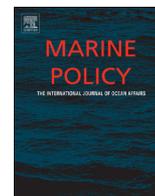




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One hundred-fold difference between perceived and actual levels of marine protection in New Zealand

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ABSTRACT

Anthropogenic threats to the global marine environment are increasing, and the Convention of Biological Diversity has set a target of 10% global ocean protection by 2020. Social factors are an important component of coastal marine protected area and no-take marine reserve creation. In order to understand social factors influencing marine reserve creation in New Zealand, public surveys were conducted in 2005 and 2011 about marine protection and threats to the marine environment (Territorial Sea and Exclusive Economic Zone). These results are compared to an experts' opinion survey of threats to the New Zealand marine environment, and actual marine protection levels. Generally, the New Zealand public identified similar New Zealand originated threats to the marine environment as those identified by experts, in contrast to expert identified global threats originating from climate change, which were minimally identified by the public. Experts identified that shallow, coastal waters were under greater threat than deep water habitats. On average, the New Zealand public thought that ~30% of New Zealand's marine environment was protected by no-take marine reserves, and that 36% should be protected, while in fact only 0.3% is protected by no-take marine reserves. There is considerable potential for publicly driven marine protection initiatives in New Zealand with sufficient awareness, education, and outreach programs to better inform New Zealanders about actual marine protection levels. The results of this study are globally important, as similar knowledge gaps about marine environmental issues have been identified in the United States and the United Kingdom.

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1. Introduction

Recent global studies of human impact on the marine environment have indicated that much of the world's oceans are affected by multiple anthropogenic threats [1,2], and that marine biodiversity is being lost as a result, impacting entire marine ecosystems [3]. As a response to these increasing human impacts, there has been a widespread call for increasing global marine protection to achieve the Aichi Biodiversity Target set by the United Nations Environment Program (UNEP) International Convention on Biological Diversity (CBD) of 10% global ocean protection by 2020. A recent report published by the UNEP and the IUCN (International Union for Conservation of Nature) indicates that marine protected areas (MPAs; multiple uses) cover 1.6% of the global ocean [4], however less than 0.2% of the global ocean is protected by no-take marine reserves (MRS; no exploitation permitted).

It has been recognised that ecological, social, and political factors play central roles in MPA implementation [5–9]. Charles and Wilson [10], have identified different drivers and instruments used in MPA creation for coastal and offshore waters. In coastal waters, community livelihood drives MPA establishment, while in offshore waters, conservation goals and integrated management drive MPA establishment [10]. Charles and Wilson [10], identify differences between the instruments used in MPA creation in coastal vs. offshore waters; where legal and institutional instruments are needed in both cases, however in the coastal setting, social mechanisms are also important. Four essential elements were identified for successful implementation of marine reserves networks in New South Wales, Australia and New Zealand: political and agency leadership, dedicated marine conservation legislation, information on natural and social sciences, and processes for stakeholder involvement and collaboration [11]. Barriers to marine reserve implementation in New South Wales, Australia and New Zealand include: varying levels of political will and agency support and leadership, poorly coordinated marine conservation policy, inconsistencies with the use of legislation, polarised views and opposition from some stakeholders, and difficulties with defining and mapping conservation features [11].

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This paper will focus on social perceptions of marine protection and threats to the marine environment.

Surveys of public opinion and awareness about threats to the marine environment and marine conservation provide information that can be used to understand social mechanisms [12,13]. Surveys about public awareness of marine issues in the United States and the United Kingdom have found that there are large knowledge gaps between public perceptions of threats to the marine environment and marine conservation ([12,13], respectively). In the United States, knowledge levels about marine issues were explained by socioeconomic status (the trans-situational hypothesis) and personal experiences and contexts (the situation-specific hypothesis; [12]). In the United Kingdom, it was found that there was a gap between public awareness of marine environmental issues and issue-specific awareness [13]. Both studies identified areas where efforts to improve public awareness about marine environmental issues could be made [12,13].

Aotearoa (New Zealand in Māori) was one of the first states in the world to designate a fully no-take MPA, locally referred to as a marine reserve (MR; from here on in MR indicates fully no-take), with the establishment of the Cape Rodney – Okakari Point (Leigh or Goat Island) MR in 1975. Since then, another 33 MRs have been implemented, with more in the final implementation stages (Fig. 1; two are offshore island reserves and are not pictured – Kermadec Islands MR and Auckland Islands MR). New Zealand has one of the world's largest EEZs at 4.2 million km², and the New Zealand government has committed to protect 10% of New Zealand's marine environment through its MPA policy [14], in order to achieve the objectives and actions of the New Zealand Biodiversity Strategy [15], and honour New Zealand's international commitments to the CBD. Currently, the area protected by the 34 MRs accounts for 0.3% of New Zealand's marine environment, and are all located in the Territorial Sea (waters out to the 12 nautical mile limit; [16]). Of the 0.3% of New Zealand's marine environment that is protected by MRs, 99.8% of this area is accounted for by offshore island MRs (Kermadec Islands MR and Auckland Islands MR). At present, marine reserves can only be created in the Territorial Sea, as the Marine

Reserves Act does not apply to the EEZ (waters from the 12 nautical mile limit to the 200 nautical mile limit; [17]). Therefore, there is no legal mechanism to establish MRs in the EEZ. Fishing exclusion zones (benthic protection areas; BPAs) have been established in the EEZ under the Fisheries Act, and only prevent bottom-trawling [18,19]. Mid-water trawling and mining are not prohibited in the BPAs [18].

Biodiversity and ecological research for most of New Zealand's offshore waters is still largely in the discovery phase, with qualitative information accounting for knowledge of much of the area [20]. However, there has been a comprehensive review of New Zealand's marine life in all of the EEZ [21] and a prioritisation method for New Zealand's EEZ based on available habitat and biodiversity information [22,23]. There has been much more ecological research that has focussed on New Zealand's coastal waters (e.g. [24–26]), and ecosystem response to MR protection [27–31], which can be used to prioritise areas for coastal marine protection.

Of the three factors that play central roles in MPA establishment; ecological, social, and political [5,7], social factors are not well documented in New Zealand. This paper will examine the New Zealand public's perceptions of threats to the marine environment and marine protection, for comparison to expert opinion of threats to the marine environment, and actual marine protection levels. The aim of this paper is to describe social factors that provide support for, and barriers to, MR implementation in New Zealand, and how they compare globally.

2. Methods

2.1. Public surveys

In 2005, WWF-New Zealand commissioned a survey of public perceptions regarding the level of protection of and threats to New Zealand's marine environment (Territorial sea and EEZ). The Colmar Brunton, Social Research Agency conducted the survey and telephone interviewed 1001 randomly selected people aged 15+ located across the nation (survey questions are listed in Table 1; [32]). The final total sample had a maximum margin for error (MFE) of $\pm 3.1\%$ for a 95% confidence interval, which was calculated as:

$$MFE = \sqrt{\frac{p(1-p)}{n}} \times 1.96 \quad (1)$$

where p is the probability of obtaining a test statistic and n is the sample size (WWF-New Zealand 2005). In 2011, WWF-New Zealand commissioned a similar survey, also undertaken by Colmar Brunton, who conducted 1003 random phone interviews using the same methods and similar questions as in 2005 (Table 2; [33]). The final total sample had a maximum margin for error of $\pm 3.35\%$ for a 95% confidence interval (Eq. 1; [32]). The data was post-weighted to reflect New Zealand population statistics in terms of gender, age, household size, and region [32,33]. Quotas and weighting ensured that overall survey results were representative of the New Zealand population aged 15+ [32,33]. In 2011, surveys were not conducted in Christchurch, due to the earthquake that occurred there in February, 2011. In addition to the location of their residence, respondents were asked to indicate if they identified with any ethnic groups (options were: Maori, Pacific Island, Asian, New Zealander, European in 2005; Maori, Asian, New Zealander in 2011); if they had fished in the previous 12 months (in 2005 only); age; and gender.

2.2. Expert surveys

A recent report published by MacDiarmid et al., [34] utilised expert opinions from 47 scientists about the New Zealand marine environment to identify the top anthropogenic threats. Expert scientists were identified and chosen based on their knowledge of

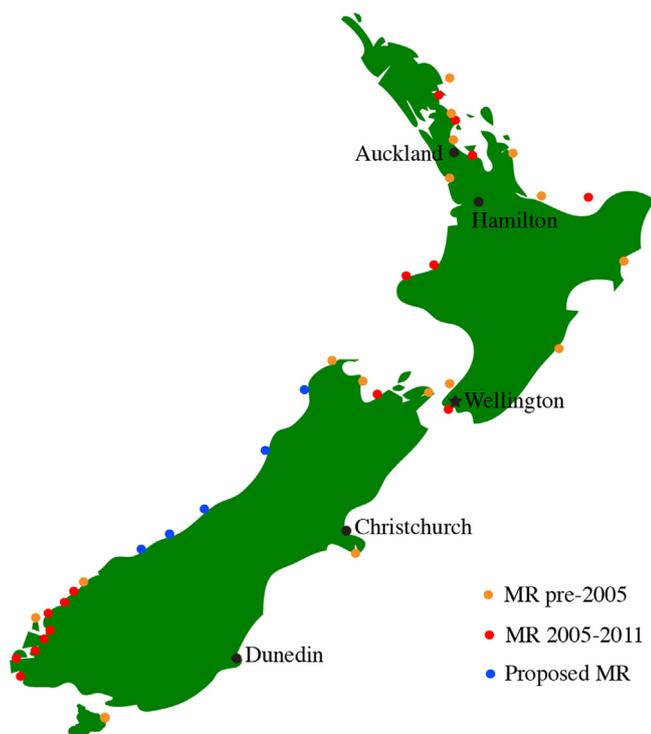


Fig. 1. Map of New Zealand showing full no-take marine reserves (MRs), according to the time that they were established, and proposed MRs.

Table 1

Questions asked during random New Zealand public telephone surveys about marine protection and threats to the marine environment in 2005.

Question
1. Please tell me how optimistic or pessimistic you feel about the future ecological health of New Zealand's marine environment over the next 10 years? By 'marine environment' I mean the sea and the life it contains from the shore out to the 200 nautical mile boundary that is governed by New Zealand. Are you... very optimistic, quite optimistic, neither optimistic nor pessimistic, quite pessimistic, very pessimistic?
2. Marine reserves allow for the following activities: research, swimming, diving, and boating, while not allowing activities such as oil drilling, mining, commercial fishing, recreational fishing, or collecting. Do you know what percentage of New Zealand's marine environment is currently protected by marine reserves?
3. What percentage is it? or What would you guess that the percentage might be?
4. Less than 1% of New Zealand's marine environment is currently protected in marine reserves. What percentage do you believe should be protected?
5. When an area is protected by becoming a marine reserve, this means that people who are currently using the area will have to stop activities such as commercial and recreational fishing, collecting and dredging. Do you think it is reasonable that this happens?
6. Do you think that overall New Zealand's marine environment is under threat? What do you think the level of threat is? Very high, quite high, moderate, quite low, very low.
7. What do you think are the top two or three threats to the marine environment?
8. And specifically for each of the aspects I will read out, what do you think is its threat to New Zealand's marine environment? Would you say it is very high, quite high, moderate, quite low, very low or not a threat at all?

Table 2

Questions asked during random New Zealand public telephone surveys about marine protection and threats to the marine environment in 2011.

Question
1. Please let me know which statements you think are true and do apply to NZ's marine reserves, and which ones don't. Marine reserves: are areas primarily managed to preserve natural habitat of marine life for scientific study; Allow activities such as research, swimming, diving; Can cover area between high and low tide; Allow boating and anchoring; Allow recreational fishing or collecting; Allow activities such as oil drilling, mining, commercial fishing.
2. Marine reserves allow for the following activities: research, swimming, diving, and boating, while not allowing activities such as oil drilling, mining, commercial fishing, recreational fishing, or collecting. Do you know what percentage of New Zealand's marine environment is currently protected by marine reserves?
3. What percentage is it? or What would you guess that the percentage might be?
4. Less than 1% of New Zealand's marine environment is currently protected in marine reserves. What percentage do you believe should be protected in marine reserves? And what percentage of the marine environment do you think the average New Zealander believes should be protected in marine reserves?
5. When an area is protected by becoming a marine reserve, this means that people who are currently using the area will have to stop activities such as commercial and recreational fishing, collecting and dredging. Do you think it is reasonable this happens?
6. Do you think that overall New Zealand's marine environment is under threat?
7. What do you think the level of threat is? Very high, quite high, moderate, quite low, very low.
8. What do you think are the top two or three threats to the marine environment?

specific aspects of New Zealand's marine environment. This study identified 65 potentially hazardous human activities that may affect 62 different identifiable marine habitats in New Zealand's EEZ, resulting in ~4000 interactions among activities and habitats [34]. Given the absence of extensive published information for the majority of these ~4000 interactions, expert knowledge was used to quantify the importance of each interaction [34]. Human activities were categorised according to their source: global human activities, catchment-based activities, human activity directly in the sea or a mix of two or more of these activities.

3. Results

3.1. Public perceptions of threats to the marine environment and marine protection

In 2005, 76% of respondents agreed that it was reasonable to prohibit fishing in an area when it becomes a MR (Table 1; question 5), while in 2011, 84% agreed (Table 2; question 5). When asked what percentage of New Zealand's marine environment (Territorial Sea and EEZ) is protected (Tables 1 and 2; question 3), the average response in 2005 was that 23% of the marine environment was protected, compared to 31% in 2011 (Fig. 2). All demographics that were identified in the surveys thought that more of the marine environment was protected in 2011 than in 2005 (Fig. 2). In both 2005 and 2011, respondents who identified themselves as Asian ethnicity thought that the greatest amount of the marine environment was protected (37% and 57% respectively; Fig. 2).

When respondents were asked what percentage of New Zealand's marine environment they thought should be protected (Tables 1 and 2;

question 4), in 2005 the average response was 36%, which was the same for 2011 (Fig. 3). In both 2005 and 2011, Māori thought that the highest amount of marine environment should be protected (52% and 50% respectively; Fig. 3). On average, females thought that more of the marine environment should be protected in 2011 compared to males (39% and 34% respectively; Fig. 3). The youngest and oldest age groups (16–29 years and 60+ years) thought that the greatest amount of the marine environment should be protected in 2011 (42% and 39% respectively; Fig. 3). Survey respondents who had fished in the previous 12 months thought that less of the marine environment should be protected compared to those who had not fished in the previous 12 months in 2005 (30% and 39% respectively, Fig. 3).

In 2005, 71% of interviewees thought that the marine environment was under threat, compared to 73% in 2011 (Tables 1 and 2; question 6). When asked to identify the top threats to the marine environment (Tables 1 and 2; question 7), commercial fishing was identified as the top threat in both surveys (by 67% of the population in 2005 and 50% in 2011; Fig. 4). The second threat identified was pollution/sewage in both surveys (63% in 2005 and 47% in 2011; Fig. 4). The third threat identified was recreational fishing (22% in 2005 and 19% in 2011; Fig. 4). The fourth threat was agricultural runoff in 2005 (12%), while it was overfishing in 2011 (18%; Fig. 4). Shipping and climate change were tied for the fifth threat in 2005 (10%), while dredging was the fifth threat in 2011 (10%; Fig. 4).

3.2. Expert identified threats to the marine environment

The number one expert identified threat to the marine environment was ocean acidification, followed by rising sea temperatures, bottom trawling, and increased sedimentation from changes in land use (Fig. 4; [34]). Climate change causing changes in currents and

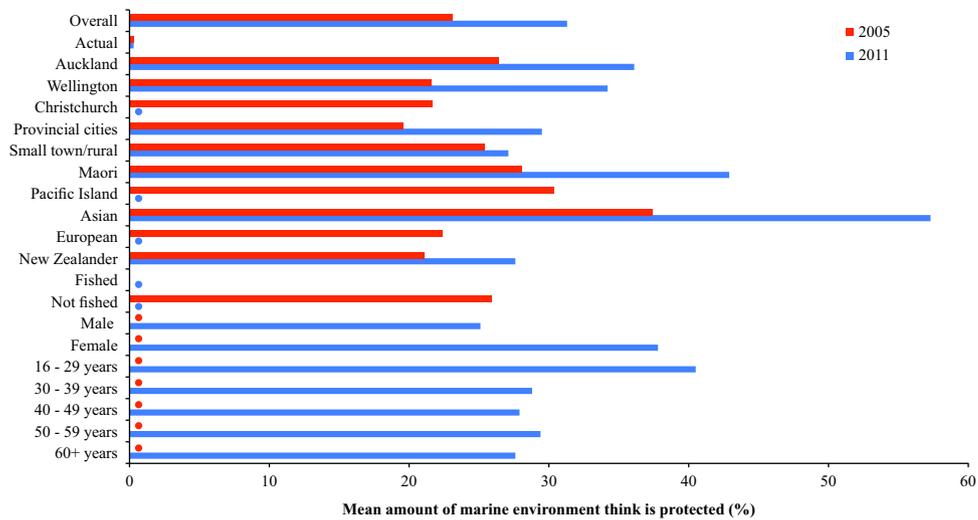


Fig. 2. New Zealand public survey results (overall average, by region, ethnicity, if they fished in the previous 12 months, gender, and age) about perceived marine protection levels for New Zealand's marine environment in 2005 and 2011, and actual protection levels for 2005 and 2011. Circles indicate that this question or demographic choice was not surveyed in the corresponding year.

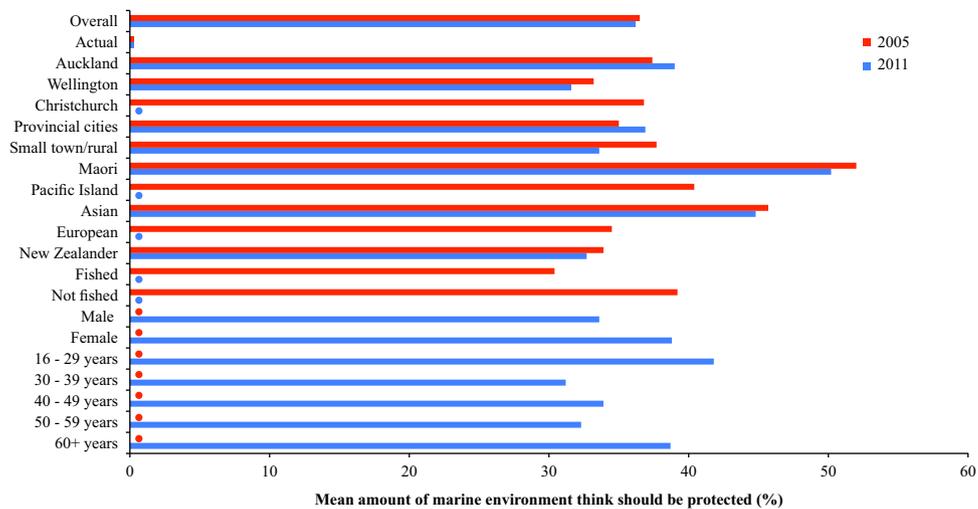


Fig. 3. New Zealand public survey results (overall average, by region, ethnicity, if they fished in the previous 12 months, gender, and age) about what marine protection levels should be for New Zealand's marine environment in 2005 and 2011, and actual protection levels for 2005 and 2011. Circles indicate that this question or demographic choice was not surveyed in the corresponding year.

frequency of storms and dredging for shellfish were tied for the fifth highest threat (Fig. 4). Of the threats to the marine environment, the two top threats, 83% of the top 6 threats, and 67% of the top 12 threats originated fully, or in part, from human activities external to the marine environment itself [34]. The highest threats to the marine environment that were directly related to human activities in the marine environment were: bottom trawling, dredging for shellfish, and invasive species [34]. Generally the number of threats impacting marine habitats declined with increasing depth. Shallow, coastal waters were affected by as many as 52 threats, while deep water habitats were only affected by four or five threats [34].

3.3. Marine protection from 2005–2011

Prior to 2005, 18 MRs had been established in New Zealand, accounting for 0.3% of New Zealand's marine environment (Fig. 1). This figure was also 0.3% in 2011, despite the creation of 16 additional MRs in the interim (which accounted for less than a 0.1% increase), for a total of 34 (Fig. 1). Eight of these MRs were implemented in Fiordland in 2005, which is a remote and sparsely populated region on the southwest coast of the South Island (Fig. 1).

The Te Matuku (Waiheke Island) MR was created in 2005, on the doorstep of Auckland (Fig. 1). Four MRs were implemented in 2006, located adjacent to populated areas of the North and South Islands. Two MRs were implemented in 2008, including the Taputeranga MR, located on the south coast of the capital city, Wellington (Fig. 1). The Tawharanui MR was created in 2011, located approximately 50 km north of Auckland (Fig. 1). Of the 34 MRs established by 2011, 32 are located in coastal waters (Fig. 1). The two offshore island group MRs are the largest in size, and account for 99.8% of the 0.3% of New Zealand's marine environment that is protected by MRs. Offshore fisheries closures were established in 2007, which if included, increase the proportion of the marine environment protected [18,19].

4. Discussion

4.1. Perceived vs. actual marine protection levels in New Zealand

The 100-fold difference between the perceived level of the marine environment protected by marine reserves in 2011, at 31%, compared to the actual protection level of 0.3%, strikingly

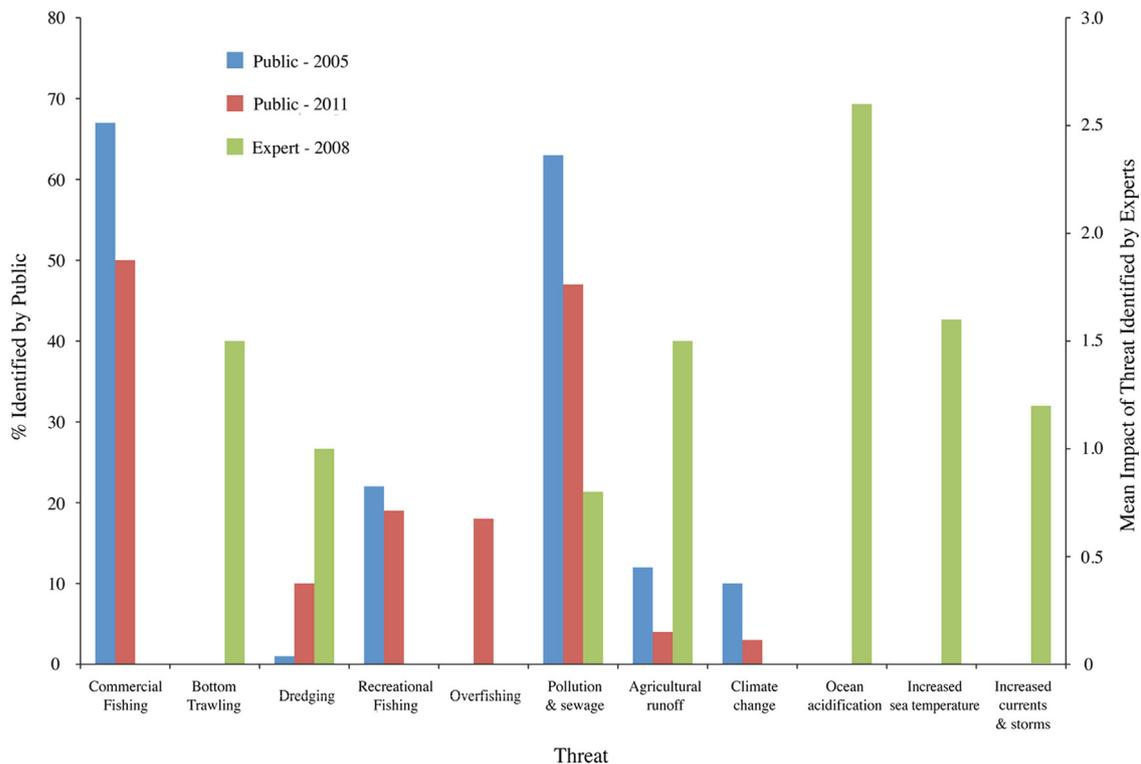


Fig. 4. Threats to the marine environment as identified by the public in 2005, 2011 (% of respondents who identified each threat), and experts (represented by relative mean impact).

illustrates the large knowledge gap about marine protection levels in New Zealand. Of the four essential elements that were identified for successful implementation of marine reserve networks in New South Wales, Australia and New Zealand [11]; 'dedicated marine conservation legislation' is missing for offshore waters in New Zealand due to an absence of legislation allowing for MR establishment in the EEZ [17]. Further marine reserve creation in coastal waters is largely being hindered by the lack of the essential element; 'political and agency leadership' [11]; as over half of the existing MRs were created through external applications lodged by interest groups [26].

4.2. The global perspective

Comparison of the New Zealand survey results to surveys conducted in the United States and the United Kingdom indicate that there are similar disconnects between public perceptions of marine environmental issues and actual threats and protection measures among continents and nations [12,13]. In the United States, it was identified that information from television and radio have a negative influence on knowledge holding, while information from newspapers and the internet have a positive overall influence on knowledge holding [12]. Additionally, situation specific variables that were significantly positively related to knowledge levels were: visiting the coast and possessing environmental values [12].

In the United Kingdom, pollution was viewed by 40% of the public as being a pressing issue, while climate change was viewed as a second tier issue, along with overfishing [13]. Sea level rise, marine litter, sewage disposal, and tourism formed a third tier of pressing issues [13]. Therefore, New Zealand is similar to the United Kingdom in that local threats are perceived by the public as being more important than global impacts resulting from climate change. In this regard, strategies to educate the public about global

climate change effects could be shared across nations in order to improve public awareness.

4.3. Public vs. expert identified threats to the marine environment in New Zealand

The differences between the top threats to the marine environment identified by the public, compared to experts, are largely explained by the proximity of the source of the threat to New Zealand [32–34]. All of the top four threats identified by the public originate in New Zealand – from either marine or land based sources [32,33]. Conversely, the top two threats (ocean acidification and increasing sea temperatures) and the threat tied for fifth most important (climate change causing changes in currents and increased storm frequency) as identified by experts, are a product of global greenhouse gas emissions through the burning of fossil fuels and the reduction of forest cover [34]. Interestingly, there was a high degree of similarity between public and expert identified threats that originated within New Zealand's marine environment as: commercial fishing, recreational fishing, overfishing, and dredging were identified by the public as the greatest threats to the marine environment (first, third, tied for fourth, and tied for fifth respectively), while experts identified bottom trawling and dredging as the most important threats (third and tied for fifth respectively; [32–34]). For land-originating threats, both the public and experts identified agricultural runoff/sedimentation as the fourth highest threat, while the public also identified sewage/pollution as the second most important threat [32–34].

Analysis of the threats identified by the New Zealand public indicates a strong understanding of the local threats to the marine environment, but less of an understanding of the most important threats as identified by experts, which are occurring on a global scale. This is likely due to the fact that the two most important threats identified by experts – ocean acidification and rising sea temperatures, are less visible compared to the effects of fishing

(commercial and recreational) and pollution; the top three threats identified by the public. These results indicate that there is a disconnect between science and public knowledge in New Zealand. Therefore, communication of this information should become a focus for marine education and outreach programs. While mitigating the effects of climate change that cause ocean acidification and rising sea temperatures requires a global effort to lower greenhouse gas emissions, public awareness can motivate political action for New Zealand's energy strategy [35], and insist on action by New Zealand in international forums such as the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

4.4. Social dimensions of marine protection in New Zealand

It appears that implementation of 16 further marine reserves impacted the public perception of marine reserve protection from 2005–2011, as New Zealanders thought on average that 23% of the marine environment was protected in 2005, compared to 31% in 2011 [32,33]. However, the MRs that were created during this time were small in size and the increase in the area of New Zealand's marine environment that was protected from 2005–2011 was less than 0.1%, therefore the figure remained at 0.3%.

The governing authority of MRs in New Zealand, The Department of Conservation, reports that over half of the existing MRs were created through external applications lodged by interest groups such as: tangata whenua (indigenous Māori peoples), conservation groups, fishers, divers, and marine science interest groups [26], despite the existence of an MPA Policy [14], a Biodiversity Strategy [15], and international commitments to the CBD. Therefore it does appear that social factors are in fact responsible for affecting the progress of coastal marine protection in New Zealand. Greater education and outreach that communicate actual marine protection levels could further motivate interest group efforts for additional MR applications.

Community livelihood was identified by Charles and Wilson [10], for driving MPA establishment in coastal areas. In New Zealand, MR applications are open for public consultation, and fishers, either recreational, customary or commercial, who stand to lose access to fishing grounds are often the biggest opponents, and can stall the process or prevent the MR from being established [ex., 36]. The West Coast Marine Protection Forum [37] alleviated this problem by consulting with fishers during the application process.

Of the three factors that are important for MPA designation – ecological, social, and political, it appears that social factors are the most important for coastal MR designation in New Zealand's coastal waters (Territorial Sea). Shallow, coastal waters were identified by experts as being subject to the highest level of threat, therefore further MR implementation efforts should be prioritised for New Zealand's Territorial Sea. However, amendments to the Marine Reserves Act [17] to enable MR establishment in the offshore waters of the EEZ are essential for New Zealand to achieve its CBD target of protecting 10% of its marine environment by 2020.

Following the inaction of legal and institutional instruments to achieve protection goals, individual private interest groups have taken action to establish MRs in New Zealand's Territorial Sea. The motivation for these efforts is likely related to the New Zealand public's high awareness of local threats to the marine environment. That the New Zealand public thought on average, that 31% of New Zealand's marine environment was protected by MRs in 2011, when in fact 0.3% was protected, suggests that the public is not well enough informed to effect greater change. If awareness levels about actual marine protection levels improve, further socially driven conservation efforts are likely because New Zealanders thought on average in both 2005 and 2011, that 36% of the marine environment should be protected. This approach is relevant for the

United States and the United Kingdom, where gaps in public knowledge of marine issues were also identified [12,13].

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