BEFORE THE ENVIRONMENT COURT
AT AUCKLAND
I MUA I TE KŌTI TAIAO O AOTEAROA
TĀMAKI MAKAURAU ROHE

UNDER	the Resource Management Act 1991
IN THE MATTER	of appeals under Clause 14 of Schedule 1 of the Act
BETWEEN	**BAY OF ISLANDS MARITIME PARK INCORPORATED**
	(ENV-2019-AKL-000117)
	ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INCORPORATED
	(ENV-2019-AKL-000127)
	Appellants
AND	**NORTHLAND REGIONAL COUNCIL**
	Respondent

STATEMENT OF EVIDENCE OF TIMOTHY DENNE (ECONOMICS)

TOPIC 14 – MARINE PROTECTED AREAS

19 March 2021

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INTRODUCTION

1. My name is Tim Denne. I am an applied economist, and director of Resource Economics Ltd. I am providing this evidence on behalf of the Royal Forest and Bird Protection Society of New Zealand Inc ("Forest & Bird"), Bay of Islands Maritime Park Inc ("BOIMP") and Ngāti Kuta Hapū ki te Rawhiti ("Ngāti Kuta").

SUMMARY OF EVIDENCE

2. Using a Cost Benefit Analysis (CBA) framework, I identify the expected economic effects of establishing new marine protected areas (MPAs) on commercial and recreational fishers, on divers and snorkellers, and on the wider community.

3. The effects are summarised in Table 1.

Table 1 Summary of Costs and Benefits

Sector/Group	Costs	Benefits
Commercial fishers	Restrictions from fishing in MPAs may result in increased effort required to catch fish elsewhere or using alternative fishing methods (where provided for).	Possible spillover benefits from MPAs producing larger and more numerous fish, crustaceans and shellfish
Recreational fishers	Fishing displaced to less-favoured sites or increased effort required using alternative fishing methods (where provided for)	Possible spillover benefits from MPAs producing larger and more numerous fish, crustaceans and shellfish
Divers and snorkellers		New sites offering high value experiences, not available in many other NZ locations.
Wider community		Existence values – benefit of knowing of increased biodiversity in MPAs.
Maori		Some restoration of *mana* where there are cultural connections to areas in MPAs.

4. The costs identified are from the greater effort being required to catch fish (commercial fishers), of displacement to less-favoured sites (recreational

fishers), or the need to use alternative methods (all fishers). These costs may be compensated, at least in part, by spillover benefits from the MPAs.

5. The benefits include the new recreational opportunities created for divers and snorkellers. Because there are few sites offering such high value experiences, these are unlikely to be simply the transfer of diving/snorkelling activity from other locations. There are existence value benefits for the wider community that values conservation of marine life.

QUALIFICATIONS AND EXPERIENCE

6. I have a PhD in resource economics from the University of London (Imperial College) (1988) and an MSc (1st Class Hons) in Resource Management from the University of Canterbury (1983).

7. Since 2014 I have been an owner and Director of Resource Economics Ltd an economics consultancy that specialises in applying economic theory and analysis to the management and regulation of the environment and natural resources.

8. From 2003 to 2020, I was co-owner and Director of the economics consultancy, Covec Ltd. Prior to this I held positions in central and regional Government in New Zealand, in economics and environmental consultancies in the UK, as Deputy Director of a Washington, DC-based policy think tank and in university research posts in New Zealand and the UK.

9. Relevant to this current appeal, I have previously led studies on the economic costs and benefits of interventions to protect marine and freshwater environments. I have led studies that include:

    a. advising the then Ministry of Fisheries on methodologies for estimating the economic impacts of closure of commercial fisheries to establish reserves;

    b. advising Auckland Council on the benefits of improved marine water quality from wastewater/stormwater separation;

    c. leading the cost benefit analysis of the 2020 National Policy Statement for Freshwater Management; and

    d. advising the Environmental Defence Society (EDS) on economic issues relating to New Zealand's Quota Management System (QMS) during the EDS investigation into fisheries management.

CODE OF CONDUCT

10. I have read the Code of Conduct for Expert Witnesses in Part 7 of the Environment Court's Practice Note 2014. I agree to comply with the Code of Conduct. In particular, except where I state that I am relying upon the evidence of another person as the basis for any opinion I have formed, the evidence in this statement is my expert opinion within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

EVIDENCE

11. My evidence covers the following issues:

    a. The reasons for adopting the framework of social cost benefit analysis (CBA) in identifying the economic effects.

    b. The expected costs for commercial and recreational fishers.

    c. The potential for spillover benefits from the MPAs back to the commercial and recreational fisheries.

    d. The expected benefits from new recreational opportunities, and those that accrue more widely in the community.

Approach: Cost Benefit Analysis

12. I use a CBA framework to identify costs and benefits. This approach contrasts with others used for economic valuation, such as economic impact analysis ("**EIA**") which measures the impacts on value added or GDP.

13. There have been some New Zealand EIAs which have calculated the value of New Zealand's commercial[1] and recreational[2] fisheries, of the Goat Island Marine Reserve[3] and the Hauraki Gulf.[4] These are static analyses which do not provide a basis for estimating the effects of small changes in activity (eg changing the size of fisheries) or of the establishment of new marine protected areas (MPAs) as they do not estimate how labour and other resources might be allocated otherwise (the counterfactual).

14. In addition, EIAs focus narrowly on impacts on value-added (or some other macro-economic indicator), whereas CBA derives from welfare theory in

[1] See Williams J, Stokes F, Dixon H and Hurren K (2017) *The economic contribution of commercial fishing to the New Zealand economy*. Berl.
[2] Southwick R, Holdsworth JC, Rea T, Bragg L and Allen T (2018) Estimating marine recreational fishing's economic contributions in New Zealand. *Fisheries Research*, 208: 116–123; New Zealand Marine Research Foundation (2016) *Recreational Fishing in New Zealand. A Billion Dollar Industry*. The South Australian Centre for Economic Studies (1999) *Value of New Zealand Recreational Fishing*. Project: REC9801. Undertaken for: New Zealand Ministry of Fisheries;
[3] Hunt L (2008) *Economic Impact Analysis of the Cape Rodney Okakari Point (Leigh) Marine Reserve on the Rodney District*. A report prepared for the Department of Conservation.
[4] Barbera, M (2012) *Towards an economic valuation of the Hauraki Gulf: a stock-take of activities and opportunities*. Auckland Council technical report TR2012/035

which the best decision in any circumstance is defined as the one which produces the maximum gain in wellbeing for the whole community.

15. The requirement in plan making under the Resource Management Act is to identify and assess the benefits and costs of the economic effects[5] that are anticipated from the implementation of the provisions.[6]. The Treasury notes that EIA might provide useful contextual information for decision-makers, but it is not suitable as a tool for measuring the balance of costs and benefits of a decision to society.[7] I agree; and because it is the total impacts on society that are of interest, I use the assumptions of CBA here.

Costs

16. The costs of the proposals result from restrictions on activities in marine protected areas (MPAs). The changes are listed in Table 2. They include a mixture of prohibition of fishing and restrictions on fishing method.

Table 2 Summary of Proposed Marine Protected Areas

Name	**Area (ha)**	**Current restrictions**	**Proposed restrictions**
Mimiwhangata Rahui Tapu	Marine Park increasing from 19km^2 to 47km^2	Commercial fishing prohibited in Marine Park. Method restrictions on recreational fishing	Area of prohibition extended, and extended to recreational fishing
Mimiwhangata Rahui Tapu Buffer Area – EAST and WEST (proposed by Te Uri o Hikihiki)	West - 3.36km^2 East – 6.47km^2 (NB: these Buffers are within the current Marine Park)	Commercial fishing prohibited in Marine Park. Method restrictions on recreational fishing	Prohibition on commercial fishing, prohibition extended (Method restrictions added) for recreational fishing.
Maunganui – Oke Bay Rahui Tapu	1.6 km^2 increasing to 6.25km^2	Temporary closure (only kina gathering allowed) within current Rahui Tapu	Permanent (only kina gathering allowed) for current area, extended to full 6.25km^2
Manganui – Oke Bay Rahui Tapu Buffer Area	4.34km^2	Trawl vessels >46m prohibited Some method restrictions apply	Additional method restriction categories
Ipipiri Benthic Protection Area	c. 50km^2	Commercial fishing (except Rock Lobster) prohibited during summer and otherwise method controls apply.	No (recreational) dredging added as method restriction
Ipipiri-Rakaumangamanga Protection Area	c. 500km^2	Trawl vessels >46m prohibited	Additional method restriction categories apply.

[5] As well as other types of effects that are outside my expertise and are addressed by other witnesses.
[6] Section 32 RMA.
[7] The Treasury (2015) *Guide to Social Cost Benefit Analysis*.

		Some method restrictions apply	
Te Au o Morunga Protection Area (proposed by Te Uri o Hikihiki)	c. 620 km^2	Trawl vessels >46m prohibited Some method restrictions apply	Additional method restriction categories apply

17. The cost of the MPAs would be equivalent to the amount current users (who would be denied from certain activities in the identified sites in the future) would be willing to pay to continue use. This willingness to pay (**WTP**) would be less than the current net value obtained from use of these areas if there are substitute areas that could be used instead, e.g. if the availability of marine space was not the limiting factor for users to obtain value. I explore this below for the different users.

Commercial Fishing

18. When commercial fishing is restricted from parts of a fishery, the loss is the reduction in the future stream of net benefits. However, the area available for fishing may not be the binding constraint on the quantity of fish caught and the revenue obtained. Rather the availability of Annual Catch Entitlements ("**ACE**") under the Quota Management System ("**QMS**") is the binding constraint.

19. A commercial fisher with ACE, restricted from fishing in one area, can move to another. This has costs. We might assume that fishers go to current areas because this is where they maximise profit as revenue minus the costs of their effort. Restricting activity from areas that are currently used would be expected to increase the effort required to catch the quantity of fish allowed by their holding of ACE. This might be because they need to travel further or to fish for longer. But what defines their costs is the cost of their effort that goes up rather than any loss of revenue.[8]

20. In areas where fishing is not prohibited altogether, a fisher may be able to change to a different fishing method. The net costs of changing method might include the costs of new equipment, greater effort per catch, or the costs of changes to location of fishing where this is a lower (net) cost option.

21. The net effect also depends on whether any increase in costs of effort is compensated either by a reduction in the price of ACE or by an increase in the price of fish. This is unlikely for small marginal changes in allowed areas, but may occur where fishing method changes (e.g. if the fisher is able to change from trawling to longlining, and a premium is paid for longline-caught fish).

[8] Taylor N and Buckenham B (2003) *Social impacts of marine reserves in New Zealand*. Science for Conservation, 217. Department of Conservation.

Recreational Fishing

22. Recreational fishers go fishing for a wide range of reasons, that combined, provide positive contributions to their wellbeing. This might be through catching fish for consumption or for the enjoyment of a day's fishing with friends or family.

23. The costs for recreational fishers who currently use areas in which MPAs would be established, would not be expected to be significant if there were nearby substitute sites where the same activities can be pursued.[9] However, unless where they fish is chosen at random, we can assume that the substitute sites provide less value or enjoyment.

24. Several non-market valuation studies have assessed the value of recreational sea fishing in New Zealand. The value is measured as the surplus that people obtain; it is the difference between their costs (e.g. what they spend on travel or bait etc) and their expressed WTP. This surplus, summed across all recreational fishers, is assumed to be the measure of social (or community) benefit.

25. Published New Zealand studies use different survey questions to produce different values on different bases, including value per fish caught,[10] per fisher per year,[11] per person per day[12] and per fishing trip.[13]

26. Wheeler and Damania (2001), for example, used a survey at boat ramps which asked fishers if they would still go fishing that day if their trip was more expensive by stated amounts (based on increased costs of bait, fuel, ice, etc.). Kerr et al (2003) produce relatively low estimates of value based on a survey which assessed fishers' willingness to pay for a marine fishing licence which would be required for sea fishing. They suggest the values include the influence of protests about the idea of a marine fishing licence.

27. However, to use these values to estimate the costs of new MPAs would require estimates of change in one of the relevant indicators: the number of fish caught, total recreational fishers, numbers of fishing days or trips. However, I do not have such estimates, particularly because I would expect significant site substitution to occur.

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[9] Kerr GN and Latham N (2011) The Value of Recreational Inshore Marine Fishing. Paper presented at the 2011 NZ Agricultural and Resource Economics Society (NZARES) Conference Tahuna Conference Centre. Nelson. August 25-26, 2011.

[10] Wheeler S and Damiana R (2001) Valuing New Zealand recreational fishing and an assessment of the validity of the contingent valuation estimates. *The Australian Journal of Agricultural and Resource Economics*, 45(4): 599-621

[11] Kerr GN, Hughey KFD and Cullen R (2003) Marine Recreational Fishing: Perceptions and Contingent Behaviour. *Lincoln University Commerce Division Discussion Paper No. 99*.

[12] Kaval P and Yao R (2007) New Zealand Outdoor Recreation Benefits. *University of Waikato Department of Economics Working Paper in Economics* 07/14.

[13] Schischka T and Marsh D (2008). Shared fisheries; results from an investigation into the value of the recreational and commercial catch in a New Zealand quota management area. Presented at the *Australian Agricultural and Resource Economics Society 52nd Annual Conference, Canberra, 6-8 February 2008*.

Costs of Monitoring and Enforcement

28. In addition to the compliance costs falling on fishers, there will be costs to introduce the new regulations, including education of fishers and the community, and to monitor and enforce compliance.

29. Identifying such costs is not straightforward as it depends on the level of enforcement, levels of community engagement and the expected conservation outcome. Costs will be high when there is continuous patrolling and enforcement but can be low where it depends more on voluntary measures and/or reporting by locals.[14] Where the costs of enforcement are significant (taking account of the effectiveness of voluntary restraint), they can have an impact on decisions over the optimal size of an MPA[15] (in the absence of policy requirements to protect particular environmental features, which may override that consideration).

Benefits

30. The benefits of spatial closures of fisheries to commercial and recreational fishing (and to a lesser extent, method restrictions) are estimated to result from the restoration of habitats and an increase in biodiversity and abundance.

31. These effects, in turn are expected to result in:

- An increase in levels or associated values (consumer surpluses) of activities that are enabled by the greater biodiversity. This might include snorkelling and diving;
- Increases in existence value for people who value the ecological quality of the MPAs;
- Increases in cultural values for some people and groups;
- Potentially positive spillover benefits for commercial and recreational fishing in areas close to the MPAs.

Recreational Benefits – new activities

32. The predicted change in ecological quality inside the MPAs[16] enables new recreational opportunities that are not widely available elsewhere or not with such high value. This can be seen from the use of other marine reserves:

    a. The Cape Rodney–Okakari Point Marine Reserve (or Goat Island Marine Reserve), near Leigh, is smaller than the current proposals but

[14] Brown CJ, Parker B, Ahmadia GN, Ardiwijaya R and Game ET (2018) The cost of enforcing marine protected areas to achieve ecological targets for the recovery of fish biomass. *Biological Conservation*, 227: 259-265.
[15] Albers HJ, Preonas L, Capitán T, Robinson EJZ and Madrigal-Ballestero R (2020) Optimal Siting, Sizing, and Enforcement of Marine Protected Areas. *Environmental and Resource Economics*, 77:229–269.
[16] As predicted in the evidence of Mark Morrison, Nick Shears, and Rebecca Stirnemann.

closer to the large population of Auckland. A 2010/11 survey found 47% of visitors to the reserve said snorkelling was their main reason for the visit and that it is widely regarded as "the place to swim with the fish".[17] Estimates of annual visitor numbers to the reserve range from "a conservative figure of 200,000"[18] to 375,000.[19]

b. The Poor Knights Island Marine Reserve is more difficult to access and approximately 1053 commercial trips were made to in 2003–2004 carrying approximately 14,836 passengers.[20] A survey of 355 boats within the reserve between 1998 and 2002 found diving was the main activity for 80% of the passengers.

33. To value these activities requires an estimate of the additional recreational trips expected because of the change in ecological values, in addition to a value per additional trip. Although there are some per trip values in the literature,[21] I do not have estimates of the number of additional trips. Even if I did, it is important to take account of whether these recreational trips are truly additional, or if they represent a change in location and/or in activity. Unlike the removal of recreational fishing opportunities for which there are likely to be substitutes, as discussed above, the creation of MPAs is developing something unique, enabling snorkelling and diving for which there are fewer equivalent substitute sites. This is supported by the evidence of Julia Riddle and Craig Johnston, both of whom describe their businesses being constrained by a lack of available dive sites.

34. Thus, new or enhanced recreational opportunities are expected to compensate, in part, in whole or in excess, for recreational fishing that might be displaced to new sites.

Existence values

35. People express values for the existence or quality of natural sites and habitats they might never visit. These are referred to as 'existence values'. [22]

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[17] Race SM (2011) *The characteristics and experiences of summer visitors to Goat Island Marine Reserve, New Zealand.* A thesis submitted to Auckland University of Technology in fulfilment of the requirements for the degree of Master of Philosophy (MPhil); Race SM and Orams MB (2014) The Experiences of Summer Visitors to Cape Rodney–Okakari Point (Goat Island) Marine Reserve, Auckland, New Zealand. *Tourism in Marine Environments*, 10(1-2): 101-114.

[18] Race (*op cit*)

[19] DoC (2005) in: Hunt L (2008) *Economic Impact Analysis of the Cape Rodney Okakari Point (Leigh) Marine Reserve on the Rodney District*. A report prepared for the Department of Conservation.

[20] Sim-Smith C and Kelly M (2009) *A literature review on the Poor Knights Islands Marine Reserve*. Report prepared by the National Institute of Water & Atmospheric Research Ltd for Department of Conservation.

[21] See, for example the value of saltwater recreation in: Kaval P and Yao R (2007) New Zealand Outdoor Recreation Benefits. University of Waikato Department of Economics Working Paper in Economics 07/14

[22] Sharp B and Kerr G (2005) *Option and Existence Values for the Waitaki Catchment*. Report Prepared for Ministry for the Environment; Marsh D and Mkwara L (2013) Review of Freshwater Non-Market Value Studies. Department of Economics. University of Waikato.

36. One recent example of their measurement is a study in the Waikato which used a survey to estimate the WTP for improvements in water clarity, reduced numbers of *E coli* infections and increased ecosystem health (based on levels of nutrients and algae, and suitability for sensitive species). Separate values were estimated for those who visit the sites and those who do not. Non-use values accounted for 79% of the use value.[23]

37. Existence values are part of the set of values that would be enhanced by the creation of new MPAs.[24] I would expect, in the same way as in published studies of existence values, for many people living nearby and further afield to value the establishment of MPAs in the Bay of Islands because of the value they place on enhanced marine biodiversity.

38. As with most non-market values, measuring existence values requires site-specific stated preference surveys. No such study has been undertaken for the Bay of Islands MPAs.

39. An alternative approach to quantifying these less-tangible values is that used by van den Belt and Cole (2014)[25] who estimated the value of the ecosystem services provided by New Zealand's MPAs. Ecosystem services are one way of defining the benefits that people derive from ecosystems. Standard definitions include the following services:

    - Provisioning, i.e. products obtained, such as food, water, fuel
    - Regulating, such as climate regulation, water purification, pollination
    - Cultural, including spiritual and religious, aesthetic, educational; and
    - Supporting of other services, e.g. soil formation, nutrient cycling

40. Using values derived from New Zealand and international studies, particularly Costanza et al's valuation of the whole world's ecosystem services,[26] Belt and Cole estimated annual values for New Zealand marine reserves using per hectare values for individual biomes (estuaries, reefs, open ocean etc) within the reserves. The totals by service and reserve area are shown in Table 3. Because of its size, this attributes very large values of over $1.4 billion per year (2010 dollar values) to the Banks Peninsula Mammal Sanctuary. However, in my opinion this approach seems too simplistic to be useful, and it does not differentiate between the before and after effects of creating reserves.

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[23] Phillips Y (2014) *Non-market values for fresh water in the Waikato region: a combined revealed and stated preference approach*. Waikato Regional Council Technical Report 2014/17.
[24] Davis KJ, Vianna GMS, Meeuwig JJ, Meekan MG and Pannell DJ (2019) Estimating the economic benefits and costs of highly-protected marine protected areas. *Ecosphere*, 10(10): e02879.
[25] van den Belt M and Cole A (2014) *Ecosystem goods and services in marine protected areas (MPAs).* Science for Conservation, 326. Department of Conservation.
[26] Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P and van den Belt M (1997) The value of the world's ecosystem services and natural capital. *Nature*, 387: 253-260.

Table 3 Value of Ecosystem Services provided by Marine Reserves (2010$ million/year)

Reserve	Area (ha)	Supporting	Regulating	Provisioning	Cultural	Total
Banks Peninsula Mammal Sanctuary	405,820	$1,229	$58	$58	$59	$1,403
Poor Knights	1,922	$4	$3	$0	$0	$8
Whangarei Harbour (Motukaroro)	26	$1	$0	$0	$0	$1
Whangarei Harbour (Waikaraka)	211	$7	$2	$0	$0	$9
Te Angiangi Marine Reserve	443	$8	$1	$0	$1	$10
Westhaven (Te Tai Tapu)	526	$24	$1	$0	$0	$25
Piopiotahi	721	$29	$1	$0	$0	$31

Source: van den Belt M and Cole A (2014) Ecosystem goods and services in marine protected areas (MPAs). Science for Conservation, 326. Department of Conservation

41. These ecosystem service values are more than existence values, but the recognition that natural areas provide ecosystem services is part of the reason for existence values being expressed. I expect there will be existence values for new MPAs in the Bay of Islands, but I am not able to accurately quantify them.

Spillover Benefits

42. The establishment of marine reserves can provide safe spawning grounds for commercial and recreational fish and other species, allowing them to develop to larger sizes or in greater number, within more diverse ecosystems.[27] One of the arguments frequently raised is that these effects have spillover benefits for surrounding areas as the reserve becomes a source for increased numbers and larger individuals in fished areas.[28]

43. Although widely predicted, spillover benefits have been notoriously difficult to measure as statistically significant effects in empirical studies, particularly when the size of the reserve is small compared with the surrounding area that is fished.[29]

44. Increasing the number of fish available to recreational and commercial fishers was one of the goals of the California State Government when it implemented a string of marine protected areas (MPAs).[30] One recent study

[27] Roberts CM, Bohnsack JA, Gell F, Hawkins JP, Goodridge R (2001) Effects of Marine Reserves on Adjacent Fisheries. Science, 294: 1920-1923.
[28] Dayton PK, Sala E, Tegner MJ and Thrush S (2000) Marine Reserves: Parks, Baselines, and Fishery Enhancement. *Bulletin of Marine Science*, 66(3): 617–634.
[29] Babcock R (2003) The New Zealand Marine Reserve Experience: the science behind the politics. In: Hutchings P and Lunney D (Eds) Conserving marine environments. Out of sight out of mind. Royal Zoological Society of New South Wales, Mosman, NSW, pp 108–119.
[30] Bland A (2019) The Benefits of Marine Protected Areas Spill into Neighboring Waters. *Hakai Magazine*, July 12, 2019.

in Southern California has identified positive spillovers for spiny lobsters.[31] The results show that a 35% reduction in fishing area was compensated for by a 225% increase in total catch after six years. The authors suggest the effects are more detectable in lobster species because they can be intensively fished using stationary traps that can be placed near reserve borders.

45. Despite positive spillovers reported in several other studies, including greater catch numbers or larger fish,[32] some have not identified a detectable effect, particularly with greater distance from reserve boundaries. However, Di Lorenzo *et* al (2016) suggest this is more a challenge to research rather than evidence of little or no effect.[33]

46. Research in New Zealand has shown large increases in abundance and size of species within MPAs, including of snapper, spiny lobster and blue cod, and that these increases have been rapid, occurring within one year in the case of snapper (Babcock, 2003;[34] Willis, 2013).[35] And Babcock suggests the spillover effects would be impossible to detect given the small proportions of New Zealand coastline protected in reserves. Davidson et al (2002) recognise the difficulty of measuring increase in adjacent areas but note that improvements in density of populations in a marine reserve may indicate the potential for emigration from that reserve.[36]

47. If there are positive spillovers, fishers might be better off through the establishment of MPAs. However, they are unlikely to be established through voluntary arrangements amongst fishers as each individual fisher continues to have the incentive to use these areas.[37] It is likely to require government intervention to establish them.

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[31] Lenihan HS, Gallagher JP, Peters JR, Stier AC, Hofmeister JKK and Reed DC (2021) Evidence that spillover from Marine Protected Areas benefits the spiny lobster (*Panulirus interruptus*) fishery in southern California. *Scientific Reports*, 11:2663.

[32] Halpern BS, Lester SE and Kellner JB (2010) Spillover from marine reserves and the replenishment of fished stocks. *Environmental Conservation*, 36(4): 268–276;
da Silva IM, Hill N, Shimadzu H, Soares AMVM and Dornelas M (2015) Spillover Effects of a Community-Managed Marine Reserve. *PLoS ONE* 10(4): e0111774.
Russ GR, Alcala AC, Maypa AP, Calumpong AP and White AT (2004) Marine Reserve Benefits Local Fisheries. Ecological Applications, 14(2): 597-606.
Roberts CM, Bohnsack JA, Gell F, Hawkins JP, Goodridge R (2001) Effects of Marine Reserves on Adjacent Fisheries. *Science*, 294: 1920-1923.

[33] Di Lorenzo M, Claudet J and Guidetti P (2016) Spillover from marine protected areas to adjacent fisheries has an ecological and a fishery component. *Journal for Nature Conservation*, 32: 62-66.

[34] Babcock R (2003) *The New Zealand Marine Reserve Experience: the science behind the politics*. In: Hutchings P and Lunney D (Eds) Conserving marine environments. Out of sight out of mind.
Royal Zoological Society of New South Wales, Mosman, NSW, pp 108–119.

[35] Willis TJ (2013) Scientific and biodiversity values of marine reserves: A review. DOC Research and Development Series, 340.

[36] Davidson RJ, Villouta E, Cole RG and Barrier RGF (2002) Effects of marine reserve protection on spiny lobster (Jasus edwardsii) abundance and size at Tonga Island Marine Reserve, New Zealand. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 12: 213–227.

[37] This could be regarded as an example of the Tragedy of the Commons after: Hardin G (1968) The Tragedy of the Commons. *Science*, 162(3859): 1243-1248.

Cultural Benefits

48. Additional benefits accrue to Maori, in particular, where the MPAs enable additional customary food collection or the restoration of habitats with which they have a cultural connection. These are even more difficult to quantify than other values discussed above, particularly because ecosystem damage may not be regarded as something that can be traded-off against other sources of value.

49. I understand the principle of reciprocity (*tau utu utu*) is an important part of exercising *kaitiakitanga* (guardianship). Environmental protection provides benefits to the natural world and means that the ecosystem or resource can then provide benefit back to people.[38] Where there are historical cultural connections and perceived responsibilities to guardianship and to restoration, environmental damage reduces *mana* because it suggests a failure to exercise *kaitiakitanga*. Reducing the intensity of fishing, where it enables habitat restoration, may restore *mana*.

Quantification

50. Although I have not attempted to quantify the costs and benefits here, some international studies have attempted to do so. This includes one study in Western Australia of the costs and benefits of a network of large scale marine sanctuaries. It suggested costs for commercial and recreational fishers of approximately A$9 million and $2 million respectively, with offsetting benefits including new ecotourism benefits of A$5-$10 million, spillover benefits of up to A$2 million and non-market (existence) values of A$100-$200 million.[39]

51. The authors were able to quantify the effects by, e.g. assuming a 15% reduction in average rock lobster catch, rather than estimating increased effort, and by making simple assumptions about the increase in eco-tourism numbers. They also had a relevant non-market valuation study which had estimated a $140 WTP per person per year for ecological improvements in Ningaloo Marine Park. This was multiplied by a State adult population of 1.6 million. In contrast, I do not have the relevant and transferable data for costs or benefits to enable this type of assessment.

Summary of Costs and Benefits

52. I summarise the identified costs and benefits of establishing MPAs in Table 4.

[38] Harmsworth GR and Awatere S (2013) Indigenous Māori Knowledge and Perspectives of Ecosystems. In: Dymond JR (Ed) *Ecosystem Services in New Zealand – Conditions and Trends*. Manaaki Whenua Press, Lincoln, New Zealand.

[39] Allen Consulting (2009) *The economics of marine protected areas: Application of principles to Australia's South West Marine Region*. Report to the Conservation Council of Western Australia.

53. The costs identified are from the greater effort being required to catch fish (commercial fishers), of displacement to less-favoured sites (recreational fishers), or the need to use alternative methods (all fishers). These costs may be compensated, at least in part, by spillover benefits from the MPAs.

54. The benefits include the new recreational opportunities created for divers and snorkellers. Because there are few sites offering such high value experiences, these are unlikely to be simply the transfer of diving/snorkelling activity from other locations. There are existence value benefits for the wider community that values conservation of marine life.

Table 4 Summary of Costs and Benefits

Sector/Group	Costs	Benefits
Commercial fishers	Restrictions from fishing in MPAs may result in increased effort required to catch fish elsewhere or using alternative fishing methods (where provided for).	Possible spillover benefits from MPAs producing larger and more numerous fish, crustaceans and shellfish
Recreational fishers	Fishing displaced to less-favoured sites or increased effort required using alternative fishing methods (where provided for)	Possible spillover benefits from MPAs producing larger and more numerous fish, crustaceans and shellfish
Divers and snorkellers		New sites offering high value experiences, not available in many other NZ locations.
Wider community		Existence values – benefit of knowing of increased biodiversity in MPAs.
Maori		Some restoration of *mana* where there are cultural connections to areas in MPAs.

Tim Denne
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