire Paris, & Ashwanth Srinivasan
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Connectivity Considerations
Charles Birkeland
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MPAs in Puerto Rico: Lessons Learned
Manuel Valdes Pizzini
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Banco Chinchorro Biosphere Reserve, Mexico
Barbara Reveles
National Commission of Protected Natural Areas
CONANP, Mexico

Integrated Coral Reef Ecosystem Mapping & Monitoring to Support Living Marine Resource Management
Mark E. Monaco, T.A. Battista, A.M. Friedlander, W.R. Callender
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Silver Spring, Maryland

Research and Monitoring: Evolution, Methods and Case Studies
Jeff Miller, Matt Patterson, Dr. Andrea Atkinson, Judd Patterson, Rob Waara, Dr. Kevin R.T. Whelan, Brian Witcher, Alexandra Wright
NPS South Florida/ Caribbean Network I&M Program
St. John, Virgin Islands

Long-term Monitoring of Reef Fishes in Virgin Islands National Park
Alan Friedlander & Jim Beets
University of Hawaii
Hilo, Hawaii

Research and Monitoring in Caribbean MPAs: Lessons Learned
Hazel A. Oxenford and Patrick McConney
Centre for Resource Management and Environmental Studies (CERMES)
University of the West Indies
Barbados

Current Research And Monitoring Efforts In Puerto Rico's No-Take Mpas
Edwin A. Hernández-Delgado, Richard Appeldoorn, Mayra García, & María del Mar López
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Exuma Cays Land and Sea Park (ECLSP), Bahamas
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The Seaflower MPA, Columbia Monitoring And Management Priorities
Martha C. Prada
Corporacion para El Desarrollo Sostenible del Archipielago de San Andreas, Providencia, y Santa Catalina
CORALINA

South Florida / Caribbean Network Inventory & Monitoring Program
Matt Paterson
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Protection and Management of Natural Heritage in Belize
Isaias Majil
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Marine Zone Monitoring Program: Florida Keys National Marine Sanctuary
Brian D. Keller
Science Coordinator
Florida Keys National Marine Sanctuary

APPENDIX C. Virgin Islands National Monument Proclamations and Dry Tortugas National Park Research Natural Area Designation

Proclamation 7392—Boundary Enlargement and Modifications of the Buck Island Reef National Monument
January 17,2001
By the President of the United States of America
A Proclamation
Buck Island Reef National Monument was established on December 28, 1961 (Presidential Proclamation 3443), just north of St. Croix in the U.S. Virgin Islands, for the purpose of protecting Buck Island and its adjoining shoals, rocks, and undersea coral reef formations. Considered one of the finest marine gardens in the Caribbean Sea, the unique natural area and the rare marine life which are dependent upon it are subject to the constant threat of commercial exploitation and destruction. The monument's vulnerable floral and faunal communities live in a fragile, interdependent relationship and include habitats essential for sustaining the tropical marine ecosystem: coral reefs, sea grass beds, octocoral hardbottom, sand communities, algal plains, shelf edge, and oceanic habitats. The boundary enlargement effected by this proclamation brings into the monument additional objects of scientific and historic interest, and provides necessary further protection for the resources of the existing monument.

The expansion area includes additional coral reefs (patch, pur and groove, and deep and wall), unusual "haystacks" of elkhorn coral, barrier reefs, sea grass beds, and sand communities, as well as algal plains, shelf edge, and other supporting habitats not included within the initial boundary. Oceanic currents carry planktonic larvae of coral reef associated animals to the shallow nearshore coral reef and sea grass habitats, where they transform into their juvenile stage. As they mature over months or years, they move offshore and take up residence in the deeper coral reefs, octocoral hardbottom, and algal plains. Between the monument's nearshore habitats and its shelf edge spawning sites are habitats that play essential roles during specific developmental stages of many reef-associated species, including spawning migrations of many reef fish species and crustaceans. Several threatened and endangered species forage, breed, nest, rest, or calve in the waters included in the enlarged monument, including humpba ck whales, pilot whales, four species of dolphins, brown pelicans, least terns, and the hawksbill, leatherback, and green sea turtles. Countless species of reef fishes, invertebrates, plants, and over 12 species of sea birds utilize this area.

The ecologically important shelf edge is the spawning site for many reef species, such as most groupers and snappers, and the spiny lobster. Plummeting to abyssal depths, this habitat of vertical walls, honeycombed with holes and caves, is home to deepwater species and a refuge for other species.

The expansion area also contains significant cultural and historical objects. In March 1797, the slave ship Mary, captained by James Hunter of Liverpool, sank in this area, and its cargo of 240 slaves was saved and brought to Christiansted. In March 1803, the General Abercrombie, captained by James Booth of Liverpool, also wrecked in this area, and its cargo of 339 slaves was brought to Christiansted. Slave shipwrecks in U.S. waters are rare. The monument contains remnants of these wrecks. Other wrecks may also exist in the monument.

Section 2 of the Act of June 8, 1906 (34 Stat. 225, 16 U.S.C. 431), authorizes the President, in his discretion, to declare by public proclamation historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest that are situated upon the lands owned or controlled by the Government of the United States to be national monuments, and to reserve as a part thereof parcels of land, the limits of which in all cases shall be confined to the smallest area compatible with the proper care and management of the objects to be protected.

Whereas it appears that it would be in the public interest to reserve such lands as an addition to the Buck Island Reef National Monument:

Now, Therefore, I, William J. Clinton, President of the United States of America, by the authority vested in me by section 2 of the Act of June 8, 1906 (34 Stat. 225, 16 U.S.C. 431), do proclaim that there are hereby set apart and reserved as an addition to the Buck Island Reef National Monument for the purpose of care, management, and protection of the objects of historic and scientific interest situated on lands within the said monument, all lands and interests in lands owned or controlled by the United States within the boundaries of the area described on the map entitled "Buck Island Reef National Monument Boundary Enlargement" attached to and forming a part of this proclamation. The Federal land and interests in land reserved consist of approximately 18,135 marine acres, which is the smallest area compatible with the proper care and management of the objects to be protected.

All Federal lands and interests in lands within the boundaries of this monument are hereby appropriated and withdrawn from all forms of entry, location, selection, sale, or leasing or other disposition under the public land laws, including but not limited to withdrawal from location, entry, and patent under the mining laws, and from disposition under all laws relating to mineral and geothermal leasing, other than by exchange that furthers the protective purposes of the monument.

For the purpose of protecting the objects identified above, the Secretary shall prohibit all boat anchoring, provided that the Secretary may permit exceptions for emergency or authorized administrative purposes, and may issue permits for anchoring in deep sand bottom areas, to the extent that it is consistent with the protection of the objects.

For the purposes of protecting the objects identified above, the Secretary shall prohibit all extractive uses. This prohibition supersedes the limited authorization for extractive uses included in Proclamation 3443 of December 28, 1961.

Lands and interests in lands within the monument not owned or controlled by the United States shall be reserved as a part of the monument upon acquisition of title or control thereto by the United States.

The Secretary of the Interior shall manage the monument through the National Park Service, pursuant to applicable legal authorities, to implement the purposes of this proclamation. The National Park Service will manage the monument in a manner consistent with international law.

The Secretary of the Interior shall prepare a management plan, including the management of vessels in the monument, within 2 years that will address any further specific actions necessary to protect the objects identified above.

The enlargement of this monument is subject to valid existing rights.

Nothing in this proclamation shall be deemed to revoke any existing withdrawal, reservation, or appropriation; however, the national monument shall be the dominant reservation.

Warning is hereby given to all unauthorized persons not to appropriate, injure, destroy, or remove any feature of this monument and not to locate or settle upon any of the lands thereof.

In Witness Whereof, I have hereunto set my hand this seventeenth day of January, in the year of our Lord two thousand one, and of the Independence of the United States of America the two hundred and twenty-fifth.

[Filed with the Office of the Federal Register, 8:45 a.m., January 19, 2001]

NOTE: This proclamation was published in the Federal Register on January 22.

Proclamation 7399—Establishment of the Virgin Islands Coral Reef National Monument - January 17, 2001

By the President of the United States of America

A Proclamation

The Virgin Islands Coral Reef National Monument, in the submerged lands off the island of St. John in the U.S. Virgin Islands, contains all the elements of a Caribbean tropical marine ecosystem. This designation furthers the protection of the scientific objects included in the Virgin Islands National Park, created in 1956 and expanded in 1962. The biological communities of the monument live in a fragile, interdependent relationship and include habitats essential for sustaining and enhancing the tropical marine ecosystem: mangroves, sea grass beds, coral reefs, octocoral hardbottom, sand communities, shallow mud and fine sediment habitat, and algal plains. The fishery habitats, deeper coral reefs, octocoral hardbottom, and algal plains of the monument are all objects of scientific interest and essential to the long-term sustenance of the tropical marine ecosystem.

The monument is within the Virgin Islands, which lie at the heart of the insular Caribbean biome, and is representative of the Lesser Antillean biogeographic province. The island of St. John rises from a platform that extends several miles from shore before plunging to the abyssal depths of the Anegada trough to the south and the Puerto Rican trench to the north, the deepest part of the Atlantic Ocean. This platform contains a multitude of species that exist in a delicate balance, interlinked through complex relationships that have developed over tens of thousands of years.

As part of this important ecosystem, the monument contains biological objects including several threatened and endangered species, which forage, breed, nest, rest, or calve in the waters. Humpback whales, pilot whales, four species of dolphins, brown pelicans, roseate terns, least terns, and the hawksbill, leatherback, and green sea turtles all use portions of the monument. Countless species of reef fish, invertebrates, and plants utilize these submerged lands during their lives, and over 25 species of sea birds feed in the waters. Between the nearshore nursery habitats and the shelf edge spawning sites in the monument are habitats that play essential roles during specific developmental stages of reef-associated species, including spawning migrations of many reef fish species and crustaceans.

The submerged monument lands within Hurricane Hole include the most extensive and well-developed mangrove habitat on St. John. The Hurricane Hole area is an important nursery area for reef associated fish and invertebrates, instrumental in maintaining water quality by filtering and trapping sediment and debris in fresh water runoff from the fast land, and essential to the overall functioning and productivity of regional fisheries. Numerous coral reef-associated species, including the spiny lobster, queen conch, and Nassau grouper, transform from planktonic larvae to bottom-dwelling juveniles in the shallow nearshore habitats of Hurricane Hole. As they mature, they move offshore and take up residence in the deeper coral patch reefs, octocoral hardbottom, and algal plains of the submerged monument lands to the south and north of St. John.

The monument lands south of St. John are predominantly deep algal plains with scattered areas of raised hard bottom. The algal plains include communities of mostly red and calcareous algae with canopies as much as half a meter high. The raised hard bottom is sparsely colonized with corals, sponges, gorgonians, and other invertebrates, thus providing shelter for lobster, groupers, and snappers as well as spawning sites for some reef fish species. These algal plains and raised hard bottom areas link the shallow water reef, sea grass, and mangrove communities with the deep water shelf and shelf edge communities of fish and invertebrates.

Section 2 of the Act of June 8, 1906 (34 Stat. 225, 16 U.S.C. 431), authorizes the President, in his discretion, to declare by public proclamation historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest that are situated upon the lands owned or controlled by the Government of the United States to be national monuments, and to reserve as a part thereof parcels of land, the limits of which in all cases shall be confined to the smallest area compatible with the proper care and management of the objects to be protected.

Whereas it appears that it would be in the public interest to reserve such lands as a national monument to be known as the Virgin Islands Coral Reef National Monument:

Now, Therefore, I, William J. Clinton, President of the United States of America, by the authority vested in me by section 2 of the Act of June 8, 1906 (34 Stat. 225, 16 U.S.C. 431). do proclaim that there are hereby set apart and reserved as the Virgin Islands Coral Reef National Monument, for the purpose of protecting the objects identified above, all lands and interests in lands owned or controlled by the United States within the boundaries of the area described on the map entitled “Virgin Islands Coral Reef National Monument” attached to and forming a part of this proclamation. The Federal land and interests in land reserved consist of approximately 12,708 marine acres, which is the smallest area compatible with the proper care and management of the objects to be protected.

All Federal lands and interests in lands within the boundaries of this monument are hereby appropriated and withdrawn from all forms of entry, location, selection, sale, or leasing or other disposition under the public land laws, including but not limited to withdrawal from location, entry, and patent under the mining laws, and from disposition under all laws relating to mineral and geothermal leasing, other than by exchange that furthers the protective purposes of the monument. For the purpose of protecting the objects identified above, the Secretary shall prohibit all boat anchoring, except for emergency or authorized administrative purposes.

For the purposes of protecting the objects identified above, the Secretary shall prohibit all extractive uses, except that the Secretary may issue permits for bait fishing at Hurricane Hole and for blue runner (hard nose) line fishing in the area south of St. John, to the extent that such fishing is consistent with the protection of the objects identified in this proclamation.

Lands and interests in lands within the monument not owned or controlled by the United States shall be reserved as a part of the monument upon acquisition of title or control thereto by the United States.

The Secretary of the Interior shall manage the monument through the National Park Service, pursuant to applicable legal authorities, to implement the purposes of this proclamation. The National Park Service will manage the monument in a manner consistent with international law.

The Secretary of the Interior shall prepare a management plan, including the management of vessels in the monument, within 3 years, which addresses any further specific actions necessary to protect the objects identified in this proclamation.

The establishment of this monument is subject to valid existing rights.

Nothing in this proclamation shall be deemed to revoke any existing withdrawal, reservation, or appropriation; however, the national monument shall be the dominant reservation.

Warning is hereby given to all unauthorized persons not to appropriate, injure, destroy, or remove any feature of this monument and not to locate or settle upon any of the lands thereof.

In Witness Whereof, I have hereunto set my hand this seventeenth day of January, in the year of our Lord two thousand one, and of the Independence of the United States of America the two hundred and twenty-fifth.

[Filed with the Office of the Federal Register, 8:45 a.m., January 19, 2001]

NOTE: This proclamation was published in the Federal Register on January 22.

Dry Tortugas National Park Research Natural Area

The Research Natural Area Zone (RNA) will cover 46% (46 square nautical miles) of the park. It will include a representative range of the park's near-pristine terrestrial and marine ecosystems (e.g. islands, sea grass beds, shallow and deep coral reefs, sand and hard bottom sea floors). Management emphasis will be to provide the greatest possible protection of resource integrity and to promote non-manipulative research1 and visitor education. Natural processes will occur without disturbance or impacts from humans. The RNA will protect biological diversity, provide a baseline area for measuring long-term ecological changes and a serve as a reference site for separating the effects of human activities from those caused by natural environmental changes.

A variety of recreational and educational opportunities will be available to visitors in the RNA such as wildlife viewing, snorkeling, and diving. Recreational fishing and other resource consumptive activities will not be allowed in this zone. To prevent damage to corals and other delicate organisms, commercial tour providers and private boaters will be required to use mooring buoys, and anchoring will be prohibited. Allowing non-consumptive uses in the RNA, with careful monitoring of impacts of these activities, will provide exceptional resource appreciation and public education benefits. The objectives of the research natural area fulfill the legislated purposes of Dry Tortugas National Park are compatible with and complement the Tortugas Ecological Reserve recently established by the Florida Keys National Marine Sanctuary.

The U.S. Department of the Interior (DOI) is the nation's principal conservation agency, charged with the mission to "*protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities*." More specifically, Interior protects America's treasures for future generations, provides access to our nation's natural and cultural heritage, offers recreation opportunities, honors its trust responsibilities to American Indians and Alaska Natives and its responsibilities to island communities, conducts scientific research, provides wise stewardship of energy and mineral resources, fosters sound use of land and water resources, and conserves and protects fish and wildlife. The work that we do affects the lives of millions of people; from the family taking a vacation in one of our national parks to the children studying in one of our Indian schools.

NPS D-90, February 2007