Biodiversity Research in Wakatobi Marine National Park, Indonesia

Peter Herbert (6776797)
ENVR 4000
# Table of Contents

1.0 INTRODUCTION  
2.0 BACKGROUND  
3.0 REEF PRESSURES AND DISTURBANCES  
4.0 REEF MANAGEMENT AND CONSERVATION  
5.0 SKILLS AND TRAINING ACQUIRED  
6.0 RECOMMENDATIONS  
7.0 CONCLUSIONS  
NOTES AND REFERENCES
List of Figures and Tables

FIGURE
1 - Buton Island and the Wakatobi Marine National Park 6
1.0: Introduction

Despite the fact that oceans cover approximately seventy percent of the Earth’s surface, (Strahler and Merali 2008) there is comparatively little attention paid to the ecosystems associated with them by the general public outside of scientific networks. Regardless of the reasons for this, the sanctity and resilience of marine ecosystems is an issue of increasing importance. As global population is rising, so too is the demand on natural resources of all kinds. Even resources such as the seas, which until fairly recently were (and in some cases still are) seen as essentially limitless, are beginning to become weakened by the increasing strain placed upon them by humans. Given the important role that these ecosystems play in the provision of resources for the planet, it is therefore essential to ensure their continued health for future generations by taking steps towards the development of research and conservation management plans to protect them, and maintain or even restore their levels of biodiversity.

2.0: Background

Indonesia’s Wakatobi Marine National Park, located southeast of the island of Sulawesi, covers an extensive area, and it is the second largest marine park in Indonesia, covering approximately 1.39 million hectares, (UNESCO 2006) which is roughly 2.5 times the size of Prince Edward Island. Wakatobi is comprised of a number of islands, with the four largest being the islands of Wanci, Kaledupa, Tomia, and Binongko. Of these islands, Kaledupa is the largest both in area and population. (May and Coles 2004) The island of Hoga, where the main Opwall research centre for Indonesia is located, lies adjacent to
Kaledupa, across a small channel that separates the two islands. Hoga Island is at the centre of what is known as the Coral Triangle, a triangle of reefs with the highest known diversity of hard corals on the planet. (Operation Wallacea 2011)

In addition to the extremely diverse coral ecosystems, there are also large mangrove and sea grass beds that form a vital part in the overall health and function of the surrounding ecosystems. The total circumference of the coral islands is approximately 600km, and the park has 25 chains of coral reefs of varying types including fringing, barrier, and atoll reefs. (UNESCO 2006) The Wakatobi area is classified as a global diversity hotspot, with at least 250 different species of coral, and 500 different coral reef fish species found on the Wakatobi reefs alone. (a 2011 Aug. 10 Lecture on threats to coral reef systems as part of reef ecology course; unreferenced, see “Notes”) Coral reefs are extremely important ecosystems for a number of reasons. Aside from the large contributions that they make overall to global biodiversity, they are also important
food and economic resources for a large number of people, while also acting as natural buffers that provide coastal protection from ocean waters. Currently, the total value of coral reefs worldwide is estimated to be in the range of $365 billion dollars, (ibid) with approximately 500 million people dependant on them for food. (Ibid) This number is expected to double over the next thirty years. (Ibid) Reef-based tourism is also estimated to generate in the range of $300 billion dollars a year, making up 85% of coastal tourism. (Ibid)

Given the ecological, economical, and cultural importance of the reefs to the area and its inhabitants, it has been recognized in recent years that proper management and conservation techniques need to be applied in order to maintain it for future generations, especially given rising human populations. A number of different research studies are based out of the Hoga research station, and one of the overall objectives of this research is the establishment of a sustainable reef fishery. As with other Operation Wallacea research sites, a native Indonesian NGO called Lembaga Alam was formed from local Indonesian staff to administer the research station. The Opwall Trust in conjunction with another Indonesian NGO known as Forkani runs the reef fishery project. These groups hope to understand the complex systems of the area so that comprehensive management plans may be created and possibly applied to other reef ecosystems in need of management plans to conserve and/or recover levels of biodiversity. This research includes studies on coral reef dynamics and diversity, fisheries ecology, mangrove and sea grass systems, and reef-based economics, among others.
3.0: Reef Pressures and Disturbances

It has been suggested that reefs as they are known today could disappear within the next 50 years without proper conservation and protection efforts (*ibid*). There are a variety of disturbances that affect reef systems, with human-induced ones ranking near the top. Some of the main anthropogenic impacts on reefs include:

- **Nutrient loading:** this can lead to increased algal and plankton densities, macroalgae growth, and decreased reef integrity and reproduction which in turn may result in phase shifts that effectively cause the system to collapse.
- **Increased turbidity** as a result of traffic or effluent discharge, which decreases the level of available light and therefore the photosynthetic ability of producers.
- **Sedimentation,** which is different from turbidity in that in addition to contributing to decreased light levels also serves to smother corals.
- **Unsustainable tourism,** which causes physical damage both from direct human contact and from the collection of souvenirs and resources for sale, as well as from resort-style hotels, which often discharge sewage into reefs.

All of these impacts affect the biodiversity, productivity, growth, and fecundity of reef ecosystems.
Other more immediate forms of anthropogenic disturbance include forms of destructive fishing techniques, such as blast and poison fishing. Blast fishing is performed using either dynamite or homemade explosives made from fuel and fertilizer. It is a non-specific technique, meaning that it stuns or kills all organisms within its area of effect, including species that are not desirable for catch. Blast fishing has an extremely devastating effect, reducing reef structures to barren craters of coral rubble. Also, given the destructive nature of this type of fishing, it is a one-time use technique. With poison fishing, divers use the chemical sodium cyanide to stun fishes so that they can be harvested either for sale as food or to the tropical fish aquarium trade. This form of fishing, while less devastating than blast fishing still causes reef destruction, as the divers often rip apart sections of the reef in order to get at fish and other species hiding within the crevices.

Other natural forms of disturbance also affect reef systems, although it may be debated that some of them are also ultimately the result of human activity. Factors such as climate change affect elements such as water temperature, pH levels, light availability, storm activity, weather patterns, currents and phenomenon such as El Nino can also act as disturbances for coral reefs, along with diseases, and the increase of coralivore species such as the Crown of Thorns sea star.

4.0: Reef Management and Conservation

The effective management of reef ecosystems depends on a number of variables. (Ibid) First, the objectives of management plans need to be clearly
defined, so that appropriate data can be collected and analyzed. Objectives may include maintaining or increasing species diversity, to increase species productivity, to increase recreational use, or the development of education and research initiatives. Secondly, site parameters need to be defined, such as the location and size of the area to be managed. Third, management is dependent on the availability of resources such as workforce and financial capacity to achieve the desired objectives.

Reef ecosystems have traditionally been considered to exist in a vacuum with regards to planning and conservation efforts. However, it is now widely realized that other coastal habitat areas, such as mangrove and sea grass habitats, affect coral reefs. This creates a need for both integrated coastal-zoned and/or multi-zoned management strategies. In addition to the complex marine systems, the islands of the marine park are also host to a number of traditional and local human populations. This adds an extra dynamic to the park, as these populations require the use of its resources in order to survive and make a living. This makes the park different from most marine parks in that conservation management plans need to consider with much more weight the economic and social components of ecosystem management rather than the more typical approach that focuses primarily on environmental factors.

There are approximately 100 000 people living within the Wakatobi area, (Operation Wallacea 2011) the majority of which are dependent on the fisheries as both their main source of protein and income. In recent years, given rising
populations and the lack of management plans, the level of artisanal fishing was so high that the fishery was on the verge of collapse. (May and Coles 2004)

Were fishing to continue unchecked and unmanaged as it had in the past, the stress placed on the ecosystem would eventually have caused it to collapse, likely resulting in a phase shift to an algae-dominated ecosystem due to the removal of fish from the area, which graze on algae, keeping its numbers low enough to prevent it from smothering coral beds and removing habitat for a number of species dependent on the reef ecosystem. In response to this, a sustainable fishing initiative was started in the area in 2007, (Coles 2010) with the aim of preventing any such phase shift from occurring. As a part of this initiative, a weekly monitoring program was established to monitor all fish landed over 24 hours in 9 villages around the island of Kaledupa. From this, a database was developed that can be used to model the effects of various potential bylaws that may be considered to increase fishery levels. In conjunction with this, another database was developed that catalogued over 1000 fishers and their fishing gear. Lastly, all motorized boats used for fishing were registered. Currently, there is no other area of Indonesia where such a detailed census of fishers has been completed, and 100% of fishing boats have been registered. (Ibid) It was believed these measures would contribute to a recovery of the fishery.

However, it was determined that community enforcement and forum-agreed regulations were unlikely to reduce the pressures faced by the reefs sufficiently to levels where stocks could recover. Thus, a small percentage of
licenced fishers were offered small businesses in exchange for surrendering their licences. This was a voluntary process, and the licences were exchanged only for businesses that would create more or an equivalent amount of income than would have been generated by fishing. This meant that those that remained in the fishery would have a licence worth at least that of the businesses that could also be used as an asset to trade amongst other islanders with or to use as collateral for raising money from the bank. There are also plans to develop a plant to process the approximately 3000 tonnes of seaweed currently being grown in the area but sold elsewhere. (Opwall 2011) The plant is estimated to generate approximately $6 million in annual turnover. (Ibid) The second business opportunity is the development of ecotourism in the area with the use of homestays. This is a very effective technique for providing income for local families, as more of the money goes to the community than would from the establishment of a hotel or resort. As a way of supplementing incomes and supporting the bylaws, designs have been made to further develop the capacity of the area to support ecotourism. Given the somewhat remote and inaccessible nature of the area, government-sponsored subsidies were supplied to provide infrastructure to accomplish these goals. Most notably, the construction of an airstrip has allowed for planes larger in size than that of seaplanes to land in the area, and designs are being made to expand the airstrip to accommodate flights from the more distant capital region on the island of Bali. Given the diverse nature of the research objectives, the high amount of investment and consultation with local communities, the development of bylaws that reflect this,
and the diversity in planning for and developing alternative income sources for local residents so that catch levels may be reduced, there is strong evidence indicating that the fisheries project has a strong chance of success. Coral and fish monitoring surveys indicate that a decline in fish stocks may have been halted, but that there is still a considerable way to go in terms of allowing fish stocks to recover to levels where maximum sustainable yields can be increased from present levels. The Wakatobi government is also investing into developing the current Opwall site located on Hoga into an international marine research centre as a flagship for further developing the ecotourism industry. (Ibid)

Compliance is often a difficult point to obtain in the conservation of marine protected areas, (see “Notes”) as there is often no consultation and therefore an inability for stakeholders involved agree with or adapt to the institution of reef management strategies. Given that there are often few alternatives available, non-compliance can be common, as stakeholders are typically dependent on reef resources in order to maintain a livelihood. It is therefore important for a participatory approach to be used with regards to local stakeholders during the formulation of conservation management plans. Enabling stakeholders to voluntarily participate often increases agreement, and results in the creation of stakeholder management committees in which local communities can be represented. Awareness is also a critical component in the development of management strategies, as they can serve to educate both public and private sectors, and demonstrate the need for management. Also, as mentioned,
research objectives should be defined in such a way so as to increase knowledge pertaining to sustainable reef management and conservation.

During the planning process in developing the management plan for the Kaledupa fisheries, local communities and stakeholders were heavily involved in the design of conservation efforts, as well as development of legislation and bylaws to support those efforts. (Coles 2010) The community-based Kaledupa Fisheries Forum (KFF) composed of representatives from various stakeholder and conservation groups, drafted and agreed upon 24 bylaw restrictions for the fishery, including limits on the quantities and dimensions of various fish trap types that were to be allowed within the fishery. (Ibid) Enforcement of the zonation plan and the associated bylaws was undertaken primarily by park rangers, however communities also policed their agreed areas to ensure that only village-registered fishers were using the areas.

There are five main achievements of the fisheries project to date that have contributed towards a restoration of the fishery. The first is the development and continued running of the weekly monitoring program for fisheries catches, and the second is the compilation of comprehensive database records for over one thousand fishers and their equipment, as well as the registration of all motorized boats used for fishing. The third achievement is the development of potential income streams with the financial power to buy out enough fishers’ licences through the development of a processing plant for locally harvested seaweed, as well as the development of ecotourism and associated infrastructure. The fourth achievement is the publication of numerous pieces and material in a variety of
media types describing and showcasing the management plan and process as a way of increasing public awareness and garnering both private and public sector support. Lastly, and most importantly is the formation of the Kaledupa Fisheries Forum and the drafting of the 24 bylaws associated with it. This makes the fishery especially unique, as there are likely few managed fisheries where participants have voluntarily agreed to a fairly large number of bylaws in such a short period of time.

5.0: Skills and Training Acquired

Prior to participating in any field research, volunteers are required to complete and pass a detailed course in coral reef ecology. The course consists of both lectures and field instruction exercises highlighting the variety of marine species that inhabit the area, primary producers, invertebrate identification, coral biology and identification, fish identification, mangrove and sea grass systems, threats to reefs, and methods of assessment. A strong emphasis is placed on readily identifying species, as the raw data collected is crucial for future analysis and inference.

Of the topics covered by the indo-pacific coral reef ecology course, the lectures covering methods of assessment is particularly valuable for students wishing to gain first hand familiarity and experience with field techniques, as they provide research assistants with transferable skills that can be utilized in other settings.
Divers when performing a reef survey use a large array of different techniques. The techniques employed depend on a number of factors, including the conditions and size of the site, the study objectives (detailed information or rapid assessment), the amount of time available for the study, and the experience of the researchers. These points should be determined prior to undertaking any research. Some examples of assessment used in marine research include:

- **Manta Tow and Spot Surveys**: These survey types are good for rapid characterization of an area, and are often performed in order to allow for informed decisions to be made regarding further research.

- **Remote Sensing and GIS surveys**

- **Transects**: A variety of transect types may be used, depending on the type and quantity of data to be collected. Line-intercept transects record data at set intervals, and are especially useful for observing fish and other motile species. Continual transects record all desired data types for the entire length of the transect, and are useful in identifying changing patterns in coral and other non-motile species, as well as determining substratum cover types. Lastly, belt transects utilize the area within a predefined distance of the transect line, and are useful for collecting data on both motile and non-motile species. Depending on the data to be collected, they can be either continuous or line-intercept in design.
Quadrats: Quadrat surveys are useful for obtaining more detailed quantitative data, but are dependent on time available, habitat, and target species.

Given the size of the Wakatobi National Marine Park, Operation Wallacea employs the use of a liveaboard research vessel, known as the Bintang Sedang, as a means of conducting research in areas of the park that are not readily accessible via day trips from the Hoga base. The Bintang Sedang is a mid-sized vessel that holds a small research crew of up to twelve people. Research surveys are conducted at varying sites within the park 2-3 times per day, depending on crew size. Research occurring on the Bintang is typically that of Reef Check surveys that aim to assess the integrity and health of local reefs by monitoring a number of elements, including plant/algal, invertebrate, coral, and fish species over selected transects typically spanning 80m. The aims of Reef Check surveys are twofold: the first aim is to raise public awareness about the value of coral reefs, the threats to their health, and the solutions to the problems facing them. The second is to obtain sufficient high quality data on the status of given reefs in order to allow them to be managed on a local, national and regional scale. Surveys occur on both pristine (unimpacted) reefs as well as human-impacted ones, however they are restricted to moderately exposed reefs with both a crest and outer slope, so that a variety of different niches and habitat types are represented. Transects at two different depth contours of 2-6 and 6-12m are used to record data. Each transect is 20m long, and four main types of data are collected, namely:
• Site descriptions (observational and historical locations)
• Fish belt transects (4 transects, each with a 2.5m observation radius around the transect line)
• Invertebrate belt transects, with the same parameters as the fish transects
• Substratum line-intercept transects, comprised of four 20m consecutive transects, with point sampling occurring at 50cm. intervals.

The transects are designed to look for specific species or species types that are typically indicator species that give an idea as to the overall reef diversity. Also, the presence of any large species such as sharks, turtles and rays are recorded regardless of their distance from the transect line. All surveys take place at the same time of day, typically morning and late afternoon, so as to maintain consistency, as a greater number of species are typically active at these times and may be inactive during other times of the day. Lastly, any other factors pertaining to reef integrity are noted, such as instances of coral bleaching, increasing algal dominance, or evidence of destructive fishing events.

The opportunity to actually utilize and apply the theories and information presented in lectures and instruction allows for them to be learned rather than simply presented and remembered. Skills gained from this experience include the ability to identify numerous algal, plant, invertebrate, fish and coral species, knowledge of how to properly define survey and sampling methods that match the parameters of the and objectives of the study, as well as the ability to identify various types of disturbances and their effects on reef ecosystems, such as those previously listed.
6.0: Recommendations

The Kaledupa fishery seems to be recovering as a result of concerted efforts to seriously and equitably consider the biological, social and economic factors that affect the fishery. However, now that the overall management plan is underway, there are a number of further possible improvements and recommendations that may be made. Among them should be plans to investigate more means of developing alternative income streams so as to further diversify the local economy, making it more dynamic and able to adapt to change. Also, further development of stakeholder communication avenues should be considered so as to address potential issues of contention before they become significant problems. Social equity must be ensured as a part of this, as some cultural values may need to be considered heavily, such as those of the Bajo villagers, who maintain traditional ways of life within the park. A major improvement that can be made on the existing management plan is an increase in funding for park monitoring (such as patrols and inspections) in order to reduce the incidents of destructive or illegal fishing methods, as well as poaching. In developing ecotourism opportunities in the area, it is also important to establish high standards in order to ensure the sanctity of local habitats and populations for both marine species and local communities. An example of this would be moving away from the development of resort-type facilities in lieu of ones that expose potential ecotourists to all sides of the area, cultural, economic and environmental, so that they are sensitive and/or educated on the local situation.
Also, stricter repercussions for instances of poaching and destructive fishing need to be implemented, especially for foreigners and individuals from outside the community. This was made especially evident during my time on Hoga, when a group of European sport fishers caught and killed via spear gun the long-standing apex predator of a protected reef, a King Barracuda nicknamed ‘Barry’ by local researchers. This was done on a reef in the vicinity of the main research station on Hoga, and in extremely close proximity to a group of student divers, posing a public safety risk as well. It is also recommended prior to any major development projects that may in some way affect the fishery that comprehensive consultation with researchers and local communities should be first undertaken; coral and marine ecosystems can be very fragile in nature and easily susceptible to even small alterations of the surrounding environment. Therefore due care and the consideration of long-term costs to benefits must be carefully considered.

Conservation management plans in other regions of the Wakatobi Marine Park should also be implemented using similar frameworks to that of Kaledupa that are adapted to address the unique concerns of local communities. Pending the initiation of such processes, an organization with the aim of facilitating continued communication between various communities should also be formed. Lastly, the establishment of a sustainable harvest program and practices in the development of alternative income plans such as that of the seaweed processing plant should also be undertaken. Sea grass beds are an integral part of marine ecosystems, and it must be ensured that the overexploitation of fisheries will not
necessarily be substituted by the overexploitation of grass beds, which serve as important nursery grounds for larvae and various immature forms of species found on coral reefs in adult form.

7.0: Conclusions

Socially oriented and responsible conservation management planning will need to play an increasingly important role in the future development of natural resources in order to achieve high yields without severely impacting the overall biodiversity of ecosystems. Given the increasing global population, high yield and healthy ecosystems will be of great importance. Therefore, it is critical to begin the development of these plans now, in order to avoid any crises that may otherwise arise as a result of ecosystem collapse or mismanagement. This is especially true for marine systems, which can be very sensitive to pressures and disturbances. The Kaledupa Fisheries Project is a prime example of this type of planning, as it heavily incorporates social and economic components into its objectives alongside biological and environmental considerations. In doing so, a balance is struck that results in a more equitable solution for all stakeholders, both human and otherwise.
Notes:

1. Some notes were gathered from a series of lectures spanning from August 6-10th, 2011 on the topic of coral reef systems as a part of reef ecology training with Operation Wallacea.

References/Works Cited:


