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72194 Sustainable Development and New Zealand

Assignment 3

Fishing in New Zealand: Implications for conservation and fisheries management in the context of sustainability

Contents

List of Figures

1 Executive summary

Introduction

This report discusses fishing-related activities with respect to their impacts on New Zealand's environment and society, and reviews management options towards sustainable fishing.

Background

Fishing is an integral part of New Zealand's identity: about 20% of the population identifying as recreational fishers; Maori have strong cultural links to fishing; fishing is also a major export earner. Overfishing, by-catch, and unsustainable fishing practices have considerable effects on marine ecosystems. Fishing pressures continue to affect threatened species, such as the New Zealand sea lion. A large number of New Zealand's fish stocks are managed through a system of individual transferable quotas (ITQs) that are subject to annual catch limits ("total allowable catch" or TAC). Marine reserves are used to protect marine ecosystems and help fish stocks to recover.

Discussion

The quota management system is an effective economic tool, but does little to ensure that fisheries are sustainable. The annual total allowable catch limits have been criticised as somewhat arbitrary as scientific information on the status of many species is lacking.

Significant positive effects of marine reserves have been measured and confirmed for reserves of various sizes and ages, but ecosystem recovery can take a long time. Currently, less than 1% of the EEZ is protected. Spatial conflicts may arise from the establishment of marine protected areas. The upcoming Oceans Policy is designed to help resolving these conflicts.

Conclusions

The threat to marine ecosystems posed by fishing activities ranks high and has been shown to amplify other pressures which are difficult to address with conventional management tools. New Zealand's quota management system is not sufficient to ensure that fisheries are sustainable because assessment of fish stocks suffers from a lack of data. As a consequence, the number of fish stocks in decline has grown over past years. Past reviews of marine reserves have repeatedly demonstrated their positive effects on marine ecosystems, yet only very little of the EEZ is currently protected. The establishment of marine reserves can cause conflicts with fishers who feel that their inherent fishing rights are restricted. These conflicts must be addressed to ensure that fishing is also economically and socially sustainable.

2 Introduction

This report discusses fishing-related activities with respect to their impacts on New Zealand's environment and society, and reviews management options towards sustainable fishing.

3 Background

3.1 Fishing in New Zealand: an overview

New Zealand is more ocean than it is land. Covering some four million square kilometres, its Exclusive Economic Zone (EEZ)—the area of the sea over which New Zealand has sovereign right according to international law—is among the largest in the world and is roughly 15 times the size of New Zealand's total land mass (Ministry for the Environment, 2005). The EEZ extends from 12 nautical miles off the coast to 200 nautical miles seaward and contains a wide range of habitats, such as mud plains, volcanic vents, and cone-shaped seamounts, some of which are considered to be hotspots of biodiversity (Ministry for the Environment, 2005; Rowden, O'Shea, & Clark, 2002; Rowden & Clark, 2004).

According to the Ministry for the Environment (2005), "fishing (including aquaculture) is New Zealand's fourth largest export earner", and some 20 percent of New Zealand's population consider themselves recreational fishers (Statistics New Zealand, 2002). Although, traditionally seafood was not an important part of the diet of New Zealanders of European descent, in the last 30 years seafood has been accepted as a regular food source (Ministry for Culture and Heritage, 2012). Seafood is also a customary source of food for many Maori, and their strong cultural ties to fisheries are recognised in regulatory legislation (Statistics New Zealand, 2002). In the fisheries quota management system (discussed below), Maori own about 50 percent of the total fishing quota (The New Zealand Seafood Industry Council, Ltd. 2012).

Although New Zealand's fish fauna consists of more than 1,387 species, only about 130 species are fished commercially, 43 of which are commercially significant (Gordon, Beaumont, MacDiarmid, Robertson, & Ahyong, 2010; Statistics New Zealand, 2002). According to the Ministry for the Environment (2005), New Zealand's fisheries are among the deepest in the world, so commercially targeted species are dominated by deepwater species, such as hoki, hake, ling, orange roughy, oreo dories, squid, and silver warehou (Statistics New Zealand, 2002). Other target species include the spiny red rock lobster, abalone, mussels, and the snapper fish (Statistics New Zealand, 2002).

3.2 The impacts of fishing

Activities associated with fishing not only affect the species targeted but also the surrounding marine environment. The environmental impacts of fishing that will be discussed in this section include *(a)* the effects of (over)fishing on the stocks of target species, *(b)* the modification and destruction of marine habitat, *(c)* cascaded effects on dependent species through the food web, and *(d)* the catch of non-target species (by-catch).

The state of the marine environment is also an important factor in estimating the damage that fishing practices have on fish stocks, because 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 the affected populations more vulnerable to overfishing (Walther et al., 2002, p. 393).

Inadequate use of fishing gear in vulnerable regions and destructive fishing methods belong to those fishing-related threats with the largest impact (Halpern, Selkoe, Micheli, & Kappel, 2007). Bottom trawling, for example, a fishing method employed for a third of all recorded catch events in the past two decades (Gordon et al., 2010), can obliterate marine ecosystems such as sea-grass beds and negatively impact communities of bottom-dwelling species (P. K. 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 P. 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).

By-catch is a serious problem for various marine communities. According to P. K. Dayton et al. (1995), most sensitive species have been affected by by-catch, including marine mammals, sea birds, turtles and sharks. Many species are particularly vulnerable as they appear in high densities and have low birth rates (P. K. Dayton et al., 1995). P. K. Dayton et al. (1995) further state that by-catch 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 (P. K. Dayton et al., 1995).

The continuing decline of threatened New Zealand sea lion populations is a prime example for the effects of fishing activities on non-target species. Following extensive human predation in the 19th century, recovery of sea lion populations has been a slow process. The pup production on the Auckland Islands has been in steady decline since 1998 (Department of Conservation, 2009, p. 11) with only 1501 pups born in 2009. Resource competition with fisheries and fisheries-related by-catch are now considered to be the major drivers of this continuing decline (Robertson & Chilvers, 2011). Research by Chilvers (2009) indicates that sea lions are competing with one another for prey animals which are in limited supply due to fishing operations. Trawl fishing poses another threat to sea lions. Entanglement in trawling nets causes a significant number of sea lions to drown every year (Chilvers, 2008).

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 by-catch, bait harvesting, and pollution. Unfortunately, there is very little data for the impact of recreational fishing in New Zealand. According to Abraham, Berkenbusch, and Richard (2010), data extrapolated from interviews with fishers suggests that the accidental catch of seabirds and threatened marine mammals in New Zealand's non-commercial fisheries is a problem that deserves more focused attention in the context of species conservation.

Miethe, Dytham, Dieckmann, and Pitchford (2010) note that size-selective fishing may reduce population biomass by increasing mortality of the largest individuals. Birkeland and P. K. Dayton (2005) report that the larger and older individuals of some fish species produce larvae with considerably higher survival potential. Selective fishing pressure on larger individuals may result in a decrease of fecundity, average body size, and genetic heterogenity of harvested fish populations (Birkeland & P. K. Dayton, 2005). The loss of genetic diversity leaves these fish populations vulnerable to diseases and may lower their productivity and persistence in the long term (Birkeland & P. K. Dayton, 2005). Research by Hauser, Adcock, Smith, Ramírez, and Carvalho (2002) has shown that, contrary to expectations, declines in genetic diversity are measurable even in fish populations counting millions of individuals. Hauser et al. (2002) demonstrated this effect in a population of New Zealand snapper, despite an estimated minimum census population size of 3 million individuals.

New Zealand's 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). About 15 percent of all assessed stocks in 2011 were below the soft limit (i.e. in a state that is deemed overfished and requires active rebuilding); six percent were below the hard limit (i.e. are considered collapsed, requiring the closure of fisheries to rebuild the affected stock) (Ministry for Primary Industries, 2011).

3.3 Fisheries management

3.3.1 The quota management system

According to Craig et al. (2000), New Zealand was the first country to manage its fisheries by means of a system of individual transferable quotas (ITQs). New Zealand's quota management system was established in 1986 and as of 2012 there are 97 species or species groups and more than 636 fish stocks managed in the system (Ministry for Primary Industries, 2011; The New Zealand Seafood Industry Council, Ltd. 2012). Under the quota management system, New Zealand's EEZ was segmented into management regions for each species. Within this framework, the government would each year define the "total allowable catch" (TAC) per fish stock—a limit determined under consideration of expected commercial, recreational, customary and illegal catch[1]—and allocate its commercial part (TACC) proportionally to each quota holder. For many species the TACC equals the TAC, as there is no interest in these species in the recreational fishing sector (Newell et al., 2002). The trade of fishing quotas is generally limited to the same fish stock, management region, and year (Newell et al., 2002).

3.3.2 Managing the impacts on non-target species

To reduce the fishing-related impact of by-catch on threatened marine mammals, the Ministry of Fisheries annually imposes a fishing-related mortality limit (FRML) for New Zealand sea lions on the squid fishing industry under the Fisheries Act (1996). The limit for the 2010 fishing season has been reduced from 113 to 76 sea lions as a response to the low level of pup production (Ministry of Fisheries, 2009). Trawl fisheries are using SLEDS[2], which are designed to help sea lions to escape from trawl nets to further minimize the risk of by-catch (Ministry of Fisheries, 2010). More research is needed to determine how effective these de-

[1] Prior to 1990, the government issued fixed-tonnage quotas, making it very expensive to reduce the TAC for conservation purposes once the quotas were issued (Newell, Sanchirico, & Kerr, 2002).

[2] Sea lion exclusion devices

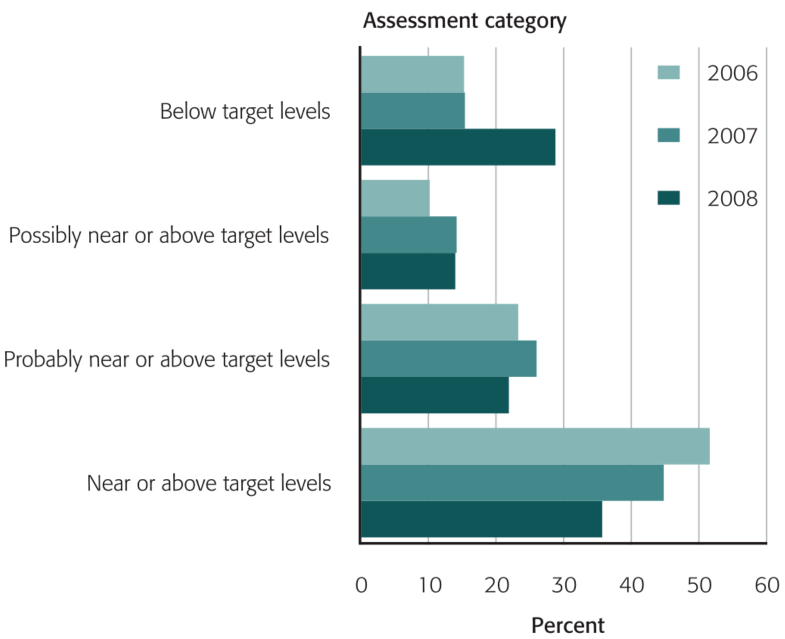

Figure 1: Proportions of assessed fish stocks by assessment category from 2006 to 2008. Reproduced from Statistics New Zealand (2009).

vices are.

For the critically endangered Hector's dolphin, a limit has been set of three set netting-related dolphin deaths per year, but this limit only applies to the area between the Waiau River and Waitaki River (Ministry of Fisheries, 2005). Four new marine mammal sanctuaries have been proposed, in order to adequately protect the remaining dolphin populations (Ministry of Fisheries and Department of Conservation, 2007).

3.3.3 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 customary harvest of seafood (and sustainable commercial fishing in taiapure) can continue while enabling sustainable management through by-laws (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.

4 Discussion

4.1 The quota management system

While New Zealand's quota management system has often been cited as an economic success, its contribution to the goal of sustainable fisheries is harder to judge (Craig et al., 2000). Although over 600 fish stocks are managed in the system, the available information for some species is too limited to define their total allowable catch limit with confidence (Statistics New Zealand, 2002). Craig et al. (2000) go even so far to say that "poor knowledge of the ecology of *most* species involved severely limits the ability to estimate sustainable TACCs" (emphasis mine). The usefulness of a quota management system as a tool towards sustainable fisheries ultimately depends on the accuracy of stock assessment and the reliability of species indicators (Dewees, 1998).

Craig et al. (2000) further criticise the large role that the fishing industry was given in the assessment of fish stocks following the 1999 amendment of the Fisheries Act. Dewees (1998) made a similar statement two years earlier in his review of individual quota systems:

> In New Zealand, the Fisheries Minister (a member of Parliament) sets the TACs using advice from the Ministry of Fisheries, the fishing industry, and other stakeholders. In the long run, it might be better to base the TAC decisions on management plans rather than on the judgement of an elected official.

Another related problem that the quota management system fails to address is the difficulty to control and estimate recreational catch, especially in inshore fisheries (Craig et al., 2000). The impact of non-commercial fisheries may also be an underestimated problem in the context of threatened species management (Abraham et al., 2010). A general lack of reliable reporting in recreational fisheries makes it all the more important to improve the scientific foundation for the calculation of annual TACs.

Target catch levels are based on the concept of Maximum Sustainable Yield, which demands "fishing down" of a given fish stock to decrease intra-species competition and reduce the fishing mortality rate before reducing and maintaining lower catch rates, thereby leading to constant increased yield. When the maximum sustainable yield for a given fishing stock is estimated, however, the spatial structure and biological interactions within the stock are usually ignored, and there often is not enough data to confidently assess stock health (Punt & Smith, 2001).[3]

Despite these problems, New Zealand's fish stocks compare favourably to international fisheries (Ministry for Primary Industries, 2011).

4.2 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

[3]In New Zealand, TACs are actually derived from two quantities related to MSY: the maximum constant yield and the maximum average yield. For both of these quantities the same caveats as to MSY apply.

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.

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 molluscs 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.

Despite their expected positive effects on fish stocks and their potential to aid ecosystem recovery, marine reserves extend to only a fraction of a percent of New Zealand's EEZ (Gordon et al., 2010). Scientific knowledge of marine habitats is still relatively poor and marine conservation efforts are minimal compared to management of ecosystems on land (Craig et al., 2000).

4.3 Spatial conflicts

The positive effects of reserves on marine ecosystems both inside and outside the protected area notwithstanding, the establishment of marine protected areas comes at 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—which are often considered encroaching upon 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).

The Oceans Policy, a whole-of-government effort lead by the Ministry for the Environment, is an attempt to resolve conflicts in the management of activities in the marine environment. These conflicts arise from inconsistent legislation due the overlapping scope of statutes such as the Fisheries Act, the Resource Management Act, and the Marine Reserves Bill, each of which have their own limited scope (Ministry of Fisheries, 2005). With this kind of unified legislation, spatial conflicts resulting from the proposed establishment of marine protected areas can be addressed in a manner that promotes sustainability (Bess & Rallapudi, 2007).

5 Conclusions

The threat to marine ecosystems posed by fishing activities ranks high and has been shown to amplify other pressures which are difficult to address with conventional management tools. New Zealand's quota management system is not sufficient to ensure that fisheries are sustainable because assessment of fish stocks suffers from a lack of data. As a consequence, the number of fish stocks in decline has grown over past years. Past reviews of marine reserves have repeatedly demonstrated their positive effects on marine ecosystems, yet only very little of the EEZ is currently protected. The establishment of marine reserves can cause conflicts with fishers who feel that their inherent fishing rights are restricted. These conflicts must be addressed to ensure that fishing is also economically and socially sustainable.

6 References

Abraham, E., Berkenbusch, K., & Richard, Y. (2010). *The capture of seabirds and marine mammals in New Zealand non-commercial fisheries* (tech. rep. No. 64).

Ballantine, W., & Langlois, T. (2008). Marine reserves: the need for systems. *Hydrobiologia*, *606*, 35–44. doi:10.1007/s10750-008-9347-7

Bess, R., & Rallapudi, R. (2007). Spatial conflicts in new zealand fisheries: the rights of fishers and protection of the marine environment. *Marine Policy*, *31*(6), 719 –729. doi:10.1016/j.marpol.2006.12.009

Bill, B. (1999). Marine reserves in New Zealand: the development of the concept and the principles. In *Proceedings of an international workshop on marine conservation for the new millenium, Korean Ocean Research and Development Institute* (pp. 3–38).

Birkeland, C., & Dayton, P. K. (2005). Uncovering secrets of our seamounts. *Trends in Ecology and Evolution*, *20*(7), 356–358.

Chilvers, B. L. (2008). New Zealand sea lions *Phocarctos hookeri* and squid trawl fisheries: bycatch problems and management options. *Endangered Species Research*, *5*, 193–204. doi:10.3354/esr00086

Chilvers, B. L. (2009). Foraging locations of female New Zealand sea lions (*Phocarctos hookeri*) from a declining colony. *New Zealand Journal of Ecology*, *33*(2), 106–113.

Clark, M., & O'Driscoll, R. (2003). Deepwater fisheries and aspects of their impact on seamount habitat in New Zealand. *Journal of Northwest Atlantic Fishery Science*, *31*, 441–458.

Claudet, J., Osenberg, C. W., Benedetti-Cecchi, L., Domenici, P., Carcia-Charton, J.-A., Perez-Ruzafa, A., … Planes, S. (2008). Marine reserves: size and age do matter. *Ecological Applications*, *11*, 481–489. doi:10.1111/j.1461-0248.2008.01166.x

Cole, R. G., Ayling, T. M., & Creese, R. G. (1990). Effects of marine reserve protection at Goat Island, northern New Zealand. *New Zealand Journal of Marine and Freshwater Research*, *24*, 197–210.

Craig, J., Anderson, S., Clout, M., Creese, B., Mitchell, N., Ogden, J., … Ussher, G. (2000). Conservation issues in New Zealand. *Annual Review of Ecology and Systematics*, *31*, 61–78.

Cudney-Bueno, R., Lavin, M. L., Marinone, S. G., Raimondi, P. T., & Shaw, W. W. (2009). Rapid effects of marine reserves via larval dispersal. *PLoS ONE*, *4*(1).

Dayton, P. K., Thrush, S. F., Agardy, M. T., & Hofman, R. J. (1995). Environmental effects of marine fishing. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *5*(3), 205–232. doi:10.1002/aqc.3270050305

Department of Conservation. (2002). *Building community support for marine protection*.

Department of Conservation. (2009). *New Zealand sea lion species management plan: 2009–2014*.

Department of Conservation. (2010). Map of marine conservation areas. Retrieved October 29, 2011, from http://www.doc.govt.nz/about-doc/role/maps-and-statistics/map-of-marine-conservation-areas/

Dewees, C. (1998). Effects of individual quota systems on New Zealand and British Columbia fisheries. *Ecological Applications*, *8*(1), 133–138.

Friedlander, A. M., Brown, E., & Monaco, M. (2007). Coupling ecology and GIS to evaluate efficacy of marine protected areas in Hawaii. *Ecological Applications*, *17*(3), 715–730.

Garcia, S. (2005, May 27). World inventory of fisheries. Destructive fishing practices. Issues Fact Sheets. Retrieved October 5, 2011, from http://www.fao.org/fishery/topic/12353/en

Gordon, D. P., Beaumont, J., MacDiarmid, A., Robertson, D. A., & Ahyong, S. T. (2010, August). Marine biodiversity of Aotearoa New Zealand. *PLoS ONE*, *5*(8), e10905. doi:10.1371/journal.pone.0010905

Halpern, B. S. (2003). The impact of marine reserves: do reserves work and does reserve size matter? *Ecological Applications*, *13*(1), S117–S137.

Halpern, B. S., Selkoe, K. A., Micheli, F., & Kappel, C. V. (2007). Evaluating and ranking the vulnerability of global marine ecosystems to anthropogenic threats. *Conservation Biology*, *21*(5), 1301–1315.

Hauser, L., Adcock, G. J., Smith, P. J., Ramírez, J. H. B., & Carvalho, G. R. (2002). Loss of microsatellite diversity and low effective population size in an overexploited population of New Zealand snapper (*pagrus auratus*). *PNAS*, *99*(18), 11742–11747. doi:10.1073/pnas.172242899

Heatley, P., & Wilkinson, K. (2011, August 26). Five marine reserves announced for West Coast. Retrieved October 28, 2011, from http://beehive.govt.nz/release/five-marine-reserves-announced-west-coast

Huntington, B. E., Karnauskas, M., Babcock, E. A., & Lirman, D. (2010). Untangling natural seascape variation from marine reserve effects using a landscape approach. *PLoS ONE*, *5*(8).

McPhee, D., Leadbitter, D., & Skilleter, G. (2002). Swallowing the bait: is recreational fishing in Australia ecologically sustainable? *Pacific Conservation Biology*, *8*, 40–51.

Miethe, T., Dytham, C., Dieckmann, U., & Pitchford, J. W. (2010). Marine reserves and the evolutionary effects of fishing on size at maturation. *ICES Journal of Marine Science*, *67*, 412–425.

Ministry for Culture and Heritage. (2012, June 16). Seafood consumption—food in New Zealand. Retrieved February 29, 2012, from http://www.nzhistory.net.nz/culture/no-pavlova-please/seafood-consumption

Ministry for Primary Industries. (2011). *The status of New Zealand's fisheries 2011*.

Ministry for the Environment. (2005). *Offshore options: managing environmental effects in New Zealand's Exclusive Economic Zone*. Ministry for the Environment, Wellington.

Ministry of Fisheries. (2005). *Briefing for the Minister of Fisheries*. Retrieved June 16, 2012, from http://www.fish.govt.nz/en-nz/Publications/Ministerial+Briefings/Ministerial+

Briefing+05/Ministerial+Actions+and+Issues+to+December+2005/Operational+issues.htm

Ministry of Fisheries. (2009, December). Retrieved July 17, 2011, from http://www.fish.govt.nz/en-nz/Press/Press+Releases+2009/December09/Fisheries+Minister+sets+cautious+sea+lion+limit.htm

Ministry of Fisheries. (2010, June). Retrieved July 17, 2011, from http://www.fish.govt.nz/en-nz/Press/Press+Releases+2010/June10/Sea+lion+management+based+on+expert+science.htm

Ministry of Fisheries and Department of Conservation. (2007). *Hector's and Maui's dolphin threat management plan: draft for public consultation*.

Minitry of Fisheries. (2010). Mataitai reserves. Retrieved from http://www.fish.govt.nz/en-nz/Maori/Management/Mataitai/default.htm

Morrison, M., Lowe, M., Parsons, D., Usmar, N., & McLeod, I. (2009). *A review of land-based effects on coastal fishieries and supporting biodiversity in New Zealand* (tech. rep. No. 37). Wellington.

Newell, R., Sanchirico, J., & Kerr, S. (2002). An empirical analysis of New Zealand's ITQ markets. *IIFET 2002: Fisheries in the Global Economy, International Fisheries Economic Conference*.

Punt, A., & Smith, A. (2001). The gospel of maximum sustainable yield in fisheries management: birth, crucifixion and reincarnation. In J. Reynolds (Ed.), *Conservation of exploited species*. Conservation Biology Series. Cambridge University Press. Retrieved from http://books.google.com/books?id=W8WldjwSjZYC

Robertson, B. C., & Chilvers, B. L. (2011). The population decline of the New Zealand sea lion *Phocarctos hookeri*: a review of possible causes. *Mammal Review*, 253–275. doi:10.1111/j.1365-2907.2011.00186.x

Rowden, A., O'Shea, S., & Clark, M. (2002). *Benthic biodiversity of seamounts on the northwest Chatham Rise* (tech. rep. No. 2). Ministry of Fisheries, Wellington.

Rowden, A., & Clark, M. (2004). Uncovering secrets of our seamounts. *Water & Atmosphere*, *12*(3).

Russ, G. R., & Alcala, A. C. (2011). Enhanced biodiversity beyond marine reserve boundaries: the cup spillith over. *Ecological Applications*, *21*, 241–250. doi:10.1890/09-1197.1

Russ, G. R., Alcala, A. C., Maypa, A. P., Calumpong, H. P., & White, A. T. (2004). Marine reserve benefits local fisheries. *Ecological Applications*, *14*(2), 597–606.

Statistics New Zealand. (2002). *Monitoring progress towards a sustainable New Zealand*.

Statistics New Zealand. (2009). *Measuring New Zealand's progress using a sustainable development approach: 2008*. Wellington; Statistics New Zealand.

Steneck, R. S., Graham, M. H., Bourque, B. J., Corbett, D., Erlandson, J. M., Estes, J. A., & Tegner, M. J. (2002). Kelp forest ecosystems: biodiversity, stability, resilience and future. *Environmental Conservation*, *29*(4), 436–459. doi:10.1017/S0376892902000322

Taylor, N., & Buckenham, B. (2003). *Social impacts of marine reserves in New Zealand* (tech. rep. No. 217).

Tegner, M., & Dayton, P. (2000). Ecosystem effects of fishing in kelp forest communities. *ICES Journal of Marine Science*, *57*(3), 579–589. doi:10.1006/jmsc.2000.0715

The New Zealand Seafood Industry Council, Ltd. (2012, May 12). Seafood industry fact file. Retrieved June 16, 2012, from http://www.seafoodindustry.co.nz/factfile

Walther, G.-R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T. J., … Bairlein, F. (2002). Ecological responses to recent climate change. *Nature*, *416*, 389–395.