
Management Plan for Cades Bay Marine Reserve

With feasibility analysis for a single marine reserve management unit and
monitoring plan for all Antigua & Barbuda's Marine Reserves



Cades Bay Marine Reserve

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Note:

The conclusions and recommendations of this report are solely the opinions of the author and do not constitute a statement of policy, decision, or position on behalf of the Fisheries Division or the Government of Antigua.

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PART 1: MANAGEMENT PLAN BACKGROUND

Introduction

Cades Bay Marine Reserve (CBMR) was gazetted in 1999 but as yet no formal management plan has been implemented. The area was established under the Fisheries Act to promote biodiversity monitoring, sustainable fisheries resources and encourage interest in the marine environment, both within the local community and tourism. The area contains three main important ecosystems within the Southwestern watershed of Antigua, namely coral reefs, seagrass beds and integrated coastal systems (Beaches, Mangroves, lagoons and other wetlands). As such the management plan to be developed needs to incorporate the needs of these three distinct ecosystems while keeping the reserves goals in sight. The Cades Bay area and its associated ecosystems have been the focus of numerous studies over recent years (see Reference section, page 32-33), and this information, combined with that gathered through recent field assessments (Wynne, 2012), have been used as the foundation for the design of the current management plan.

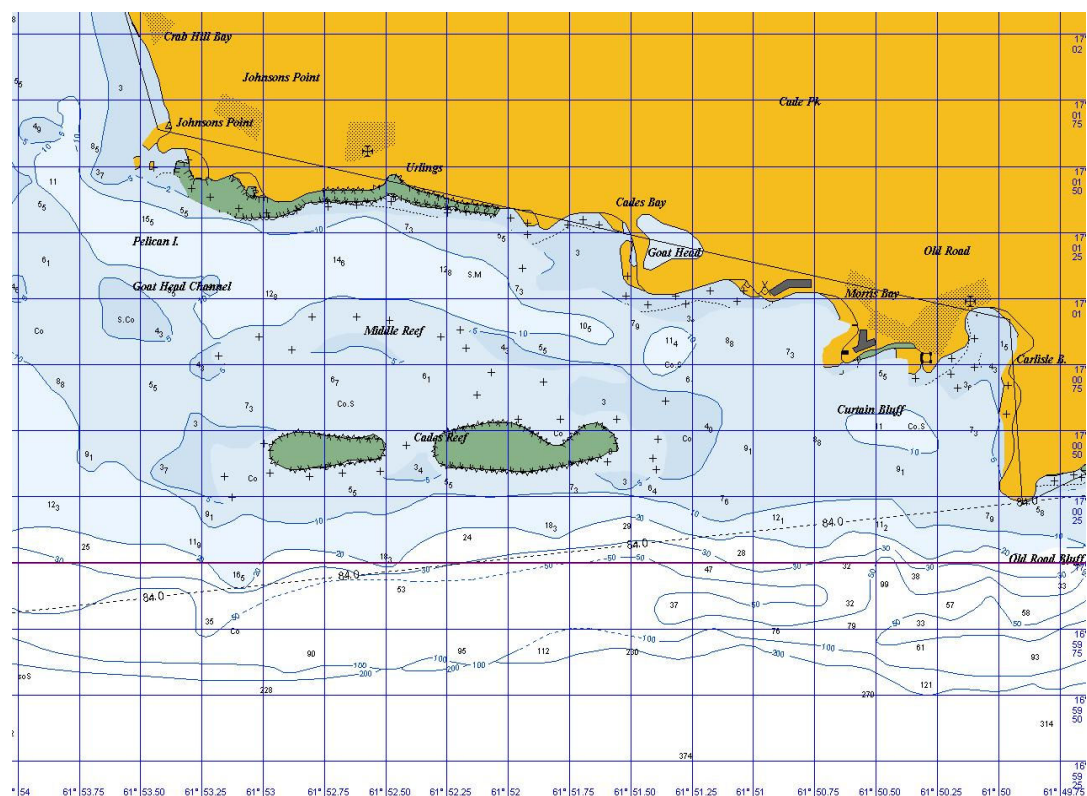


Figure 1: Map detailing Cades Bay Area in the Southwestern coastal region of Antigua. Green areas represent shallow reef zones, with blue contours at 5m depth gradients. Yellow land mass is mainland Antigua.

During the latter part of the last decade a management plan was designed for the Northeastern region of Antigua's coastal marine zone (Jackson, 2007) that became known as NEMMA (Northeastern Marine Management Area). This area is significantly larger than CBMR, and as such its management is much more complex with significantly more challenges. These complexities and challenges have led to certain parts of the NEMMA plan falling behind schedule. Indeed, in light of the current economic climate, some aspects of this plan may no longer be feasible. Nonetheless, it is imperative, despite differing in physical makeup, that the management of CBMR & NEMMA be developed harmoniously. An ultimate goal for Antigua and Barbuda would be to have a network of Marine Reserves, and thus include the other, as yet unaddressed, Marine Protected Areas (Diamond Reef & Palace Reef). To enable the development of such a network the legislative requirements of each area must not conflict other areas, and as such the current management plan for CBMR seeks to require as little legislative changes as possible, unless complementary to, or otherwise suggested by, the management plan developed previously for NEMMA. In fact, as a whole the current management plan has been developed with simplicity in mind as, once it meets the needs of the area, added complexities lead to challenges that can ultimately cause unnecessary delays/failures to the management process.

Additionally, in order to harmonize the different management units and the various stakeholder groups, it is essential to create a central agency dedicated to the interests of these areas. An agency, solely for the management of the Northeastern area was detailed in the management plan for NEMMA, but to date has yet to be established. This may be because it was an ambitious proposal with potential economical challenges. In light of this it is necessary that the current proposal for a management agency be more conservative, and for it to be one that care-takes both NEMMA & CBMR, with the capacity to expand into Diamond Reef and any other new Marine Reserves that may be established in the future. Appropriately, part 3 of this document details a feasibility analysis looking into the minimum requirements of such an agency and the viability of it ultimately being economically self sustaining.

Finally, to ensure the success of any management plan, monitoring, both anthropogenic and ecological, is essential. Without community support and a feeling of ownership, a management plan is likely doomed to failure. If monitoring and general inclusion of the local communities and their opinions does not occur then this sense of ownership is lost. Similarly, ecological monitoring is essential in order to ascertain what effects the management measures being implemented are having, and thus how they must be adapted on into the future. As such a monitoring plan and associated monitoring protocol, has been developed for CBMR and laid out in Part 4 of this document. The monitoring plan can be easily expanded into other marine areas with the hope that it will ultimately be undertaken in all reserve areas with representative 'out-of-park' sites for comparison.

Reserve Boundaries (as gazetted in 1999)

Notice of the Declaration of the Cades Bay Marine Reserve. By the authority vested in me, Honourable Vere C. Bird Jr., as Minister of Agriculture, Lands And Fisheries, under the provision of section 22 (1) of the Antigua and Barbuda Fisheries Act, Cap. 173, of the Laws of Antigua and Barbuda Revised Edition (1992). I hereby declare the area bounded seaward by;

*lat.17° 00' 18"N and long. 061° 50' 05"W to
lat.17° 00' 00"N and long. 061° 49' 59"N to
lat.17° 00' 00" N and long. 061° 54' 02"W to
lat.17° 01' 37" N and long. 061° 54' 02"W to
lat.17° 01' 37" N and long. 061° 53' 25"W;*

and landwards by the landward edges of the mangrove and wetland systems from Johnson's Point to Carlisle Bay and Claremont, Old Road, in the Parish of St. Mary's, where they exist and the coastline where they do not, as the Cades Bay Marine Reserve.

Dated this 27th day of April, 1999, Vere C. Bird Jr., Minister.

Resource Use and Perceived Threats

Based on resources available and size of area Cades Bay is not as heavily used as NEMMA, but nonetheless is under pressure from a number of anthropogenic stressors. Kyaking, snorkelling, diving, fishing, farming and coastal resort use are some of the activities that take place there. A full list of stakeholders and details of landuse in the Southwestern Watershed area (which encompasses CBMR), including detailed maps, can be found in Balwin, K (2011). The stakeholders listed on page 23 of the Balwin report may or may not directly use the CBMR (for example, only Sandals, Curtain Bluff and Jolly Dive use CBMR regularly for diving purposes), but all will have a vested interest in the area and its management due to operating within its vicinity and therefore with indirect benefits/consequences. There are usually three to five pleasure boats in the park during daylight hours (including dive operators), with regular snorkelling trips from Jolly Harbour and South Coast Horizons visiting the offshore reef area (Wynne, 2012). Snorkellers also use the coastal reef on a daily basis but usually do so privately rather than through a tour operator. Jet Skis are not known to be operated within CBMR although they are popular in other areas. There is some agriculture bordering the park but it does not occur within the park boundaries (which are defined in the previous subsection as the landward edges of the mangrove and wetland systems). A fisheries complex is located centrally within the coastal limit of the park which is used by approximately a dozen fishing operations. Listed following are the perceived threats to CBMR, not only through resource use but also due to other potential stressors. All will need to be addressed within the management plan.

Mangrove, Wetland & Other Coastal Systems

- **Flora Removal:** Historically mangroves have been harvested for charcoal making and building fish traps. Reportedly however this no longer occurs within CBMR (Baldwin, 2011). Flora other than mangroves may be removed by coastal development or recreational users. Removal of beach flora can influence erosional processes and also threaten the sun/shade balance that is important for deciding the sex ratio of developing turtle eggs. It also acts as a nutrient filter and/or sediment trap for runoff.
- **Illegal Dumping:** Dumped garbage was observed during the 2012 field visit and was also reported by Baldwin (2011). Not only aesthetically unappealing, leached chemicals can damage the environment and items can pose a physical threat to wildlife (entanglement etc).
- **Tourism:** Although most tourism in the area appears to be, at least to a certain extent, environmentally 'sensitive', it is virtually impossible for coastal developments to have zero impact on the environment. For example, most of the beaches within CBMR have had turtle nestings reported (Baldwin, 2011, p20). Beach loungers and other obstacles left overnight on the beach can obstruct nesting, and beach lighting interfere when hatchlings need to orientate themselves with the ocean.
- **Sand Mining:** A known threat to Antigua (James, 2002), sand mining interferes with erosional processes and can cause significant ecological damage beyond the initial removal of material. Although historically present within CBMR it reportedly no longer occurs (Baldwin, 2011).
- **Fires:** Small burnt areas were noted within the mangroves close to Old Road Bluff during field visits, but no active fires observed. These were reportedly set to burn old piles of coconut palm fronds and allow better access along the dirt tracks within the system.
- **Agriculture:** A pineapple farm is present just beyond the mangrove system close to Cades Bay and other arable farming is present close to Old Road Bluff. Some small mango plantations and banana palms are also present in the area. Expanding agriculture can pose a threat to Mangrove systems as flora gradually gets removed from the peripheral areas of cultivated land. This expansion can go almost unnoticed until significant changes have occurred. Nutrients can also be leached from agricultural land, but this poses more of a threat to coral reef and seagrass systems (see following section), especially if mangroves become depleted.
- **Fishing:** Mangrove areas are important nursery grounds for fish and as such removal of juveniles can have knock on effects to reef fish or pelagic fish fisheries. There is a small amount of fishing that occurs within the

wetland areas (James, 2002), including seine netting for juveniles/bait fish. Conch are also taken from the shallow coastal regions with spearfishing a suspected problem also.

- **Hunting:** Some species of bird are reportedly hunted for sport around Antigua although no reports have yet been made within CBMR.

Seagrass & Coral Reef Systems

- **Fishing:** Any extractive industry has the potential to damage the environment and fishing is no exception. Overfishing depletes fish stocks with spearfishing, trap fishing, ghost trap fishing and seine netting of greatest concern to manage responsibly. Traps placed directly on the reef structure can cause considerable physical damage to coral structures. Fishing does occur within the reserve, mainly from fishers who operate out of the areas fisheries complex. These fishers do also visit areas outside of the park a lot of the time.
- **Anchoring:** When used indiscriminately anchors can cause considerable damage to the reef structure, snapping off coral heads and damaging juveniles (the latter occurs especially when setting an anchor or by the chain after the anchor is set). Even careful anchor use (setting by hand or only intending use in sandy areas) can be damaging in rough conditions: Chain damage, dragging, line entanglement, etc. Anchoring is also harmful to seagrass beds, often causing gashes and/or holes in plant cover.
- **Lionfish:** An invasive species from the Indo-Pacific, Lionfish (*Pterois violans*) have been sighted in Antiguan waters and recently photographed in CBMR (see page 31). They are voracious predators of juvenile fish and have few natural predators. This means they have the potential to damage fish populations through over consumption of juvenile stock.
- **Runoff & Sedimentation:** Sediment plumes were noted in the area by Baldwin (2011) a problem that will be accentuated by run-off, especially in times of high rainfall. Run-off can also bring nutrients with it from land-based sources, including agriculture. The mangrove system helps to restrict these processes, as does other coastal flora. Details of the effects of terrestrial runoff to coral reef systems can be found in Fabricius *et al.*, (2005).
- **Pollution/Eutrophication:** Non-organic pollution is not thought to be a problem in the Cades Bay area, but organic 'pollution' (or nutrients) do enter the reserve from local sources and can lead to eutrophication. This in turn affects water clarity which impacts photosynthetic process (both for seagrasses and corals zooxanthellae). It also leads to increased macroalgae growth which can smother coral and restrict the settlement of

juveniles, and also promote cyanobacteria growth. Cyanobacteria can overgrow seagrass again affecting photosynthetic processes, or overgrow corals and lead to diseased colonies. Nutrient input can also occur through salt pond/lagoon flushing especially in times of adverse weather conditions. Yachts and other ocean vessels may also dump waste water into the area. No known sewage outfalls occur directly into the sea but there is the potential for septic tanks to leech into the reserve. Nutrients and other organic/inorganic pollutants will also originate from regional sources and as such be much more difficult to directly manage.

- **Disease:** As mentioned in the previous paragraph diseases threaten coral colonies and over recent decades have reportedly become more prevalent throughout the Caribbean region (Goreau *et al.*, 1998). These are not only caused by cyanobacteria, but can be due to other infections, for example, *Vibrio* pathogens have been widely documented to be responsible for Yellow Blotch disease (Dona *et al.*, 2008). Taking White Band Disease as a case in point, it was reportedly responsible for the demise of massive tracks of Elkhorn & Staghorn Coral (*Acropora sp.*) across many Caribbean islands in the 1970's (Mayor *et al.*, 2006). These corals are the most important framework-building species and without their recovery the future of Caribbean coral reefs looks bleak (Aronson & Precht, 2001). Aronson & Precht go on to point out that the outbreak of such diseases has been coincident with increased human activity, and as such the possibility of a causal connection should not be ruled out. Disease can also affect other species that are key within ecosystems, for example, the Long-Spined Sea Urchin (*Diadema antillarum*) suffered regional declines in the 1980's which is thought to have been caused by a pathogen that traveled via ocean currents (Miller *et al.*, 2003). Their populations are now beginning to recover throughout the region, a situation that was observed to be occurring in certain areas around Antigua during field visits.
- **Bleaching/Hurricanes:** Both these (and associated) issues and therefore their impacts are directly related to climatic systems and as such almost impossible to manage for on a local level. Climate change is reportedly responsible for increasing the frequency of hurricanes and increasing sea surface temperatures that lead to bleaching events. Hurricane damage can be of severe detriment to reefs, but being natural events, reefs historically were able to deal with them. In fact, such events actually benefited reefs by dispersing colony fragments that later reattached to available substrate. If increasing in frequency however, and combined with bleaching events and/or disease, colonies are not able to reattach and recover as they once could. Thus, these once natural events now pose a serious threat to reef longevity.

Note: As is highlighted by the crossover between the last three threats listed, marine processes are tightly interlinked and thus a management measure may address more than one threat or have multiple benefits.

Socioeconomic Aspects

A number of meetings with stakeholders took place to enable the production of this management plan, which were in addition to the Socioeconomic report produced for CBMR (James, 2007). Similar reports have been produced for NEMMA (Espeut 2006 & ECL 2007) that are relevant here in order to harmonise management. Also of interest is a feasibility study produced by EASL & Associates (2010) that analysed stakeholders and co-management issues in the southwestern region of Antigua as a whole.

James (2007) found that fishing is still an important industry in the three main communities close to or within CBMR although the area depends on tourism as an important source of income also. Many residents feel that they are not involved enough with decision making relating to the management of CBMR and that they lack information regarding such, however, most feel that compliance with new coastal management rules would be good.

Of significant importance, it is clear through meetings with officials and discussions with fishers that a relatively high number of resource users are in favour of CBMR being a no-take preserve with the potential to re-seed surrounding areas. Such a perception is key for the management plan to achieve its goals, and as such an important step has already been made towards this. Of the fishers interviewed however a need was established for an area in between the outer reef and the coastal fringing reef to be made available for them to keep their traps in times of adverse weather conditions.

Habitat Assessment

The three main habitats present within CBMR were rapidly assessed during the 2012 field visit (Wynne, 2012). In-water assessments were conducted at three sites within CBMR by the FORCE project (Newman *et al* 2009), and referred to in the associated report as Cades South, Cades Deep and Big Sponge. These sources of information were used to assess relative health of each habitat.

Mangroves: Concluded to be in a good state of health based on observations and stakeholder interviews. Local opinion is that over recent decades the overall health of the habitat has increased, probably due to wood no longer being harvested from the area and local developments promoting the habitat as a tourist attraction. For example, South Coast Horizon organize kayaking trips from a lagoon within the reserve through the mangrove system to the sea where they then take a small outboard craft to the outer reef for snorkelling. The most abundant species present is the Red Mangrove (*Rhizophora mangle*) and very dense stands exist throughout the reserve area, especially behind Carlisle Bay and in a number of areas between Goat Head and Johnsons Point. Numerous Blue Herons and Egret are present in the area. Large snappers, mullets and tarpon were observed within the habitat as were numerous juvenile fish in the root systems.

Seagrass: Concluded to be in a relatively good state of health, although grass coverage in some areas could have been denser. In some areas sediment coverage over the grass blades was significant although it is not known if this is seasonally influenced. Few large Queen Conch (*Strombus gigas*) were noted, but Cushion Stars (*Oreaster reticulatus*) and Donkey Dung Sea Cucumbers (*Holothuria mexicana*) were regularly sighted. Numerous juvenile fish were noted including (but not limited to) species of wrasse, snapper and butterflyfish. No significant anchor damage was noted in the areas rapidly assessed suggesting it is not commonly practiced in the reserve area.

Coral Reef: Concluded to be in a relatively poor state of health although there is good potential for at least limited recovery. The conclusion is based on observations of very low coral cover and, in certain areas, high levels of macroalgae. The FORCE report (Newman *et al.*, 2009) backs this up by reporting the three sites within CBMR have c.40% algae cover and less than 10% coral cover. At one site (Cades Deep) a 20% cyanobacteria cover was recorded. Furthermore, over 40% of the coral cover is represented by Mustard Hill (*Porites astreoides*) which is not a significant hermatypic coral species. Infact, the lowest coral cover recorded throughout the FORCE report was within CBMR at Cades Deep (6%), and that Antigua as a whole has the lowest coral cover and second highest macroalgae cover throughout the Caribbean islands studied. This, however, could be based on physical differences between the islands which may or may not be historically prevalent. For example, Antigua was also recorded as having the second lowest reef complexity value for these islands, but this could be a natural phenomenon and not due to reef degradation. This may have a knock on effect to fish abundance, as lower complexity reefs generally have lower overall fish densities. Such relationships may be responsible for the low fish abundances reported (and observed) within CBMR, as Cades South was recorded to have the lowest species richness (Newman *et al.*, 2009) but also had the lowest complexity being a 'flat limestone plateau'. Interestingly though the site did have higher than average grouper numbers and overall the low complexity reefs surveyed had surprisingly high species richness. The most common fish species were surgeonfish, wrasse and parrotfish although few large individuals were recorded.

James (2007) found that fishers and dive operators painted a bleak picture of coral reef health also, thus backing up the above findings. However, despite this relatively poor state of health there are positive signs for the future. Even though coral cover is low and macroalgae cover high, the FORCE reported also recorded relatively high levels of available substrate (33%, 64% and 52%), which means that juvenile corals have a sufficient amount of settlement space. This available substrate was also observed during field visits. Certain areas rapidly assessed had high densities of Long-Spine Sea Urchin (*Diadema antillarum*), which may be the reason for the encouraging levels of available substrate. Also encouraging for the future is that a number of fishers spoken to are in favour of CBMR being a no-take fishing zone to act as a seeding area for surrounding areas.

Conclusion

The management plan for CBMR needs to focus primarily on mitigation measures to encourage the recovery of the coral reef systems in the area. It is recognized that aspects of the poor appearance of the reef may be 'natural' to the area (i.e. a low complexity reef may have always been historically prevalent), but it would still be expected for there to be a higher coral cover and lower macroalgae cover than currently observable. This is not to suggest that the mangrove or seagrass systems should be neglected within the management plan, rather the current situation be encouraged on into the future. Taking the mangroves as an example, the management of these areas should continue in a manner that reflects what has happened there over recent decades as their health now is better than many local people can remember in years gone by.



View across to Cades Reef also illustrating thin mangrove strip and lagoon

PART 2: MANAGEMENT PLAN

Management Actions To Implement

- ***Establishment of central marine management unit:*** Such a unit is essential to act as liaison between other bodies (both governmental and NGO) and stakeholders with vested interests in CBMR, NEMMA and other marine areas around Antigua & Barbuda. The marine management unit (MMU) should be staffed with fully trained professionals capable of fulfilling the management goals, not just of CBMR, but also all other marine areas. The overall goal is to have harmonised management of all marine resources, and the MMU will play a pivotal role in this. Aside from initial start up costs it is hoped that the MMU will be self financing via the collection of user fees. These fees will provide users with correctly installed and maintained mooring fields within marine reserves and other park services. A feasibility analysis for the establishment of the MMU, including an examination of initial start up costs, minimal staff requirements, and delegation of various duties will be detailed in part 3 of this document. The MMU can be established in law under the Marine Areas Preservation and Enhancement Act (1972) section 5.
- ***Establishment of a user fee structure:*** In order to finance the reserves as mentioned in the previous paragraph officials within the Fisheries Division will need to decide on, organise the legislative background for, and implement a structured user fee regime. If the MMU has at this time been formed then they should work in unison with the Fisheries Division to establish such a structure. Suggestions for this structure can again be found in the feasibility analysis in Part 3 of this document. These user fees and associated permit can be announced by public notice in the gazette under the Marine Areas Preservation and Enhancement Act (1972) section 6, subsection 1 (e) & (h).
- ***Stakeholder meetings:*** As highlighted in the Socioeconomic report conducted for CBMR (James, 2007) it is essential to hold stakeholder meetings throughout the management process. This gives people a sense of ownership, satisfies the need for information, offers a forum for questions and answers, and on the whole increases the likelihood of local communities supporting management ideas and complying with rules and regulations.
- ***Establishment of mooring fields:*** Already established in NEMMA, reliable mooring fields are essential to discourage anchoring within reserve areas and also provide a visible justification for user fees. Two mooring fields are needed within CBMR, together with other dedicated dive moorings. A proposal has already been received from Antigua Helical

Moorings (AHM) detailing revenue collection withing NEMMA from the moorings already installed in that area by this company (see appendix 1). This proposal needs to be expanded to cover the CBMR moorings and any other new areas that are established in the future. It will likely be necessary for AHM and the Fisheries Division to work with the MMU for the installation, maintenance and collection of revenue within both CBMR and NEMMA. Again, feasibility of such an arrangement will be detailed in part 3 of this document.

- ***Reserve Zonation:*** CBMR is designed to promote biodiversity monitoring, sustainable fisheries resources and encourage interest in the marine environment, both within the local community and tourism. As such, and because it is a relatively small area, a complex zonation plan is not needed as it is in NEMMA. Therefore the whole reserve is designed to be a no-take preserve, with the exception of a thin zone between the inner and outer reefs, to be referred to as the Zone of Limited Use (ZLU). Within the ZLU fish traps are permitted in order to provide an area within which the fishers from the local fisheries complex can keep their gear in times of adverse weather conditions. Rules and regulations within the no-take preserve area and the ZLU will be detailed in the following section. The zonation plan is illustrated in appendix 2. This zonation plan can be implemented by way of a map under the Marine Areas Preservation and Enhancement Act (1972) section 3, subsection 3. If needed, exact ZLU coordinates will be decided through consultations at a later date.
- ***Attaining necessary legislation for reserve usage:*** To have the greatest chance of success this management plan will strive to implement measures that require little or no new legislation. New legislation can take long periods to introduce, or may not gain ministerial support and as such make the associated regulations defunct. However, it will be necessary for some new legislative amendments which can mostly be announced by public notice in the gazette, and as such fall under the current Fisheries Act (1983) Part V, section 39, subsection 2. These should be sought by the MMU and/or Fisheries Division at the earliest opportunity to ensure smooth running of this management plan. An alternative for some 'rules' is for their operation to be on a goodwill basis, where correct conduct is suggested (through public outreach) but not enforceable by law. Details of where the rules and regulations will get their legal or goodwill basis will be covered in the following section. The Marine Areas Preservation and Enhancement Act (1972) can also be used for this purpose.
- ***Public Outreach:*** As with stakeholder meetings, public outreach is essential to inform and educate users on incorrect conduct and the law within CBMR, together with the reasons for such regulation. A leaflet has already been designed for CBMR (contact fisheriesantigua@gmail.com for copies), but posters and notice boards will also be needed to be designed and strategically placed (as has taken place within NEMMA).

Regulations & Justifications

The following regulations will be enforceable under the law. The MMU will be responsible for surveillance as set out in Part 3 of this document but will not have enforcement capabilities. Such function will remain with Fisheries Officers and other law enforcement officials (including the Coast Guards). The MMU will be able to radio for such officials in cases of encountering an infringement, or may see fit to issue warnings where such infringement is not considered significant. It will also be prudent for MMU boat patrols to carry a law enforcement official as often as possible in order to give on the spot enforcement capabilities and overall credibility/respect as a management body.

Boat Owners Must Hold the Correct License/Permit for Park Usage – In order to ensure reserve users have paid any necessary fees and hold the necessary licenses/permits it must be obligatory for proof of such possession to be provided on request by any officer of the law or MMU staff. The licensing and charging of fees in relation to CBMR and other protected areas is governed under the Marine Areas Preservation and Enhancement Act (1972) section 6, subsection 1 (e) & (h).

No Fishing within CBMR – Fishing is not permitted anywhere within the CBMR, although fish traps may be placed in the Zone of Limited Use (ZLU) during times of adverse weather. Spearfishing is illegal in all Antiguan waters and so special vigilance of this activity within CBMR by surveillance/enforcement authorities is essential. Spearfishing, although fundamentally ecofriendly as fishers can target specific fish species of specific sizes, the reality is a 'take-all' mentality and can thus strip a reef of any significant fish populations. By restricting fishing it is hoped to mitigate against eutrophication, encouraging herbivorous populations and therefore reduce macroalgae, thus promoting coral growth. A study priority within CBMR (and other areas) should be to establish when/where snapper & grouper spawning aggregations take place as their protection is important to preserve current populations and ensure future growth/recoveries can take place. Groupers are the only documented predators of the invasive lionfish and, along with snappers, are also important from a socioeconomic standpoint. Restricting trap fishing also avoids potential ghost fishing, reef damage, and all round fisheries sustainability. It is hoped that CBMR will act as a seeding ground for surrounding areas/populations. This law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(a), where permission is granted for trap use in adverse weather conditions in the ZLU.

No Harvesting of Mangroves – As with reef resources CBMR is designed to be a preserve area and as such mangrove stands should be protected from harvesting and other damage. This law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(b).

No Removal of Beach Flora or Fauna – Beach flora helps protect against erosional processes and also provides shade and housing for various animals. Of critical importance is shade for nesting turtles that rely on flora to shade their nests and as such regulate their temperature. This temperature regulation governs the sex ratio of hatchlings. The removal of beach flora has been attributed to a higher female sea turtle population percentage which can lead to fewer successful matings. Coastal flora also acts as a filter for runoff, trapping nutrients that may be present in agricultural leaching and sediments that may be carried with rainwater. This law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(b).

Burning of Mangroves and other Flora – The setting of fires is important to control as it can lead to contravening the previous two regulations, and also, if left unattended the fire could spread and cause considerable damage. This law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(b), but due to recreational interests it is suggested some lenience be allowed. If fires are in the form of barbeques and as such set in fire pits or grills, and using coals rather than collected wood, no action should be taken. This should be in line with fire regulations under the police.

No Hunting or Harming of other Fauna – Including birds, reptiles, turtles and their nests. Specific legislation for turtles already exists but in general this law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(b).

No Touching or Removing Corals – Corals are delicate animals and can be killed when roughly touched. As highly important creatures for reef structure they deserve complete protection. This law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(b) & (c).

No Shell Collecting – Although not a hugely damaging practice, if left unregulated it has the potential to damage the environment. Eroded shells contribute to beach sand, but more importantly live molluscs are sometimes collected for their shells, and sold as curios in the tourist trade. This practice, like the collection of fish for the the aquarium trade, should not be permitted in reserve areas as it can ultimately damage populations. This law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(b) & (c).

No Sand Mining or Offshore Dredging – These practices are highly damaging to the environment and can cause significant damage to erosional regimes. This damage may not only be limited to where the materials were removed from, but can have knock on effects to neighboring systems. Whole beaches can be lost through these processes. This law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(c).

No Dumping of Garbage – Not only unsightly, garbage can harm wildlife and chemical leeching from certain items can pollute the environment. Birds can become entangled in it and turtles can ingest it, blocking their digestive systems. Beach goers should be encouraged to take any garbage away with them, or bins be provided that are emptied on a regular basis. This law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(c).

No Discharging of Waste Water – Sewage outfalls were not observed in CBMR, but it is likely that in NEMMA, being more industrial in places, outfalls of some description are present. All water entering the marine system by this means needs tight control to mitigate against both pollution and eutrophication. The dumping of waste water by yachts and other pleasure craft also needs addressing. To begin with this law will be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(c), but ultimately it is suggested that new legislation be introduced to control these issues if not already in existence. The Public Health Act needs consideration here also.

No Anchoring on Coral Reefs or Seagrass Beds – The use of mooring buoys should be strongly encouraged. As this practice 'disturbs, alters or destroys the natural environment' it can be governed under the current Fisheries Act (1983) Part II, section (22) subsection (2)(c). However, it may be prudent to, by public notice in the gazette, petition the minister to make regulatory additions to restrict this practice under the current Fisheries Act (1983) Part V, section (39) subsection (2)(n)(i).

No Jet-Skiing without Special Permission – The use of jet-skis within park areas is not permitted unless special permission is granted by the chief fisheries officer. The justification for such regulation is that it does not promote CBMR goals (to promote biodiversity monitoring, sustainable fisheries resources and encourage interest in the marine environment, both within the local community and tourism). If jet-skiing is allowed it must take place in specially marked areas to protect snorkellers and swimmers. Although this regulation could be announced by public notice in the gazette under the current Fisheries Act (1983) Part V, section (39) subsection (2)(n)(i), it is suggested that it initially be governed by goodwill. If jet-skiing becomes a significant problem in CBMR (where it is currently is not observed to take place), or needs better regulation in other protected areas (it was observed to take place in NEMMA), this matter can be revisited.

Other Fishing Restrictions – Although CBMR is being set up as a no-take area, it does possess a Zone of Limited Use, where fish traps may be kept during times of adverse weather conditions. Furthermore, it is planned that the management within CBMR will become harmonious with other protected areas, as that these areas will contain zones where fishing is permitted. As such it is important to keep in mind other fishing regulations that would be prudent to consider the

introduction of. Example of such would be the obligatory return of by-catch to the water and the obligatory use of 'escape hatches' in traps. It may also be deemed necessary to introduce minimum sizes for certain species of concern. All these potential additions to the previous list of regulations could be announced by public notice in the gazette under the current Fisheries Act (1983) Part V, section (39) subsection (2).

Of special concern, in a trap fishery surveillance and enforcement can become problematic when fishing gear ownership comes into question. In order to solve this problem, and thus identify fishers who are placing their traps in restricted areas, fishing gear needs to be labeled with the fishers license number. Officers of the law need to have the enforcement capabilities to confiscate fishing equipment that infringes on regulations and issue warnings and/or fines to the owners. The MMU wardens will be able to report infringements but not have the legal capacity for fishing gear confiscations or the issue of fines. They will be able to issue warnings however, as detailed in part 3 of this document. The need to label fishing gear should be announced by public notice in the gazette under the current Fisheries Act (1983) Part V, section (39) subsection (2) (b) & (q).

In addition to the Fisheries Act (1983), the Marine Areas Preservation and Enhancement Act (1972) also has provision for the above regulations to be announced by public notice in the gazette, and as such it may be more appropriate to do so. This will be a decision for the MMU and/or Fisheries Division at the appropriate time.

Active Management Measures

Aside from the regulations in the previous section, other active management measures will be implemented in order for CBMR to achieve its goals, and are recommended in all Reserve areas. Listed here are four such example measures. A full list is not possible to document as needs change with time and as such they have to be adaptive in nature. These measures are not governed by law and will be the sole responsibility of the MMU, although assistance may be called upon from time to time if extra manpower is needed.

Promote Lionfish Harvesting – An invasive species from the Indo-Pacific region, the Lionfish (*Pterois volans*) has now firmly established itself in the Caribbean. A voracious predator it has the potential to damage fish stocks through the consumption of juveniles. In other parts of the region steps have been taken to actively manage the spread of this species through promotion of it as a food item and removal of specimens from selected reef areas. Although it will not be possible to eradicate the species, removal from certain reef areas is favorable to mitigate its impact. It is suggested that this be undertaken within CBMR, and leaflets be produced warning the public of its toxic spines while encouraging its safe consumption. The MMU will spearhead this campaign in conjunction with the Fisheries Division.

Collection of Garbage – Initially the MMU will conduct a sweep of the land portions of CBMR and remove all garbage found dumped in the area. Waste bins will have to be installed in key areas where recreation is popular, and regularly emptied - an activity that the MMU should delegate out to the relevant authority. Regular checks on the mangrove areas will need to be undertaken to assess the success of garbage dumping prohibition, and if unsuccessful steps be taken to enforce legislation.

Translocation of Threatened *Diadema antillarum* Populations – Although recovering throughout the Caribbean after suffering a mass mortality event in the 1980's, the Long-Spined Sea Urchin (*Diadema antillarum*) has still yet to recover in all shallow reef areas around Antigua. As a key herbivorous species, any recovered populations that are threatened by coastal development should be translocated to protected areas as described in Wynne (2008).

Ongoing Monitoring – Essential for management to adapt over time as the effects of current management are documented. A detailed monitoring plan for CBMR is detailed in Part 4 of this document, which it is hoped will ultimately be applied to NEMMA and other marine areas around Antigua. Monitoring priorities include (but are not limited to): Reef fish & benthic surveys; Seagrass bed surveys; beach profiling; Lionfish population studies; In-water and nesting beach turtle monitoring; and grouper/snapper spawning aggregation studies. Such activities also ensures CBMR achieves its goals while promoting scientific study and research as stated to be a potential reason for declaring a marine reserve under the current Fisheries Act (1983) Part II, section (22) subsection (1)(c).

Management Action Time-line

June – December 2012: Finalization of management plan and the establishment of the MMU, beginning with the employment of a manager. These activities should be spearheaded by the Fisheries Division. During this time the manager should work closely with the Fisheries Division to organise the mooring fields and marine reserve permit fee structure. Logistical needs of the MMU should be assessed by the manager, most importantly an ocean patrol vessel. Land based transport needs also need assessing. The manager will also be responsible for assessing the financial viability of the MMU and adjusting the proposed permit fee structure as necessary. If other funding is needed for specific project expenses the manager should investigate other sources. Stakeholder meetings need to occur at various times during this period and the design of public outreach materials be finalized.

January – June 2013: By this time the company responsible for installation and maintenance of the mooring fields will be decided and their installation within CBMR begun. A permit fee structure will also have now been decided. The MMU manager should begin to focus on the necessary regulations that need to be announced by public notice in the gazette and the employment of wardens to

work within the MMU (see part 3 of this document). Public outreach materials should be distributed accordingly. Public notice boards with the proposed zonation plan for CBMR (pending public notice in the gazette) should now be in the design process. Stakeholder meetings to gauge public support should be taking place at regular intervals at this time. Permanent monitoring sites (PMS) should be established at this time and baseline data collected for them. This is essential as management effectiveness is to be measurable in future years. PMS should be established in CBMR, NEMMA and some out-of-park areas (as appropriate).

July – December 2013: By the end of the year the appropriate number of wardens should have been employed by the MMU and the marine reserve permit structure established in law to begin funding the MMU. Mooring fields, including moorings for dive operators (as deemed necessary), should now also be completed and regular maintenance undertaken by the company responsible for them. Regular patrols undertaken by the wardens should begin during this time, not just in CBMR but also in NEMMA. NEMMA management needs to be addressed by the manager based on that detailed within this management plan and also with reference to the NEMMA management plan produced in 2007.

January – December 2014: By now the MMU should be operating in its full capacity (pending future expansion as finances and logistical needs dictate), with regular patrols conducted in Reserve areas and the efficient collection of reserve permit fees. This year will be the time for the manager to assess the functioning of the MMU and identify areas where improvement can take place. Any legislation that has not been completed yet needs managerial attention. Preparations at this stage should be underway for the MMU to consider expanding its attentions to other protected areas, including Diamond and Palace Reef. Before this can happen though it is essential that CBMR and NEMMA management is taking place in a satisfactory and appropriately harmonious way. Of special concern is that the relatively complex NEMMA zonation functions correctly. PMS and monitoring protocol/logistics will have been tested this year after last years initial surveys and again the manager needs to assess effectiveness/operation. Additional monitoring sites should be established as necessary. Stakeholder meetings to assess public perception of the MMU and address and concerns should take place as appropriate.

2015 and on: After last years assessments by the manager, additional changes to the strategy and function of the MMU should be implemented this year. An adaptive approach should be undertaken where effectiveness is assessed on a continual basis and changes brought in by the manager (in consultation with the Fisheries Division) as necessary. Annual monitoring of PMS should now be occurring, and an associated report produced detailing the findings and conclusions of such monitoring. This process becomes an annual cycle where data is collected and analyzed, stakeholder meetings take place and concerns addressed, and managerial assessment takes place. The results from these inputs are all fed into the following years strategy plan.

PART 3: FEASIBILITY ANALYSIS FOR SINGLE MANAGEMENT UNIT

Introduction

In the 2007-2010 NEMMA management plan (Jackson, 2007) a management structure was suggested that ultimately was not established. It is likely that this is because it was a very ambitious structure with approximately thirteen staff, two boats, two land vehicles and a dedicated new build office and visitor centre.

To avoid this happening again it is important to conduct a feasibility study and ascertain the most financially viable structure for the Marine Management Unit (MMU) to take. One that can both achieve the necessary goals while being of a size that does not over-stretch resources. For this reason, at least initially, it will be prudent for the MMU to delegate certain management aspects to other agencies with a vested interest in the resources being managed. Ultimately however, if the MMU succeeds in its goal of being financially independent (funded on Marine Reserve user fees), these delegated aspects can gradually be taken over by the MMU as much as possible. The MMU will not only be responsible for the CBMR but also NEMMA and any other actively managed protected areas. For example, it is recommended that management plans be developed for other areas, for example Diamond Reef, a reserve area currently under a no-take status. These three areas could become part of an Antiguan Marine Reserve Network (along with any new Reserve areas established in the future), a network whom the MMU has sole responsibility for.

Initial Set-Up

The initial set-up of the MMU will only be possible with an injection of funds either from Government, external agencies or both. These funds will need to cover the purchase of a boat of suitable size, a land vehicle, equipment, and initial staff expenses. Due to the limitation of funds it will be necessary to begin with a 'bare bone' structure and expand from there. How to do this is detailed below. Initially the MMU will have to rely heavily on other agencies until revenue starts to come in from reserve user fees.

Ocean Vessel: In keeping with a limited budget it is necessary to only obtain a vessel that meets minimal requirements. It will need to carry at least three people, two of which may have dive and other monitoring equipment. Ten meters (30ft) is an appropriate length. The vessel also needs to be equipped with all necessary safety and navigational gear, including (but not limited to): life vests, first aid kit, GPS and two way radio. A vessel has already been procured for the use of the MMU and as such one of the largest initial expenses has already been covered.

Land Vehicle: Ultimately a four by four pick up with trailer to move the boat from place to place will be needed, although it is suggested that, until financial independence is achieved staff use their own vehicles to a limited extent, and other agencies vehicles be used to conduct official MMU duties when possible.

Equipment: Initially very little equipment will be needed as the agencies delegated various activities by the MMU will be done so based on their ability to conduct the tasks. Therefore they will be able to provide their own equipment. The MMU will potentially need to subsidize wear and tear on equipment use and filling of dive tanks (etc), therefore an equipment budget will still be needed.

Staff: For initial start up three staff members will be needed to fulfill the MMU objectives. All staff members must be competent boat handlers. It is preferable that all staff members be qualified divers, understand mooring buoy installation and maintenance, and be able to conduct monitoring activities (species ID, research techniques etc). These preferable skills can however be taught during employment, although training sessions will have financial implications. It is therefore recommended to obtain the most highly qualified individuals possible. The three initial staff will consist of a manager and two wardens. Their responsibilities will be detailed in the following section.

Office: Ultimately the MMU will require their own office although initially only the manager will require desk space with PC, telephone etc. It is proposed that space be found in the Fisheries Division offices to begin with, and potential offices be investigated once the MMU achieves financial independence.

Operation of the MMU

The first tasks for the MMU to achieve (if not done so already) are the establishment of mooring fields within CBMR (in line with NEMMA), the establishment of a user fee structure, and the establishment of a protocol for the collection of user fees. These activities will only require a manager to work in unison with the Fisheries Division, and as such the manager should be the first staff member employed. As these initial aspects are completed the manager will begin to organise MMU activities, arrange and begin the logistics needed to collect permit fees and begin searching for the remaining staff. Within this feasibility study it is suggested only two wardens be employed and any activities outside of the MMU's capacity be delegated out to appropriate agencies. At this time one of the managers key roles is to assess financial viability of the MMU by conducting reserve usage studies. If, after the user fees begin to be collected, it appears the MMU can't sustain itself financially a number of options will be available. These include, but are not limited to: Adjustment of the user fee structure to increase revenue and altering work rota to reduce warden/boat hours. As their key function the manager will be expected to fill financial short fallings by seeking external funding, although these will have to be for separate project aspects rather than annual running costs of the MMU. It is essential these

running costs are covered by Reserve permit fees with minimal government subsidy. Once financial sustainability has been achieved the manager should seek to increase the MMU's capacity as is possible. Thus, some of the activities delegated out below may ultimately end up being carried out by the MMU as this capacity expands. For this to happen more staff will need to be employed and/or consultants contracted in at various time to complete project aspects.

User Fee Structure & Collection: Foreign vessels are suggested to pay a daily user fee, chargeable on check in at their port of entry. Total days payable will be decided on a trust basis where boat captains are asked how long they intend to stay in Antiguan waters. In-water spot checks will be carried out by various agencies to ensure vessels within Reserve areas have the correct permit. Antigua Helical Moorings suggested a nightly mooring fee of \$25 US (see Appendix 1), although an appropriate fee would have to be arrived at through detailed Reserve usage surveys and discussions with various stakeholders and officials. For example, fees might be decided to vary based on vessel size and numbers of passengers (a heavier usage footprint). It is expected that revenue collection would be substantially higher in NEMMA than in CBMR and therefore more MMU resources would go into spot checking vessels in NEMMA than CBMR. User fees on foreign vessels would be payable irrespective of where the boat intended to visit while in Antiguan waters as it is highly unlikely that they wouldn't, at some point, pass through a Reserve area. Fee justification however is largely based on mooring usage. Daily charters and other local recreational vessels would be required to pay an annual fee, which would likely vary based on boat size and average number of passengers. A detailed tariff structure should be developed by the MMU manager through discussions with various stakeholders and other officials. Local boat owners possessing other usage permissions (for example fishing licenses) would not be required to purchase Reserve permits. Dive operators will have a separate fee structure, based somewhere in between the tariffs for foreign and local vessels. The Local charters fees and dive permits will be obtained either from the Fisheries Division or the MMU (if in a different office). Spot checks by the MMU, Fisheries Division and Coast Guard will be carried out to ensure all vessels carry a correct and valid permit. Note: It is expected that dive permits will be introduced island wide in the future as a means of revenue collection, and as such official dive moorings untimely placed at all dive sites around the island.

Mooring Installation and Maintenance: Antigua Helical Moorings installed moorings in NEMMA and could do so in CBMR also and be responsible for their ongoing maintenance. Their initial estimate for annual maintenance of the NEMMA moorings was \$5000 US (see Appendix 1) with the potential for this to increase as spare parts are needed. It is assumed that to also cover the CBMR moorings a larger total annual fee would be required. It is suggested that the manager/Fisheries Division seek external funding for the initial installation of the CBMR moorings and also seek external funding when purchasing bulk orders of mooring supplies. This will make an ideal project aspect that will be appropriate for such a funding source.

Surveillance and Enforcement: The MMU, in their own vessel, will conduct regular surveillance patrols, although they won't have enforcement capacity. If users are found contravening regulations warnings will be issued, and if repeat offenders are noted or severe infringements identified the Fisheries Division and/or Coast Guard will be radioed for assistance. The MMU will also regularly request a Fisheries Officer, Coast Guard, or other law enforcement officer to accompany them on their patrols. Key goals for the patrols are to show an official presence within the Reserve areas, conduct spot checks on recreational vessels for possession of the correct user permit, and to assess overall compliance with Reserve regulations. Detailed records of observations made should be kept in order to aid future decision making and overall Reserve management success.

Mangrove, Wetland & Beach Monitoring: It is proposed that this be delegated out to the Environmental Awareness Group (EAG), as they have been involved in a significant amount of work in these areas in the past. This may include Antigua Racer surveys, bird surveys, water quality monitoring, nesting turtle surveys and forest structure assessment. If any of these aspects can't be undertaken by the EAG then responsibility will fall back to the MMU and/or Fisheries Division.

Seagrass & Coral Reef Monitoring: The Fisheries Division will be delegated the in-water monitoring aspect as they have trained divers and a full complement of equipment. It is suggested however that the initial set up of monitoring sites be contracted out to a consultant, and they be present for initial surveys. This will ensure all survey staff are correctly trained and conduct monitoring work in a standardized manner. The consultant will conduct species training workshops, not just for Fisheries Division staff, but also for the staff of the MMU. The consultant will also produce a report detailing the data collected from this 'baseline' and provide a data storage system for this and future survey efforts. This structure will allow for external funding to be sought as it represents an individual project aspect. Expenses of future monitoring efforts conducted solely by the Fisheries Division (and later the MMU if their capacity allows) will be funded through the MMU's annual budget.

Socioeconomic Monitoring: To be conducted by the MMU in order to give the Unit a public identity and a chance to get direct feedback from local communities and stakeholders. Although during their initial setup a number of stakeholder meetings should happen, long term, socioeconomic monitoring is a good way to keep public involvement and interest. Annual meetings are however still encouraged, again organised by the MMU, with the results from the monitoring presented and a chance for questions/answers and concerns to be raised.

Outreach and Education: Already spearheaded by the Fisheries Division with, for example, brochure production for CBMR and notice boards for NEMMA. It will be important for the MMU to continue this, and also incorporate an educational element to the program, possibly aided by the EAG.

Collection of Garbage: In order to try to avoid regulation infringement bins need to be provided in key recreational areas that should be emptied regularly by the relevant authority. The MMU however will be responsible for overall surveillance of garbage dumping and the removal of materials as necessary. It is also suggested that the MMU, in cooperation with the EAG, organise community beach cleanup operations at regular intervals at beaches that suffer from a build up of marine garbage within Reserve areas.

Funding: As most activities are delegated out, and initial office space for the MMU will be provided by the Fisheries Division, the running costs of the MMU should be minimal. They will be limited to staff salaries, fuel costs, and mooring buoy & boat maintenance. Maintenance costs are difficult to estimate, and fuel costs are variable depending on usage and fuel prices at the time. Salaries will be in line with those those in similar positions in government (providing user fee revenue will allow this). One of the managers first responsibilities, as mentioned previously, is to assess this and adjust the user fee structure as necessary. It will also be necessary for the manager to arrive at a feasible starting salary for the wardens, again based on this revenue assessment.

Example Weekly Rota: As finances are initially limited and because quantities of revenue to be collected are unclear the following proposed weekly work rota for the MMU is somewhat conservative in nature. However, it serves as an example of how three staff members, if flexible in hours/days worked, can fulfill the work goals of the MMU initially. The manager will be responsible for working out the weekly rota, and present it to the staff on Monday AM (thus all staff members are required to attend Monday AM meetings, when also issues from the previous weeks work can be discussed). The rota should vary week by week, as should boat patrols, in order to give surveillance a random nature and as such make predicting the MMU's presence in reserve areas impossible. This is far more financially sensible as a continuous presence in reserve areas becomes expensive in terms of both boat fuel, maintenance, and man hours. If the MMU's capacity grows in the future such surveillance efforts can however be increased. Although surveillance patrols will mainly be conducted by both wardens, the seven day a week work ethic needed will mean that the manager at times has to accompany one of the wardens. Sometimes though this space can be filled by a Fisheries Officer or Coast Guard. The bulk of the managers time be spent in the office liaising with other agencies, report/proposal writing, and general day to day MMU organisation as necessary.

Table 1 – Example weekly MMU work rota for two wardens: Each warden (W1 & W2) will need to work eighteen two hour blocks per week to account for 36 hour working week. Each week the rota will change, and where the two wardens are not shown as working together either the manager (M) will accompany them or an enforcement officer (EO). If one staff member is on vacation the rota will have to be adjusted accordingly, with the manager and/or enforcement officer needed more frequently for patrols.

	08.00 – 10.00	10.00 – 12.00	12.00 – 14.00	14.00 – 16.00
Monday	Meeting All staff	W1 & W2 Land patrol		
Tuesday			W1& W2 NEMMA patrol	W1 & W2 NEMMA patrol
Wednesday	W1 & EO NEMMA patrol	W1 & EO NEMMA patrol	W1 & M NEMMA patrol	W1 & M NEMMA patrol
Thursday	W1 & W2 Land patrol	W1 & W2 CBMR patrol	W1 & W2 CBMR patrol	W1 & W2 Land Patrol
Friday	W2 & EO NEMMA patrol	W2 & EO NEMMA patrol	W2 & M NEMMA patrol	W2 & M NEMMA patrol
Saturday		W1 & W2 NEMMA patrol	W1 & W2 NEMMA patrol	
Sunday		W1 & W2 CBMR patrol	W1 & W2 CBMR patrol	

Conclusion

Based on this planning assessment it seems highly feasible for a single management unit to take over the management of the Antigua Marine Reserve Network. Having said this, the success is based the MMU having a flexible staff base, where work days vary week by week and often call for half day weekends. It is also based on having other agencies support the goals of the MMU and as such offer their services to fulfill relevantly delegated roles. Finally, in order for the MMU to be financially sustainable it is essential that they begin small (with Government support), and grow as necessary, a growth that will largely be based on the user fee structure decided upon, the efficiency of fee collection and surveillance, and the number of users visiting the Reserve areas on a daily basis.

PART 4: MONITORING PLAN

Introduction

Essential to the successful management of an area such as CBMR, a detailed monitoring program needs to be established to provide feedback to staff/decision makers as to the effectiveness of this management. It is proposed that the monitoring plan detailed below ultimately be expanded into NEMMA and other protected areas (for example Diamond Reef) as the management of all Marine Reserves become unified under a single management unit (as described in Part 3). It is also essential to have 'out-of-park' sites to act as comparisons (or controls) for sites in actively managed areas, and for all data to be accurately stored in a database for access when writing reports and conducting temporal analysis. It is suggested that to initiate this monitoring plan a consultant be contracted to set up permanent monitoring sites, conduct the first round of surveys, ensure that all monitoring staff are correctly trained in the survey techniques, construct a database for data storage, and produce an associated report. During the initial field visit for this management plan four provisional locations were chosen as potential permanent monitoring sites within CBMR. Sites still need to be decided on within NEMMA and other areas around Antigua & Barbuda as required.

Coastal Monitoring

Mangrove & Wetland

In terms of monitoring the mangrove and wetland systems, a proposed biological monitoring plan for these areas was developed for the Environmental Awareness Group (EAG) that covered not just the Cades Bay area but also other wetland regions in the Southwestern part of Antigua (Jarecki, 1999). It is suggested that the methodology detailed in this report be followed for these areas and surveys conducted by the EAG. The EAG already conduct survey work in NEMMA and as such already have the expertise needed, although their resources may need expanding to enable them to take on this work as extensively as needed. It is also suggested that the EAG take on the turtle nesting and in-water surveys within CBMR (and thus ultimately NEMMA and other areas) as again they already conduct such surveys and/or have the expertise to do so. These monitoring aspects would be orchestrated by the MMU (as detailed in Part 3).

Beaches

Beach profiling should be conducted quarterly and follow a standard protocol using a Clinometer or Abney Level. A permanent marker is installed at each site to be studied. It is preferable to use a permanent structure such as a tree, and mark with paint the standardized starting point for each field visit. Starting from

the painted mark, a pole is placed down the beach where a sand inclination change is subjectively decided upon by both surveyors. The slope angle measured with the Clinometer (or Abney Level) and the distance between the two poles (following slope, not horizontal distance between poles) is recorded with a tape measure. This process is continued down the beach towards the sea at all noticeable inclination changes until the point is reached where the sea doesn't expose the sand any longer. As with noticeable inclination changes, the point at which to finish profiling is subjective and based on the tidal range at each site (and therefore tide time when profiling and tide cycle – spring/neap times). It is therefore important to have staff trained equally and/or use identical staff for monitoring as much as possible. The Fisheries Division has conducted beach profiling work in the past and as such it is appropriate for them to continue this work in Reserve areas. On such sites currently exists within the CBMR boundaries.

Socioeconomic

Regular socioeconomic monitoring is necessary for a number of reasons, firstly to gain feedback on public perception of Reserve areas and their management, but most importantly to give local communities a feeling of inclusion in decisions and a sense of ownership of resources. It is essential that stakeholders support the management of these areas as compliance with regulations is implicitly linked with this. It is only through socioeconomic monitoring that such support can be assessed. The Fisheries Division conducted a socioeconomic assessment of CBMR in 2007 (James, 2007) following the 'socmon' protocol. It is suggested that this protocol be used as a framework for future monitoring and that such monitoring be conducted on a two yearly basis in combination with regular stakeholder meetings and public outreach materials. As proposed in Part 3, it is suggested that this monitoring and any meetings are lead by the MMU as it is vital that this central management unit be given an identity with the public so that they can visualize its role and importance.

Coral Reef & Seagrass Monitoring

Annual monitoring of both seagrass and coral reef systems was proposed in Part 3, and suggested to be conducted by trained staff from the Fisheries Division following the initial set up of permanent monitoring sites by a contracted consultant. The first sites to be established will be within CBMR and surrounding areas, but to be ultimately expanded into NEMMA and other marine areas. It will be beneficial if in-water monitoring could ultimately become biannual, but this will largely depend on logistics and availability staffing resources. The MMU will be responsible for liaising with the Fisheries Division to plan in-water monitoring and to keep data stored in a safe and organised fashion, also producing annual reports. With time, if the MMU manages to become financially independent, it is envisaged that they could expand their capacity to conduct this monitoring, but for the time being out-sourcing the work to the Fisheries Division is prudent.

Seagrass Monitoring

Subsurface markers set into the seagrass bed with concrete block (or similar) are positioned centrally within the permanent monitoring site (PMS) and GPS coordinates taken so that it can be located during subsequent visits.

Upon arriving at the PMS a surface marker is deployed with a weighted line. A snorkeller then enters the water and locates the subsurface marker, moving the weighted surface marker to its location so that the boat crew will have a visual reference of where the in-water survey work is being conducted. Two divers then enter the water and place four 25m transects radiating out from the central subsurface marker in known directions, thus ensuring that the same areas of seagrass are being surveyed as in previous PMS visits. Two 50m transects can be set instead, divided in half with the 25m mark crossing the central marker. A usual method of orientation is to set two 25m transects parallel to the coastline and two perpendicular, but this will depend on the sites physical morphology.

Each transect then undergoes monitoring. Quadrats are laid every five meters along each transect and various parameters measured, including (but not limited to) seagrass species present, percentage cover of seagrasses/calcareous algae/fleshy macroalgae/sand, average blade length of main seagrass species, average number of blades per plant, epiphyte cover, sediment cover and other invertebrates present. While one surveyor is conducting the quadrat surveys another assesses fish and key invertebrate populations. Belt transects are swum (4m wide) and all fish present counted to species and put into 5cm size class categories. Two replicates take place on each transect. Key Invertebrates are also counted with the belt transect with Queen Conch (*Strombus gigas*) and species of Echinoderm being of special interest.

Coral Reef Monitoring

Subsurface markers attached to the reef structure (or similar) are positioned centrally within the permanent monitoring site (PMS) and GPS coordinates taken so that it can be located during subsequent visits. Upon arriving at the PMS a surface marker is deployed with a weighted line. A snorkeller then enters the water and locates the subsurface marker, moving the weighted surface marker to its location so that the boat crew will have a visual reference of where the in-water survey work is being conducted. Two divers then enter the water and place four 25m transects radiating out from the central subsurface marker in known directions, thus ensuring that the same areas of coral reef are being surveyed as in previous PMS visits. Two 50m transects can be set instead, divided in half with the 25m mark crossing the central marker. A usual method of orientation is to set two 25m transects parallel to the coastline and two perpendicular, but this will depend on the sites physical morphology.

Firstly, both divers swim along the transect at a consistently slow speed and conduct fish belt transects. Only commercially and economically important

species are detailed (i.e. Parrotfish, snapper, grouper, triggerfish, butterflyfish, surgeonfish etc), with each surveyor responsible for different families. Fish are recorded to species and placed into 5cm size class categories. Each transect undergoes two replicates. Following the belt transects one surveyor conducts an RDT survey (roving diver technique) recording all fish seen during a thirty minute circular tour of the PMS (swimming at a consistently slow speed, noting all fish to species seen two meters either side of the surveyor). Two replicate surveys are conducted. During this time the second surveyor places quadrats along each transect at five meter intervals and measures various parameters including, (but not limited to) hard coral species and percentage cover, soft coral family and percentage cover, algae percentage cover (split into different categories: fleshy, calcareous, turf, etc), coralline algae percentage cover, sand and sediment percentage cover, cyanobacteria percentage cover, zoanthid percentage cover, and details of other invertebrates present. Physical characteristics are also recorded including (but not limited to) depth, rugosity and relief.

Following these surveys both divers conduct an intercept transect survey, where each surveyor is responsible for either the perpendicular transect(s) or the parallel transect(s). Protocol for these surveys follows the AGRAA methodology (Kramer *et al.*, 2005), where focus is on recording details of the coral colonies that lay directly underneath the transect tape. Other underlying substrate types are also recorded. For example, the diver swims along the transects and notes that between zero and seventy centimeters the underlying substrate is rock. At seventy (until ninety) centimeters there is a coral colony. At this point the surveyor records the colonies physical characteristics, including (but not limited to), species, length, width, height, and percentage of colony living/recently dead/long dead/ diseased or bleached. They then move along the transect tape and note that between 90 and 130cm it is again rock, at 130 to 170cm the substrate is sand and again from 170 to 255cm it is rock. At 255cm there is a coral colony and the colonies physical characteristics are recorded (and so on).

Finally each transect undergoes a second belt transect where key invertebrate species are noted, with particular attention to species of lobster (mainly *Panulirus sp.*) and echinoderm.

These surveys all serve different purposes and provide detailed information on the habitat both physically and biologically. For example, the RDT surveys provide detailed information on species diversity and overall fish abundance, being especially useful for recording rare or scattered species. The fish belt transects on the other hand provide information on relative biomass and size class distribution of important species that would otherwise not be possible to collect for all fish species present on the reef. Similarly, the quadrat surveys provide detailed benthic information, whereas the intercept transects provide information on coral health that would not be feasible to collect from the quadrats. Both survey results can be combined to arrive at more robust results for coral cover than would be derived from each technique separately.

Note on in-water monitoring methodologies

In order to attempt survey standardization and therefore facilitate comparisons with other monitoring programs standard protocols have been followed that are widely accepted throughout the Caribbean. Having said this, monitoring programs inherently vary from place to place as program goals, logistical capabilities and habitat attributes vary from place to place also. Here, the Atlantic and Gulf Rapid Reef Assessment (AGGRA) methodologies have been followed for the most part (Kramer *et al.*, 2005), although survey effort has been expanded slightly to increase survey robustness. For these expansions accepted methodologies have again been used (for example, English *et al.*, 1997). For a detailed example of an established program using the protocol described here please refer to Wynne (2007).



A Lionfish observed on the Cades Bay Reef during the 2012 field visit. Assessing abundances and spread of this invasive species is an example of one of the key findings that such a monitoring program as described here would produce.

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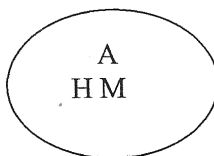
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Appendix 1 – Antigua Helical Moorings Proposal

ANTIGUA
HELICAL
MOORINGS



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PROPOSAL FOR COLLECTION OF REVENUES FROM NEMMA MOORINGS PROJECT

Background: In April 2011 29 Marine moorings for yachts up to 60 Feet , were installed in the North East Management Area (NEMMA) under the supervision of The Fisheries Division of the Ministry of Agriculture, Fisheries,Lands and Planning , and overseen by the Secretariat of the OECS in St Lucia.

Objectives: The Mooring Installations require maintenance on a regular basis, in order to ensure the continued safety and integrity of units, and in order to preserve the reputation of Antigua and Barbuda as a premier Yachting destination in the Caribbean. The marine environment (warm salt water , Ultraviolet Radiation from the sun, galvanic corrosion, wear and tear) is hostile to virtually all man made materials, and although the mooring systems have been constructed of the most suitable materials a regular schedule is necessary .

In order that the management of the moorings be self-sustaining financially, it is necessary to put in place a suitable Revenue collection system .

Options:

1. Revenue could be collected at the Ports of Entry as the Yachts clear Immigration and Customs and Port Authority, or on site in the NEMMA, or a combination of both.
2. Revenue could also be collected from the local Day Charter boats that use the NEMMA. This could more be an annual fee.

Notes:

- 1 As the system is new to Antigua and Barbuda, it is difficult to make projections as to the probable revenue that would be collected, certainly usage of the moorings will be seasonal.
- 2 The small numbers of moorings and the fact that usage is optional limits the overall amount of revenue that can be collected.
- 3 It is probable that if revenue was only collected on site that the cost of administration would exceed the revenue collected.
- 4 If a suitable vessel was kept at Shell Beach Marina and a single person was employed to do the necessary trip and make any collections in the NEMMA, I estimate each trip would cost approximately \$170 US taking into account maintenance of the vessel as well, based on an average nightly mooring fee of \$25 US, this would mean that to cover costs, it would require at least 7 moorings being used per night or a 25% average usage.
- 5 One suggestion would be an "honour" system with a penalty fine of \$100 US for using the moorings without prepayment at the Port of Entry.

The yacht would be given the option to use the moorings when they Clear in at the Port of Entry, and pre pay for the usage and be given a 'permit' to use the moorings. The Yacht would display the 'Permit' in a prominent place when using the moorings.

The NEMMA Warden would patrol on a random basis to check for Yachts using the moorings and if they have a valid permit and collect fines where necessary.

This would save on overheads and yet still control usage of the moorings.

6. The moorings require periodic inspection and replacement of any necessary parts, six monthly intervals would be optimal, annually would be bare minimum,
7. Initially an annual budget of \$5000 US would suffice for maintenance but with time the budget will need to be increased as parts will wear out and need to be replaced.
8. In order to keep overheads to a minimum, we would require duty and tax free concessions to outfit and maintain a suitable vessel and for the warden's use and for duty free fuel, when that comes on stream for fishermen.

Conclusion:

I am prepared to provide a suitable vessel and train a warden to carry out the necessary duties to enforce proper use of the moorings and maximize collections, Clearly the first season will be a trial as making any kind of projections at this point is very difficult.

Bernard Evan-Wong

Appendix 2 - Zonation Plan For Cades Bay Marine Reserve

