REPORT

CORAL REEF BIODIVERSITY COMMUNITY-BASED ASSESSMENT AND CONSERVATION PLANNING IN THE MARSHALL ISLANDS: BASELINE SURVEYS, CAPACITY BUILDING AND NATURAL PROTECTION AND MANAGEMENT OF CORAL REEFS OF THE ATOLL OF RONGELAP.

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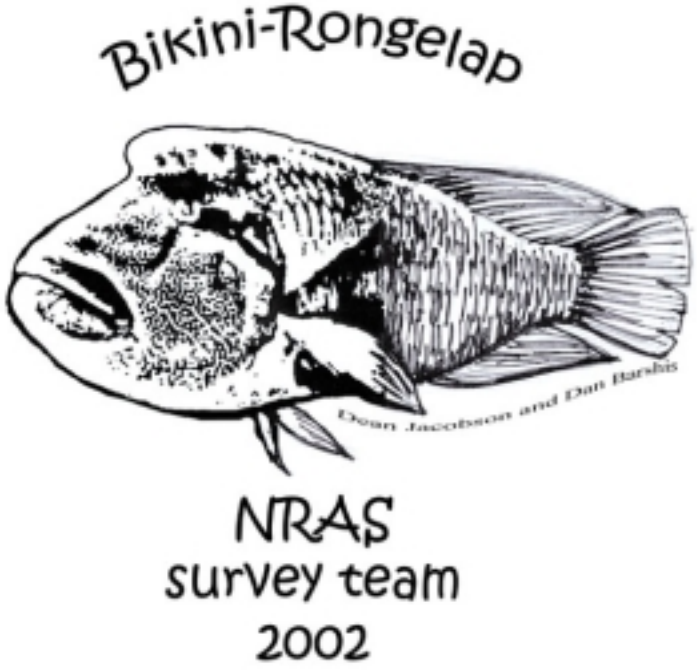


6. Recommendations

The results of this study documented an outstandingly pristine and healthy coral reef ecosystem on Rongelap Island. This detailed survey provided a baseline for future changes and impacts that might occur as a result of resettlement. The most important and foremost recommendation is that the resettlement should be carried out in a well-controlled and regulated manner, concerning all activities that may impact the coral reef ecosystem. A completely intact and prosperous coral reef is a highly valuable resource, which is becoming extremely scarce on a global scale. The Rongelapese people now have the unique chance to prove that reef deterioration must not always be the inevitable results of human habitation. Wisely managed uses of the resource as well as well managed land-based activities would ensure that human populations and thriving coral reefs can co-exist.

We provide below a list of important issues to consider in the context of coral reef management and conservation. These include but are not limited to:

- Fisheries,
- Waste disposal,
- Tourism,
- Traditional use,
- Aquaculture and pen holding, and
- Energy use.

One of the most efficient methods of reef management is the establishment of no-take reserves (sanctuaries) in combination with management of the adjacent reef zones. We will consider each point below.

6.1 Fisheries

Artisanal fisheries can provide a source of income and food if properly managed. It is important to establish the status of the resource by continuous monitoring and adapt exploitation accordingly. Recreational fisheries are likely to target pelagic fish such as tuna, but also reef fishes such as groupers or snappers. While this fishery appears fairly small compared to commercial operations, it is important to keep track of quantities being caught as this usually is easily overlooked.

Industrial fishing activities such as shark fishing should be approached with caution. While allowing foreign vessels into the local waters will generate short-term income by fees, on a long-term basis it could destroy the resource. Fishing on an industrial scale is likely to overexploit the resources, particularly when foreigners move into new fishing grounds and become a main cause of depletion of resources, since they use high extractive methods and are not concerned about future uses and impacts on sites that belong to another country. It is very difficult to establish the status of top-predators such as sharks or tuna. Sharks have a very low reproductive efficiency, they mature late and only produce a few young. For animals with such characteristics, it is often too late to maintain populations by the time it is realised that they are severely depleted.

6.2 Waste management

Waste disposal on land is extremely important for the management of coral reefs. Nutrients from effluents can cause the reef to experience a phase shift from coral reef to algal reef, as nutrients facilitate algal growth, whereas corals require low nutrient levels. Garbage such as plastic bags, soft drink cans and Styrofoam plates are easily removed from site on land by throwing them into the sea, however this creates new problems. This waste smothers the corals, kills sea turtles that

eat plastic bags thinking they are jellyfish, suffocate seabirds and poison the waters. We recommend a careful solid waste management. A well designed dumping site should be created, featuring (a) a strong containing wall ensuring waste cannot be blown out of the pit, (b) a sealed bottom to prevent seepage into the groundwater and the sea, and (c) a control outlet to monitor the toxic and nutrient concentrations in the liquid collecting at the bottom of a pit.

Prevention is the best cure, so we recommend a wise use of one-way non-recyclable items such as Styrofoam plates or cups. Drink cans should be recycled for their metal content. Household sewage should be treated in three stages before disposal.

6.3 Tourism

Tourists can be attracted by healthy and abundant marine resources, which they like to view and experience. Fully protected marine reserves can be highly attractive to tourists as the habitat is protected from any activities and is pristine; larger fish and large school of big fish accumulate in the area. Sustainable and environmentally sound tourism would be provided by ecotourism, where tourists would benefit the island but not begin to take it over or degrade its environment. Tourism can also bring prosperity to an area with creation of job opportunities (boat taxing, local shops, dive shops, hotels), alternative livelihood, - often better than fishing - , and increased income. However tourism always damage to a certain extent marine reserves and coral reefs in general. Coral reefs are particularly susceptible to sediment release during hotel construction (sediments can smother and kill corals), algal growth boosted by nutrient input from tourist sewage facilities, anchor drops from boats. Tourist themselves can also create considerable damage by breaking corals while diving or snorkeling.

We recommend strictly limiting numbers of tourists and utilising environmentally sound hotel management practises, including composting food wastes and sewage treatment. Mooring buoys prevent anchor damage and breakage of tourists has been proved to be reduced through education and making them wear lifevests when snorkeling. This also increases their safety if they are not confident swimmers. It is important to ensure that tourism development is properly regulated so that it does not exceed the sustainable capacity of the environment. With careful management it is possible to achieve a balance that is favourable to both environment and tourism.

6.4 Aquaculture

Aquaculture is a promising income generating venture for the people of Rongelap. It involves growing marine species from a larval or young stage to saleable size. However, it can severely impact reefs through nutrient enrichment of the water and catches of young or adult fish. There have been proven successful aquaculture ventures in Majuro and the other atolls that have good airfreight connections. The success of Rongelap aquaculture would depend upon improved and reliable air services, or high speed catamaran sea freight. The species proven to be good for atoll aquaculture are giant clams and pearl oysters. Local businesses in Majuro have profited from oyster and giant clam farming. Simon Ellis was quoted to say that the southeast of Rongelap atoll was promising for clam farming while the northwest has deep waters suitable for pearl production (Pacific Business News, 18 June 2002).

Trade of fish and corals for the aquarium market is a temptation in the economic development of Rongelap. This temptation will be enhanced since the Great Barrier Reef Marine Park Authority and Queensland Government will be either closing or severely restricting this industry in Australia. Australia is lucky to have alternative industries that have proven to yield export earnings. In the case of RMI, the aquarium trade is one of the few private industries that have earned export earnings. We are not advocating a blanket ban on all aquarium trade, but we unequivocally ask RALgov to give Napoleon-wrasse and other endangered species full protection within the local government area.

Personnel associated with Australian aquaculture and aquarium-trade industries are familiar with opportunities in RMI, and so there may be opportunities for collaborative development. Beware that opportunities come with risks, and so RALGov should be cautious with extraction of fish and corals for the aquarium trade. In the case of the Great Barrier Reef, tourism has proven to be far more valuable that extractive fishing, and so the Australian Government has applied very strict regulations of fishing and vastly expanded the extent of marine protected areas. We recommend that all aquaculture or aquarium industry proponents be required to provide a complete business plan, including marketing research and an analysis of transport costs, environmental impacts and risks.

Already there have been investment ventures aquaculture/aquarium trade from Rongelap. Sea cage holding pens have been proposed for live fish trade (Pacific Island Report, 2001). This would involve catching the fish on the adjacent reefs and storing them in holding pens until the fish can be collected by freight ship. The impact of such an operation could be substantial, as it would remove large quantities of fish to export it to the Asian markets. This could result in a severe depletion of target species as well as the fish caught to feed them, and should be approached with care. Again, a detailed business plan and environmental impact assessment should be required from any proponent and scrutinized by third-party experts.

6.5 Energy use

Stage I of the Rongelap resettlement has included two 225 Kw diesel generators, a reverse-osmosis desalinisation plant 40,000 gallons freshwater storage, warehouse and maintenance buildings, and a Field Station to accommodate 40 people, including a kitchen, food storage, dining area, and recreation room.
Stage II has been proposed to include over 50 family homes; Medical Centre; School; Library; Municipal Buildings; Port and Airport Buildings; and a bulk fuel storage and loading facility. The later would be tank farm that holds 150,000 gallons, with provision for expansion to 500,000 gallons (RALGov, 2002).

Non-renewal energy resources are extremely expensive on atolls, and should be used wisely. Although this is only indirectly related to the health and status of reefs, there are some important impacts:

- Firstly, the shipping of generator fuel increases the threat of oil and fuel spills in the lagoon.
- More importantly, burning fossil fuel increases the output of CO2, which feeds the global climate change tendencies towards higher temperatures. This in turn has heavy impacts on reefs as it is the major cause for coral bleaching (Reaser et al. 2000, Hughes et al. 2002).
- The lighting and cooling of all buildings on Rongelap Island are currently dependent on a diesel-electric power plant. This facility creates a large amount of noise pollution and runs 24 hours per day.

We recommend that acoustic attenuation be provided by way of a block wall screening around the power plant. We also recommend that an energy audit be conducted to establish what size of population the existing power plant is capable of servicing.

It is expected that diesel power generation requirements would be maximum during night-time, while photovoltaic (PV) panels could provide a substantial amount of electric power during daylight hours, when air-conditioning loads are greatest.

The existing power plant might suffice without added PV capacity if other renewable energy resources were exploited. Ocean thermal energy conversion (OTEC) has been demonstrated in

Hawaii (Halloran, 1990). The OTEC principle is to extract cold water available off the continental shelf for air-conditioning purposes (Van Ryzin and Leraand, 1991). A by-product of OTEC is the production of freshwater, as it condenses on air-conditioning cooling coils.

6.6 Marine protected areas

Marine conservation areas are needed to preserve these regions of reefs that are particularly high in biodiversity, i.e. rich in species, as stated by the Biodiversity Strategy and Action Plan, Goal A1, Strategic Theme A, B and D (Conservation of biodiversity and the marine environment). These conservation sites would be a revitalization of traditional environmental practices, enhanced by modern knowledge and scientific understanding. The need to reinvigorate the "*traditional environmental conservation practices*" in order to "*harmonize development with environmental sustainability*" is also stated in Vision 2018, Goal 10, Objective 5 (RMI, 2001). Also internationally, the interest in MPAs has increased widely.

We recommend to establish a community-based coastal resource management plan that can apply the principles of participation, social equity, productivity and self-reliance along with environmental sustainability. It should aim to (a) manage the fishery resources, (b) protect reef ecosystems and all the goods and services they provide, and (c) mange land-based activities to minimize impacts on reefs. We stress the importance on the community-based approach, since when a community becomes responsible of its fishery resources, the people develop a sense of ownership and become protective users.

This proposed action plan is the constitution of a network of small marine protected areas or no-fishing zones, to be created around the atoll and monitored for a minimum of 5 years.

6.6.1 Why establishing a marine conservation site?

There are several benefits to establishing a marine reserve. We define a marine reserve as an area of reef, ocean and adjacent intertidal zone where management measures are applied; these also include sanctuaries or no-take areas, where no extractive activities are allowed. Conservation measures should be applied on pristine reefs as well as on damaged or over-fished reefs. Pristine reefs that were protected are found for example in the Great Barrier Reef in Australia and in Papua New Guinea. Following the *Precautionary Principle*, the local government should facilitate conservation of biodiversity and pristine habitats. Excellent results from the establishment of marine protected areas are being witnessed all around tropical areas. The positive effects of no-take zones are numerous:

- ***protection of areas of habitat in pristine conditions***. Pristine habitats are more likely to receive higher levels of recruitment as a result of providing the correct environment for young fish (Roberts and Polunin 1991);
- ***enhanced social and economic opportunities***, including activities such as wilderness experiences, ecotourism, diving, underwater photography and advanced marine education (Murray et al., 1999); in some regions the economical benefits originating from these activities may exceed the extractive uses of marine reserves (Brock, 1994). Sanctuaries are luring divers looking for healthy reefs and dense fish populations;
- ***increased scientific knowledge and understanding of marine ecosystems*** and their management (Murray et al., 1999). No-take marine ecological reserves are necessary to provide essential reference areas to evaluate impacts of fishing and other human activities on the ecosystem and to allow a better understanding of ecosystem structure, function and performance. Reserves provide monitoring sites so that natural long-term changes can be distinguished from anthropogenic changes;

- ***conservation of large predatory fish*** - often the target of fishermen and the first to decline on coral reefs (Russ and Alcala, 1996);
- ***maintenance of intra-specific genetic diversity*** (Roberts and Polunin, 1991);
- ***species and biological diversity and ecosystem structure conservation***. Fishing activities change species composition and alter the food web structure. Changes in ecosystem structure and functioning become more likely as the pressure of fishing and other activities increase (Murray et al., 1999);
- ***increase in abundance, mean size and biomass of fish populations in overfished areas*** (Bohnsack, 1995; Roberts and Polunin, 1991; Roberts et al., 1995; Rowley, 1994);
- ***control of male-female sex ratio***, that heavy fishing tends to change into a smaller sized female dominated ratio (Bohnsack, 1998; Law et al., 1993; Ricker, 1981);
- ***enhanced yield in adjacent areas via emigration of fishes from the reserves*** (Bohnsack, 1998; Robert and Polunin, 1991; Rowley, 1994; Russ and Alcala, 1989);
- ***higher production of eggs by larger females*** (Roberts and Polunin, 1991).

The location of MPA should be based on:

- Local needs (good fishing spots, accessibility, uses, heritage value, recreation);
- Resource assessment (reef health, coral cover, fish abundance & size, diversity);
- Enforcement ease (accessibility, observation);
- Threats potential (pollution, erosion, coral bleaching);
- Economics (potential for tourism).

Sizing a marine reserve is an important issue. Form a biological standpoint, the bigger a reserve the better. However large areas are difficult to enforce, while small areas usually include fewer features. In order to meet goals for fisheries and biodiversity conservation, reserves must encompass the diversity of marine habitats. The concept of adding many small areas into a "chain of pearls" leads to a large reserve, thereby facilitating connectivity between protected areas, including larval exchange and adult fish migration. Sizes of reserves around the world vary greatly, as do their zonation and management concepts. Below we provided examples of sizes from MPAs around the world.

- St Lucia – 2.6ha
- Apo Island – 12 ha
- Danjugan Island – 60ha
- Bunaken NP – 1300ha
- Tubbataha WHS – 33 200 ha
- Great Barrier Reef - 2000km long, 100km wide

Recommended sizes of marine reserves range from 10%, 25% to 30-50% of the total available reef area that should be protected as "no-take" marine reserves (Salm 1984, Salm et al. 2000, Hughes et al. 2002). The large distances between oceanic reef habitats and sources of larvae means atoll reefs may largely self-recruit. If this is the case, breeding populations of all species on the reef must remain intact to ensure the integrity of the reef. Other features of the reef system that must be managed include key functional groups and food webs. The structure of the reef must also be protected to ensure that rates of reef growth balance rates of erosion or sea-level rise.

6.6.2 Marine reserve at Rongelap Island

Marine reserves should be established based on several factors to ensure maximum conservation efficiency. The major selection criteria are (a) biological integrity, (b) low threats potential, (c) social acceptance, and (d) logistical ease.

6.6.2.1 Selecting a location

The survey results suggested that there were two major biological zones on Rongelap island, the lagoonal and outer reef ecosystems. An adequate portion of each habitat should be included in a reserve network. We recommend here to locate a marine reserve at Jaboan, where the outer reef and the lagoon habitats meet, and where there are also habitat features that do not occur elsewhere. The highest count of fishes was found here. As the size of the proposed reserve will by far exceed the size of our survey plots, several of the survey sites would be included in the proposed reserve, thus incorporating sites that supported a high coral species count. Threat potentials are low as there is adequate flushing through the pass, lower settlement potential and good forest cover on land to prevent sedimentation. However, should there be the need to choose a different site arrangement, other sites could also be selected. This should incorporate the outer site R10 (opposite the airport terminal) and R6 (lagoonal site half way between airport and Jaboan point) where a large patch-reef is located. As this is an alternative suggestion that would require a higher effort (i.e. 2 reserves), we will focus on Jaboan Point in the following part of the report.

There are several issues to be considered in establishing a marine reserve that are beyond biological suitability. Consideration should be given also to the socio-economic and customary use, the accessibility of the site and the ease of surveillance in addition to the biological factors (Table 1).

Table 1. Factors to be considered when creating a MPA at Jaboan Point.

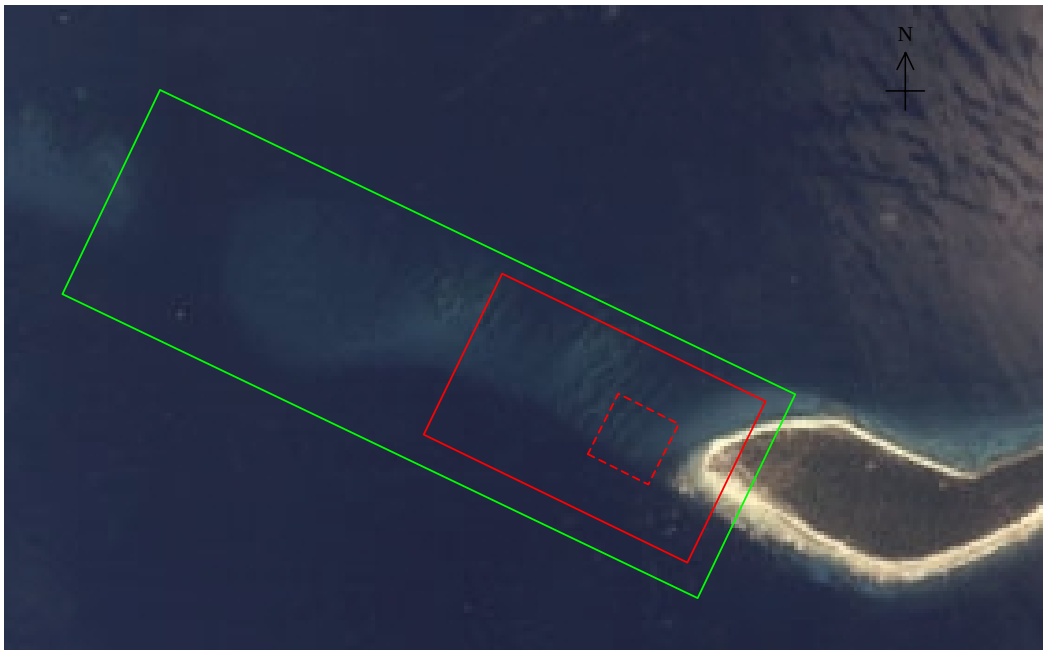
Positive factors	Negative factors
High biological integrity, including the presence of sharks and turtles; they also act as tourist magnets.	Other users (e.g. fishing) loose a good spot.
Water exchange	Potential exit point for rubbish entering the lagoon (but this must be avoided by proper waste management)
Sheltered from prevailing wind	High exposure to currents during tidal changes
Easy access by track or sea	Potential for pollution from ship traffic through the pass, e.g. by oil-spills
Easy to enter and exit the water from the shore (diving or snorkelling)	Exposure to currents may translate into higher maintenance of facilities such as buoys.
Furthest site from population pressures	Safety issues for diving and snorkelling due to exposedness

The factors against establishing the sanctuary at Jaboan would be mitigated by creating a buffer zone around the core zone. The buffer zone will protect sites R1 through R9 (all around Jaboan point). Jaboan is owned by the *alap* Hemos Jiles and his permission will have to be sought to establish an MPA on his property. Finally, a sanctuary at Jaboan achieves the aims of protecting a high diversity of Marshallese food-fish and edible invertebrates within a biologically superior area to encourage ecotourism.

6.6.2.2 Size of the proposed sanctuary

Literature suggests that a small MPA is better than no MPA at all (Dayton, 2000, Jones, 1992, Ballantine, 1991), but also that any MPA should be accompanied by other management and conservation measures of the surrounding reefs (Allison, 1998). The minimum size for an MPA recommended in literature ranges from 20 to 50 % of the total reef area (Day, in press, Hughes, 2002). In the case of Rongelap Island, 20% area is from R1 to R9 extending out past the reef into the pass, calculated using MapInfo® (Figure 1). The sanctuary in total should be comprised of an area of land, a core zone and a buffer zone to be fully successful. The buffer zone protects the core of the sanctuary with restrictions both on the land and in the sea. The buffer zone was drawn from the chart and aerial photographs of the island around the reef surrounding the core zone (Figure 2).

Figure 1. Core zone and buffer zone of sanctuary at Jaboan.



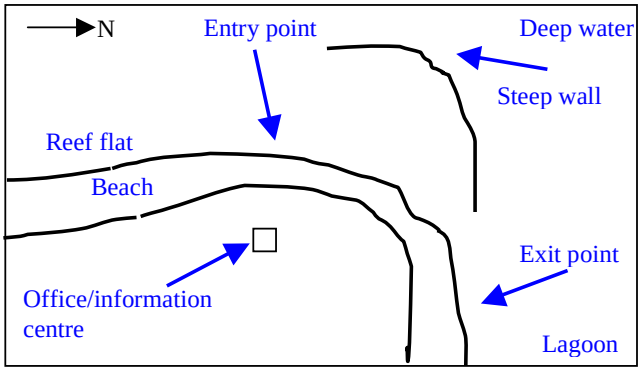
Key:

Core zone

Buffer zone

Area sketched in figure 5.4.

Figure 2. Jaboan point as a marine sanctuary.



6.6.2.3 Guidelines for the establishment of the sanctuary and its management plan

The creation of an effective marine reserve is and ongoing, interactive process that does not end with passing it into law. To maintain efficacy and satisfy all stakeholders in a long term, adequate measures for monitoring (measuring the effect of the reserve), surveillance (enforcement) and education (let local people experience their own reef) are crucial.

As outlined in the MIMRA Act, 1997, a management plan shall include a description of the fishery by reference to the area, fish species and present state, objectives to be achieved and an outline strategy to achieve these, methods for evaluating effectiveness and a date to review the performance. A management plan should also address:

- other beneficial objectives (ie conservation of biodiversity),
- management of pollution,
- user profiles and permits,
- land- based activities in coastal strip,
- waste disposal and sewage discharge,
- social implications,
- exceptions (if applicable),
- monitoring,
- surveillance, and
- guidelines for future adaptive measures if necessary.

Non-negotiable guidelines on the sanctuary rules will be clearly displayed in English and the local language of Marshallese.

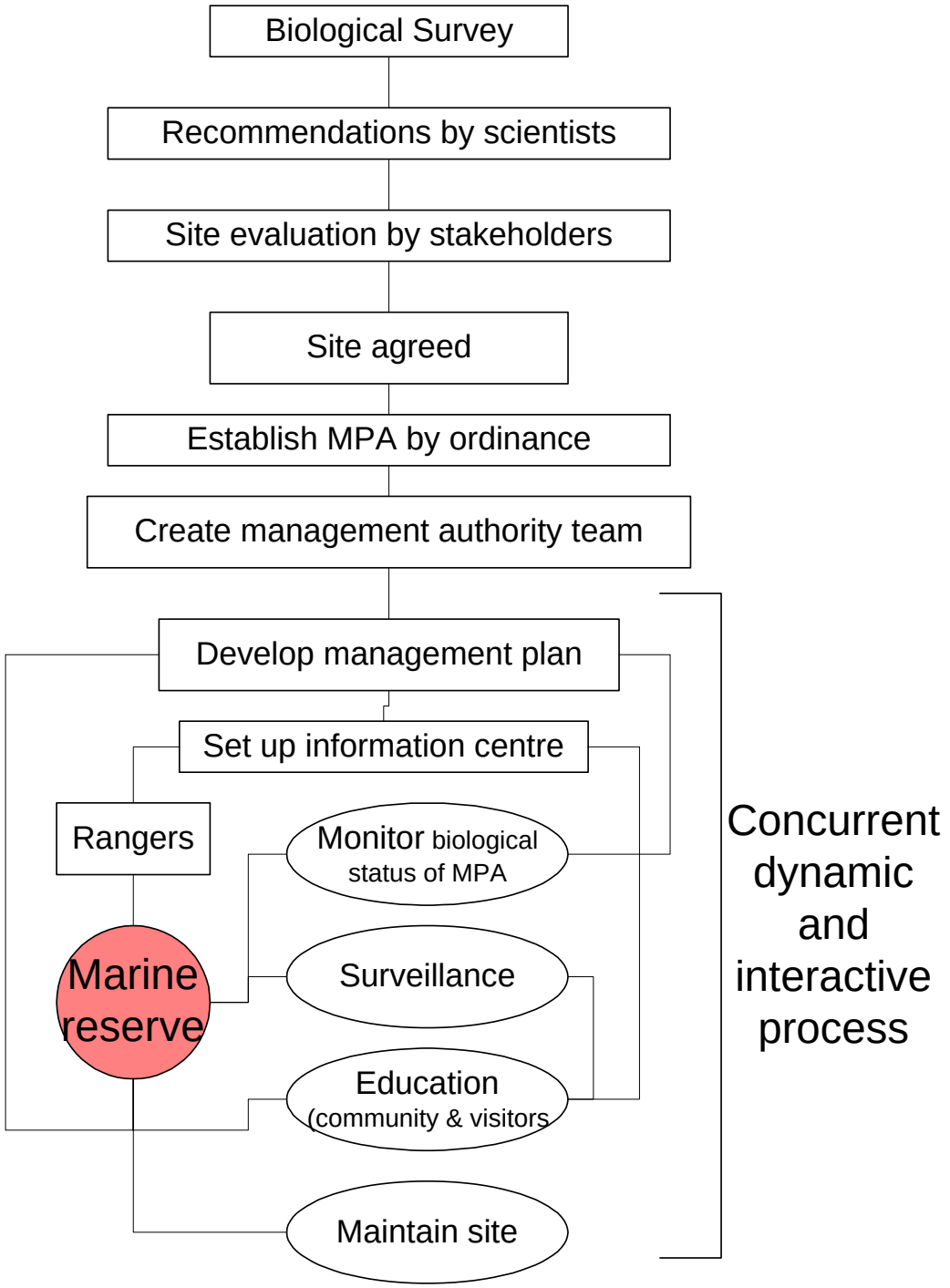
The researched sanctuary eventually will be based within a wider scale management plan of the whole atoll and possibly even the three atolls governed by RALGov. Linking the protected areas means that they all benefit from each other, particularly the smaller sanctuaries, which can be destroyed in single disaster events.

A marine sanctuary on the community's doorstep may give it a better understanding of the other proposed protected areas in the atoll. It is also important to establish the sanctuary well before the resettlement, and commencement of anthropogenic uses and impacts in the surrounding area. The present data set will provide a baseline for monitoring.

The permanent transect laid provide an ideal means for monitoring. It can be compared to the other permanent transect laid outside the proposed reserve area, this will allow the community to see the changes (growth, decline or stability). The monitoring will assess the impact over time from fishing and diving activities as well as natural processes such as recruitment or coral bleaching.

Once the MPA management plan is approved by RALGov and the other authorities involved, the plan will represent the first example of coral reef conservation in the RMI and the model of establishment could be used to help conserve further atolls in the country.

Figure 3. Steps to MPA establishment on Rongelap Island.



6.6.3 Community-based management planning

Community-based resource management is taking force all over the world as new and best practice for use of coastal resources in a sustainable manner. It is recognized that ***humans are part of the ecological system***: coastal habitats are the results of complex interactions among physical, biological and human forces. Community based management should involve all level of users into the detection of issues or problems (natural, environmental, economic problems) and the determination of solutions. Through participatory approach, management gains several advantages:

- ***Enforcement is easier:*** support (financial political, practical) is obtained from local communities that recognize the need for conservation. The use of participatory techniques reinforces people awareness, knowledge, ability, and motivation to make decisions about their future. The community understands the principles involved. The outcome is a guarantee of success that is much greater than when running a project from a governmental agency. In return the communities benefit from shared income generated by MPAs, through improved fishery yields, through increased employment.

- ***Education***: Community-level monitoring or participatory approach is an important way to increase understanding of causes or resources degradation. Information an education are to provide the community the necessary material and tools to increase their knowledge and appreciation of coastal and marine environment, basic ecological principles, the various threats to the environment, and what community members can do to help promote coastal resource management.

6.6.3.1 Requirements for Community-Based Management

- ***Information***: The users should be informed at all stages of a management plan development: they should be consulted and involved in the process. Resources cannot be managed or protected in a sustainable manner unless those who exploit them are committed to this goal and involved in the management process (White, 1989).

- ***Education*** is important in order to build capacity for self-organization and self responsibility. Education can help people understand why management is necessary and may help initiate their participation. Workshops, public meetings, campaigns, citizen groups, school programs and special projects involving the community can be used as participatory tools.

- Traditional leaders support. Lessons from different regions of the world highlight the need to take into account customary supporting frameworks provided by traditional kings or leaders, chiefs, religious leaders. These powerful key players must be fully involved in developing strategies for wise use of resources. Future marine management plans need to include all levels of the governmental hierarchy, the national government, local government, the *iroij* and the *alaps* (traditional landowners).

***- Traditional knowledge*:** The natural world has been protected from the most disruptive human influences through laws or cultural or religious taboos preventing overexploitation. The loss of traditional knowledge about resource use in one of the central problems of our times. Local people have a knowledge of ecology in their context that is far subtler and sometimes superior to that of outside "experts". Traditional practices can be invaluable tools for management. However, "*traditional practices do not necessarily result in environmental sustainability*" and they must be assessed in the light of changes in population dynamics and pressures. Local explanations may need to be reviewed in light of scientific understanding. It is important that researchers working with local people *ensure a two-way exchange of information, ensuring that local wisdom is incorporated into management strategies, and feeding back scientific knowledge and data to the communities.* Local environmental knowledge can be a powerful source of authority. Moreover, when park regulations for resource use are based on local traditions, the local people take an active role in ensuring the respect of the rules.

- Coordination. Decentralization can lead to greater efficiency and reliance on co-management structures, but if this decentralization is not coordinated it can result in competing and overlapping jurisdictions, conflicts or a total abandonment of responsibility by government agencies. The focal point of a community-based management and conservation plan should include education of local

communities and formation of *marine management committees*.

***- Participatory Monitoring Programs*:** Important part in a management program is to monitor for changes over a year or so to determine if changes are taking places and whether the reef is improving or getting worse. Monitoring for changes and success of management is essential to detect how systems are performing.

→Moreover, the government and the decision makers in the atoll *need to know with more scientific certainty how forces such as migration, urbanization, rapid population growth, tourism and high rates of resource consumption will affect and are affecting the natural ecosystems*. At the same time it is important that the community itself participates in this analysis. Communities involved in monitoring see for themselves the impacts of interventions and can recommend corrective actions if necessary. In this way baseline and monitoring surveys can build awareness.

6.6.3.2 Job opportunities

With the creation of marine parks or conservation sites, there would be availability of local employment opportunities for skilled marine surveyors and marine park rangers.

Marine park rangers would be needed to patrol and monitor marine reserves for local and global threats. Specialized marine technicians could become the work force able to monitor reefs for global warming effects, as part of a local plan "*to counter the emerging threats resulting from the adverse effects of Climate Change*" (Goal 10 –Environmental Sustainability – Objective 2, Vision 2018 – RMI, 2001). Including local users of resources in their management would be part of the process of instigating "*the sense of ownership and responsibility*" in people from all levels of society (as demanded by Goal 5 – A productive people- Objective 2-4, Vision 2018 – RMI, 2001).

Tourist guides and awareness leaders for tourists would be especially needed as well. These guides would not only have the responsibility of leading visitors groups in marine parks, but would also be in charge of giving biological information on the local natural ecosystems as well as on how to behave in the respect of the marine environment. These people would have the skills to become the educators on atoll environments for both visitors and the community, and thus they would take part in the environmental awareness promotion whose necessity is claimed by Vision 2018, Goal 10, Objective 2-4 and Objective 5-2 and by BSAP, goal D2 (RMI, 2001).

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