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72196 Introduction to New Zealand Ecology

Assignment 3

Task 1: Investigative Report

Marine Reserves

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Summary

Introduction

This report discusses anthropogenic effects on marine environments and investigates to what extend marine reserves can mitigate these problems.

Background

Major threats to marine environments are related to human activities, including fishing, pollution, and the modification of catchment areas leading to increased sedimentation rates due to erosion. Some threats are mutually amplifying. The establishment of a marine reserve is one of a range of tools to protect marine ecosystems and sustain the populations of exploited species by alleviating some of these threats. Although assessing the success of marine reserves is difficult, significant positive effects of marine reserves—such as increase of biomass, species diversity and population densities—have been measured and confirmed for reserves of various sizes and ages. Reserve effects can also spill over to surrounding waters by exporting larvae and adults. The effects can be more pronounced when sites are protected that are significant in the life histories of marine species. The recovery of marine ecosystems can take a long time, especially when other threatening activities continue.

Fishers often initially oppose reserve proposals, and policing reserves to ensure compliance with restrictions can be expensive. Experience with other marine reserves has shown that the support of the general public and fishers can be gained by encouraging public involvement in the proposal and through education.

Conclusions

Marine reserves are necessary but not sufficient for marine conservation, as they can mitigate only the threats posed by fishing. Since the impact of fishing on marine environments ranks very high, the establishment of marine reserves is a requirement for ecosystem recovery and may in some cases be sufficient to halt the decline of ecosystems.

Recommendations

- Invite participation of stakeholders early in the decision-making process
- Communicate the benefitial effects of marine reserves for conservation, education, tourism, science, and fishing stocks to the general public and stakeholders
- Investigate whether the proposed area could be improved by including sites that are significant for the life histories of certain species
- Discuss restoration programmes in the catchment of Tauranga Harbour with the DOC

1 Introduction

This report discusses anthropogenic effects on marine environments and investigates to what extend marine reserves can mitigate these problems.

2 Background

2.1 Anthropogenic effects on marine environments

To understand to what extend marine reserves contribute to the protection and recovery of marine environments, the causes of processes that negatively affect them must be investigated. Marine environments suffer directly from human activities as well as from the indirect consequences thereof. The effects of harmful processes often amplify one another (Morrison, Lowe, Parsons, Usmar, & McLeod, 2009). Increased recruitment failure of fish populations due to the effects of climate change, for example, leaves them more vulnerable to overfishing (Walther et al., 2002, p. 393). Halpern, Selkoe, Micheli, and Kappel (2007) identify the following major threats to marine environments: *(a)* climate change, *(b)* destructive fishing methods, *(c)* organic pollution, *(d)* an increase in sediments, *(e)* hypoxia, and *(f)* direct modification (Halpern et al., 2007, p. 1309).

In the investigation below, particular attention is given to Tauranga Harbour (Bay of Plenty), the estuary that the Pohutukawa Cove is connected to.

2.1.1 Climate change

The phenomenon of climate change has at least four measurable effects on marine environments, according to Halpern et al. (2007): *(a)* increase in sea temperature; *(b)* changes in sea level; *(c)* acidification; and *(d)* variation of UV radiation. Higher water temperature promotes eutrophication as well as invasions of non-native species from adjacent regions, and negatively affects recruitment success of native fish populations (Walther et al., 2002; Scavia et al., 2002). Climate change also amplifies the effects of human exploitation and other ecosystem stresses (Scavia et al., 2002).

2.1.2 Pollution

Eutrophication is the largest pollution-related threat to marine ecosystems (Halpern et al., 2007). Organic pollutants such as fertilisers or untreated human waste water are transported by rivers and streams from pollution sources in their catchment areas to estuaries and coastal marine ecosystems where they promote the growth of phytoplankton and epiphytic algae (Smith, Tilman, & Nekola, 1999). This negatively affects water quality, and has been associated with hypoxia and an increased risk to valued fish species (Smith et al., 1999). Although

most point sources have been removed from Tauranga Harbour in the 1990s, many rivers still have elevated nutrient levels (Sinner et al., 2011).

Pesticides and heavy metals in run-off waters are only a minor threat, but their harmful effects are cumulative and may threaten predators that feed on a higher trophic level (Halpern et al., 2007).

2.1.3 Fishing

Inadequate use of fishing gear in vulnerable regions and destructive fishing methods belong to those fishing-related threats with the largest impact (Halpern et al., 2007). Bottom trawling, for example, a fishing method employed for a third of all recorded catch events in the past two decades (Gordon, Beaumont, MacDiarmid, Robertson, & Ahyong, 2010), can obliterate marine ecosystems such as sea-grass beds and negatively impact communities of bottom-dwelling species (Dayton, Thrush, Agardy, & Hofman, 1995; Garcia, 2005). Seamounts which are important habitats for deepwater fish are particularly vulnerable to this fishing method (Clark & O'Driscoll, 2003).

Fishing can result in a shift in marine animal communities that can cascade down the food web. Findings by Tegner and Dayton (2000) have shown that the exploitation of marine animals that are predators of the herbivorous sea urchin (*Evechinus chlorotics*) increases grazing pressure on kelp forests (*Ecklonia radiata*). The loss of kelp has grave implications for species that depend on kelp forests as nursery grounds or for habitat and food (Steneck et al., 2002).

Bycatch is a serious problem for various marine communities. According to Dayton et al. (1995), most sensitive species have been affected by bycatch, including marine mammals, sea birds, turtles and sharks. Many species are particularly vulnerable as they appear in high densities and have low birth rates (Dayton et al., 1995). Dayton et al. (1995) further state that bycatch amounts to the majority of discarded organic material in most fisheries. Large quantities of discarded organic material attract scavengers, and decomposition may lead to hypoxic conditions, rendering the habitat unsuitable for many species (Dayton et al., 1995).

Recreational fishing also impacts marine environments. McPhee, Leadbitter, and Skilleter (2002) reported that recreational harvest in Australia exceeds the commercial harvest, yet remains unmanaged. Their review shows that recreational angling is not sustainable due to the significant impact on marine ecosystems caused by the enormous take of biomass, discarded bycatch, bait harvesting, and pollution.

Miethe, Dytham, Dieckmann, and Pitchford (2010) note that size-selective fishing may reduce population biomass by increasing mortality of the largest individuals. Such fishery-induced evolutionary changes can negatively affect recruitment. Fish stocks have been in decline and the percentage of assessed fish stocks below target levels has increased by 15 percent in 2008 compared to 2006 (see Figure 1).

2.1.4 Sedimentation

Forest clearing and the drainage of wetlands has lead to an increase of sediment inputs into estuarine and coastal marine ecosystems (Sinner et al., 2011, p. 8). According to Sinner et al. (2011, p. 18), pasture is by far the largest contributor to sediment load in Tauranga Harbour. Increased sediment inputs result in muddier, shallower waters, reducing habitat quality for filter feeders and limiting survival rates of juvenile fish (Sinner et al., 2011, p. 24). As intertidal communities are sensitive to changes in the mud content of their habitat, sedimentation can alter the structure and distribution of invertebrate communities (Halliday, Thrush, Hewitt, & Funnell, 2004). Habitat is also reduced for those species relying on sea-grass beds, mussle beds, kelp forests, and other habitat-forming species as their environmental conditions are altered by chronic sedimentation (Sinner et al., 2011, p. 10). Sedimentation also benefits the spread of mangroves, while further reducing sea-grass habitats. The establishment of mangroves in turn supports the accumulation of even more sediment, thereby creating positive feedback (Sinner et al., 2011, p. 10).

2.1.5 Introduction of exotic marine species

Isolated from other landmasses, the majority of New Zealand's commerce volume relies on shipping by sea (Statistics New Zealand, 2007). With the large international Port of Tauranga located in Tauranga Harbour, the estuary is vulnerable to the introduction of exotic species (Sinner et al., 2011, p. 12). Non-native species are accidentally introduced into the waters of New Zealand as they attach to ship hulls or when they are present in the discharge of ballast

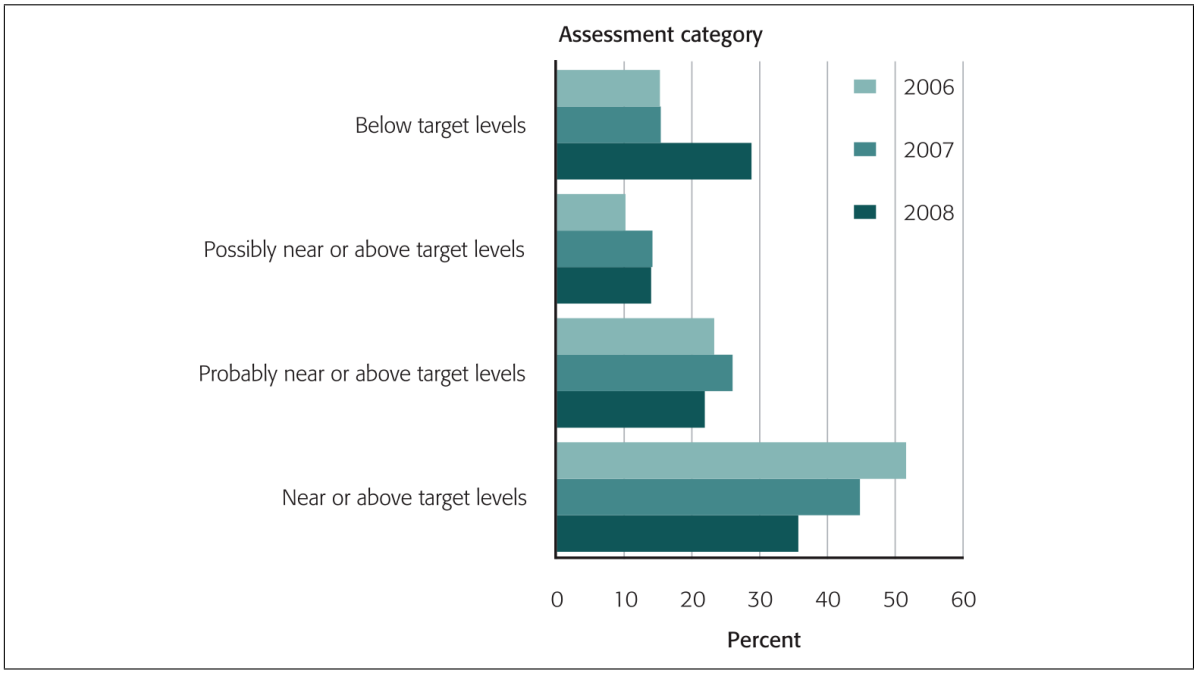

Figure 1: Proportions of assessed fish stocks by assessment category from 2006 to 2008. Reproduced from Statistics New Zealand (2009).

water (Hewitt et al., 2004). According to Sinner et al. (2011), twelve exotic marine species have been identified in Tauranga Harbour, though currently there is no indication that they are a serious threat to the estuary.

2.2 Marine reserves

Bill (1999) describes New Zealand's marine reserves as permanent marine protected areas with clear restrictions on human use for the purpose of protecting or restoring their natural processes. In marine reserves a no-take policy is established, prohibiting any fishing or removal of any material within the area. In addition to these restrictions, human activity is prohibited that might alter or otherwise disturb the ecosystem (Bill, 1999, p. 7). Currently, there are 33 marine reserves in New Zealand (Department of Conservation, 2010) protecting 7.8% of New Zealand's territorial sea, i.e. about 0.3% of its EEZ (Gordon et al., 2010). In August 2011 the establishment of five new reserves encompassing a total area of 17,528 ha was announced (Heatley & Wilkinson, 2011).

Mataitai reserves and taiapure are established to ensure that traditional harvest of seafood (and sustainable commercial fishing in taiapure) can continue while enabling sustainable management through bylaws (Minitry of Fisheries, 2010) to avoid the severe disruptive effects of continued exploitation of marine communities (Huntington, Karnauskas, Babcock, & Lirman, 2010). New Zealand's only mataitai reserve is located around Mt Maunganui at Tauranga Harbour.

2.3 Assessment of marine reserves

The effects of protection efforts in marine environments are somewhat difficult to quantify, as the accuracy of an assessment depends on sampling methods, the availability of sufficient data before the establishment of a reserve, and on the degree of success to take into account temporal and spatial variability of the studied environment (Huntington et al., 2010). According to Huntington et al. (2010), the majority of reserve assessment studies in the years 2004–2009 compared data from control sites inside reserves with data gathered from sites outside. As this approach does not control for effects of natural seascape variation, beneficial effects of protection may have been inadvertently distorted.

This problem is apparent in the assessment of the marine reserve at Goat Island by Cole, Ayling, and Creese (1990). Comparing samples taken over a period of ten years in the marine reserve with samples outside the protected area, Cole et al. (1990) noted that significant long term effects of the establishment of a marine reserve on fish abundance were hard to detect for many species, citing their patchy distribution and motion patterns as probable culprits for this unexpected result. A possible influence of spatial variation inside the reserve was recognised but not investigated. Huntington et al. (2010) have shown that significant reserve

effects, which would be hidden using traditional methods, can be made visible by grouping and comparing study sites with similar properties.

2.4 Beneficial effects of marine reserves

Until the late 1990s only very little research was aimed at assessing the success of marine reserves (Halpern, 2003). Halpern (2003) reviewed relevant studies and noted that for most observed biological indicators (density, biomass, organism size and diversity) significantly higher values were measured after the establishment of reserves. On average, relative to unprotected areas population density was doubled, biomass tripled, and organism size as well as biodiversity increased by up to 30% per unit area. Recovering predator populations would reduce the number of sea urchins and thereby alleviate grazing pressure on kelp forests.

The beneficial effects of marine reserves are more pronounced in certain environments while other seascapes show much less response to reserve protection (Friedlander, Brown, & Monaco, 2007; Huntington et al., 2010). Halpern (2003) notes that a number of the reserves in the reviewed studies were not located in strategically important places. An even larger effect could be expected if reserves were placed at spawning grounds or along migratory routes.

A study by Russ, Alcala, Maypa, Calumpong, and White (2004) demonstrated that the hypothesised "spillover effect" and "recruitment effect" can be observed at the edges of marine reserves. The recruitment effect—i.e. the dispersal of larvae and juveniles from marine reserves to surrounding fisheries—was confirmed in later studies, one of which was conducted on a reserve network in Northwest Mexico. The surveys conducted by Cudney-Bueno, Lavin, Marinone, Raimondi, and Shaw (2009) indicated that the protection from marine reserves resulted in a three-fold increase in the density of the larvae of commercially valued mollusks at the reserve edges. Later research by Russ and Alcala (2011) showed that inside two reserves the species richness of predatory reef fish increased eleven-fold. The reserve effects of enhancing biodiversity reached beyond the boundaries of one of the observed marine reserves (Russ & Alcala, 2011), confirming the "spillover effect" once more. In a review of data collected from 19 European reserves Claudet et al. (2008) argue that these effects increase with size and age of the reserve.

2.5 The costs

The positive effects of reserves on marine ecosystems both inside and outside the protected area notwithstanding, their establishment comes with a cost. Ensuring compliance with the no-take restrictions is expensive and ultimately depends on the support of local fishers (Taylor & Buckenham, 2003). Many fishers initially oppose reserve proposals as the restrictions—regarded as the loss of inherent fishing rights—require them to travel farther to fish outside the protected area (Taylor & Buckenham, 2003). As the recovery of marine ecosystems can take a

very long time (Ballantine & Langlois, 2008), the immediate benefit to fishers is small (Taylor & Buckenham, 2003). Experience with existing marine reserves, however, has shown that reserves are rather popular with the general public—including fishers— (Bill, 1999, p. 12), especially when all affected parties were involved in the discussion of proposals (Department of Conservation, 2002).

3 Conclusions

Of the many threats marine environments are facing due to human activity, the establishment of marine reserves only directly mitigates one—the impact of fishing. Hence, the establishment of marine reserves does not make land-based management, restoration and conservation efforts obsolete (Allison, Lubchenco, & Carr, 1998). Although ecosystem recovery may be inhibited by other factors than fishing (Morrison et al., 2009), the threat posed by fishing activities ranks very high (Halpern et al., 2007) and has been shown to reinforce other pressures which are difficult to address with conventional management tools. Past reviews of marine reserves have repeatedly demonstrated their positive effects on fish populations as well as kelp forests. To amplify these reserve effects, the establishment of marine reserves should go along with land-based restoration efforts (Allison et al., 1998).

4 Recommendations

- Invite participation of stakeholders early in the decision-making process
- Communicate the benefitial effects of marine reserves for conservation, education, tourism, science, and fishing stocks to the general public and stakeholders
- Investigate whether the proposed area could be improved by including sites that are significant for the life histories of certain species
- Discuss restoration programmes in the catchment of Tauranga Harbour with the DOC

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Task 2: Newspaper article

The Red Queen's race: are we losing the race against biodiversity loss?

Ricardo Wurmus
November 5, 2011

The Red Queen's race: are we losing the race against biodiversity loss?

In February 2000, more than eleven years ago, the New Zealand government published the New Zealand Biodiversity Strategy (NZBS) as a management framework to guide government agencies and community groups in their efforts to ensure the conservation of our biodiversity—the unique range of animals and plants, and the environments they inhabit. Without targeted management efforts, the fate of many threatened species—many of which are found only in New Zealand—would be extinction. The authors of the Strategy outlined action plans envisioned to halt the decline of key species by 2020. More than half of this 20-year period has passed; now, in the first year of the International Decade of Biodiversity, it is time to turn around to see what progress has been made.

Protection out of balance

The NZBS identifies five major obstacles to the conservation of terrestrial biodiversity (see table on page 15 for a complete list). One of these high-priority issues is the lack of adequate protection for a number of habitats. Even though the land area under protection increased from 11 percent in 1992 to more than 33 percent in 2009—more than any other country—, many distinct habitats are still without any legal protection. A lack of balance is the issue here: while some montane environments enjoy a protection of more than 90% across New Zealand, some lowland environments have less than one percent of their area under legal protection. Ecologists say that the biodiversity in degraded habitats with less than 20% of remaining native vegetation can collapse dramatically. About 30% of New Zealand's terrestrial habitats belong to these highly vulnerable environments and less than 1.5% of this area is legally protected. Addressing this problem is an enormously difficult task. As important habitats are widely scattered and fragmented it is impossible to attain to all areas equally. In fact, the failure to protect those environments despite a general increase in funding is largely due to limited management capacities. Loss of suitable habitat is a main reason for the continuing decline of already threatened species (see picture on page 16).

Involving communities

Another problem that was declared a key issue in the Strategy is the difficulty to manage and protect areas on privately owned land. The majority of the rise of protected land area in the last five years was due to the voluntary South Island High County Tenure Review programme, but the review is progressing slowly and more than a third of the South Island leases are not in tenure review, likely because the aspirations for land use and development often conflict with

Key issues in the conservation of terrestrial biodiversity (According to Department of Conservation, 2000, pp. 37–39).

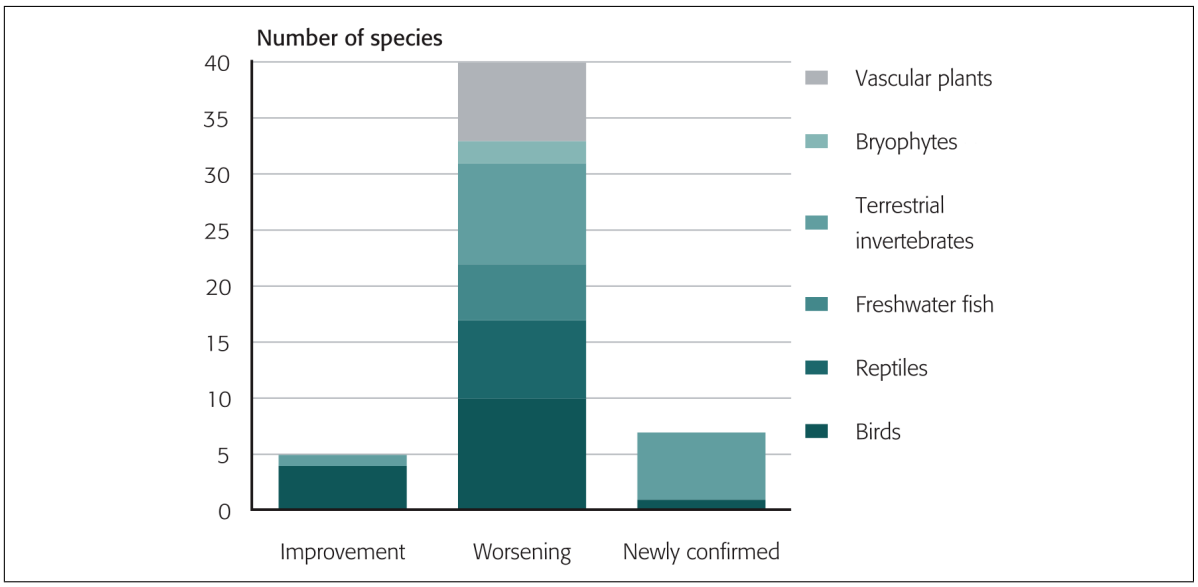
Issue	**Explanation**
Protecting ecosystems and habitats	Many important habitat types are poorly represented in the network of protected areas.
Habitat fragmentation	Threatened areas are often isolated which makes them even more vulnerable to further degradation.
Pests and weeds	Pest control is expensive and difficult to achieve. Pest invasions are only barely stopped on priority lands under management by the Department of Conservation. Indigenous species in other habitat are at risk to be ousted by invasive species.
Threatened species	The vast number of threatened indigenous species makes it impossible to manage all of them properly. While priority species are actively managed, others continue to decline.
Management priorities and research	The lack of understanding of indigenous species and their vulnerabilities inhibits conservation decision making.

the need to protect sensitive habitats. To address this problem, the Strategy suggested that community initiatives to protect habitat on private land be encouraged and financially supported. The New Zealand Landcare Trust, for example, has been using government funding to implement a range of sustainable farming projects all over New Zealand in recent years with enthusiastic support from rural communities. One of the projects supported by the DOC, the Landcare Trust and two other organisations in 2002 aimed at the restoration of the privately owned Myross Bush reserve in Southland. Weeds had invaded the protected area despite the efforts of the owners over the years. With the backing from the Biodiversity Condition Fund, the project gained many supporters from the community and even a local school whose curriculum is now interwoven with the ongoing restoration project.

Our battle against invaders

To resolve uncertainty of local authorities in making decisions in regards to protection and management of important habitats on private land, the Ministry for the Environment currently revises a proposal for a National Policy Statement on Indigenous Biodiversity—another key target in the NZBS. The current proposal requires local management plans to be put in place within five years of the Policy Statement taking effect to prevent further loss of threatened species and important ecosystems.

This task is greatly complicated by the fact that pests—introduced animals and weeds that seriously threaten a great number of native species—are ravaging the land. Despite recent



Change in threat classification status of native species from 2002 to 2005. Reproduced from Statistics New Zealand (2009).

budget cuts more than a third of the Department of Conservation's budget in 2010/11 for the management of natural heritage was spent on pest control (about a quarter was used for species conservation programmes). Thanks to education programmes such as the "Weedbusters" programme and continued funding, there has been sizeable progress in controlling weeds. Continued efforts have made it possible to keep priority islands pest-free. Although remarkable successes were achieved in clearing offshore islands, pest-free areas are still dwarfed by the areas that receive only limited or no management. Pest control also requires continued maintenance in order to be effective. Declared rat-free in 1997, rats were again discovered on Ulva Island last year, prompting the Department of Conservation to design a plan to eradicate rats from Ulva Island which is currently being executed.

The Red Queen's race

Are we losing the race against biodiversity loss? The management programmes so far appear to be effective and community support is growing stronger, but as this review has shown New Zealand's biodiversity is only barely defended from lingering threats. To halt the decline and possibly even reverse the trend, short-term community projects must become part of a sustainable culture—only then may we hope to win the race.

> "Now, here, you see, it takes all the running you can do, to keep in the same place.
> If you want to get somewhere else, you must run at least twice as fast as that!"
> — The Red Queen (*Through the Looking-Glass* by Lewis Carroll)

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