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THE PRACTICALITY AND BENEFITS OF A MARINE RESERVE NETWORK

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SUMMARY:

Temporary closures, gear restrictions, size limits and quotas have a long history in marine fisheries management, but these are applied only to particular species and/or on a local basis as problems arise. Non-extractive marine reserves have been established in some places recently, but again only on a local basis or in response to specific problems. Regional planning is now being rapidly extended into the sea by territorial authorities. However there are, as yet, no policies to use this opportunity to unite the management of living resources in the sea with other aspects of planning and to provide for conservation in the marine environment.

In the sea, there have been no attempts, so far, to apply standard conservation principles. On land, systems of unexploited reserves are regarded as having important intrinsic values, as well as providing general solutions to a wide range of potential problems. The questions discussed in this paper are:
(i) Would a system of "no-take" marine reserves have intrinsic values, and if so, would these include the same range of benefits as unexploited reserves do on land?
(ii) Do the clear differences in ecology between land and sea make a marine reserve system impossible or merely alter the necessary arrangement?
(iii) Would a system of marine reserves assist in resource management?
(iv) If the answers to these questions are not clear on present evidence, what principles should be invoked and what should our immediate policy be?

It is suggested that present knowledge of marine biogeography, climate, marine ecology and population dynamics is sufficient to design a network of non-extractive marine reserves large enough to satisfy precautionary principles, to provide the likely benefits and to test the important questions; while being small enough to be politically practical. It is concluded that a system of marine reserves should be established forthwith.

In New Zealand, where there is already a scatter of marine reserves:
(a) the revision of fisheries policy should require a network of non-extractive marine reserves in the management process (in addition to quotas and other species-specific and problem-related systems) as part of an ecosystem approach.
(b) the new Regional Coastal Plans should include a sustainable and representative set of non-extractive marine reserves for each region for their intrinsic values.
(c) Local proposals for extra planning, such as the Hauraki Gulf Marine Park idea in New Zealand (and Marine Santuaries in the U.S.A), should be based on a network of "no-take" areas as the priority zoning.
(d) The immediate and minimum amount for the network of marine reserves, in all regions, should be 10% by area of all habitat. In special cases, where the facts justify it, this should be increased.

INTRODUCTION

New Zealand has a unique opportunity to lead in marine conservation, having the advantages of a geographic position at the centre of the 'water hemisphere'; being a relatively small country but one with a large amount of marine habitat and a great diversity of marine life; having a relatively low population density and a relatively high degree of economic security, education and democratic government. New Zealand also has the administrative framework to enable positive action on marine conservation and some actual examples of proven success.

Having visited and discussed this subject in at least a dozen countries in four continents, I can assure you that everywhere has the same serious problems in fisheries management and marine conservation. In my opinion, this fact should give us some confidence and courage. We should stop spending all our time and energy creeping about solving problems, reducing damage and adjusting conflicts. We should start looking at principles and begin to adopt systems that would prevent problems arising, restore resources and avoid conflicts.

I am one of the few participants in this workshop who does not represent any user group, interest group or government department. This means means there is no pressure on you to pay attention to any of my opinions. It also means I can concentrate on facts and principles, especially those which are awkward and unwelcome. It may help you to regard me as the small boy who reminded the important people that "*The Emperor has no clothes*".

THE REAL RULES, OUR IGNORANCE AND THE NEED FOR PRINCIPLES

I wish to remind you about the real world out there. It is understandable that we should tend to forget. The whole of civilisation, and all technological, scientific, economic and social development, is basically designed to protect us from the vagaries of nature. This is successful in a superficial sense, and hence we imagine we are in real control. Politicians and high-level policy advisors are particularly prone to forget about

the ultimate rules because they are forced to spend so much of their time deciding urgent and complex human problems. Nevertheless we must remember. The rules of the natural universe do not depend on votes or money. They do not have to be fair or reasonable in human terms. The real rules exist without our aid or permission. Unless our policies fit with these rules, regardless of how popular or profitable the policies may seem in the short term, they will produce nonsense.

I wish to remind you that so far as the sea and its life are concerned we only have a very sketchy idea of the natural rules and the processes they control. We rarely have any good data on the rates of these processes, their limiting conditions and their natural variation. In itself, our ignorance is not the problem. We do know how to operate safely when we are ignorant. We use pilot tests, we spread the risks, we insure widely, we have fall-back positions, we are careful and precautionary. Ignorance is not itself dangerous, but not recognising our ignorance certainly is. The idea that we can create marine policy on detailed knowledge and accurate predictions is not only wishful thinking, it is dangerous. We must make our policy on the basis that we do not know what is achievable, hence the prime aim must be to keep our options open.

PROFESSIONAL PRINCIPLES

People do not live permanently at sea. Hardly any of the sea is privately owned. Many human activities cannot occur in the sea. Nevertheless the list of "users" and "interested parties" is so long it is not surprising that politicians become confused and defensive when trying to control them.

The sea is huge. It is highly mobile. It has a great capacity for self-regulation. Nevertheless the list of human-induced problems in the sea is so long that it is not surprising that administrators and planners become confused and defensive when trying to deal with them.

There are now large numbers of marine scientists, environmental consultants and advisors. They have a wide range of equipment and techniques. They have discovered and published a lot of information. Nevertheless our knowledge of the sea, its life and processes is very low compared to that on land. It is not surprising that marine scientists become confused and defensive when asked to provide principles and predictions to administrators and politicians.

Yet this is their job. From day-to-day they can justify themselves to their bosses, peer reviewers and editors, but the justification of their professions is that they can deliver better advice, based on principles, than ordinary citizens could develop from their own experience.

My suggestion, as a professional marine ecologist, is that we should try harder to produce the kind of advice that is needed by the administrators, the politicians and the public. In particular I want to suggest that:

(a) As professionals we must learn how to give useful advice when we do *not* have the detailed information we would like. For example: If we have insufficient evidence to say what will happen to a particular species after a period of protection by a proposed marine reserve, we should not sit dumb or ask for a large grant to think about it. We should say what in our professional opinion is likely to happen. Failing even that, we should still say whether it is worth trying it to find out, by doing it.

(b) We should appreciate that it is not our job to make *specific* decisions, these are (and should be) political. Scientific advice should indicate the real constraints, the practical alternatives and the likely outcomes, it should not dictate social policy.

(c) *General* advice, based on scientific principle, is useful to politicians and administrators. When they keep asking for more specifics, they are dodging their job. We should support and educate them in general terms, but encouraging procrastination is unprofessional. If we accept grants for it the word is harsher.

(d) General solutions to problems are *practical* and common in human affairs, and work well when they are based on principles. (This does not mean actual hard data for specific cases).

(e) General solutions require *broad and arbitrary* decisions. This upsets politicians, but they get used to it once they understand the principles.

(f) Scientists and consultants are citizens, parents and taxpayers as well as professionals, they have a duty to try to give advice which *maximises the long-term public interest*, regardless of the immediate public or political popularity rating.

AN ANALOGY:

If the tyres on your automobile have become smooth and bald, using it is dangerous. This principle is independent of being able to determine any specifics - when and where you would skid and what precise damage would occur as a result. The solution is simple. Get some new tyres. If you haven't enough money, buy retreads. If that is too expensive, go by bus or stay home.

However it is not quite so simple, the situation creeps up as the tyres slowly wear smoother. There is no precise moment at which you should take action. You have to make an arbitrary decision.

This point is even more difficult for the administrators and politicians. They have to make a broad arbitrary decision: e.g. vehicles with tyres of less than a certain amount of tread will not be allowed on the public roads. Everyone knows this decision is bound to be inappropriate in many specific cases and that the particular figure cannot be proved in scientific terms. Nevertheless sensible people know it is better to have a figure and enforce it, because this preserves lives and vehicles, as well as reducing public expenditure on hospitals, police and orphan support.

THE PRESENT SITUATION

We have a long history of damage control in marine resource management. In fisheries management, temporary closures, gear restrictions, size limits and quotas are often applied to particular species and/or on a local basis as problems arise. More recently non-extractive marine reserves have been established in several countries, but again only on a local basis or in response to specific problems.

So far, there seem to have been no attempts, in the sea, to apply standard terrestrial conservation principles or their marine equivalents. On land, systems of unexploited reserves are regarded as having important intrinsic values, as well as providing general solutions to a wide range of potential problems.

(i) Would a system of marine reserves have intrinsic values, and if so, would these include the same range of benefits as land reserves?

The answer to this question is an emphatic yes! Everyone in my audience probably knows all the items listed. But have you put them together and, if so, have you considered their cumulative force.

Heritage and moral values:

People, including future generations enjoy looking at, learning from, or simply appreciating the existence of natural undisturbed marine life. They should be able to do so, if possible directly and personally, if possible without great expense. *This* public use of resources should not be relegated to remote areas or restricted to places where entrepreneurs can make money out of them. Since these people are not using up anything, their "rights" should have priority over those who wish to kill, disturb or remove things. This is especially true in very heavily used areas. Large numbers of people can look at the same fish, coral clump or seaweed, only one person can kill it or take it away. Furthermore, left alive, it continues to reproduce.

All this is obvious, yet most marine planning to date is based on the opposite. It first assumes that fishing and other forms of marine exploitation are important (which is correct), it then assumes these activities are rights (which is unwise) and then it assumes that fishing must be allowed everywhere (which is just plain silly).

We know it is possible, civilised and useful to have trees and flowers even in the middle of cities, but we also know that this can only happen with an absolute rule of "no take". In New Zealand the existing marine reserves are very popular. Indeed, at the only reserve on the mainland coast, the main problem is that it is crowded (see Ballantine, 1991, page 58). More such reserves are needed, if only for social purposes.

Conservation values

To get a species formally recognised as endangered or at risk, we have to identify and describe it, measure its abundance, show that its density has decreased, and that this puts it at risk. To get anything done about it, we have to find out what caused the change and how, before we can even ask for something can be done. Since only a small fraction

of marine species have been described to date and that even for the great majority of these we have no abundance data, this is a good way of saying "forget it" for the great majority of marine life. This is unscientific.

It is clearly even more important to preserve vast chunks of nature that we know little or nothing about, than a few cowries or dolphins that we happen to have noticed. We already recognise this principle on land, and may even spend money helping to preserve tropical rain forest for that reason. While we are busy lecturing the Brazilians on this point, it would be a good idea to apply it closer to home - in the sea. This would cost us nothing but hard thought and the full use of the democratic process; but failing to do so could cost our grandchildren more than we can imagine.

Marine reserves are not just concerned with with species diversity, but also with genetic, habitat and ecosystem diversity (Ballantine, 1991, Ch.2 & 3).

Scientific values:

Marine reserves certainly focus research work and this in turn helps the study of subtle interactions. The status, protection and focus all promote continuity, long-term data (normally lacking) and assist a steady incremental increase in knowledge. Marine reserves provide the protection essential for experiments which involve expensive and/or delicate equipment, require long term measurements, or the observation of natural behaviour (see Ballantine, 1991, Chapter 5).

(ii) Do the clear differences in ecology between land and sea make a marine reserve system impossible or merely alter the necessary arrangement?

The short answer is that we do not know for certain or in any detail. A longer answer would include the following points:

1. Some similarities in principle are known. These include conserving diversity, promoting sustainability and avoiding the "tragedy of the commons".
This indicates a marine reserve system would be highly desirable.

2. Some differences in principle are known. These include: The mobility in three dimensions of the major habitat itself; the decoupling of recruitment from reproduction due to planktonic phases; the microscopic nature of most primary producers; and the much lower levels of present knowledge.
This shows that an effective arrangement for a marine system would be different.

3. There are undoubtedly many unknown principles. The high rate of new discoveries over the past few decades shows no sign of levelling off.
This suggests that a system of marine reserves would be an experiment.

4. Pressures on marine ecosystems are increasing. Exploitive, extractive and degrading pressures on marine resources have increased rapidly over time and will increase even more in the future. The reasons include: population increases and improved technologies for access and extraction.
This suggests that we should act with urgency to create a system of marine reserves.

5. The appropriate system for urgent but precautionary action in a poorly understood situation is broad insurance.
This suggests the system of marine reserves should be a network.

(iii) Would a system of marine reserves assist in resource management?

On available evidence there is no certain answer to this question The main reason for this is simply that it has never been tried. However it is possible to comment:

1. Traditionally fisheries management (a) reacts to problems that are proven and significant, (b) treats species separately, and (c) acts only for that species in relation to that problem.

2. As a result, even with "good" management it is difficult to avoid sporadic but progressive declines or degradations of the resource.

3. All this is an inevitable result of traditional views on the "rights" of exploitation. which have generally been interpreted as "everywhere, all the time, by anyone for anything, unless and until there is a problem".

4. An alternative view is that some general and precautionary action would be a valuable addition to standard fisheries management.

5. This alternative view is supported by general experience (common sense) and by known scientific principles, but, so far, little effort has been made to translate these into policy (or even into public discussion).

The general public and some of those directly concerned with fisheries (e.g. Bohnsack, 1990) are becoming more and more doubtful about the piece-meal, reactive approach to fisheries. They believe that it does not make sense to protect nothing in the sea until it is so badly damaged that we can can actually measure the damage, and then only act to minimise further damage.

It never did make sense to deny precautionary principles in the sea because we knew very little about it. Ignorance is one of the first things we should insure against.

(iv) If the answers are not clear on present evidence, what trials should be conducted now?

In my opinion, based on general principles and the evidence from a few small examples, it is now appropriate and practical to take decisive action. Indeed, I believe that, if the precautionary principle is invoked, such action is mandatory.

Political initiatives are at present being pursued in relative isolation, and treated as separate matters. In particular, governments generally attempt to maintain a distinction between marine biota (deemed to be "fisheries" and the responsibility of fisheries management) and planning for the physical marine environment (deemed to be the province of the adjacent local territorial authority).

Despite the long history of this idea and the fact that it often suits existing administrative arrangements, this separation has no scientific basis and is likely to cause serious and increasing practical problems. Similar ideas have proved unworkable on land and there is no reason to suppose that they will be appropriate in the sea.

Under any arrangements, "standard" marine resource management systems will continue to exist. Someone will continue to decide on fisheries management, water quality management, reclamations, etc. These standard management systems all concentrate on "problem solving" and "conflict resolution". This is virtually inevitable, is normal worldwide, and is not a criticism of those carrying it out now or in the past.

But it is not the only possibility. On land, over and above such "standard" management, it has been found desirable and practical to have additional systems. These are aimed at positive benefits, at preventing problems arising and at avoiding conflicts. While these plans, regulations and policies may have been suggested by problems, the policies and action under them are proactive. These are so common (on land) that we take them for granted and rarely distinguish them as such. Virtually all land use planning is designed to be proactive, and it includes not just compatible use zonings, but also the full range of unexploited reserves (scientific, scenic, recreational, and for conservation). A network of unexploited marine reserves is scientifically desirable, socially important and politically practical (see Ballantine 1991 a and b).

Marine scientists should promote their profession and the interests of the general public by:
(a) promoting more political coordination in marine resource management
(b) supporting the inclusion of a system of unexploited marine reserves (as a network) in all future marine planning, for both intrinsic and scientific value
(c) basing this support on objective and professional principles

Before discussing these principles, it is useful to look the history of marine reserves in New Zealand ; their scientific uses; and the alternatives available.

PROGRESS TO DATE WITH MARINE RESERVES

It took 12 years to establish the first marine reserve in New Zealand (1965-77), and in the subsequent decade only one more was established. Since the establishment of the Department of Conservation in 1987 events have become somewhat faster. By 1992 :

(a) 2 more marine reserves fully established	Kermadec Is.(north of N.Z.)
	Kapiti (Wellington)
(b) 5 proposals awaiting final decisions	Pollen Is (Auckland)*
	Hahei (Coromandel)*
	Long Is. (Marlborough Sounds)*
	Milford and Dusky (Fiordland)*
	Mayor Is. (Bay of Plenty)*

(c) 7 proposals at an advanced stage

Kaikoura
Kaiora (Gisborne)*
Gt. Barrier Is.
Whanganui Inlet, (S. Island NW)*
Hawkes Bay*
Waiheke Is. (Hauraki Gulf)
Bay of Islands

(d) At least 12 more marine reserve proposals have been publically discussed and are in various stages of investigation and/or development (These include Te Kaha, Island Bay, Abel Tasman*, Nuggets Pt., and Paterson Inlet).

Note: By 1999, those marked * had been formally established as marine reserves.

LACK OF CLEAR PROGRAMME, POLICY OR PRINCIPLES

However, even in New Zealand, despite this scatter of local initiative and official action, despite increasing public and scientific interest, despite some general approval at higher levels, there is still nothing resembling a formal programme or even a real policy on marine reserves.Two decades after the passage of the Marine Reserves Act and five years after the establishment of a department with a formal mandate for marine conservation there is no clear agenda for marine reserves or generally recognised principles on which to base one.

This has important scientific as well as socio-political implications. Although the existing marine reserves have demonstrated their value in science at many levels from single sensitive experiments to large scale natural baselines, these advantages are only available for a small fraction of marine habitats in a few regions. Even if *all* the current proposals for marine reserves were adopted, the majority of marine habitats (even on crude definitions) would remain without representation and some large regions would have no representation whatever. This means that, even in the foreseeable future, there is no guarrantee that observations or experiments can be performed with reasonable controls for human exploitation or direct interference.

Without the provision of some basic scientific principles, the efforts of well-meaning groups of citizens will not have any systematic benefits. The only marine reserves that are likely to be created are those which have some combination of:

Local enthusiasm
Unique biological characteristics or scenic values
Urgent problems
Remote location or low extractive interest
Trivial size

ALTERNATIVES TO MARINE RESERVES FOR SCIENTIFIC PURPOSES

It is, of course, standard practise to arrange short-term, specific and/or local controls for exploitation effects. However, such attempts in marine ecology, both in academic and applied fields, are particularly difficult to arrange and are often very unsatisfactory in scientific terms. The usual methods include:

- Finding localities which are not currently exploited (or are much less exploited) in the particular way(s) deemed to be important in the study.
- Arranging for some temporary cessation of the particular exploitation(s) deemed relevant.
- Using historical data from a time before the exploitation effect(s) existed.
- Obtaining data from a large number of localities/dates and hoping to scale these (by multi-variate proceedures) to give a picture of the exploitation effect(s).

The disadvantages of these methods are fairly obvious. All of them require considerable amounts of assumption and/or plain luck. Many of the assumptions would not stand up to a basic scrutiny of experimental design. These methods are only "approved" when no better alternative exists. They often require a large proportion of the total expense and effort of the investigation.

Furthermore all these forms of "control" are will become progressively more difficult with time. The range and intensity of marine exploitation is increasing and is likely to go on doing so. Even if the present state of affairs is acceptable, without a systematic effort to provide better controls, the situation is bound to deteriorate.

PROFESSIONAL ATTITUDES AND SCIENTIFIC PRINCIPLES

The situation is just as bad or worse overseas and that there is little that individual scientists can do to change it in terms of their next project. However, while this may enable us press on in good conscience on a day by day basis, it does nothing to alter the fact that a marked improvement is desirable in scientific terms and could be arranged politically, if enough people wished it to be. There is, at the very least, a responsibility for marine scientitsts to keep stating the advantages of more natural "control" areas in both scientific and social terms.

This means thinking very clearly about basic scientific principles and providing good specific examples of their application and non-applicatiion.

BASIC PRINCIPLES

1. INTRINSIC VALUES AND "CONTROLS" FOR HUMAN INTERFERENCE.

All scientists hold the principle that potentially confounding effects should be controlled for in any experiment or set of observations. Areas in the sea where direct exploitation is eliminated and other human interference is reduced would assist this. Some scientists would go further and hold that more natural situations have an intrinsic value transcending strictly scientific use. Provided the principle is carefully worded, all

views can be incorporated for the purpose of informing the public and the decision makers on this fundamental point.

Standing in a container port, it is not necessary to have any mystical view of nature to make the following points:

- Major changes have occurred and people made these changes.
- The changes not only improved cargo handling, but also had significant effects on pre-existing states ranging from mudsnail populations to tidal prisms.
- The scientific assessment of these changes, their significance and interaction, is only effective with mental comparisons to the pre-existing state.
- Such a comparisons are easier and more objective if similar places still exist in this earlier state or something closely approaching it.

The same argument applies whether the discussion is about changes due to trawling or spearfishing, dumping or souvenir collection, oyster farms or sewage disposal, marinas or fishing tournaments. It makes no difference if the argument is conducted in terms of experiemental design and confounding effects, or as a social discussion of natural values. In either case there is a basic requirement for information relating to "natural" baselines. We may not able to define natural baselines in precise positive terms, but we can (and regularly do) operate objectively with the negative side. We can identify many forms of human interference and reduce or eliminate these from some places. Unless this principle is accepted widely we could easily have end up with separate areas free (by political action) from trawling or dumping or sewage disposal, etc, but no area which was free from all direct and significant forms of interference. Scientists can obtain clearer information about basic processes and the effects of human actions if areas free from all direct exploitation are available for comparison. If these are perceived to have other and non-scientific benefits, so much the better.

2. Biogeographic Representation

Whether these are assigned practical or intrinsic values (or both), marine reserves with a minimum of human interference would be needed in different biogeographic areas. This principle is independent of agreement on the number of areas thought to be sufficiently different for the purpose, or the methods for determining this. The possible range of opinion on these points should not be allowed to obscure the fact that the principle is clear and generally agreed.

3. Habitat Diversity and Ecological Representation

The argument here parallels that for biogeography, with an even stronger proviso that agreement on the classification is not relevent for agreement on the principle. While a specialist might have 66 varieties of submarine canyons, no marine scientist is going to confuse any of these with an estuary or a midshelf plain, either physically or biologically. The general public and politicians still have trouble recognising *any* marine habitats (they see just a featureless grey surface) so it is important for scientists to insist on the "highest common factor" of distinction.

4. THE CONSERVATION OF SPECIES AND GENETIC DIVERSITY

All scientists would agree in principle that no species should be extinguished arbitrarily or casually, and that this includes species that have not yet been described. Since large numbers of marine species are as yet undescribed, this principle can only be maintained effectively by the protection of representative habitats in all biogeographic areas. It is not just in tropical rainforests that a good case can be made for protecting things we have not even discovered yet. The public should be made aware that our level of knowledge on marine species has increased very rapidly in recent years, but is still poor even in "well-known" groups. The number of described species of fish in the New Zealand region has trebled in the last 30 years. It is estimated by Dr. Marshall of the National Museum that their *existing* collections of marine molluscs contain approximately the same number of undescribed species as those already described. In many groups from nannoplankton to nemerteans the process of species description has barely begun.

5. THE PRECAUTIONARY PRINCIPLE

This is an expression of the fact that we do not know all that we would like, we are unlikely to do so in the foreseeable future, and that hence, precautions should be taken in principle to protect ourselves (and our descendents) from the consequences of ignorance. Aspects include:

the available data may not be good enough for sensible decisions
the interactions we know are not necessarily the only ones
the present use may not be the best use, or that wanted in the future
the most practical management may be a high risk one
the Law of Unintended Effects always applies

Having some areas where our present uses and normal management do not apply is in principle a useful precaution. We should note that while current users (if they agree) are entitled to risk *their* money and livlihood, they are not entitled to extinguish the natural basis in a way which eliminates any future use. Present information suggests that even an economically collapsed fishery eventually recovers, but the data is not good and we do *not* wish (for social and economic reasons!) to have the point proved by well-documented examples of extinctions.

The next four principles suggest at first sight that the total area required for marine conservation would be relatively large. The principles are, however, not additive in their effects (see 10).

6. REMOTE DISPERSAL

Most marine species have means for remote dispersal, and in many species these effectively decouple the reproductive effort of each "population" from its recruitment. While this situation is the source of much confusion and a barrier to any simple small scale "zoning" in the sea, it also has positive effects for planners. Sustainability and conservation in the sea requires multiple areas, but does not require single areas to be as large as possible (as it does on land). Although the theory of "megapopulations" is still in its infancy, and there is only a meagre amount of hard data (e.g. from *Acanthaster*

outbreaks on the Great Barrier Reef), it is fairly clear that a scatter of conservation areas along the main current directions is the main feature required for sustainability.

7. Natural Variation

There is increasing evidence (from some long-term local measurements and satellite coverage) that interannual variation of marine conditions in the New Zealand region is large when measured as a proportion of the seasonal range or in terms of biological effects. It seems likely that these variations are so large that without some calibration for their effects (or at least their trend) that short-term studies (less than 2-3 years) are unreliable guides for decisions. There is a strong possibility that even for long-lived and/or dominant species "mean" conditions may not exist (see Ballantine, in press, for a discussion).

Interannual variability is linked with meso-scale geographic variation in a complex manner in the sea. Relatively small amounts of between year variability on a global scale in currents, convergences and other large scale features can produce major differences between areas on a regional scale. Because this can involve both the actual movement of water and/or the marine biota, the concept of locality at sea is basically different from that on land. Unless very large areas are used, marine conservation will require multiple locations within regions.

8. Sustainability

While there is endless argument about how to apply this principle to commercial species, this should not obscure the general agreement on the principle itself. Furthermore it applies just as clearly to habitats and ecosystems. A marine reserve system should be self-sustainable.

9. Replication as both science and insurance

The scientific value of replication requires no justification here, but it is appropriate to note that it also applies economically and socially. Just as in formal experiments the possible effects of chance and cooincidence must be covered by replication; matters of social or economic value should not have "all the eggs in one basket". Risk spreading and insurance are widely understood as principles.

10. Network design

Fortunately the principles listed as 6 to 9, if considered in combination, provide a practical answer to the problems that they raise separately. The appropriate principle for the design of marine reserves is a network. A network design is capable of providing replication and uses remote dispersal as an advantage. It could incorporate natural variation effects and provide for sustainability within much the same total area required for replication. Furthermore a network design is practical without specific data, so long as the repesentative and intrinsic value principles are maintained.

OPTIMISTIC AND PESSIMISTIC SIGNS IN NEW ZEALAND

1. The Ministry of Agriculture and Fisheries originated the idea of a marine reserve network for New Zealand (MAF, 1985); they have actively cooperated on some proposals (notably Mayor Is); and are currently considering the idea that some inshore "permanently closed areas" may be necessary for at least the Auckland region. A protocol exists stating that Fisheries, as well as Conservation, must approve all marine reserve applications, but the consultation is not public and has no known rules, other than the usual pressures from interest groups. This leaves each marine reserve application standing on its own for final decision, and maximises the chances of delays and the influence of short-term political perceptions. Marine scientists should request a more open process for final decisions and suggest suitable principles to govern these.

2. Regional Coastal Plans are mandatory under the Resource Management Act. These Coastal Plans, which cover the sea out to 12 nautical miles, must be ready by October 1993. They are a completely new venture, and offer the first real opportunity for the public discussion of sensible principles in marine planning.

Unfortunately the high-level political decision to exclude "fisheries" was made before the whole process began. Although this decision had clear precedents and suited departmental structures, it is ecological nonsense and will be increasingly impractical. Under existing legislation "fish" mean any marine biota, but there is no requirement for Fisheries to involve itself with any species that is not currently exploited. So the great bulk of marine life is not the actual responsibility of any government agency. Furthermore the idea that a Regional Council can plan for its marine environment, while having no capacity to control the marine life in it, is obviously unworkable.

Marine scientists should press for a more unified approach to marine planning and could use the marine conservation aspect as a clear and practical route to introduce this. It is already obvious to large sections of the public and some politicians that the provision of unexploited marine reserves requires at least the aquiescence of current user groups, but that this is unlikely to be obtained in a "one-by-one" approach. Many users *do* agree in principle with the value of reserves, but in the absence of any clear policy they can easily end up in confrontation on each separate proposal.

3. The first New Zealand conference on marine conservation invited all the "interested parties" and made a valiant attempt to discuss the issues. But the "fisheries exclusion" inhibited government staff from dealing seriously with anything except seabirds and marine mammals, while the "interest groups" were mainly concerned to stake out claims for ownership or control of fisheries.

The great bulk of marine life and marine habitats gained little or no attention. It would be helpful if marine scientists reminded everyone else that marine life is more than just the top predators, and that these predators need to feed in, and be supported by a full ecosystem, containing many complex habitats.

4. The present moves to restructure fisheries legislation and management obviously include much complex political ideology but very little appreciation of what actually

sustains the resources. Despite some mention of an "ecosystem approach" in the general text, virtually all the firm recommendations of the task force report are concerned with legal and economic control of the commercial and edible biota.

Marine scientists should ensure that the "ecosystem approach" is not relegated to mere lip service, and, as a minimum, should insist that if a carve up of control does occur that science, conservation and associated non-exploitive social values are a "user group" requiring a minimum of 10% of all marine habitats by area.

5. On a world scale marine conservation and its relation to fisheries is beginning to attract serious scientific and managerial attention. A major review on marine reserves and reef fish has appeared (Roberts and Polunin, 1991), and there is some offical interest in marine fisheries reserves as a management tool (Bohnsack, 1990).

However, the emphasis is almost entirely on reef fish (mainly coral reefs) and this narrow approach extends to the arguments and methods. There little mention of other marine biota or any intrinsic value for marine habitats. In an attempt to match the methods of small scale manipulative experiments on a small scale, there is much stress on the statistical significance of fish densities inside and outside marine reserves. This is emphasised to the point that common sense as well as social values are forgetten. One study cited *non*-significant losses of 66% following the breakdown of protection (losses of 80% in another family were "significant"), but there was no suggestion that at this level of precision the precautionary principle might be invoked.

Even more worrying is the implication that marine reserves only "work", if there is a large difference between the fish densities inside and out. This is rather like saying fire insurance only "works" if when buildings are badly damaged by fire. Of course, as scientists, we like clear-cut results from manipulative experiments, but as citizens we prefer not to have massive losses. Even in a scientific article it seems insensitive not to recognise that the public interest might be quite different from that of the experimenter. In economic and social terms, marine reserves would "work" best if there was little or no difference between protected and exploited stocks.

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(ii) *General Solutions and Practical Options in Marine Conservation* given at the **N.Z. Marine Sciences Society's annual conference** in Dunedin, August 1992.