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'NO-TAKE' MARINE RESERVE NETWORKS SUPPORT FISHERIES

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SUMMARY

'No-take' marine reserves offer a new and additional form of fisheries management. Over the past 20 years New Zealand has demonstrated that such reserves are practical and provide valuable support for science, education, recreation, conservation and social economics. A representative network is now the official aim. This is an opportunity for fisheries management to upgrade its aims and avoid the traps of data-dependent, stock specific management. While retaining detailed management for particular fisheries, the provision of a 'no-take' network would inject a new level of decision based on general principles - including ecosystem dynamics, the overall public interest, and the need for insurance against human error and natural disasters. Recent history strongly suggests this move would be actively supported by the general public.

INTRODUCTION

'No-take' marine reserves do not immediately appeal to most fisheries scientists and managers. They have to concentrate their efforts at the level of particular stocks. Although they often have problems, what happens to other stocks is not strictly their business. When making recommendations for action and regulation, they are stock-specific. A detailed analytical approach to management is necessary, for scientific and economic reasons, but it may not be enough. Data-based management is certainly required, but is it sufficient? Could we add other management approaches, with different advantages and problems? In particular, could we stop making all our decisions on precise data, and act on basic principles for a proportion of the business?

This is commonly done. In most human affairs, accidents, error and large variations in natural forces are so frequent as to require active counter-measures. Such measures cannot, by definition, be based on specific knowledge. But practical and efficient systems for this purpose are common and widespread. One of the few areas where they are largely absent is fisheries management.

It is my contention that a network of 'no-take' marine reserves would be a practical and effective addition to current fisheries management. The main barrier to the adoption of this additional approach is the same as its main practical advantage - it is based on general principles, not on specific and detailed knowledge.

THE PRINCIPLES FOR 'NO-TAKE' MARINE RESERVES

Most forms of fisheries regulation have to be justified by detailed data on the likely effects, and require monitoring to see if these occur. Furthermore the justification is concerned with the effects on human activites - which also change. In contrast, an out-right ban on any form of extraction can shift the justification to principles, and the basic concern to effects on the natural system. This reverses the burden of proof, changes the type of data regarded as evidence, and enables general experience (i.e. principles) to be used as hard argument.

In standard management the argument is mainly about 'allocation' and 'proof of damage'. For 'no-take' reserves, there is no allocation, and it is assumed that any extraction will have some effect. So while it is still possible to oppose the whole idea, the level of argument is different. The first principle is scientific. The provision of permanent minimally-disturbed areas is necessary to act as 'controls'. Without such 'controls', it is much more difficult to produce valid scientific conclusions (e.g. separating and measuring natural changes).

The second principle is both basic biology and social common-sense. Areas without deliberate extractions will help the conservation of biodiversity (genetic, specific, habitat and ecosystem). These less-disrupted areas will assist enjoyment of natural heritage (recreational and spriritual) and learning about marine life and its processes (education and advanced training). The overall public interest requires 'no-take' areas.

It should be noted that these princples do not depend on demonstrating that specific extractions have severe or even measurable effects. It is simply a statement that extractions *may* have serious or complex effects, and that it would be helpful to minimise *all* these in *some* places. While it is possible to believe such 'no-take' reserves should be small and rare, it is difficult to argue convincingly that they should not exist at all (which is the case in most countries at present).

Despite a slow start (the first reserve took 12 years!) the above principles are now widely recognised in New Zealand. There are now 13 established 'no-take' marine reserves. They are scientifically useful, valuable in education, popular for recreation, appreciated by tourists, supported by the local communities and clearly helpful in conservation. As a result, the rate of establishment is increasing. At least 25 more are in various stages of active public discussion. All the main political parties are promising "more marine reserves" and some are advocating "10% by the year 2000". The official aim is "establish a network of marine reserves" including "representative examples of the full range of habitats and ecosystems" (Department of Conservation, 1995).

EXISTING ASSUMPTIONS IN FISHERIES

It is reasonable to assume that the practical management of fisheries should focus on actual stocks - the self-contained breeding units. However applying this assumption has some odd effects. Managers tend to assume that fish are there to be fished. This is even more basic than the idea of 'fishing rights'. If a potentially-fishable stock exists, there may be discussion about how it should be fished, who should fish it and how much can be taken. But that it should be fished, if possible, is taken for granted. Since this is true for every stock, the question of having 'no-take' areas is not normally considered.

Fisheries scientists, who provide data for management decisions, also focus on particular stocks. They reasonably assume that better data on the stock will help. But scientists also tend to assume that the answers to management problems can be found *within* the stocks. They may admit that the existing data is inadequate or that politics, economics, or natural disasters change the rules of the game. But their job is to get precise and up-to-date stock-specific data. The question of whether 'no-take' areas would help management (or science) in all stocks is not even considered.

EXISTING PROBLEMS IN FISHERIES

Short-term efficiency is promoted by focused attention to the matter in hand, but only while the assumptions hold true. Stock-specific, data-based fisheries science and management does make sense in the short-term, and will always be the day-to-day focus of activity. Nevertheless uncertainty about the assumptions is a permanent problem and, if ignored, frequently becomes critical.

When a fish stock crashes or has critical problems, we are usually informed that this was due to some combination of:

inadequate data	changing economic conditions
inappropriate analysis	new technology
political interference	natural changes
insufficient enforcement	

The main public discussion then becomes a search for scapegoats and compensation. It tends to be assumed that the 'causes' listed above are relatively rare and could be predicted or avoided. A more dispassionate analysis indicates that some levels of ignorance, error and unforeseen changes are to be expected even in the best regulated systems, and consequently some higher level control is also required. The types of uncertainty listed above apply to almost every kind of human business, including farming, manufacture trade, government and sports. In most of these, high-level controls based on general principles are regarded as standard management practice.

Problems regarding by-catch and bait fish, vote-catching political decisions, fashions in food and recreation, complex analytical difficulties, natural changes in stocks or currents

(and dozens of similar problems) are likely to be with us in the foreseeable future. Fisheries also need some forms of control based on principles, rather than stock-specific data.

Ludwig *et al* (1993), reviewing the history of fisheries, reject the idea that sustainability can be based on a scientifically-agreed stock-specific data. They suggest that we confront uncertainty in fisheries and "consider a variety of hypotheses and strategies; favour actions that are reversible, informative and robust to uncertainty; probe, monitor, and modify" and above all "hedge".

A network of 'no-take" marine reserves would do much of this and would assist with the rest. It would provide an escape from the infinite regression in which we are now trapped. Instead of *always* needing more data to predict precisely the effects on detailed user-group activities, we could also start at the other end. What actions are most robust to uncertainty, most informative, provide a hedge on existing activities, allow better monitoring and are easily reversible? One such action would be to have areas with no fishing at all.

What are the reasonable hypotheses on the level of provision for 'no-take' areas, even if total fishing effort and catches are to be maintained or enhanced? The answers seem to lie in the 10-30% range, based on general principles. But, of course, there have been very few trials (and these are mostly small, isolated and poorly monitored). Essentially we have not yet ventured to do the experiment.

THE PRINCIPLES FOR A NETWORK OF 'NO-TAKE' MARINE RESERVES

When the scientific, conservation and social values are accepted as principles, the argument turns to the question of quantity. The first principle for this is representation. To be representative,'no-take' marine reserves are needed in each major biogeographic region (simply because these have different biota). Within each region the 'no-take' areas would include some of each major habitats/communities (for the same reason). The second principle is replication. An example of each habitat in more than one location would be required to provide scientific replication, to give protection against accidents (whether pollution or local natural disasters) and to improve social values (including recreation and tourism).

The principle of sustainability needs to be included here. In order to maintain its values, the whole system of 'no-take' reserves must be self-sustaining. Single marine reserves are unlikely to be self-sustaining, since most marine organisms have remote dispersal mechanisms (e.g. planktonic larvae). A 'network' would be needed to provide sustainability. The principle of networks is that they are non-specific in action.

These simple principles add up to a significant total requirement in area. Indeed the total might be a serious problem but for two further points.The first is that the principles are not strictly additive. One reserve can (and should) have more than one habitat. Replication can be included within the network needed for sustainability.

The second point is directly related to fisheries management. A self-sustaining network of 'no-take' marine reserves would automatically act to support all exploited fish stocks. Such reserves are not 'fenced in'. Eggs, larvae, and adults can and will move out. In the absence of exploitation the breeding potential is likely to increase, and such increases are most likely when exploitation outside is high. These points are based on firm biological principles. However, it will be difficult to measure, even after the event, just how much any particular stock has benefited, or which problems had been prevented. It will be impossible to predict stock-specific effects in detail.

Why does that worry us so much? We do not bother about this when promoting 'networks' for transport, education, fire insurance, etc. When the principles are recognised, general action seems wise and practical. Indeed specific action based on actual data is clearly a later stage. We plan and develop roads, schools and insurance systems without knowing what particular journeys will be made, how many engineers will be needed or which buildings will catch fire.

The important and useful point is that 'no-take' networks will act on known biological principles in predictable directions regardless of whether we have detailed data or not. They are thus valuable additions to management, epecially for stocks where the available data are unsatisfactory, the dynamics are complex, the economics and politics are fierce, or large natural changes occur. Since one or more of these points are valid for most stocks, the value of non-specific action is very real.

Most reviews of marine reserves for fisheries management confine themselves to detailed stock-specific points (e.g. Roberts and Polunin, 1991; Rowley, 1994), but more general principles are beginning to be discussed (e.g. Dugan and Davis, 1993: Dayton *et al*, 1995). In 1990, a team of fisheries scientists in Florida concerned about the multi-species reef fisheries, suggested making 20% of the whole region 'no-take' as the best management option (Plan Development Team, 1990). This idea was a shock to many people, but a review panel of independent scientists supported both the arguments and conclusions (Roberts *et al*, 1995). It seems that when we are forced by local or special circumstances to consider many stocks and whole ecosystems, the advantages of 'no-take' areas to fisheries science and management are obvious and robust. The real problem is that such breadth of vision rarely occurs.

SOME STEPS TOWARDS ECOSYSTEM MANAGEMENT

1. *The long-term public interest is paramount*
The sea has many uses. Some are extractive, but all ultimately depend on the continued functioning of the ecosystem. The overall public need is for marine ecosystems to continue to operate naturally.

2. *Permanent 'no-take' areas in the sea are needed to ensure this.*
While our power of disruption is now great, we do not have the knowledge or technique for positive control. The systems must be allowed to 'manage themselves'. 'No-take' areas will assist this and enable us to check it is happening.

3. *Non-extractive uses should be encouraged in 'no-take' areas*
The benefits of 'no-take' areas to science, education, recreation, personal experience, etc. are valuable in themselves. These uses also generate an informed public. With a better knowledge of natural conditions and exploitive effects, the public is much more likely to support sensible arrangements for conservation and management.

4. *Representation of all marine habitats in every biological regions is needed.*

5. *Replication is essential.*

6. *A network design is required. (i.e. non-specific to problems, stocks or species)*

7. *The minimum level of provision is that which is self-sustainable.*

8. *The general pattern of 'no-take' areas is determined by marine topography.*
The fractal form of coastlines and depth contours determine the pattern - basically 'stripes' normal to straight coasts with parallel contours, through 'clusters' on indented coasts with islands, to 'geometric networks' in complex (high fractal) regions.

9. *The regional arrangement is partly deterministic and partly an optimisation.*
The actual scale of the general pattern (e.g. the width and spacing of 'stripes') is based on the actual scale, diversity and pattern of the habitats (using topography as proxy data if necessary), but constrained by the optimum retention of replication, etc.

10. *The precise location of 'no-take' areas is not deterministic.*
Within the constraints of 5-10 above, the precise locations cannot be determined on scientific criteria. There may be several, or many, possibilities. Other factors (e.g. social) are biologically permissable and politically advantageous at this final stage.

Several of these points, especially the last, are counter-intuitive. The order of consideration is critical. My prime point is that if consideration begins with a particular problems or any sectional interest, the conclusions are radically different. Until recently solving problems and carefully considering sectional interests did seem to be the name of the game. I suggest that this is no longer the only option, or even a very sensible one.

UPGRADING 'FISHERIES' SCIENCE AND MANAGEMENT

Years ago, the public naively assumed that fisheries scientists and managers were the arm of government that looked after the sea for them. New Zealand once had a "Marine Department" - which was supposed to manage everything from lighthouses and reclamations, to fishing regulations and waste disposal. It was hard to be 'professional' over such a range, so it was broken up. Worldwide, over the past few decades, fisheries science and management have become very professional, but the aims have narrowed. This has also happened in 'transport', 'coastal planning' and 'pollution control'. They too are now much more efficient, of course, but they have all become specialised niches. The public no longer knows who is 'looking after the sea' and is beginning to suspect that the answer is no one.

This is starting to worry them. It is easy to be cynical about movements to save the whales, ban drift nets, stop ocean dumping, protect coral reefs, etc. It would be more sensible

to see these as indicators of a trend. The public no longer accepts as an axiom that existing user-groups should control whole ecosystems - whether they are foresters, miners, or fishermen. The rate of change is very variable - by region and topic, but it is all one way. The trend is predictable and the stages have been labelled (Landner, 1994) Fisheries may be late in the game, but it is not immune.

Can we learn from what is already happening in forestry and mining, or will the same kind of messy confrontations develop in fisheries? Who will promote some intelligent principles to rally the not-so-silent majority as they begin to realise it is their sea, and the fish in it belong to their children.

If we can already recognise many values and uses for 'no-take' marine areas, and we can see that a significant network of such areas would be supportive of fisheries science and management, why don't we upgrade the existing professional aims. The public need a lead. They want to believe someone cares about more than details and problem-solving. They would support moves to principles and attempts to prevent more problems in the sea. This process has already started in New Zealand and is accelerating. The politicians were taken by surprise, but are catching up. The professionals are mostly still sceptical. I believe this is unwise. Professionalism is recognition of the relevant principles and an insistance that these control detailed action. Ecosystem management may still be a distant objective in fisheries, but practical moves towards it deserve active professional support. The overall public interest for the sea and its life processes may not be the responsibility of 'fisheries', but it certainly hasn't been given to anyone else.

CONCLUSIONS

'No-take' marine reserves offer a new and additional form of fisheries management. Such reserves avoid detailed arguments about 'allocation' and 'proof of damage', and allow non-specific but strong support for stocks, habitats and ecosystems. The first 'no-take' marine reserve in New Zealand was established in 1977. A further 12 have been added since, and at least 25 more proposals are under active public consideration. A representative network is now the official aim.

To date, the promotion and use of marine reserves has come mainly from marine scientists, divers, conservationists, teachers, tourists, and the general public. Most fisheries scientists and managers have remained sceptical or uninterested. This could change rapidly, due to political pressure or professional recognition of the opportunities. All major political parties in New Zealand now support more marine reserves. Despite the application of many stock-specific management techniques, it is officially recognised that many N.Z. fisheries have serious problems, and new ideas are needed.

Data-based, stock-specific fisheries management, focused on the interests of existing user groups, is a political and practical necessity. However, the history of resource management and recent events in fisheries indicate that this approach is not sufficient. Concentrating on the effects of existing activities distracts attention from the intrinsic

properties of the ecosystems, and prevents consideration of other values or different uses. Furthermore the standard approach inevitably suffers from 'infinite regression', with more-and-more data being required to predict increasingly precise questions.

Well-understood business systems have many types of insurance, that operate in different ways. Insurance assumes uncertainty, ignores detailed causation, and concentrates on preventing damage without specific prediction. Its success depends on the perception of risks, not on knowledge of causes.

The multiplicity of fishery regulations obscures:
(i) the focus on stock-specific dynamics - which excludes the intrinsic properties of the ecosystem
(ii) the need to demonstrate damage to stocks - which prevents proactive management;
(iii) the assumption of fishing rights - which precludes natural baselines and promotes 'brinkmanship' (e.g. maximum sustainable yields).

Until recently, non-involvement in fishing meant non-interest, except in the price of food fish. However, as has already happened in forestry and mining, the environmental views of the general public are becoming significant. 'No-take' marine reserves appeal to the lay public as a form of insurance, not because they doubt the skill of fisheries scientists and managers but because they believe their aims are too narrow. Such ideas are reinforced by the discovery that fisheries management is not always successful even in sustaining fisheries.

If fishery scientists and managers upgraded their status to 'public guardians of all marine life' (which they earlier held by default), they could escape from the problems of extreme specialisation, promote 'no-take' marine reserves as an sensible form of insurance, and earn the active support of an increasingly-concerned general public.

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