Impact of snorkeling tourism on marine habitats of Watamu Marine National Park

A Conservation Research Report

by

A Rocha Kenya

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A Rocha Kenya, Watamu

— *A Rocha Kenya Occasional Research Report #26* —

December 2012

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Executive Summary

This study investigated the impact of snorkelling tourism on coral reef habitats and its implications for the ongoing sustainability of Watamu Marine National Park (WMNP) in Kenya. A range of factors were studied including evidence of damage to coral, benthic composition, the number of boats and tourists visiting the park, tourist demographics and tourist enjoyment of the park. There was some evidence to suggest that tourist pressure resulted in changes to marine life in the heavily visited 'Coral Gardens' site including snapped coral, lower coral cover, higher turf algal cover and lower abundance of *Acropora* corals. Tourist levels were similar in magnitude to reefs in other tropical resort areas at around 10,000 people a year. The degradation caused didn't seem to diminish the enjoyment of the majority of visitors with 78% of tourists willing to pay park entrance fees at the current levels. However, it is concluded that management steps are required to ensure the future ecological and economic sustainability of the park.

1. Introduction, rationale and objectives of the Study

Fig. 1.1 Tourist trampling in Coral Gardens
Photo – Benjamin Cowburn

Tourism is big business in Watamu Marine Naitional Park (WMNP) as in many Marine Protected Areas (MPAs) around the world (Davis and Tisdell 1995). In 2010 approximately 20,000 visitors entered the park and reserve paying $240,000 in park entrance fees (Alati 2011). Income from tourism is by far the largest economic gain from the ecosystem in the park with income from recreational use being two orders of magnitude greater than income from fishing in the reserve (Alati 2011). However, the very people paying to enjoy the wildlife of the park may be causing damage to the habitat (Fig. 1.1), a threat observed in popular tropical MPAs around the world (e.g. Hawkins and Roberts 1992, Muthiga and McClanahan 1997, Medio et al. 1997).

Damage may come from several sources (Hawkins and Roberts 1992 and Hemery and McClanahan 2005), including finning and resuspension of sediment, finning and scraping of substrate, trampling substrate, holding substrate, removing organisms and benthic components and fish feeding. These behaviours have been shown to damage the reef through harming and breaking coral (Kay and Liddle 1989), altering community composition of reefs (Allison 1996) and reducing aesthetic appeal of reefs (Hawkins and Roberts 1993). MPAs in tropical developing countries have multiple goals including to promote conservation and tourist income. Where these goals conflict a balance should be made (Dixon et al. 1993 and Davis and Tisdell 1995). Tourist induced damage to reefs can reduce both conservation and tourist value of a location and so it is crucial to understand how these two parameters are being affected by damage in order to maintain an ecologically and economically sustainable park. No such assessment has been completed for WMNP.

Dixon et al. (2003) set out a framework to consider the different parameters of how tourists and damage are related shown in Figure 1.2. The extent of damage could come from the number of tourists visiting the park, i.e. more tourists more damage. However, it has been shown that good snorkelling practise can reduce damage per tourist (Medio et al. 1997). Dixon et al. also introduce a concept called in this study the "sustainable threshold model" with defined levels above which the ecological and aesthetic damage become unacceptable and detrimental. There is

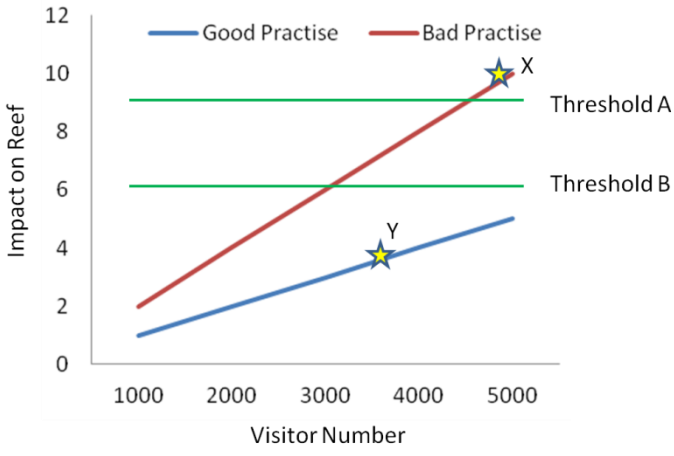

Fig. 1.2 Sustainable threshold model. Relationships between tourists and condition of the reef, after Dixon et al. (1993)

debate about where these thresholds lie (e.g. Plathong et al. 2000) and it is also interesting to consider which threshold comes first as degradation progresses. Is an ecological threshold met before an aesthetic threshold or *vice versa* (shown in Fig. 1.2 as threshold A and B to avoid indicating which is crossed first). To a large extent these thresholds will be determined by a definition of acceptable levels of damage and local factors, such as reef resilience (for ecological threshold) and tourist demographic (for aesthetic threshold). From this model it can be summarised that the following factors are important to understand the sustainability of a tourist industry in an MPA;

- Number of visitors
- Visitor behaviour
- Ecological state of the reef
- Visitor profile

There are many studies which have examined various aspects of reef tourism in MPAs, but very few which link the factors together (see Barker and Roberts 2004 and Medio et al 1997 for a broad coverage). There is also an imbalance of attention to certain issues, for example many papers have focussed solely on tourist induced ecological damage to reefs (e.g. Hawkins and Roberts 1993), but far fewer on how this damage influences enjoyment and willingness to pay (e.g. Dixon et al. 1993). Watamu Marine National Park has received very little attention as to the state of its tourist industry. The aim of this study is assess where the park is within Fig. 1.2; are we in sustainable position 'Y' with reasonable tourist numbers, good snorkelling practise and acceptable reef condition or in 'X' with too many visitors damaging the reef through bad snorkelling to a point which serves neither conservation or tourists?

1.1 Specific Objectives

1. Investigate the number of tourists visiting the reef.
2. Assess the extent to which bad practise occurs.
3. To determine whether the marine life in the main tourist visited site is negatively affected compared to less visited sites.
4. Determine the level of snorkelling experience and environmental awareness of tourists visiting the park. Who are our customers?
5. Investigate the tourist perceptions and enjoyment of the reef and reef-based trips. What do our customers think?
6. Determine the level of information transfer about the park from various stakeholders to tourists. How are we managing our customers?

2. Methods

There are four methods utilised to answer the above questions:

1. Data collection from tourist boats and KWS patrol boats examining tourist numbers and bad practise. This will provide information for objectives 1 and 2.
2. Shore-based boat counting to assess total number over a longer period. For objective 1.
3. Ecological survey of coral damage comparing impacted and un-impacted reef sites. This data collection will fulfil objective 3.
4. Questionnaires to gauge awareness, perceptions and information transfer to tourists, which will satisfy objectives 4, 5 and 6.

2.1 Boat-based data collection

In Watamu most tourists visit a reef site known as Coral Gardens when they visit the park and most other reefs found in the lagoon receive few to no visitors. When collecting boat-based data one recorder would sit on the boat at Coral Gardens and the following data would be collected: tourist boat arrival time, tourist boat leaving time, number of tourists on the boat and number of tourists that get into the water. Specific tourists would be chosen haphazardly and the amount of time they spent in the water recorded.

Observers would enter the water and follow a tourist for ten minutes without their knowledge. In those ten minutes, the number of times they were observed finning and resuspending sediment, finning and scraping the substrate, trampling substrate, holding substrate and removing organisms and benthic components were recorded. The gear they used would also be recorded.

2.2 Shore-based monitoring

Boat counts were conducted from a roof onshore overlooking Coral Gardens for an entire day. The goal was to count every boat that went out that day as well as how long the boat spent at Coral Gardens. Binoculars will be used and the names of boats recorded to ensure a boat wasn't counted twice.

2.3 Ecological Surveys

The surveys comparing Coral Gardens and those reefs less visited by tourists follow the methods used by Muthiga and McClanahan (1997) who investigated the effects of tourists on Kisite Marine Park in Southern Kenya.

There are three main ecological components to the surveys;

- Benthic Cover: 10m long line intercept transects placed parallel to one another along the reef at 5m intervals. The following categories were recorded along each transect: hard coral, soft coral, fleshy algae, turf algae, coralline algae, sand and rubble. The length of each patch/colony of this benthic type was measured in order to produce percentage benthic cover of each substrate type.

- Community Structure: The genra of the hard coral and algae found along the transects was recorded in order to see if there are differences in community composition between impacted and un-impacted sites.
- Damage Index: 1m quadrats were placed at three intervals along the transects and the following categories of damage recorded for each quadrat: abraded coral, snapped coral, diseased coral, bleached coral and dead coral overgrown with turf algae. Each sign of damage was scored once per quadrat, giving a maximum damage index of 5.

2.4 Questionnaires

Questionnaires were conducted with tourists visiting the park on tourist boats by asking questions on the way to Coral Gardens and on the way back. The questionnaires were divided into three sections. The first section assessed their awareness of conservation issues and prior experience of snorkelling coral reefs. A second section was about the information transfer to them of the keys issues mentioned before, such as reef's protected status, wildlife and snorkelling safety. A final section sought their opinions and enjoyment of the reef and the tourist experience they received.

On the way out general questions such as, "how did you find out about the snorkelling trip?" and "how do you rate yourself as a snorkeller?" were asked and on the way back specific questions were asked relating to their experience, such as, "did you notice any human impact on the reef?" Open questions like, "what human impacts do you know which can damage coral reefs?" were asked without any suggestions and assigned to categories post-hoc. Questions were designed to be indirect, non-leading and non-confrontational in order to get honest responses, for example, asking "Please describe the reef's legal protected status" instead of "Do you know this is Marine Protected Area?"

3. Results

3.1 Boat and Tourist Observations

Boat and tourist observations were made during to the peak tourist season from October 2011 until February 2012.

3.1.1 Magnitude of Tourism to the Reef

A total of 64 boats were observed on 17 days both from boats at Coral Gardens and from rooftop observations. Rooftop observations were used to assess total numbers of boats each day, giving an average 10.7 (SE±0.83) boats. However this was based on a small sample size of 6 days only in February. Boats spent an average 38 minutes (SE±2.28) at Coral Gardens, with some spending up to 1 hour and 25 minutes and spending a minimum of just 10 minutes.

Counts of people in boats were conducted while at Coral Gardens showing an average 13.4 (SE±1.2) people per boat, but there was a large amount of variation with some boats having over 30 visitors, while others had just one or two tourists aboard. Using average boat number (above) and counts of people, a tentative figure of 143 people can be estimated to visit the reef every day; a number which is not highly robust, but can give an idea of magnitude. Interestingly, it was observed that not everyone visiting the reef actually got in the water, with 36% of tourists remaining on the boat. This means that on any one day an estimated 91 people swim on the coral reef.

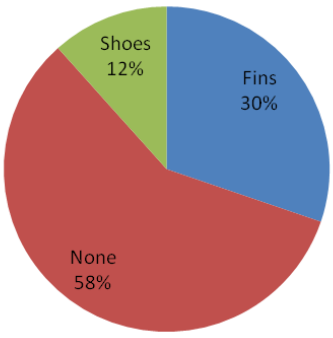

Fig. 3.1 Proportion of Visitor footwear

3.1.2 Tourist Behaviour at the Reef

Tourist behaviour was monitored by watching people from boats and following them in the water. There were 93 people observed from boats and 47 people followed in the water. Observations were intended to be 10 minutes long, but because some people left the water before 10 minutes expired a total 396 minutes were recorded.

The average time in the water was 19.1 minutes (SE±1.18) and maximum time observed was 1 hour and 6 minutes. Most visitors went in the water barefoot, but 42% did wear some footwear (Fig. 3.1). 15% used a buoyancy aid of either a ring or life jacket. Remarkably not all tourists went into the water with a snorkel and mask with 15% merely swimming or playing in the water (see Fig. 3.4).

64 examples of contact between tourists and the reef were observed through in situ sampling (Fig. 3.2). These were classified into trampling, sediment suspension, holding, scraping and removing objects. The

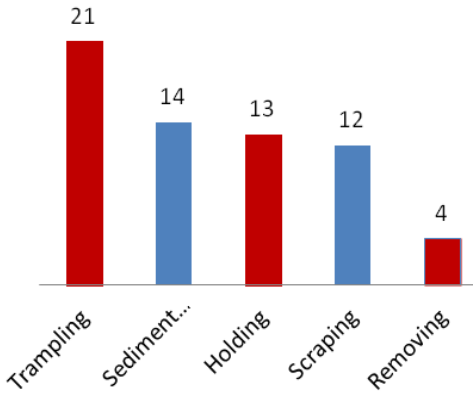

Fig. 3.2 Proportions of contact type with reef. Red = Intentional, Blue = Accidental

most common contact was trampling, observed 21 (32%) times (Figs. 3.2 and 3.4). These contacts can be classified as intentional and accidental e.g. removing a shell is intentional whereas kicking a coral while swimming is not; over half the observed contact (59%) was intentional (red in Fig. 3.2).

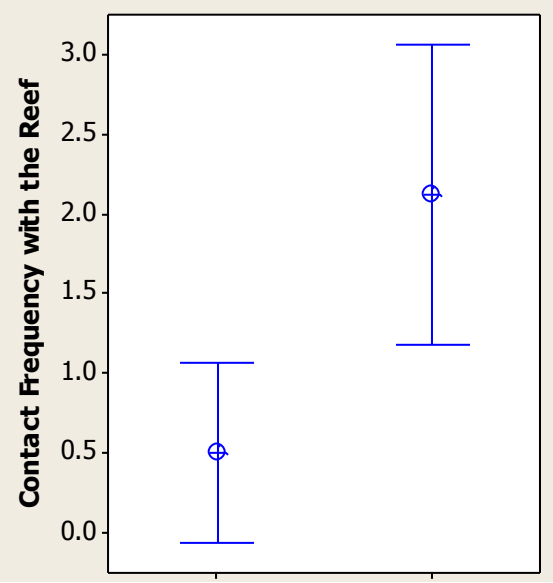

Fig. 3.3 Interval plot of contact frequency at different tide states. Interval = 95% Confidence Interval

The relationship between contact frequency and footwear was investigated. There was no significant difference between the number of times people made contact with reef and whether they wore footwear or not (p=0.904) i.e. barefooted people were just as likely to stand on or scrape the reef as those with fins or shoes.

The relationship between contact frequency and tide state was also investigated. Low tide was defined as Chart Datum up to 0.8m above it and high tide from 1.8m to 2.3m, with equal numbers of tourist observations being made at either tide state. A one-way ANOVA showed that this was highly significant (p=0.006) with tourists at low tide making more contact with the reef (mean 2.2 (SE±0.46) times per 10 minutes) than those at high tide (mean 0.5 (SE± 0.27) times per 10 minutes) (see Fig. 3.3).

Fig. 3.4 Examples of tourist behaviour at Coral Gardens. Left: Standing on coral head at low tide Right: Tourists concentrated at coral gardens; note two people in foreground not wearing snorkel or mask and top right; a boat full of people, many not snorkelling.

3.2 Benthic Surveys

A total of 38 transects and 69 damage quadrats were completed in Coral Gardens and ecologically similar areas of reef to the north and south. Coral Gardens will be often referred to as the 'snorkelled site' and other areas as 'unsnorkelled sites'. It should be noted that unsnorkelled sites do still receive visitors, but at a much lower, and assumed negligible frequency, than Coral Gardens (pers. obs.)

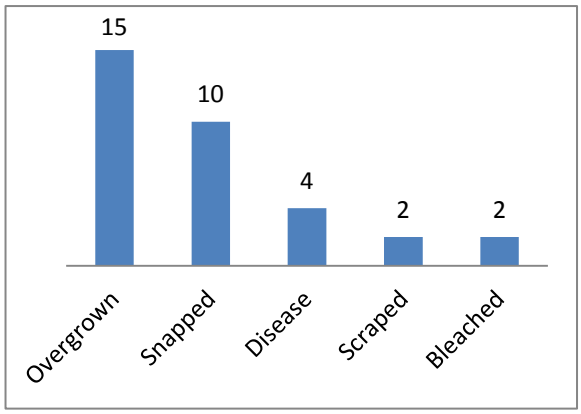

Fig. 3.5 Frequency of damage types

In the damage quadrats a total of 33 examples of coral damage were observed including overgrown, snapped, diseased, scraped and bleached corals (Figs. 3.5 and 3.6). The most frequent of these damages were corals killed and overgrown with turf algae and snapped corals. Coral damage was seen in coral gardens and in less visited areas of the reef as well. Due to the statistically low frequency of damaged coral for the area covered by quadrats it was not possible to see if there were any significant differences between snorkelled and unsnorkelled sites in terms of damage observed.

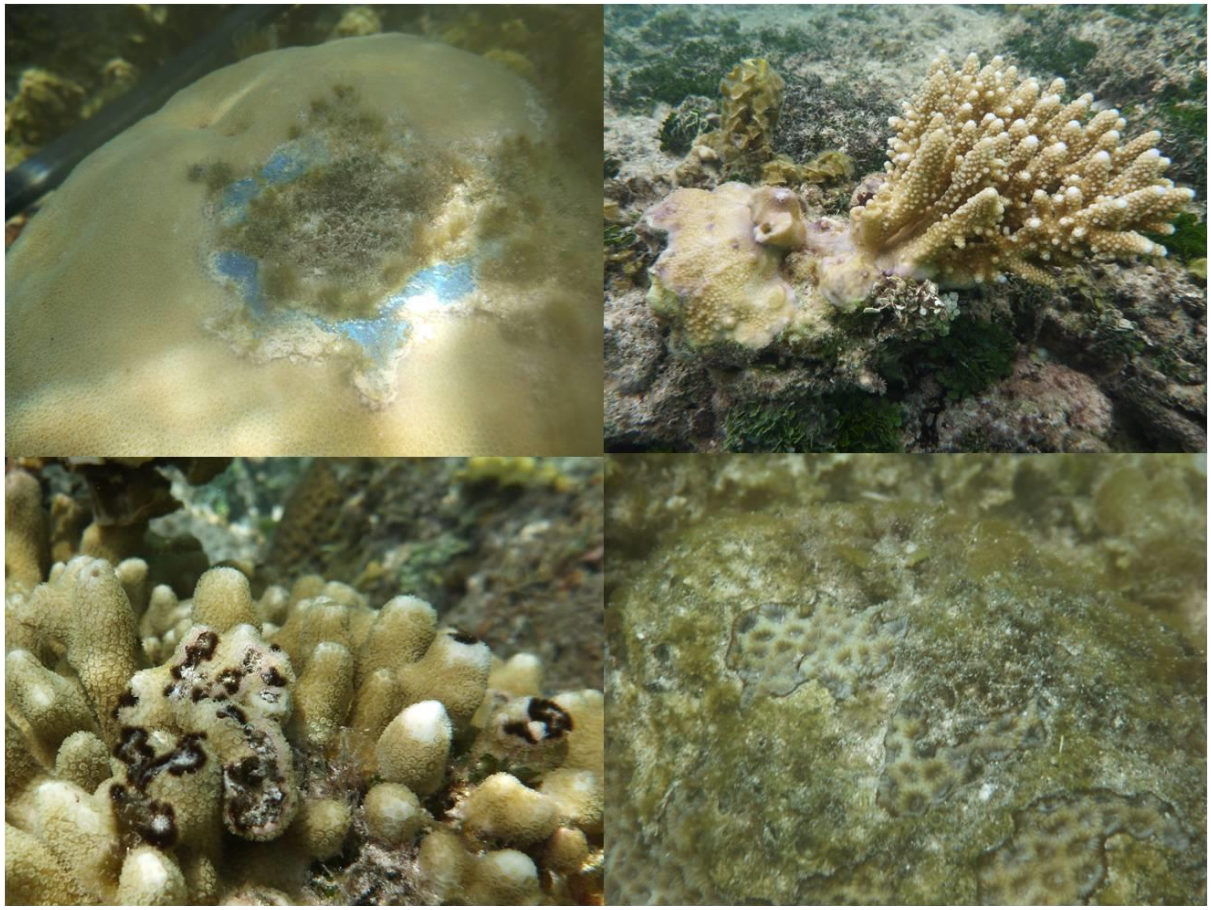

Fig. 3.6 Photos of coral damage. Clockwise from top left: Porites head scraped by a boat; snapped Acropora, Favites overgrown with turf algae and snapped and diseased branching Porites. (all photos by Benjamin Cowburn)

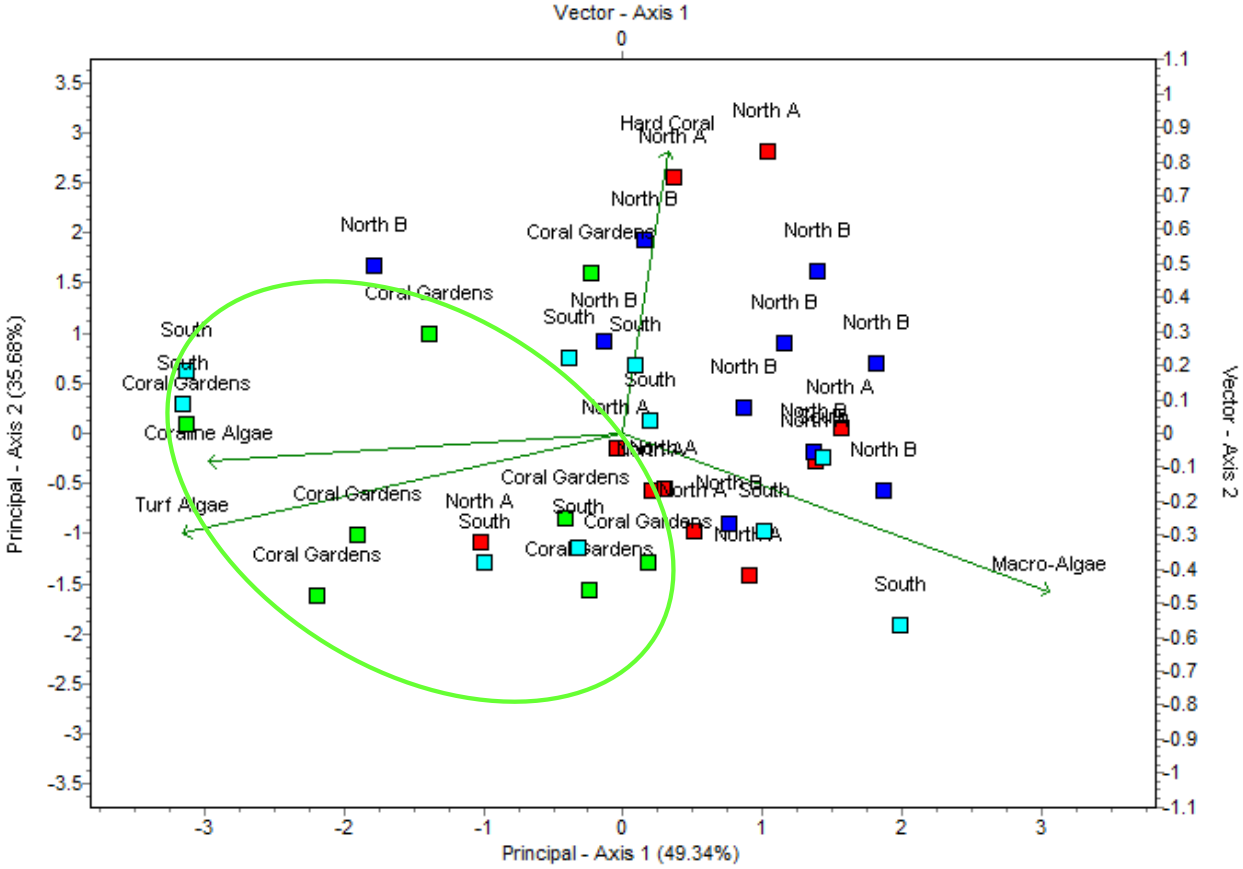

Fig. 3.7 Principal Component Analysis Plot for coral, macro-algal, turf algal and coralline algal cover. Green - Coral Gardens; Red, light blue and dark blue – Unsnorkelled sites. Ring drawn to highlight coral garden cluster.

A principal component analysis (PCA) was conducted on the data from transects. This is a multivariate technique which plots multiple ecological axes, in this case coral cover and various algal covers, into multi-dimensional space. The plot (Fig. 3.7) shows these points condensed into two imaginary axes to show how the communities recorded along each 10m transect cluster by similarity. The first and second imaginary axes combined explain 85.02% of the variation between points, indicating that this representation of the data is robust.

From the plot it can be seen that snorkelled sites at Coral Gardens are clustered with a degree of separation from other transect points (green ring) and characterised by high levels of turf algae and coralline algae (indicated by arrows pointing in this direction). One-way Analysis of Variance (ANOVA) was used to test levels turf and coralline algae by site and it was found that Coral Gardens did indeed have statistically significantly higher levels than unsnorkelled sites (turf p=0.017, coralline p=0.005) (Fig. 3.8).

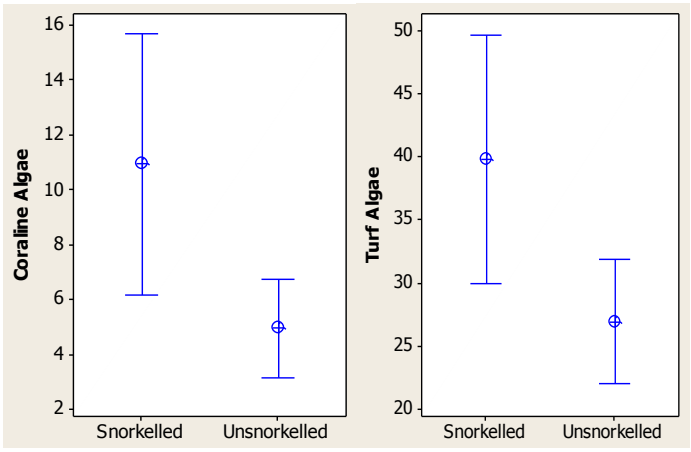

Fig. 3.8 Mean and 95% Confidence Interval for % Cover of Coralline and Turf Algae at different sites.

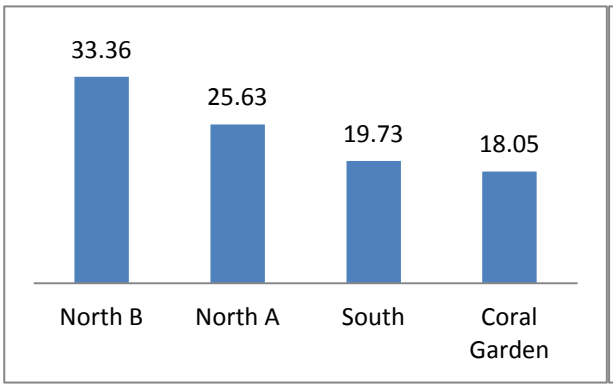

Fig. 3.9 % Hard Coral Cover at different sites

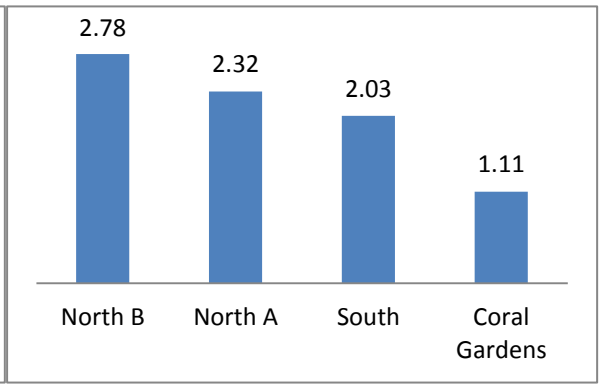

Fig. 3.10 % *Acropora* Cover at different sites

Coral cover ('hard coral') is pointing away from the Coral Gardens (Fig. 3.7) indicating lower levels in Coral Gardens. Figure 3.9 shows that coral cover was indeed the lowest at Coral Gardens at 18.05%, but a one-way ANOVA showed that this result was not significant ($p=0.112$). Coral genera were also recorded during benthic surveys and it was noticed that *Acropora,* the most common branching coral, was less abundant in coral gardens (fig. 3.10). *Acropora* in unsnorkelled sites covered, on average, 2.38% (SE±5.02) of the benthic surface compared to just 1.11% (SE±6.92) in snorkelled Coral Gardens, however this difference was not statistically significant when examined in a one-way ANOVA ($p=0.233$).

3.3 Questionnaires

A total of 50 questionnaires were conducted on 11 boats interviewing 6 nationalities (American, English, French, German, Kenyan and Italian) of tourist visiting the reef. Main trends are shown here, but numerous qualitative comments were also gathered. Please note that number of tourists for a particular response is quoted as the main form of result below. Sometimes percentage is given in brackets, which varies because not all tourists answered all the questions i.e. in one question 5 people = 10% in another it could be 15%.

3.3.1 Tourist Demographic

The majority of people visiting the reef had some prior experience of snorkelling and coral reefs. Four people (8%) were experiencing snorkelling for the first time, but over half of people (54%) considered themselves to be intermediate to experienced snorkellers. For 9 people (18%), their visit to Watamu was the first coral reef they'd ever visited, but on average people had visited 3 reefs before, in a range of locations around the world, with one visitor claiming to have visited over 20 reef locations. These reefs were located in 25 countries (see Fig. 3.11), with most commonly visited locations being Egypt, Maldives and other reefs excluding Watamu in Kenya. '

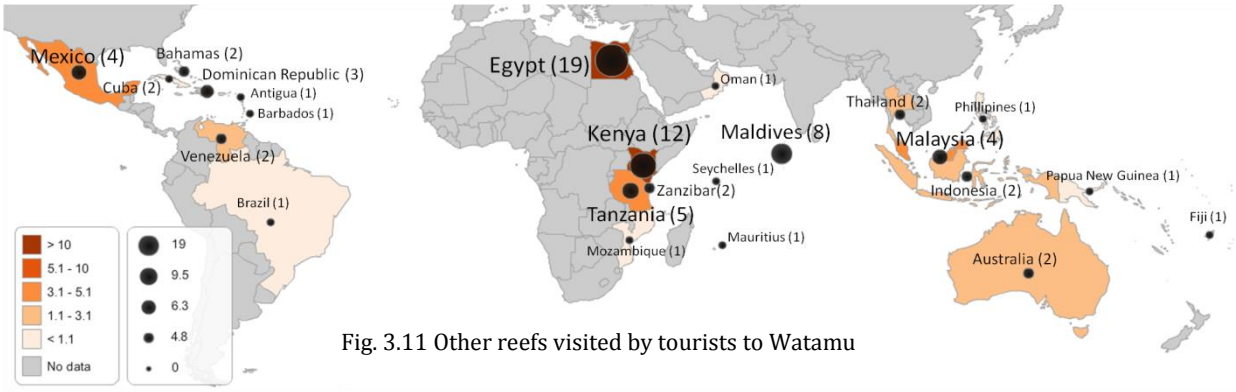

Fig. 3.11 Other reefs visited by tourists to Watamu

Visitors were asked to name as many potential human impacts on coral reefs as they could. On average 2 types of human damage were mentioned, with only 8 people claiming they didn't know any impacts. A wide range of answers were given which could be placed into 14 main categories (Fig. 3.12) with the most common responses being contact with coral and pollution. Some impacts mentioned were things which a visitor personally could cause during their visit to the reef (marked red in Fig. 3.12). The questionnaires showed that 68% of respondents mentioned one of these impacts and hence had some idea that their presence on the reef could have a direct impact on its health.

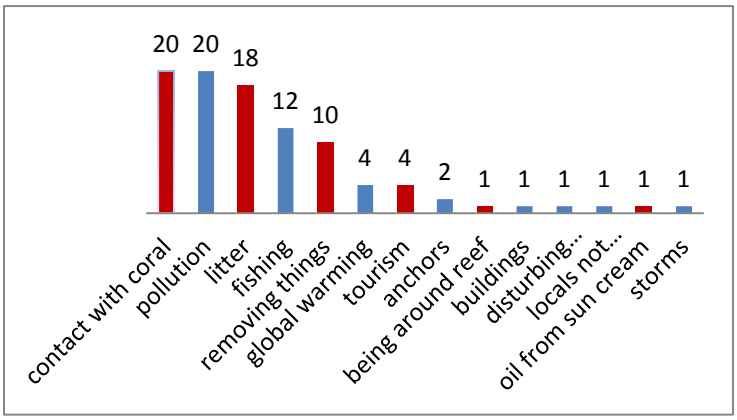

Fig. 3.12 Frequency of human impacts mentioned by tourists

3.3.2 Tourists' Perceptions and Enjoyment

Several questions were asked to understand tourist impressions of the reef itself. When asked to describe the reef using descriptive words, 82% of the words given were positive (Fig. 3.13), with the most common being 'beautiful', 'colourful', 'diverse'. Of the 18% of negative words the most common was 'not colourful' and other words included 'degraded', 'patchy' and 'dissappointing'. Five people gave only negative words, 9 gave a mix of positive and negative, while the majority of people (30) gave only positive words to describe the reef. However, despite this, a high proportion (16 people/41%) also said that they had seen better reefs elsewhere or that the reef did not meet their expectations (Fig 3.14).

Fig. 3.13 Word cloud displaying words given to describe reef. Font size indicates frequency

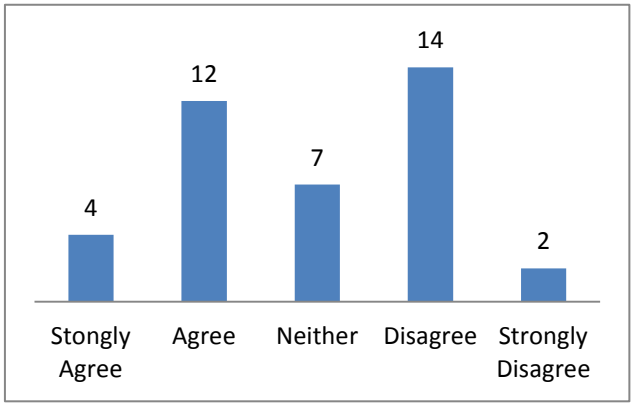

Fig. 3.14 Responses to "This reef is better than others you've seen / your expectations"

In general visitors did not notice any human impacts on the reef, with 31 people responding they saw no human influence. Of the 14 who did notice human impact, 5 mentioned fish feeding and 4 mentioned litter, with only 1 mentioning degradation of the reef. Interestingly none of the visitors mentioned they had seen the snapped and damaged coral recorded during benthic surveys.

Visitors were also asked about their perceptions and enjoyment of the excursion in terms of willingness to pay. Thirty seven people (80%) thought the excursion was value for money, while 8 (17%) said it was not. When told that the park entrance had cost $15, half of people thought this was a reasonable price and 12 people (30%) suggested higher prices for entry, but 8 (23%) thought the entrance fee should be reduced. Visitor opinion of boat operators was mostly positive and approximately 90% of people thought their boat operators were friendly and helpful. Thirty two people (67%) thought that the boat operators provided appropriate snorkelling gear, but 8 people (17%) disagreed with this. The lowest opinion related to how knowledgeable their boat operators were about the reef with just half of people considering them knowledgeable.

The several questions relating to tourist enjoyment were condensed into an 'enjoyment score' by scoring responses for each question numerically and then summing the scores. For

example each positive word mentioned when describing the reef was award 1 point and each negative word was -1, hence three positive words increased their enjoyment score by 3. The same exercise was done for their previous experience and awareness, creating an 'experience score'. While these scores are somewhat arbitrary, careful consideration was given to the weighting and nature of responses contributing to a score and these scores can give a tentative idea of any particular visitors overall previous experience and excursion enjoyment. A regression analysis then explored the relationship between enjoyment and experience finding that there is a near significant (p=0.053) negative relationship (Fig. 3.15). This implies that more experienced tourists didn't enjoy Watamu Marine National Park as much as those with less coral reef experience.

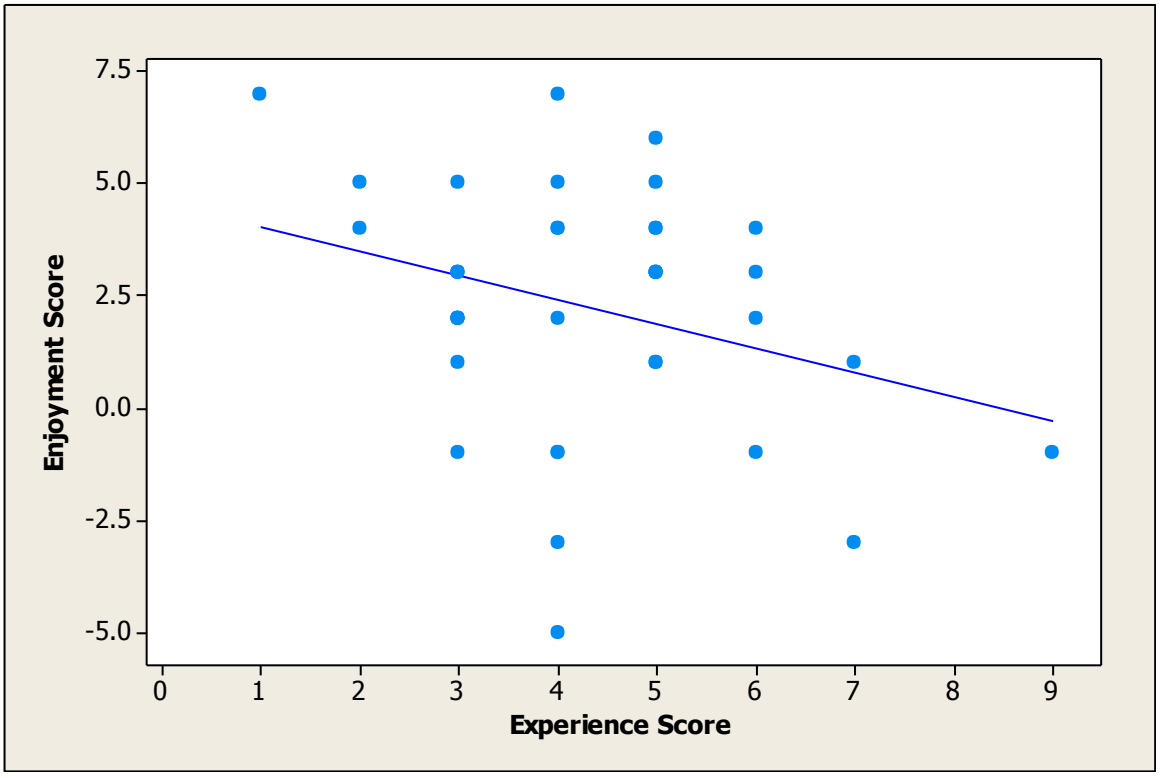

Fig. 3.15 Regression of experience and enjoyment

3.3.3 Information Transfer to Tourists

The majority of tourists found out about visiting the reef once they had already arrived in Watamu with 56% of people discovering about snorkelling excursions from either beach operators (informal salesmen on the beach) or from their hotels (Fig. 3.16).

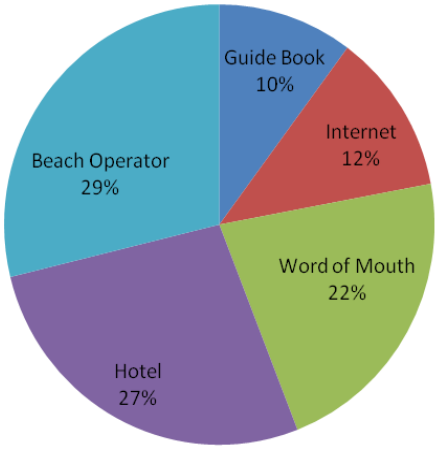

Fig. 3.16 Sources from which people discovered about reef excursions

Visitors were asked how much information they were given by their hotel and boat operators on various topics (Fig. 3.17). They were able to answer that they were given either no information, a little or a lot of information. The majority of visitors didn't feel they received any information on any of the topics, with over half responding "none". The most information provided by both hotels and boat operators was about wildlife in the park (19 and 21 respondents respectively) and the least information given was about how to use equipment (8 and 17 respondents respectively).

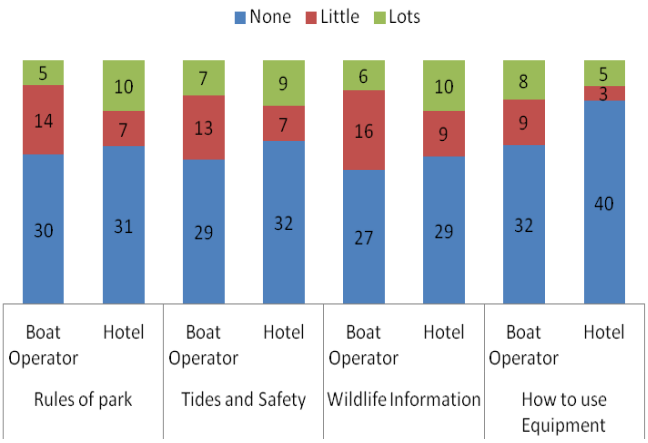

Fig. 3.17 Information Visitors received from hotels and boat operators

Finally visitors were asked if they had seen Kenya Wildlife Service (KWS) during their excursion to the reef. Although it was recorded that KWS were indeed present with their own labeled boat at Coral Gardens for 47 of the 50 interviews conducted, only 17 visitors noticed their presence. Just 3 of these claimed that KWS offered any information or assistance during their visit to the park.

In order to understand awareness of the marine park, visitors were asked to describe the reef's legal protected status. Eighteen people didn't answer this questions indicating they didn't understand what was meant by "legal protected status", which could suggest a lack of awareness of park status. A further 18 said categorically they didn't know if the reef had a legal status and only 14 gave an answer indicating they knew the reef was a MPA (e.g. game reserve, national park). Further to this people were asked if any of the money from the excursion fee went to conservation (i.e. the $15 park entrance fee every visitor must pay), and only a quarter of people (13) knew that they had paid a park entrance, and only 7 knew the correct price of this park entrance fee.

4. Discussion

4.1 Linking tourist numbers, behaviour and ecological damage caused.

Counts of tourist numbers indicated a rough estimate of 143 people visiting Coral Gardens a day with 91 actually swimming each day on the reef during peak season. Due to the length of the study period it was not possible to see how numbers changed through the year, but statistics of park tickets sold for 2008-2010 indicate about 20,000 tickets sold a year (Fig 4.1). Not all of these tickets were for those who visited Coral Gardens with some tickets being sold for SCUBA diving to other areas, sport fishing in the reserve and other miscellaneous reasons for entering the park without visiting Coral Gardens. On an average day in Peak Season (when counts were conducted), the three dive companies take out about 10 divers each a day (30 in total) and around 15 sport fishers go out fishing (pers. obs.), plus miscellaneous others thus estimated at about 200 tickets a day. Hence, as a rough proportion, boat trippers represent 75% of tickets sold meaning 15,000 a year, and about 50% actually swim giving 10,000 people per year on the reef.

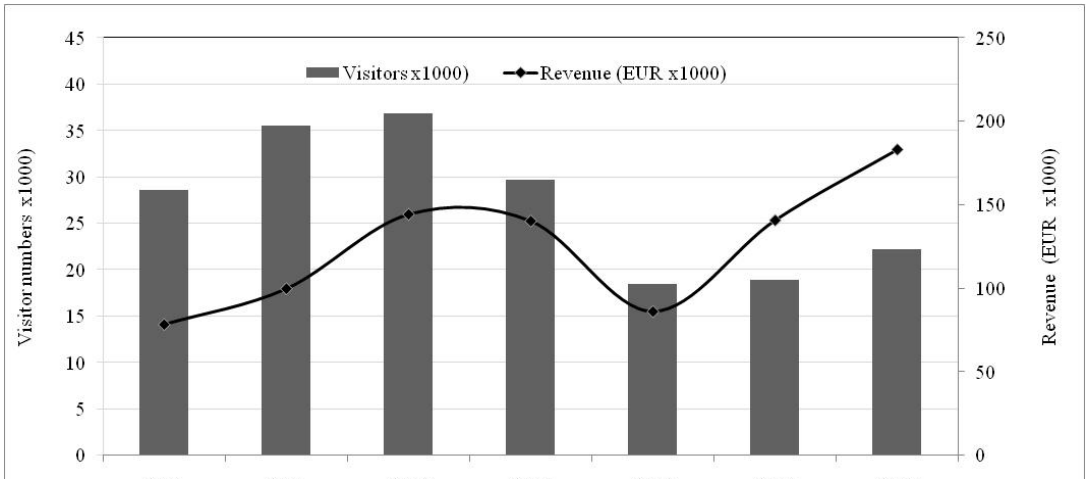

Fig. 4.1 Tickets sold and revenue gained for WMNP in recent years. Adapted from Alati (2011) with permission

This is a similar order of magnitude as other studies researching tourist visited sites, with Medio et al. (1997) reporting 20,000 per site per year, Barker and Roberts (2004) 10,000-26,000, Hawkins and Roberts 11,000 and Tratalos and Austin (2001) reporting 6000-17,000 per year. This would imply that Coral Gardens receives a rather typical level of visitors; however the other studies only assessed divers. The only study found documenting snorkeller number was by Plathong et al. (2000) in the Great Barrier Reef where only 15 people a week snorkelled the area in question, a much lower level than Watamu Marine National Park.

Number of visitors alone is not sufficient to predict damage, an idea of space and time must be taken into account. Dixon et al. (1993) assert and Tratalos and Austin (2001) confirm that most tourists in a site are concentrated around the mooring point for their boat, not travelling further than around 300m from this point giving a radial area around buoys of 1884m^2. Coral Gardens is made up of several buoys, but the area in which people are concentrated is a similar size at 2068m^2. However, snorkellers do not spend as much time in the water as divers, with the average time spent swimming being just 19.1 minutes compared to the average 40 minutes spent by divers (Medio et al. 1997).

The average number of contacts between tourists and the substrate was 0.191 contacts per person per minute or 3.65 contacts per person per trip and 331 total contacts on the reef in a day. Medio et al. (1997) observed a similar level of contact at 0.2 min^{-1}, but Baker and Roberts (2004) observed a lower level of 0.09min^{-1}. Baker and Roberts (2004) estimate that only 4.1% of contacts result in major damage such as snapping. While this rate is highly variable with benthic composition, and especially abundance of vulnerable branching corals (Kay and Liddle 1989), this figure would give an estimate of 13 cases of damage a day for Watamu. Despite this, during the study only one tourist interaction was clearly observed to result in breakage, when a man snapped a piece of coral off to show to his friends. If any other breakages occurred they went unnoticed.

Damage was observed on the reef and, while it is difficult to attribute whether these examples were of human origin, some clearly were, with an extreme example being a coral head with evidence of a boat running onto it (Fig 3.6). Damage was at low frequencies, with snapped coral frequency of just 0.2m^{-2}, and as only 15m^2 of benthic space was investigated in Coral Gardens and 54m^2 in other sites, this yielded damage frequencies too low to analyse if there were differences between areas. In addition there were no other studies found which presented damage data in terms of colonies per area, using a wide range of indicators of % damage, snapped branches per area, rubble per area and other measures. Therefore no trends can be discerned about the damage seen either within Watamu Marine National Park or compared to other locations. This highlights the need for standardisation of methods.

It seems that Coral Gardens had a distinct benthic community compared to other areas, characterised by high turf and coralline algae, lower coral cover and specifically lower levels of branching *Acropora*. This was in agreement to Allison (1996), Kay and Liddle (1989), Hawkins and Roberts (1993), Tratalos and Austin (2001) and Juhasz et al. (2010), but not to Hawkins and Roberts (1992), Muthiga and McClanahan (1997) or Plathong et al. (2000), who saw no changes in community composition. Interestingly Hawkins and Roberts (1992) and Plathong et al. (2000) both studied newly visited reefs, which had little prior tourist contact. They both claimed to see rapidly increased levels of broken coral initially, which then levelled off to stable point within months of visitors arriving, but no real changes in community composition of the reef. Studies in reefs with a much longer history of visitation saw changes in benthic community, which evidently had taken much longer to accumulate. Also interesting is that extremely low levels of visitation in Plathong et al. (2000), of just 15 snorkellers a week, still resulted in significantly higher levels of coral damage. Evidently one ecological threshold of significant human induced damage is reached at very low levels of tourist pressure. Community levels changes presumably required more time and human pressure to reach this ecological threshold, and like levels of physical damage, probably reach a stable state, where reef community becomes characteristic of high physical impact environment such as those found on reef crests (Kay and Liddle 1989). If there are higher ecological thresholds which can be crossed by tourist impact, such as localised extinctions, neither this study nor any found in the literature showed this.

4.2 Linking visitor demographics, behaviour and aesthetic damage caused

A wide range of people visited Watamu Marine National Park (WMNP), from first time snorkellers to experienced diving globe trotters. The majority of visitors had visited reefs elsewhere and hence had some level of experience and thus something to compare WMNP to. In addition most people knew of some possible human impacts to the reef with 68% mentioning something that their actions as a tourist could do to damage the reef. This indicates that the average visitor has good awareness of reefs and hence we might expect this to be reflected in how people enjoy the reef and how they behave while snorkelling.

Allison (1996) noted that more experienced snorkellers caused less damage and Barker and Roberts (2004) found that number of dives logged correlated with contact rate with the reef. This effect was attributed to the less experienced tourists' poor ability to control their movement in the water leading to unintentional contact. Indeed Barker and Roberts (2004) reported that unintentional hits from less experienced divers accounted for 81% contact with coral. However, this study observed that the majority (60%) of contact with the reef was intentional. People were most commonly observed standing on the reef to adjust snorkelling gear and sometimes simply talking to friends. On one extreme low tide tourists were even observed lying on the top of coral heads sunbathing in the shallow water. This demonstrates that despite awareness of reef issues, behaviour wasn't altered. This was also seen by den Haring (2012) leading to the conclusions that information doesn't necessarily influence behaviour.

Enjoyment of the reef was negatively correlated with experience, meaning that more experienced people presumably noticed degradation to the reef or didn't consider their boat and staff to be satisfactory. Dixon et al. (1993) saw a similar trend where more experienced divers noticed damage to the reef, but less experienced divers didn't and hence enjoyed the experience more. Despite this trend, the positive feedback about the reef and the trips far outweighed the negative comments with about 80% or more of all responses being positive. More importantly 'willingness to pay' was high with 78% of visitors willing to pay the $15 entrance fee. Most interestingly is the fact that, although the majority of feedback about the reef and the trips were positive, 41% said they had seen better reefs elsewhere. What this means is that quality of reef was not necessarily the only or even the main driver for visitor enjoyment.

Many of the boat excursions in Watamu also go for dolphin watching and to a sandy island for a picnic and several people said that this was the favourite part of the excursion for them. In addition is was evident from tourist observations that some people weren't very interested in snorkelling, spending a relatively short time in the water or swimming without mask and snorkel. Indeed some people just wanted to sunbathe, which is favourable for conservation if they are paying park entrance and sunbathing on the boat, but not if they are sunbathing on coral heads.

Williams and Polunin (2000) investigated the factors which people most enjoyed about reefs and found that actually people were most interested to see fish and coral cover and diversity was lower on their desired list. Davis and Tisdell (1995) noted that although wilderness, beauty and diversity were important drivers for people to go on an excursion, access was most important if the reef was easy to get to. Coral Gardens is located less than 2km from several large hotel complexes and fish feeding ensures there are always large active shoals of fish when visitors are present. The fact that at least 56% of people only found out about visiting the reef after arriving in Watamu shows that snorkelling and marine life was not the main reason for their holiday, and so it is to be

expected that their enjoyment isn't necessarily linked to these factors. As Hawkins and Roberts (1994) claimed, some people want "warm clear water, regardless of what there is to see".

These findings highlight the importance of visitor profile for setting the aesthetic threshold into the sustainable threshold model (see Fig. 1.2); not everyone engages in reef tourism for the same reasons and not everyone will view the reef in the same way. Despite awareness and experience, people are not dissuaded from engaging in potentially destructive behaviour nor is their enjoyment of trips diminished by bad practise or degraded coral. Therefore it could be concluded that the aesthetic threshold for Coral Gardens has not been reached.

4.3 Linking management and sustainability of the park

This study found tourist visitation to Watamu Marine National Park (WMNP) was impacting Coral Gardens, and through the data collected and comparisons to findings in the literature, it is asserted there are two significant ecological thresholds which WMNP has crossed; causing human induced coral damage and a difference in community composition (Fig. 4.2). Due to the nature of the tourists and reef excursions offered, the aesthetic threshold for Watamu is high and above the ecological thresholds. The high enjoyment and willingness to pay indicate that this threshold has not yet been breached. We also argue that snorkellers at WMNP should generally be placed in the Bad Practise category based on *in situ* observations reported herein.

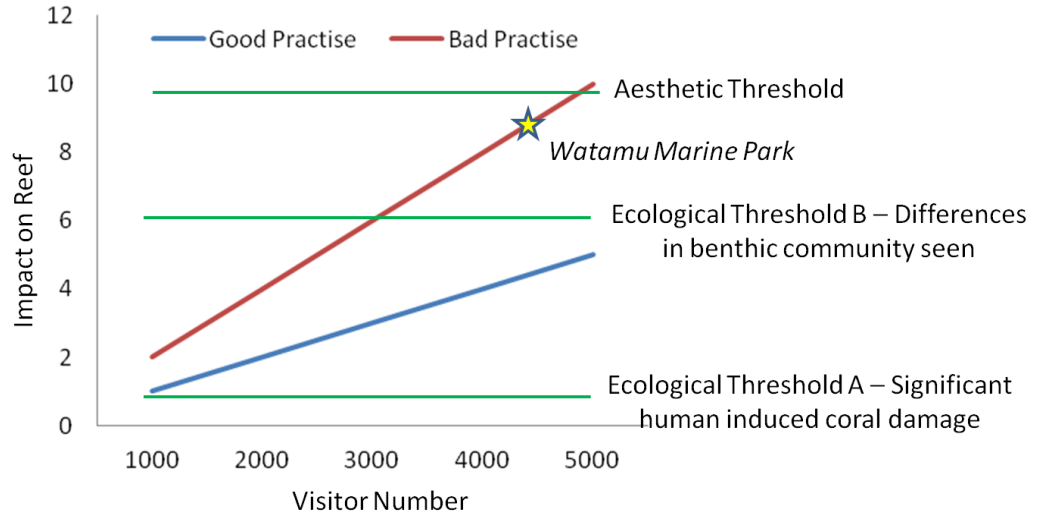

Fig. 4.2 Sustainable threshold model for Watamu. Relationship between the tourists in Watamu and the condition of the reef. Note: positions are relative and subjective to the findings of this study

Management can influence the extent of visitor impact and even the gradient of damage per visitor (i.e. good or bad practise). den Haring (2012) listed four ways in which park managers influence the impacts of their visitors through physical exclusion, rules and regulations, economic costs and education/interpretive means. Findings from this study point to certain management decisions which may increase the sustainability of the park for both conservation and tourist income purposes.

In terms of rules and regulations it is apparent that damage is being caused to the reef and the simplest way would be for all those involved in this process to reinforce rules and regulations which already exist. For example it is illegal to knowingly stand on the reef or remove objects from the reef (WMA 2010). Kenya Wildlife Service (KWS) were present in their boat at coral gardens for 47 of the 50 interviews conducted, but only 17 people noticed their presence. Only a minority of people knew they were in a marine park and only 40% of people claimed that their hotel or boat operator told them any rules about the park. This suggests that all stakeholders in park may need to play an increased role in providing information about park rules and regulations as the first step to establish good snorkelling practise at the reef. Limiting snorkellers to Coral Gardens only and forbidding boat access to other sites may help conservation of the various habitats and other coral areas in the rest of the park. Using an area like Coral Gardens as a sacrificial site is a model has been used effectively in Costa Rica's national park system in both their coral and rainforest areas (Benjamin Cowburn pers. obs). This way conservation and economic success can be achieved without having to make difficult compromises, such as limiting tourist number. A final regulation would be limiting boat access at the lowest tides. Tourist contact with the reef was significantly higher at low tides and several examples of coral with boat hits demonstrate that visiting during shallow water causes more damage.

While rules and policing are important for managing any park, education and interpretation has also been shown to be very important reducing visitor impact to a reef (den Haring 2012). Medio et al. (1997) found that a briefing on coral reef ecology and potential threats to reefs reduced visitor contact rate by half. In addition to this education also increases enjoyment of the park and hence reducing the risk of crossing the aesthetic threshold (den Haring 2012). When asked what would have made their trip more enjoyable 5 tourists said they would have liked more information about the reef. Currently very little information is given to tourists visiting WMNP, either from their hotels or boat operators and as a result this study found that just 28% people interviewed knew they were in an MPA. Even more worrying is some of the information which was given, such as boat operators telling one woman to stand on coral if she got tired and that they would find her some shells to take home as a souvenir if she wanted. Community members involved with tourism, including hotels, beach operators and boat operators, should be given access to relevant information and given training, not only increase awareness, but market and sell the marine park for a higher quality tourist experience.

Sustainability is defined as the ability to provide current needs without harming the potential for providing for the future. What does this mean for conservation? Providing for the ecological future is largely a management decision. If the goal is to maintain a pristine reef with no human impact this would mean allowing virtually no visitors to the reef, as shown by Plathong et al. (2000) where 15 visitors a week caused significant damage. A much more feasible would be a goal to maintain a level of ecological functioning and prevent species going locally extinct. It has been asserted that two ecological thresholds have been crossed at the Coral Gardens site, but this doesn't necessarily mean that the usage of the reef is unsustainable for conservation goals. It is possible that a new stable state of a impact-adapted benthic community may have been reached, but it is also possible that this section of reef will continue declining leading to local extinctions of species and even the shoals of fish which entertain tourists by chasing bread may be lost. The ecological trajectories are complex and linked with other pressures and processes which are beyond the scope of this study. Hence, using the precautionary principal, reducing human impact as much as possible is recommended for the long term conservation sustainability for Watamu Marine National Park.

The future sustainability of economic income from the park seemed positive, being within the limits of aesthetic threshold, with high levels of park enjoyment and willingness to pay. Perhaps a few seasoned marine experts will be turned away, but the dominant form of tourists visiting Watamu seem unaffected by degradation to the reef and should continue to pay to visit it. Trends from ticket sales (Fig. 4.1 above) don't confirm this conclusion, however. Peak visitation was in 2006 where 36,000 visitors came to Watamu Marine Park, and by 2010 this was reduced to just 20,000. Political instability during the 2008 election, threats of Somali terrorists and financial recession in North America and Europe has caused fewer people to visit Kenya in recent years and hence the marine park also suffered. This is a risk of marketing to the mass package holiday demographic, it is highly competitive and unstable and, as the questionnaire information showed, tourists can go to beaches and coral reefs anywhere in the world they choose. To ensure a sustainable income for the park for the future, attempts should be made to improve the competitiveness of the park in the global market. Reducing human damage on the marine life and improving education and enjoyment of the park is the responsibility of all stakeholders who benefit from the existence of the MPA from hotels to beach operators. This will ensure the tourist industry in Watamu is sustainable for future generations.

5. Conclusions

This study looked at a wide range of factors influencing the sustainability of the tourist industry in Watamu Marine National Park from abundance of coral genra to tourist enjoyment of snorkelling excursions. It was shown that human visitation was impacting the marine life of the reef, with snorkelled areas showing significant differences in community composition to unsnorkelled areas and obvious forms of human damage being recorded at Coral Gardens. Visitors to the reef were observed making damaging contact with the reef at a rate, which when multiplied by the numbers of tourists visiting the reef each day, suggests a high impact rate on the reef. Tourists visiting the reef were mostly positive about it and the excursions as a whole, but there was negative feedback as well, especially from more experience and widely travelled snorkelers. It is concluded that a business as usual approach to park management could lead to further degradation of the reef and eventually could negatively impact tourist trade. Poor information transfer and self-enforcement of park rules and regulations are severe problems hindering effective management of tourists and their behaviour. Increased information provision should help reduce bad snorkelling practise in the park, as well as increasing visitor enjoyment, if it is coupled with increased policing from all stakeholders. This will increase the park's ecological and economic sustainability in the wider global market and over years to come.

Acknowledgements

This project was undertaken in partnership with Kenya Wildlife Service (KWS) in Watamu and Coast Province research unit, particularly Dr. Omar Mohamed and Warden Dixon Korir. We are grateful for all the support they gave us throughout the study from personnel, to usage of their boats and numerous other ways which ensured the success of this work. We are also thankful to the various boat operators who allowed us to collect data on regular trips to the Coral Gardens for no fee, and for all the assistance they gave us during this large aspect of data collection. Funding was generously supplied by the Tasso Leventis Foundation, for which we are hugely thankful. Finally thanks to Joy Smith and all other volunteers from A Rocha Kenya who helped collect and analyse various data for this study.