Threatened Species Management: out of its depth for marine invertebrates

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ABSTRACT

The usefulness of listing individual marine species under Threatened Species legislation is discussed with respect to the characteristics of the marine environment and its biota. It is suggested that, apart from 'flagship species', this is not a useful strategy to follow. Instead, habitats need to be conserved. However, it needs to be stressed that threatening processes impacting on a habitat may originate from sources way beyond the habitat in question. The Great Barrier Reef illustrates this point well. Here water quality is, in large part, determined by catchment flows, which have a major effect on the communities of the GBR. Although our knowledge of the biota of the marine environment is limited, we must act now to manage and conserve it. We cannot wait until the identification and biology of all marine organisms has been documented. One of the next steps is to bring the marine environment into our mind and see that its future existence is inextricably part of our existence. Marine environments are different to those on land and need different management strategies. The major lesson is that we need to move from species conservation to a workable system of threatened habitat and ecosystem process management for the marine environment.

Introduction

The purpose of this paper is neither to discuss the details of Threatened Species legislation nor its implementation, but to review whether the intent of such legislation is appropriate for Australia's marine environment, especially with regard to the invertebrates. The paper concludes with alternative approaches to the immediate requirements for conserving our marine biota.

In Australia, a major focus for conserving its biota has been Threatened Species legislation. This allows for the listing not only of species but also of populations and communities as either endangered or vulnerable. This type of legislation, details of which vary among the States and Commonwealth, is based upon IUCN criteria (IUCN 1994). Legislative schemes were developed primarily by biologists working on vertebrates or vascular plants where detailed knowledge of population levels over time is reasonably well known. Consequently, the criteria developed are relevant only to these groups. In some States and the Commonwealth, it is possible to list invertebrates and non-vascular plants, but few have been listed because far less is known about their biology and particularly their population dynamics. While the Federal *Environment Protection and Biodiversity Conservation Act (EPBC) 1999* also covers the marine environment, not all States have legislation with this provision. In New South Wales, the *Threatened Species Conservation Act 1995*, complemented by the *Fisheries Management Amendment Act 1997*, does deal with this matter.

For a review of Threatened Species legislation with regard to invertebrates both at the Federal and State level see Ponder *et al.* (2002) and Hutchings and Ponder (1999). A working committee of IUCN has considered whether there are fundamental differences between marine and terrestrial species, i.e. whether the existing criteria are appropriate for assessments of marine species and, if not, how they could be modified to become more appropriate or relevant. The differences identified relate mainly to scale, interconnectedness and dispersal, as well as poor detectability and difficulties with obtaining measurements in the oceans (Mace 1999). A draft of the recommendations and proposed changes to the categories, criteria and guidelines have been produced (IUCN/SSC Criteria Review Working Group, 1999) but to date these have not been accepted.

Once a species, population or community is listed, it triggers the development of a recovery plan, which considers how various actions can be implemented to allow the species, population or community to recover. However, there is a considerable time lag between listing, the development of a plan, and its subsequent implementation. For marine organisms, these lags will probably be far greater than for terrestrial vertebrates and vascular plants because of the difficulty in identifying the threatening processes and how to control them.

The challenge

The marine environment is dominated by invertebrates, which range in size from macro organisms, such as cephalopods, to microscopic animals of the plankton, and they exhibit a tremendous diversity and abundance. While no accurate estimates are available as to the number of species of invertebrates there are in Australian waters, it would number many tens of thousands. Marine species occur in 31 of the 32 currently recognized phyla, with a number of phyla being exclusively or predominately marine. Invertebrates occupy all marine and estuarine environments from the supralittoral to the deepest parts of the ocean. They are represented in all habitats from the surface waters, through the water column and down to the sea floor. Some species swim or float freely in the water

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column, others are permanently attached to the sea floor or live deep within the sediment, and some are parasitic, or form other symbiotic relationships, with vertebrates and other invertebrates. Our knowledge of Australia's marine fauna is limited, with the vertebrates being far better known than the invertebrates. Ponder *et al.* (2002) have recently reviewed the current status of our knowledge of Australia's marine invertebrates and found that it varies considerably among groups and among biogeographical regions and habitats. The least information is available from the tropics and the deep sea.

In order to list a species as endangered or vulnerable, one needs to have precise information on its distribution and abundance, evidence that the population is declining and be able to identify the threatening processes contributing to this decline. Such information is difficult to obtain for marine invertebrates. Many species have not been formally described, population levels often fluctuate dramatically between years and their life cycle may consist of a pelagic larva and a sedentary adult stage. During the pelagic larval stage, which may last days to months, larvae may travel many 1000s of kms, passing in and out of state, Commonwealth and International waters. Levels of successful recruitment may vary naturally by orders of magnitude between years, depending on the vagaries of ocean currents. Some species die immediately after spawning, others breed annually for several years, and others complete their life cycles within a few weeks to months. Some species are hermaphroditic, although not necessarily self fertile, and others change sex during their life. Some species reproduce and their offspring settle adjacent to their parents. In summary, life cycles of marine invertebrates are highly variable even within a group and may even vary within a genus (Schroeder and Hermans 1975, Giangrande 1997). In addition, many invertebrates undergo asexual reproduction (Conn 1993 and refs therein, Brusca and Brusca 1990, Rouse 2000). Different threatening processes may operate during each stage of the life cycle, although others may act throughout, such as declining water quality. All these characteristics of marine invertebrates tend to make the recognition of potentially endangered or vulnerable species difficult, although some have been nominated.

Currently, Tasmania has the largest number of listed invertebrates (including both marine and terrestrial species) (for more details see the Tasmanian threatened fauna handbook at http://www.dpiwe.tas.gov.au/inter.nsf/WebPages/RLIG-5446TS?open), although this has not been without its detractors (Taylor and Bryant 1997). Under this Tasmanian legislation, the Scientific Advisory Committee uses modified IUCN criteria with consideration given to the nature of the threatening processes, and invertebrate determinations tend to emphasise population criteria rather than numbers of individuals (McQuillan 1999).

Under the *Threatened Species Protection Act (1995)* in Tasmania, two marine invertebrates, *Patiriella vivipara* Dartnall and *Marginaster littoralis* Dartnall, are listed as endangered and *Smillasteria tasmaniae* O'Loughlin and O'Hara is listed as rare. All are sedentary asteroids. *Marginaster littoralis* was described in 1970 as restricted to two sites in the Derwent Estuary near Hobart. The population of *M. littoralis* appeared to decline over the next 20 years, and a detailed survey in 1993 failed to find any specimens. Over the same period, there was a gradual rise in the population of the introduced New Zealand cushion star, *Patiriella regularis* (Verrill). If this species has really become extinct, it would represent one of the few documented cases of a marine invertebrate extinction and certainly the listing of the species did not prevent this from occurring. However, there are some uncertainties regarding *M. littoralis*. First, it superficially resembles *P. regularis* and the two species may only be distinguished by detailed studies of the calcareous plate structures. Hence some records may have been misidentifications as both species occur in the same locality. Secondly, the reasons for the decline are unclear. It may hybridise with *P. regularis*, as some specimens were intermediate in colour and morphology although allozyme studies failed to reveal any evidence of hybridisation (Materia 1994). Another contributing factor to the decline of *M. littoralis* may be related to environmental factors. The environment around the type locality has changed considerably and also the Derwent River is one of the most polluted rivers in Australia, although steps are being taken to clean it up. All these factors may have contributed to its decline. A final point is that there is a possibility that the species was introduced as it has only been recorded from close to a major port (O'Hara in O'Hara and Byrne in press), which only highlights the lack of knowledge of our invertebrate fauna.

The endangered species, *Patiriella vivipara*, a cushion star, lives intertidally and is known only from about 10 sites near Hobart. At one of these sites, repairs to a causeway threatened the population so it was decided to relocate it and about 3500 individuals were moved to a nearby site. It was planned to return them once the causeway had been repaired. Subsequently this proved unnecessary as the animals recolonised the repaired causeway. However, widening of the causeway in 2001 required a much larger relocation involving 21,500 seastars. Once these road works are completed in 2003, and algae have colonised the new sandstone rocks, some of these cushion stars will be relocated back to the widened causeway. Obviously such a translocation would not have occurred unless this species had been listed as endangered. However, should we be undertaking such massive relocations without knowledge of the specific food or habitat requirements for this species? In addition, we know little of the genetic diversity among neighbouring populations of this cushion star. Following both translocations there were no monitoring programmes implemented to assess the survival rates of those relocated *P. vivipara* (O'Hara, in O'Hara and Byrne in press).

Once a species is listed, it requires the development of a recovery plan by the relevant authority. However, some of the threatening processes, which have been identified as causing the decline of that species, may be regulated by other agencies. An example here is water quality, especially in coastal waters, which is influenced by terrestrial run off from activities in the catchment (Brodie 1997), the discharge of sewage (Smith 1997, Roberts *et al.* 1998), as well as the removal of wetlands, which tend to trap sediment and help retain much of the excess nutrients (Trott and Alongi 2000). Thus the site of the threatening processes may be many kilometres from the site of the endangered species, and not necessarily be a point source, and yet still generate the impact because of the inter-connectedness of marine habitats through ocean currents and dispersal of pollutants through the water column. If water quality has been identified as a major threatening process, the relevance of a recovery plan will be extremely limited if the agency responsible for the endangered species has no control over water quality. Indeed, a bureaucratic nightmare emerges when several agencies, both local and State government departments, are involved in controlling water quality, either directly or indirectly, such as catchment management, clearance of native vegetation and the discharge of sewage. Recently, the Great Barrier Reef Marine Park Authority (GBRMPA) recognised that quality of the water discharging from the numerous catchments which flow into the Great Barrier Reef lagoon is a major threatening processes impacting on both inshore and offshore reefs. This problem is beginning to be addressed through various Queensland Government agencies (Baker 2003), but GBRMPA has no jurisdiction over the catchments. Recently a Memorandum of Understanding on developing practical actions to improve water quality impacts on the Great Barrier Reef World Heritage Area has been adopted between the Prime Minister and the Premier of Queensland, which should facilitate intergovernmental co-operation.

Another management problem arises when a species has a pelagic larval stage and a sedentary adult stage. Protecting the habitat of the adults will be ineffective when new recruits come from unprotected sites. Benthic populations in Jervis Bay change continually and few species are consistently present (Hutchings and Jacoby 1994). Many species presumably die after spawning and their offspring leave the site (Buchanan *et al.* 1978, Gosselin and Qian 1997, Pawlik 1990). This life history strategy means that protecting an individual site has limited value in protecting that species over time. Studies by Hughes *et al.* (1999) have shown that, while many species of scleractinian corals exhibit annual synchronised spawning over a few days, the pattern of recruitment varies considerably between mass spawners and those coral species which brood. Larvae of spawning species may be capable of settling ~ 3-7 days of spawning whereas brooders have a shorter precompetency period (usually 1-2 days). These differences in length of larval duration resulted in variations in rates of recruitment of spawners of more than 25-fold among the various sectors on the GBR over the two-year study period, compared to a 5-8 fold variation for brooders. Such large-scale variation in recruitment has profound implications for managing coral reefs as well as the genetic homogeneity of populations of a species (Ayre and Hughes 2000, Ayre *et al.* 1997). Hughes *et al.* (1999) proposed that the management of such resources must be based on a sound knowledge of process and mechanisms, rather than being based upon the traditional method of monitoring patterns of adult abundance. A characteristic of all mass-spawning species is that, although many thousands of gametes are produced, mortality of gametes and larvae is extremely high. Only a tiny percentage survive to settlement on highly specific substrates to metamorphose into juveniles and become adults (Harrison and Wallace 1990). Hughes *et al.* (1999) identified that this as a major factor in controlling the structure of coral communities. They also point out that reefs within the Great Barrier Reef that are ‘sources’ or ‘sinks’ for one taxonomic group may show the opposite pattern for another, depending on factors such as stock size, larval duration, planktonic mortality and settlement behaviour (Hughes *et al.* 1999). Another study which examined both fish and coral distribution and diversity on coral reefs and related this to their reproductive strategies and availability of suitable shallow water habitat (Bellwood and Hughes 2001), reinforces the need to shift our focus from protecting individual taxa to broader habitat-based management. These life history characteristics of marine species are difficult to reconcile with the IUCN criteria. Other than promoting ‘flagship species’, the process of nominating species of marine invertebrates as endangered or vulnerable species is not a particularly useful approach. Furthermore, attempts to nominate an endangered population would be even more difficult because of the natural variation in adult population sizes over time as a result of varying levels of recruitment success, as one needs to show that the population is declining over time and assign factors responsible for this. It is often difficult to separate real declines with natural fluctuations over time if your time series only represents a few years.

The need for active management

To the question as to whether it is necessary to manage the marine environment, the answer is a categorically “yes”. Marine and estuarine environments are in dire need of active and intelligent conservation and management. This is the real alternative to listing species or populations as endangered or vulnerable.

While a few examples of habitat degradation are clearly visible to the untrained eye, such as the effects of dredging (Jones and Candy 1981) and reclamation and terrestrial run-off from extensively cleared catchments (Gilbert in press; Moss *et al.* 1992), most are not. It is not possible to see the impact of trawling on our offshore benthic communities (Poiner *et al.* 1998), the loss of seagrass beds through reduced water quality (Kirkman 1997), or the changes in water movement patterns (Larkum 1976). Most attention has been given to coastal waters, but the modification of marine habitats is not restricted to coastal waters.

Recently, a field of about 70 seamounts rising 200 to 500 m from the sea floor has been discovered 50 to 100 km off southern Tasmania in depths of 1000-2000 m. Yet, even as the fauna of these habitats was being collected and identified (Koslow and Gowlett-Holmes 1998), commercial trawling was degrading these habitats (Koslow *et al.* 2001). Subsequently, a marine park was declared over part of this area (the Tasmanian Seamounts Marine Reserve), but fishing has not been completely excluded. Long-line fishing is permitted from the sea surface to depths of 500 m in the Managed Resource Zone, whereas in the Highly Protected Zone, from depths of 500 m to the seafloor, no fishing can occur and also no mining below the seabed is allowed to depths of 100 m. These management zones protect the structure of the seamounts and its associated fauna, much of which is fragile, such as sponges and bryozoans. Allowing long-line fishing to continue may change the food webs by removing fish and mobile invertebrates from the water column above the seamounts (Frid *et al.* 1999). To date, we have little understanding of the relationships between the pelagic fauna of the water column and the sedentary fauna of the seamounts. The suspension feeders on the seamounts probably depend on the organic matter from the water column and the occasional dead animal falling onto the seamount may be critical for scavengers. This emphasises the problem of managing a marine ecosystem where the specific identity, basic biology and interrelationships of most of the organisms is unknown. This highlights the difficulties in assessing if the minimal management strategies that are now in place are adequate.

A global problem with a local impact

Australians, via graphic TV images such as the widespread bleaching events on the Great Barrier Reef during 1998 and more recently in 2002 (http://www.gbrmpa.gov.au/), are becoming aware of the increase in coral bleaching from elevated water temperatures (Hoegh-Guldberg 1999) resulting in death of some coral colonies (Baird and Marshall 2002). These temperature increases are the result of global warming and not part of a natural cycle of fluctuation in seawater temperatures. Reductions in Australia's production of greenhouse gas emissions would be welcome, unilateral action will not be sufficient to reduce water temperatures over our coral reefs. A global strategy is required. The Great Barrier Reef Marine Park Authority is in the process of rezoning the Park and it is intended that the 'no take' zones will be increased to ensure the maintenance of its biodiversity and as an insurance policy against increased use, increasing populations along the coast and the associated water quality problems (Day *et al.* 2002). The increased incidence of coral bleaching vividly illustrates the interconnectedness in the marine environment and that our coastal waters are influenced by actions in international waters. Another example of this is the management of Australia's turtle populations.

Six turtle species are listed under the EPBC Act and the Queensland National Parks and Wildlife Act. We can manage their nesting grounds in Australia, but much of the mortality of turtles occurs in international waters from fishing activities (Johnson *et al.* 1999) over which Australia has no jurisdiction. The only possible solution is international legislation, such as bans on drift nets and changes to ways in which long-line fishing occurs (Williams *et al.* 1996). As a result, turtle populations are declining primarily through activities occurring outside Australian waters, although there is still some mortality of turtles from trawling activities in Australian tropical waters (Chaloupka and Limpus 1997, Poiner and Harris 1994, Poiner *et al.* 1998, Robbins 1995). On the Great Barrier Reef, it has been mandatory since January 2001 for turtle excluder devices to be used on trawl nets within the World Heritage Area in an attempt to reduce the number of turtles caught and subsequently drowned in fishing nets (Brewer *et al.* 1998, Robins and McGilvray 1999). Australian waters host six of the seven species of turtles and these six all nest in our waters so that management of their nesting grounds is very important, but only one factor in the maintenance of the species. While this example focuses on vertebrates there are indications that there may also be invertebrates which move between marine jurisdictions. For example, there are suggestions that some populations of New Zealand rock lobsters may be sustained by larval recruits from Australia (Chiswell *et al.* 2003) and similar patterns may occur on the Torres Strait with crayfish. In these cases the management of populations of a species in one country may impact on their populations in another country.

Habitat management is the key

Apart from a few 'flagship species', listing of individual marine species is neither feasible nor useful. Instead, habitat management is more appropriate for managing and conserving marine biodiversity (Ray 1996, Reed and Clunie 1997, Gray 1997). Even this approach has its difficulties. Marine habitats often lack well-defined boundaries and fauna often moves in an out of a habitat. On an incoming tide, many planktonic and mobile species move over a mud-flat to feed on both the epifaunal and infaunal species (Potter and Hyndes 1999). As the tide recedes, these mobile animals return to deeper water offshore and the wading birds move onto the mudflats to feed on the same infaunal species and epifaunal species which have buried themselves as the tide receded (Hutchings 1996). The boundaries of mangrove forests and salt-marshes change with time and changing sedimentation patterns (Adam 1990) and sea levels (Hutchings 2001). Damming a freshwater flow into a river may allow seawater to penetrate further upstream and with it its associated marine communities. Following the construction of dams on the Hawkesbury River and its associated tributaries, marine communities have extended upstream since European settlement (Recher *et al.* 1993). Storms alter the boundaries of many marine habitats. They often change the distribution of seagrass beds and beach profiles. Witness the massive movement of sand, and presumably associated fauna, along the Gold coast, exacerbated by coastal development and the dynamic coastal environment (Roy 1984, Roy and Boyd 1996). Where such boundaries abut the land, such changing or fluctuating boundaries cause massive problems for the planners (Adam 2003).

While defining the boundaries of the habitat may be difficult, offshore the problem of incorporating a three dimensional component to the habitat considerably exacerbates this problem. Just protecting the physical structure of the Tasmanian seamounts will not be adequate, managing the surrounding water will also be necessary. It is likely that faecal pellets, from the mobile fauna above the seamounts, and the bodies of dead animals are a critical part of the nutrient cycle on the seamounts. Such a scenario occurs in the deep sea where a suite of animals has evolved to live on the occasional whale carcase which sinks to the sea floor (Newton 1999).

A way forward

One view is that all the problems are so great that management of marine habitats is not feasible. It is certainly not this author's view. What is required is an integrated management approach to cope with the fluctuating community composition as well as controlling such factors as water quality. The multi-use Great Barrier Reef Marine Park provides such an example. The Park extends over 2,000 km in length and 345,400 km2 in area and comprises some 2,500 individual reefs separated by distances ranging from a few hundred metres to tens of kilometers. It includes a variety of marine habitats and is adjacent to a number of terrestrial national parks and a rapidly developing urban coastal area. This Park has been declared a World Heritage Area and therefore Australia has a major international obligation to manage and conserve its biodiversity, the shipping lanes that pass through it, as well as the commercial and amateur fishing industry and tourist operations within the Park (Day *et al.* 2002, GBRMPA 1999). Permits tightly control commercial activities. Management within the Marine Park is undertaken by zoning plans, which define the activities in each zone. Habitat management has been the basis of zoning and the first zoning cycle during the 1970s and 1980s was probably the first conscious effort at *in situ* marine habitat management. It was based on the best available understanding and the best achievable level of activity change or control. The Authority thought that the 5% no-take protected was the best achievable in the socio-political climate of the day. It is now seen to be too small and the bioregionalisation has been better mapped and rezoning can address this issue.

However, the effectiveness of management has been questioned, which has related to the adequacy of no-take (low level and all habitats not represented), lack of protection for critical sites – especially spawning areas and enforceability/lack of enforcement. These are generally reasonable criticisms and are being addressed by the rezoning.

On their own, area management plans can only address cross boundary impacts by removing as many *in situ* impacts as possible and protecting sites that are naturally resilient or less impacted because of physical factors, such as prevailing water flow or remoteness from impact. The effectiveness of this on its own is highly questionable if *ex situ* activities are the major pressure. This is a valid concern that has followed from the water quality research. The evidence of widespread degradation of inshore reefs in parts of the Park (Gabric and Bell 1993, Wachenfeld *et al.* 1998, Fabricius and De'ath 2001) has been linked to water quality and increased sediment and fertiliser levels in inshore waters. Moss *et al.* (1992) estimated that 15 million tonnes of sediment, 77 000 tonnes of nitrogen and 11 000 tonnes of phosphorus are discharged annually into the coastal waters of the Great Barrier Reef. While some sediment has always been discharged into the inshore waters following heavy rain, Brodie (1997) has suggested that these rates have increased over four times during the past 40 years due to land clearing. Natural rates vary from 5-50 t km $^{-2}$ year $^{-1}$ although this increases to 480 t km $^{-2}$ year $^{-1}$ to 1090 t km $^{-2}$ year $^{-1}$ after logging and up to 5960 t km $^{-2}$ year $^{-1}$ after clearing (Capelin and Prove 1983). These increases have also been substantiated from analysing the barium/calcium ratios in long-lived *Porites* coral from Havannah Reef on the inner GBR from 1750 to 1998. These ratios provide a long-term record of changes in suspended sediment loads and associated nutrients entering the GBR (McCulloch *et al.* 2003). They have found that in the early part of the record, suspended sediment from river floods reached the inner reef area only occasionally, whereas after about 1870, following the beginning of European settlement, a five-to tenfold increase in the delivery of sediments is recorded with the highest fluxes occurring during the drought breaking floods. These increased rates of erosion are due to clearing and overstocking, which has led to major degradation of the semi-arid catchment of the Burdekin river, one of the major rivers flowing into the GBR. Similar results would probably be found in corals adjacent to the other major rivers in the region.

The Great Barrier Reef Marine Park Act was passed in 1975. Most of the Park was declared between 1979 and 1985 and since then population levels along the Queensland coast have increased. There has been an exponential increase in tourism. Fortunately, there has also been a marked increase in our knowledge and understanding of coral reef ecosystems, which has been recognised by the Marine Park Authority.

GBRMPA is currently undertaking a major rezoning of the Park, so that each major bioregion within the park (over 70 bioregions have been identified representing both reefal and non-reefal areas) will be included within a 'no take' zone. Phase 1 of the Public Participation Phase has occurred with over 12,000 submissions having been received and analysed. Phase 2, which commenced in June 2003, includes a draft zoning plan, incorporating the major thrusts of the public comments from Phase 1. There are many legitimate users of the Park and their concerns need to be addressed while ensuring that each bioregion is adequately represented within a 'no-take' zone. Even allowing for this rezoning based upon the best possible scientific information, it is recognised by the Authority that a zoning plan is only one mechanism needed to conserve its biodiversity.

Boundary matters

The western boundary of the Park is the Queensland coast, with numerous rivers discharging into it. Many catchments have been extensively cleared for agriculture (Neil *et al.* 2002) resulting in large increases in the amounts of sediment and fertilisers deposited in the Great Barrier Reef lagoon and beyond after heavy rain. In addition, coastal wetlands have been cleared for the sugar industry, and they continue to be cleared. Clearing wetlands has effectively removed any natural ability of the system to trap and retain the sediments after heavy rain. Instead, the sediment is now washed onto and then smothers the coastal reefs. The Authority has been working with catchment managers to improve the quality of the water being discharged onto the reef. A draft "Reef Water Quality Protection Plan for catchments adjacent to the World Heritage Area" is currently out for public comment (http://www.thepremier.qld.gov.au/reefwater/). Also, the Authority has been working with Queensland Fisheries to reduce the number of fishing boats and their landings to reduce the now-recognised impact of some fisheries on the benthic communities, as well as the need to ensure that these fisheries are sustainable in the long-term. Whether these measures will be sufficient to conserve the biodiversity of the GBR remains to be seen. It may be undermined by global warming.

The multidisciplinary approach is welcomed and is certainly moving in the right direction. Of course, some workers point out that such changes should have occurred decades ago. It is also proposed that a series of monitoring programs will have been operating for sufficient time to measure the efficacy of these new zoning plans and maintenance of the biodiversity of the reef. It is no trivial task to initiate a monitoring program on such a dynamic system by a management agency with a limited budget. Innovative programs are required and much more attention has to be focused on them.

An ideal world and the real world

Ideally, all of Australia's marine environment should be managed as a multi-use park. Realistically this is not going to happen soon. Australia's Ocean Policy was launched in December 1998. Its aims were to instigate an integrated planning and management strategy to ensure the long-term ecological sustainability of a wide range of ocean uses. To date, only one Regional Marine Plan, in south-east Australia, is being developed, although there are plans for northern Australia. There are still jurisdictional disputes between the States and the Commonwealth to be resolved before much more progress can be made. The original concept - to ensure that representatives of all the major bioregions around Australia were given some protection to provide a network of protected areas - was a good one. Progress has been so slow that it raises doubts as to whether it will ever be achieved. The conservation movement has been critical of the policy for focusing on the development of economic opportunities and lacking a strong conservation vision (Moore 1998). As in the Great Barrier Reef situation, unless damaging terrestrial inputs are reduced, and key threatening processes such as benthic trawling, pollution from oil and chemicals, ocean dumping, introduced species, are controlled, then we shall continue to degrade our marine communities and their associated biota. Much of it is yet to be described, let alone studied, and their complex interactions understood far more fully. In a few cases, the actions to be taken are obvious, as in some coastal habitats, but further offshore degradation of the environment is not visible and therefore it is difficult to create an awareness of these issues in order to encourage the implementation of management practices. Once these offshore habitats are degraded, we have no idea of how to restore them or if removal of the threatening process, such as trawling, allows these habitats to regenerate. But as we know, only a fraction of their biota, it will be difficult to evaluate if such habitats have regenerated or not, even with monitoring programmes!

Lessons from the deep

Marine environments are different to those on land and need different management strategies. A widely-employed land strategy has been to declare a species to be threatened, although this has largely been restricted to vertebrates and vascular plants. However, the majority of the terrestrial fauna comprise invertebrates. Most of it, like its marine counterparts, is not described. It is largely neglected. On land, as well as in the sea, it is communities and habitats which need to be protected and managed. As in the marine world, terrestrial communities and habitats are often impacted by outside events, such as pest infestation, changes to water regimes as a result of land clearing, and air quality, especially adjacent to urban areas. However, it is much easier to see the changes in terrestrial communities, yet this has not prevented us from destroying so many of them. If it is out of sight, it is far more likely to be out of mind as in most marine environments. That is a chilling thought for the fate of our marine communities. The major lesson is that we need to move from species conservation to a workable system of threatened habitat and ecosystem process management for the marine environment. It is feasible, but we have been slow in starting. One of the next steps is to bring the marine environment into our mind and see that its future existence is inextricably part of our existence.

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